Cultural Evolution, Innovation, and the Beginning of Modern Economic Growth

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Some of the following draws on:

- Joel Mokyr, *The Enlightened Economy: and Economic History of Britain, 1700-1850*. New Haven and London: Yale University Press and Penguin Press, 2009.

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What is "modern economic growth"

- Growth was not altogether new in 1800.
- But modern growth was different:
  - It was faster (1.8% per annum as opposed to 0.15-.2%)
  - It was more stable and less reversible.
  - It was Schumpeterian Growth (based primarily on technological innovation) and not Smithian Growth (based on trade and specialization, or better institutions and more efficient allocations).

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The Industrial Revolution and Modern Economic growth

- The period 1760-1815 was one of major technological innovations and marks the origins of modern economic growth.
- Even if growth was slowing during the Industrial Revolution, it was clearly the Overture.
- Many of them, in cotton, steam, iron, chemicals, and engineering represent fairly sharp discontinuities, some solving old problems that had resisted solution for decades or even centuries and transformed entire industries.
- Others had more symbolic or general implications: smallpox inoculation, gaslighting, food canning, hot air and hydrogen ballooning, Portsmouth block-making machinery.

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The debate on the Industrial Revolution runs something like this:

- Technological discontinuities (macroinventions) occurred in many eras before (though they were rare).
- But only one “cluster” turned into the Industrial Revolution.
- All others eventually asymptoted off to a new set of dominant designs and growth ended there. This one exponented into the sky.
- This is the historical equivalence of a phase transition in physics, or a period of adaptive radiation in biological evolution.


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The hard question is why?

- If we cannot answer the question this sea change occurred, it would be equivalent to paleontologists being unable to say anything about the evolution of *h. sapiens.*

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The argument suggested in Mokyr, 2002

- In the eighteenth century, the epistemic base of techniques in use was expanding due to the "industrial Enlightenment" (essentially the conscious expansion and dissemination of "useful knowledge").

- In some cases that occurred before the invention was made, so that science "caused" technology in the standard linear version. More usually, propositional knowledge increased to explain why an existing technique actually worked and then fed back to make it better and so on.

- Once it is known more about the "why" and the "how," it is easier to improve and tweak a technique, which is why the process of technological progress does not fizzle out. But this does not operate in a linear fashion and varies from technique to technique.

Others have suggested alternative explanations

- The importance of resources (especially coal).
- High wages stimulated L-saving innovation
- The importance of institutions (property rights)
- Empire and International trade
- Pure historical contingency (luck)

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What was left out almost altogether was "culture"

- Definition of culture:

  A set of preferences, attitudes, values, and beliefs shared by groups of people, that condition human behavior, but are not transmitted genetically (or epigenetically).

  In recent years, economists have increasing paid attention to cultural factors, not just Landes (1998, 2006) or Eric Jones (2006) but also Tabellini (2008), Guiso-Sapienza-Zingales (2006), Doepke-Zilibotti (2008) and others.

  [Note: it makes no sense to define, as in Guiso et al., "cultural" as those "attributes that remain **largely invariant** over an individual's lifetime, such as religion or ethnicity". The very idea of cultural change is that it is "Lamarckian," that is, individuals can choose].

How does "culture" matter to economic growth?

- Useful knowledge itself (and therefore technology) is part of culture.

- Attitudes and preferences determine the rate at which useful knowledge is accumulated and what kind of knowledge society emphasizes and rewards.

