

Rationally Speaking #184: Gregory Clark on "What caused the industrial revolution?"

Julia Galef: Welcome to Rationally Speaking, the podcast where we explore the borderlands between reason and nonsense. I'm your host, Julia Galef. It's my pleasure to introduce today's guest, Professor Gregory Clark.

Gregory is an economic historian at the University of California-Davis and the author of the excellent book, "A Farewell to Alms: A Brief Economic History of the World" -- along with other books, but I think he's most known, at least among my circles, for "A Farewell to Alms."

I reached out to Gregory because I've recently become obsessed with this mystery of why the industrial revolution occurred in the time and place that it did, namely, England in the late 18th century. I'm not alone in this obsession. This question is one of the big holy grails of economic history, in large part because the industrial revolution was just so uniquely transformative.

For all of the major events that a lot of historians' ink has been spilled over, like the fall of Roman empire, the Black Death, et cetera, none of them really had much impact on these big long run trends in metrics of human well-being like health and wealth... except for the industrial revolution. It's the only sort of major and lasting change to what it's like to be a human on earth.

Greg is one of the leading scholars on this topic, and has also written some very nice overviews of the different theories that have been proposed, and their strengths and weaknesses. That's what we're going to talk about today, and that's why I'm excited to have Greg on the show.

Greg, welcome to Rationally Speaking.

Gregory Clark: Thank you very much. It's great to be here.

Julia Galef: I guess my first question for you would just be, what do you think of my bold introductory claim that basically nothing else in history had any major and lasting impact on human well-being other than the industrial revolution?

Gregory Clark: I think that's actually precisely correct.

Julia Galef: Yes...

Gregory Clark: I mean, once when I was giving a talk, a scholar of 13th century Italy asked me, he said, "So basically, are you saying that everything I do really has no impact on anything?" I had to think about it for a little bit and then said, "The answer I think is yes." All of the world is essentially the same until the industrial revolution arises, and then all of the world is forever changed.

Julia Galef: Yeah.

Gregory Clark: The only outstanding problem in the history of the world really is why did this event occur, why was it delayed so long, why did it occur on a tiny island of coastal Europe, and why did it occur in a relatively remote section of that tiny island? That's a question, I'd say, that has bedeviled and kind of also spurred on economic history ever since the industrial revolution.

Julia Galef: That's right. It's not just a question that demands an answer in the sense that if it happened anywhere we would want to know why it happened there, but there's these additional factors that make that particular -- at least that particular place, I don't know about the particular time -- surprising. In the sense that England was, I don't know, 1/50th the size of China and India at that time, roughly speaking, and relatively remote geographically.

I guess one piece of the causal puzzle that might be good to start with is what role the scientific revolution played in the industrial revolution?

Because there's this relatively straightforward story that I have always believed, since I can remember thinking about this topic -- which is that we had the Enlightenment, the scientific revolution, and all