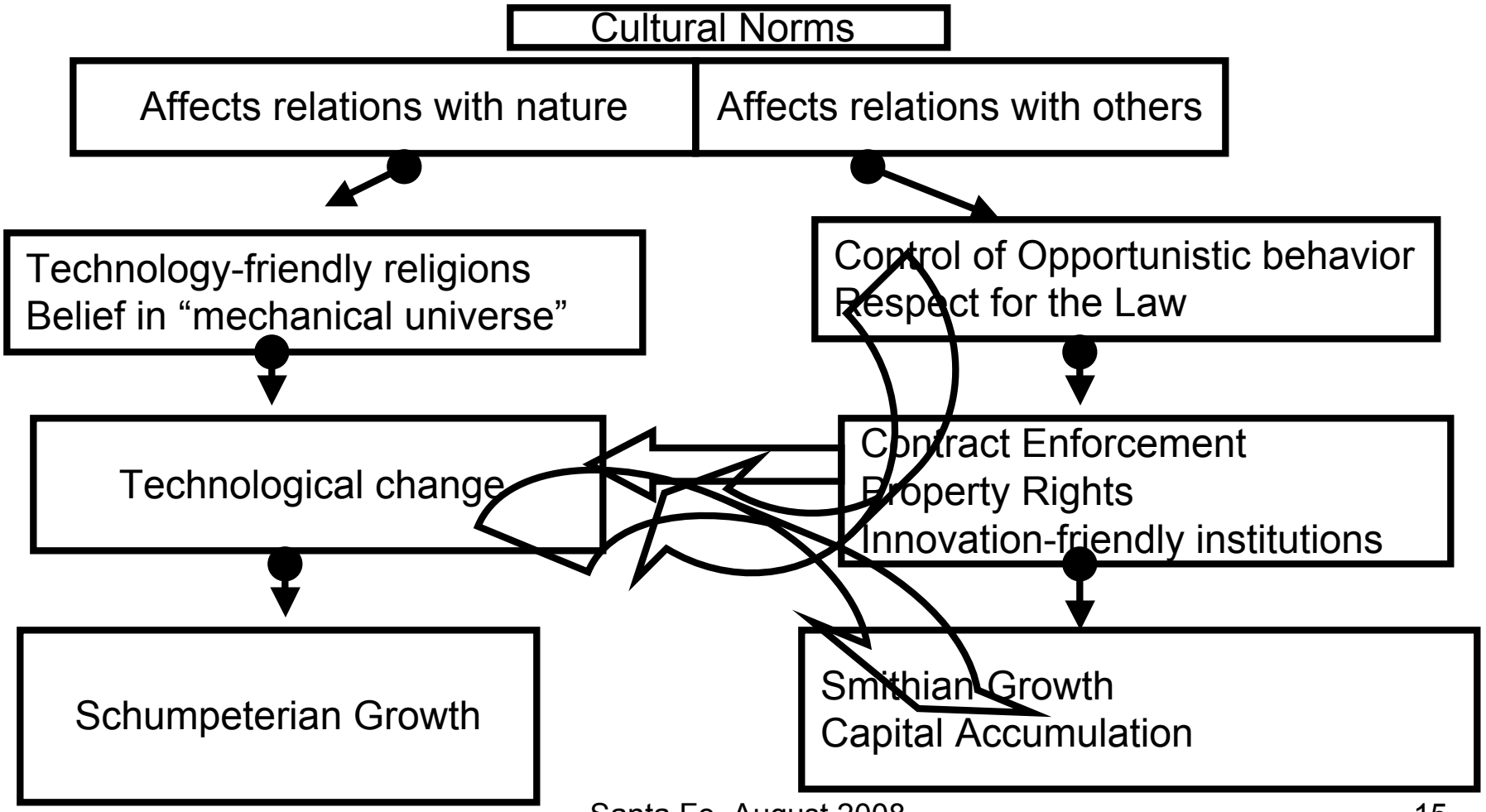
- Culture is the foundation of *institutions* (the formal and informal rules by which society plays the economic game) that determine the incentives to engage (or not) in innovative behavior and if so, what agenda will be set.

What is needed:

Models that connects culture to technological progress, so we can associate different cultures (or cultural features) with different rates of success in innovation.

- Most models that explain economic growth using culture focus on the emergence of trade through cultural beliefs. Some cultural beliefs support private-order institutions that make trade possible by preventing opportunistic behavior and allowing contract enforcement (Greif).

- But does that help us explain the Industrial Revolution? It seems more appropriate to explain Smithian Growth.


Cultural Norms
Affects relations with nature
Affects relations with others
Technology-friendly religions
Belief in "mechanical universe"
Control of Opportunistic behavior
Respect for the Law
Technological change
Contract Enforcement
Property Rights
Innovation-friendly institutions
Schumpeterian Growth
Smithian Growth
Capital Accumulation

So what I plan to do here:

1. Suggest how culture affected economic growth, with special attention to the Industrial Revolution and the century preceding it.

2. Suggest how we may want to think about explaining the changes in cultural norms evolved in seventeenth and eighteenth century Britain Western Europe, and how they affected the Industrial Revolution.

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Was there a direct connection between "culture" and technological progress?

- Lynn White's argument that Judeo-Christian anthropocentric beliefs made people more willing to manipulate and control natural forces they did not quite understand. Taproot of medieval technological progress?

- The reformation encouraged people to read on their own and thus increased literacy (not obvious what effect that had).

- Sixteenth Century beliefs that knowledge is supposed to be *useful*, culminating in the writings of Francis Bacon (Mokyr, 2005, 2008), shaped the research agenda after 1650.

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Furthermore…

- Were there "European" cultural traits (not religious) that may have mattered?

- Two may be identified:

  1. **Lack of Cultural Arrogance**

  2. **Lower respect toward the knowledge of previous generations and a lower degree of neophobia.**

The differences in these matters between Europe and non-western societies are of degree, not absolutes.

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Lack of Cultural Arrogance

Europeans were unusual in their willingness to adopt techniques used elsewhere. Relative absence of a "not invented here" attitude.

Medieval examples (predate the Great Discoveries):

- adoption of windmill
- paper
- compass
- Arabic numbers and math from Moslems
- Agricultural crops from the middle east
- medicine from Avicenna and Rhazes

[other "knowledge matters" such as Averroes' Aristotelianism]

They did so without much shame or embarrassment.

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One piece of evidence is the names used for imported products and techniques indicating their foreign origins

- "Arabic" numbers
- Calicots
- Damasks
- Muslins
- Japanning
- Chinaware
- Lateen sails
- Turkeys

Or the retention of Arabic terms such as algebra and alcohol.

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During the geographical expansion, 1500-1700

Europeans consciously imported foreign technologies and products, among them potatoes, tomatoes, silk, tobacco, tea, cocoa, coffee, maize, cinchona bark.

Eventually they imitated some of those, such as fine cotton yarns and high quality pottery.

The point is that their attitudes and beliefs are different from the Chinese and Romans (for example) who professed not to learn anything from "Barbarians." McCartney trip to China in 1792.

Typical of the Europeans' approach was the great Leibniz, who implored a Jesuit travelling to China “not to worry so much about getting things European to the Chinese, but rather about getting remarkable Chinese inventions to us; otherwise little profit will be derived from the China mission”

Or the introduction of smallpox inoculation by Lady Montague, wife of British ambassador in Constantinople into Britain in the 1720s who observed the custom in Turkey.

Most non-European societies were not nearly as good at learning from Europeans than vice versa (exception: Japan after 1868).

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Another cultural trait:

How much do we hold the knowledge of previous generations to be sacrosanct?

Was “it all” in Aristotle and Avicenna? Is learning mostly exegesis?

A dictum from the Jewish *Chazal* (earlier sages) has it that *"if those who were before us were like angels, we are but men; and if those who were before us were like men, we are but asses*.“

Concepts of “heresy” (in Christianity) and *bidaa* in Islam.

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Resistance of incumbents to new knowledge

- Many strict cultural systems insisted on the sanctity of ancient authorities and that wisdom consisted not of innovation but of repetition, interpretation, and exegesis of "a canon."

- This was true to varying extents for Confucianism, Islam, and Judaism, as well as Christianity --- but for *none of them* was it time-invariant. Also *some* innovation was always possible under the aegis of "interpretation."

[More generally, innovation may be resisted not just out of respect for traditional knowledge but also from suspicion of the "new" or high risk-aversion (e.g. European resistance to GM organisms) or the protection of vested interests]

Cultural change in Europe before the Industrial Revolution

Such respect for the canon started to decline in Europe in the late middle ages, while in other cultural systems the reverse seems to have happened.

It led to the Reformation as well as to a growing skepticism of "ancient authorities."

Slowly respect for "the canon" was eroded, as various doctrines are overturned, Copernican revolution being the most famous. Many others "heretics" (e.g., Paracelsus, Vesalius, Petrus Ramus, Bacon).

It is this "culture" that leads to the Enlightenment

- Notion of "in nullius verba" --- evidence trumps authority
- A growing belief that "useful knowledge" can be and should be accumulated and diffused so as to bring about, as Bacon said, "relief to Man's estate" (i.e., improvements in living standards.
- This corresponds to a modern notion of scientific research leading to technological change.

- What about the Industrial Revolution?

- After all, these cultural features were in place in much of Europe by 1650, and yet the Industrial Revolution occurred in Britain only a century later and in the rest of the Continent over the nineteenth century (and some places were skipped altogether).
- Many of the problems were hard and took a long time to solve, even the ones that did not require scientific breakthroughs.

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Culture has a lot of persistence, but can change, at times, quite dramatically

- For instance, through the outcome of chaotic political processes (e.g., the French Revolution, Russian Revolution).

- Or the appearance of a uniquely influential individual, who can rapidly affect the beliefs and preferences of large groups (Mohammed, Marx).

- The apparent historical problem is: no discontinuity of the sort can be observed in Britain in the eighteenth century that could have led to the Industrial Revolution: no revolution, no charismatic dictator, no major religious change, was not occupied by another nation.

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And yet, there were three major cultural changes in Western Europe and Britain that are relevant.

1. Growing belief in the improvability of society through useful knowledge (Baconian Program)

2. Growing belief in the need to change institutions and political structures in ways that furthered economic growth and reduced rent-seeking and exclusionary arrangements.

3. The growth of "social capital" or the Habermasian "public sphere."

Two recent developments in the literature

- Recent literature has linked the Industrial Revolution with evolutionary change in culture (Galor and Moav, 2002; Gregory Clark, 2007).
- Their idea of the Industrial Revolution is that in the seventeenth and eighteenth centuries evolutionary pressures favored the *middle classes* and that these classes expanded and flooded the economy with innovation and entrepreneurial energy.

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These middle classes, by this account:

- Believed in child-quality and thus invested in more human capital.
- Also invested in the *right* kind of human capital (Doepke and Zilibotti).
- Built up their children's "patience capital".
- Built up a propensity to work harder and thus have more access to market-produced goods (De Vries, 2008)
- Were willing (and able) to take more risks and thus became more "entrepreneurial."
- Consumed skill-intensive high-quality consumer goods (Berg, 2006).

- This Darwinian process is supposed to have led to human capital formation and more entrepreneur-ship and thus helped the Industrial Revolution.

- Alternative approach: deeper changes in culture changed the way society did business and generate and processed information, creating a more networked society and a more effective public sphere (Habermas).

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One of the more striking phenomena of the eighteenth century:

- The Rise of *Associational Society* (Peter Clark, 2000, many others).
- Large number of social clubs emerged over the eighteenth century in Britain. These clubs represent a spectacular growth in what some call “social capital.”
- Largely confined to Upper or (later) Middle Class males.

Source: Peter Clark, 2000, p. 132

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“Society of Dilettanti” 1777-79

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What kind of clubs were these?

- Most of them were social clubs, drinking and eating places ("Sublime Beefsteak Clubs")
- Others were literary *salons* devoted to the arts and poetry, or book clubs, library societies.
- Many of them philanthropic societies, charities to support the poor and sick (e.g. Dispensaries).
- Idealist societies supporting social reform (e.g., abolition).
- Masonic Lodges (and knock-off movements such as "The Noble Order of the Bucks")
- Prosecution societies (since there are no formal state prosecutors).
- Professional organizations (Smeatonian Society, physicians, architects, attorneys)
- Sporting clubs, musical organizations etc.

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A major effect of the growth of associational society:

Better mechanisms to disseminate private information on individuals (a.k.a. as “gossip.”). Enforces reputational mechanisms.

For such reputational mechanisms to work, a good informational exchange is necessary so that potential defectors know there is a high probability that they will be punished by everyone relevant.

Why was this important? Eighteenth century British middle class society developed much tighter ideas of respectability and “gentleman-capitalists”, people who could be trusted and believed, who paid their debts, recognized their civic duty to contribute to private-order public projects and charities, and did not engage in greedy and opportunistic behavior.

This was critical because what emerged was a self-enforcing equilibrium in which people did not play Nash strategies and hence did not require strict third-party contract enforcement

It also created mechanisms that prevented local people from free-riding on improvement projects and this helped create a “civil society” in the supply of public goods.

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The Associational Society became an Economic Civil Society

- By having one's social reputation linked to business behavior, economic agents faced strong incentives to behave cooperatively and make a relatively smooth functioning of an exchange economy possible even in the absence (or at least high cost) of formal legal action.
- Linking market relations with non-exchange social interactions, in which individuals knew that opportunistic and non-gentleman-like actions would have severe social consequences, underpinned the market economy (Spagnolo, 1999).

Typically, the growth of a culture of trust leads to *Smithian* Growth (Greif).

- Allows exchange at arms length (long-distance and colonial trade) between strangers
- Facilitates credit transactions (country banks, mortgages etc.)
- Attenuates P-A problems in labor markets
- **But does it also lead to industrialization and technological progress?**

The answer is yes. Four mechanisms:

1. Created bilateral trust between people who knew others would likely to behave like “gentlemen.” This created informal markets for venture credit.
2. Created an environment in which people could not free-ride and thus created collective goods without government. Infrastructure was important for technological progress
3. It furthered the creation of high-quality human capital.
4. It helped to lay the foundations of open science that eventually became a central component of modern growth.

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1. New Technology relied on successful partnerships between engineers and businessmen

- Most famous, of course, Boulton and Watt
- But many other successful teams like it: Marshall and Murray; Roberts and Sharpe; Hargreaves and Peel; Cook and Wheatstone.
- Tight relations between local ("country") bankers and entrepreneurs who knew one another, essential to credit.

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Trust furthered technological progress through risk management

- Having trusting relations with people in your community means one can diversify portfolios without learning a great deal about assets whose returns are uncorrelated.

- The entrepreneur-gentleman networked with people who trusted him on the basis of these social norms and by investing in their business lines (often as sleeping partners), diversified their investment portfolios (Pearson and Richardson, 2001).

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Many examples:

- *Abraham Darby III* invested not only in turnpike trusts but also in the great hotel built to face his great iron bridge in Coalbrookdale.

- The great ironmonger *John Wilkinson*, invested widely outside his field of expertise such as banks, agricultural improvements, mines, and the many canals promoted by his friend and fellow ironmaster, Richard Crawshay.

- *Charles Tennant*, owner of the St. Rollox chemical works near Glasgow, invested heavily in the Glasgow water supply and later railroad development.

2. Voluntary organizations often were a substitute for the state and provided goods that were later provided by the state.

- They did not have the formal power of coercion.
- But with strong local reputation effects they did not have to.
- This meant that a weak central state could co-exist with the provision of a high level of public goods that were complementary to private capital formation.
- Such public goods were necessary if rapid urbanization was to take place, transportation were to improve, and society was to remain stable.

Among the things that were provided for voluntarily in eighteenth century Britain:

- Prosecution and most justice administration
- Canals, Turnpikes, bridges, lighthouses
- Urban projects and public health
- Hospitals, dispensaries, and care for the elderly.
- Philanthropy and Friendly Societies (poor relief).

3. Private-order Institutions and Human Capital

Britain seems to have had a comparative advantage in applying and improving inventions of others.

This advantage came from a relatively large supply of skilled artisans who had a high level of *competence*, that is, the ability to carry out the ideas and blueprints that inventors created.

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Main evidence:

Revealed comparative advantage: Britain is a (net) exporter of artisans and skilled mechanics, and a (net) importer of inventions and ideas.

Foreigners noted this more than Britons (who took it for granted).

Two examples (of many)

"English workmen are everywhere renowned, and justly. They work to perfection, and though not inventive, are capable of improving and of finishing most admirably what the French and Germans have invented"

César De Saussure, letter dated 1727

"The enormous wealth of Britain is less owing to her own advances in scientific acquirements, high as she ranks in that department, as to the wonderful practical skills of her adventurers in the useful application of knowledge and the superiority of her workmen"

Jean-Baptiste Say, 1803

Artisans and the Industrial Revolution

- A high level of competence alone is not enough: good artisans by themselves will not create an Industrial Revolution (as believed e.g., by Berg, 2007).

- But the existence of a highly skilled labor force is strongly complementary with a high level of innovation.

- This is not a statement about the *mean* quality of the labor force but about a high density in the *upper tail of the skill distribution*.

Skills: transmitted almost exclusively through personal contractual relationships (apprenticeships).

- Ideal for this age, because so much knowledge was still tacit (or at least not yet codified) and had a rather narrow epistemic base.

- Guilds played a fairly modest role in enforcing apprenticeship regulations in Britain, so this was mostly human capital transmission through *self-enforcing, private-order apprenticeship contracts.*

- This provided Britain with an important advantage vis à vis the Continent: when guilds were more powerful, they tended to be technologically conservative and thus impeded technological progress. If they were weak, skill formation and transmission might be impeded. Britain has "the best of all possible worlds."

Apprenticeship contracts.

These contracts were highly incomplete and thus rife with possibilities for opportunistic behavior.

Some of them did end up in court, with complaints about apprentices absconding or being "terminated" (Wallis, 2006).

But here the atypical may dominate: the vast bulk of people completed their term and the apprenticeship contract was self-enforcing without having to resort to courts (Humphries, 2003). It was enforced like most market transactions through networks in which reputation mattered: relatives, neighbors, business associates, colleagues, and co-religionists.

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Some additional enforcement came from the law:

Statute of Apprentices stipulated that one cannot exercise a craft without having completed an apprenticeship. By the eighteenth century, however, this law is very weakly enforced.

[In 1777 the calico printers admitted that fewer than 10 percent of their workers had served because "the trade does not require that the men they employ should be brought up to it; common labourers are sufficient"]

Anyway, the Statute was abolished in 1814. Yet the institution of apprenticeship survived throughout the nineteenth century and shows remarkable adaptability.

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4. Finally, was there a culture that furthered useful knowledge (incl. science)?

- Growing awareness that useful knowledge could improve material conditions ("Baconian Program").
- Rise of "a scientific culture" and especially the emergence of "public science" (diffusion of science).
- Creation of a transnational community devoted to this goal ("Republic of Letters").
- The emergence of "open science" as the dominant culture of useful knowledge creation.

Open Science and Useful knowledge

- The idea of open science ("open-source science") is fully developed in seventeenth century.
- The basic idea is "credit, no profit."
- Essentially this is a signaling game, in which the person tries to broadcast a signal about his ability.
- It is then assumed that this signal is correlated with some desirable outcome for the originator.
- But there is no exclusion from the new knowledge.

What about IPR's?

- It is often thought that the establishment of intellectual property rights that excluded others from new inventions provided a critical incentive to generate the inventions of the Industrial Revolution.

- In fact, however, the famous patentees such as Lombe, Watt, and Tennant may have been more the exception than the rule.

At a more general level

- Despite the prevalence of patents, a large number of inventors chose not to take out patents and shared their knowledge.

- Most of the people who generated useful knowledge during the British Industrial Revolution did not do so primarily to make money. Many of them were part of an "open science culture."
- This does not mean that they were indifferent to money but rather that the game they were in was a signalling (reputation) game in which individuals tried to demonstrate to their peers their intellectual and technical capabilities.
- Useful knowledge that was not immediately patentable (and some that was) was placed in the public realm. New scientific knowledge was expected to be published and made available to all, but this model was equally adopted by engineers (Smeaton, Rennie) and scientists who made inventions (such as Franklin, Berthollet, Davy, and Faraday)

Cooperative invention

- Extreme case: collective invention: the main actors in technological innovation freely sharing information with competitors and claiming no ownership to it.

- There are three reasonably well-documented cases of successful collective invention:
  - the case documented by Allen (1983) of the Cleveland (UK) iron industry between 1850 and 1875;
  - the case documented by MacLeod (1988, pp. 112-113, 188) of the English clock- and instrument makers;
  - and the case documented by Nuvolari (2004) of the Cornish steam-engine makers after 1800.

A culture of gentility

- Moreover, the culture of gentility was needed to generate the kind of trust that was essential for useful knowledge to grow (Shapin, 1994).

- The idea was similar to commerce and credit : science generated by gentlemen could be believed because they had signalled that they were trustworthy.

In short,

- A culture of gentility and respectability meant that British individualism was accompanied by a set of social norms that helped create the economic environment in which technological creativity could thrive.

- The Associational Society made sure that reputational mechanisms helped enforced gentlemanly cultural norms.

- For more details, see Mokyr, 2008.

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So whence this British Culture?

- Here the concepts of cultural evolution may (or may not) be helpful.
- These were overlooked by recent evolutionary theories of the Industrial Revolution. Their idea (Clark, 2007; Galor and Moav, 2002) is basically that there are different groups in society with fixed inheritable cultural characteristics, and that these have different degrees of fitness, and get "selected" so they end up changing overall culture through natural selection effects.
- These models assumed that there were "good people" and "bad people," and that good people reproduced faster and thus multiplied and filled the earth.
- The assumption they make is that traits are fully inheritable, implying either that they are wholly genetic or that children learn exclusively from their parents.

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Culture is subject to evolutionary processes.

- The main point is that individuals at some junctures in their life cycle choose between competing forms of culture, including useful knowledge and economically relevant patterns of behavior.
- Hence there is a selection mechanism going on, and some components of culture are going to selected over others.
- What matters is thus:
  - factors that change what is on the “menu” and
  - factors that affect how and why people make the choices.
- Unlike “pure” Darwinist processes, these can be quite rapid because the process is not constrained by the length of a generation.

- At each point of time, culture is what it was in the previous period plus some “bias” or change.

- Cultural transmission means that information from a cultural genotype is copied and that leads to phenotypical effects (in actions and behavior).

- But the identity of the model that is being copied makes a big difference. Is it vertical (from parents) or “biased”?

- This bias can be “drift” or so small that it makes no difference. Or it can “explode” and account for cultural revolutions.

People affect their culture, since they can change their beliefs and preferences.

- This is much different from (and richer than) standard evolutionary models (Boyd & Richerson; Cavalli-Sforza and Feldman)
- It is however sufficiently indeterminate so that it is not very useful as a predictive tool, perhaps better at explaining the past.
- Which is why it should be of special interest to economic historians.

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Boyd and Richerson's (1985, 2005) "biases":

- **Content-based bias:** People pick cultural variants because of their inherent qualities
- **Model-based bias:** we imitate the beliefs of people who are "role models" or appear worth imitating, because these traits are correlated with others that are desirable (e.g. material success).
- **Direct bias:** through persuasion, in which some successful individuals persuade others of the correctness of their views, often through disciples or epigones (Jean Calvin, John Knox, Guido de Bres; or Adam Smith and Dugald Stewart)
- **Frequency dependence:** If many others (mostly peers) believe something, it must be true.
- **Coercion**: "accept my views" [or at least the actions implied by them] "or else" (Lenin, Khomeini). Can control transmission mechanism (schools, churches, press).
- **Salient events** can have a discontinuous effect: catastrophes such as the Black Death or 9/11 can change ideology.

But surely there is more to it than purely Darwinian dynamics (i.e., pure selection effects):

- Although it is not genetic, culture follows an evolutionary dynamic (Boyd and Richerson, misc. publications).
- It deals with the distribution of certain characteristics in a population which is subject to selective pressures.
- What is critical, however, is that it has a different system of transmission of traits and cultural beliefs. It works through imitation, learning and choices.
- Not clear whether thinking of this as “selfish memes” (Richard Dawkins, Susan Blackmore) adds much to the discussion, but that by itself does not reduce the usefulness of an evolutionary perspective.

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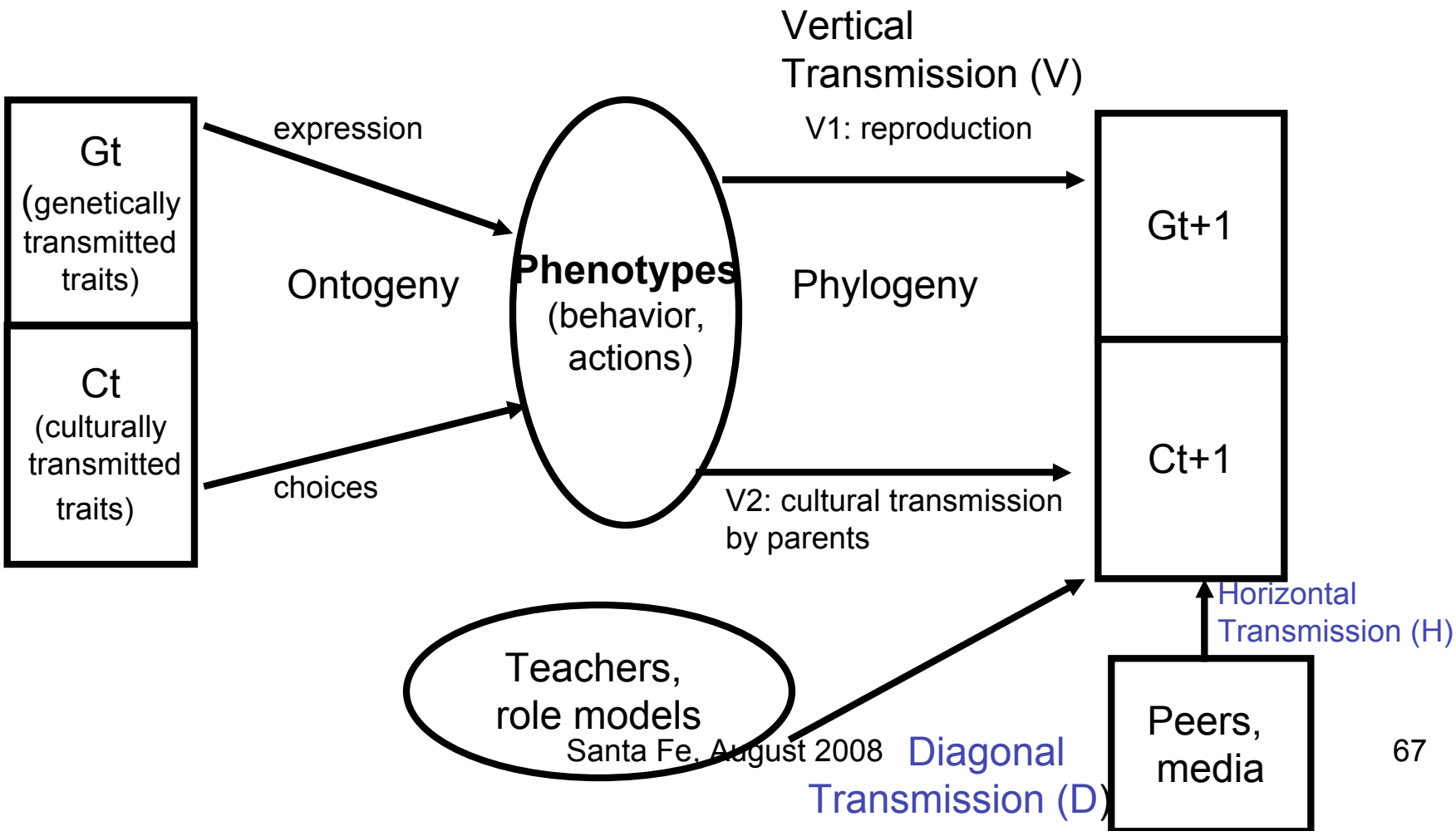
To see how this model works (based on Boyd and Richerson)



Two things mattered after 1650

- The actual changing content of “culture” (new and more enlightened ideas appear on the “menu” of choices). Not clear why that happened.

- More inputs from non-parents means: differences in the relative rates of transmission, especially changes in D/V and H/V.

Enlightenment culture

- These are not nation-wide cultures, but the cultures of relatively small elites or middle classes (did not involve laboring class all that much until later).

- These are cultural changes that are transnational but not global. The *selection* mechanisms differ from country to country, but the *menus* are very similar across western Europe and change in similar ways.

- But it involves a set of beliefs and attitudes that is highly conducive to economic growth (Mokyr, 2009).

Imitation was an important element:

- Precisely because Enlightenment values were associated with an economically successful elite, they were adopted by those who tried to emulate them.

- In that sense, Britain had the best of the all possible world:
  - It had a stratified society in which a class hierarchy was all-pervasive and quite well-defined.
  - Yet it had enough social mobility to incentivize people to adopt the culture of those one step ahead of them in the ordering.

One growing form of cultural input: storage devices

In that regard, the invention of the Printing Press is critical.

Perhaps not surprising, the Reformation depended on the printed book (Eisenstein).

In the eighteenth century, the output of published books per capita in the British Isles increased by about 67 percent. The output of newspapers, magazines, periodicals and so on grew even faster.

- However, personal contact was probably still more powerful than the transmission of codified ideas and knowledge.

- Part of culture is the preference to belong to organizations (formal or informal) of one's "peers" [however defined], which can have far-reaching economic effects.

- This takes us back to the Associational Society. Some social organizations were explicitly dedicated to the diffusion of useful knowledge.

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A few were explicitly trying to advance science and technology in the service of industry

- Society of Arts, founded in 1754
- Lunar Society of Birmingham
- Manchester Literary and Philosophical
- Chapter Coffee House in London
- Andersonian Institution in Glasgow.
- Many provincial scientific societies, including surprising places such as Northampton, Leeds, Bath.
- Mechanics Institutes.

[These were a minority taste, and their direct impact on the Industrial Revolution probably fairly limited. But they set an example]

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Meeting of the Society of Arts, 1809

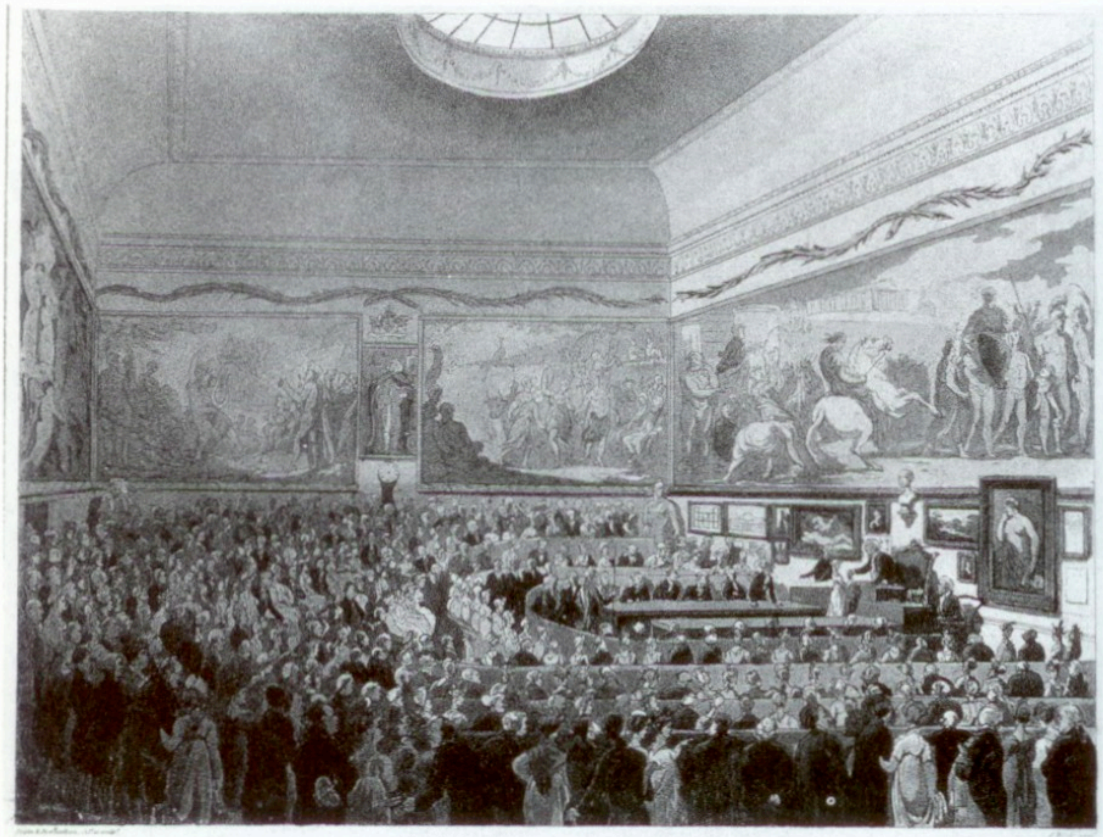

Plate 11. *Meeting of the Society of Arts at the Adelphi*, by A. Pugin, *c.*1809; Sir John Barry's paintings on the walls

In terms of the Boyd-Richerson model

- This greatly increased the flow of H; people increasingly communicated with peers and could be influenced and persuaded. So there were more “inputs” in the formation of ideology and beliefs. Decline in “access costs” (Mokyr, 2005)

- In other words, the direct vertical transmission mechanisms had to make room for more diffuse social inputs. This implies that the potential impact of fashionable ideas or influential individuals on one’s beliefs.

- Many of these influential individuals in the eighteenth century were associated with the Enlightenment (e.g., Adam Smith, Diderot).

In other words:

- Biased transmission worked precisely because the upper middle class (merchants, professionals) wants to imitate gentlemen, the lower middle class (skilled artisans, shopkeepers, yeomen) wants to imitate the upper middle class, and so on.

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Historical effects of cultural evolution

- Even if cultural selection can be maladaptive, at times some societies "got it right", that is, they choose a culture that maximizes fitness and improves human welfare.

- Eighteenth century Europe, for a while, got it right. Most of them picked a set of beliefs that were highly advantageous (from a purely economic point of view), namely the belief that useful knowledge could generate economic benefits.

- A widely-cited example is the Reformation and the "Calvinist Ethic" --- but there are serious doubts.

- Better example: the Enlightenment of the eighteenth century (see Mokyr, 2005, 2006, 2008).

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How does cultural evolution inform historical analysis?

- **Insights that are gained:**
  - Technology may be maladaptive just as any form of culture is maladaptive in the sense that cultural evolution can lead to lower fitness (Boyd and Richerson, 2005, chapter 5).
  - The dynamic of technological progress can be hugely variable, with periods of rapid change punctuated by long periods of slow change or stasis.
  - Selectionist models stress that what matters to history is that very rare events can get amplified and ultimately determine an outcome. The challenge to historians then becomes to try to understand which rare events take on that function, and under what circumstances they get "selected" (Ziman, 2000).
  - It shows the importance of contingency in economic history (unlike recent economic models), in part because of multiple equilibria.
  - By allowing for group selection under certain conditions, it shows how selfish motives may lead to negative social consequences.

Further issues:

Can “cultural changes” be large enough to qualify as “discontinuities” or even “hopeful monstrosities” in the saltational traditions of Goldsmith?

The point is that fairly small changes in genotype (underlying knowledge) can lead to cascading phenotypic effects. Most pathbreaking inventions were primarily re-arrangements and recombinations of existing knowledge.

Boyd and Richerson (2005, p. 52) dismiss this possibility

- Basically they see the history of innovation as piecemeal by the cumulative improvement of technology at the hands of many innovators. Even Harrison's amazing marine chronometer No. 4 would never have been conceived without "a history of hundreds or thousands of mostly anonymous inventors."

- This is hardly an argument against "hopeful monstrosities" in technology. Even a Goldsmithian monster consist of the building blocks of previous organism and share 99.5% of its DNA with them.

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As far as knowledge (technological and scientific) are concerned, there were significant discontinuities."

- Considerable number of "breakthrough" insights in which new knowledge makes a "leap." This is true for science as well as well as for technology.

- Such macroinventions during the Enlightenment were crucial, the entire Enlightenment is sandwiched in between Newton's *Principia* and Lavoisier's *Manuel*.

- Needless to say, *adoption* is more gradual. And every macroinvention needs to be subsequently debugged and tweaked till it actually works properly.

Conclusions

1. Modern Economic growth has strong cultural roots, without which economists may not be able to explain the events.
2. We need more powerful models of how culture evolves and how such evolutionary processes can be observed in actual historical data.
3. These models must account for innovation (what is placed on the menu), selection (is it successful), and consequences.


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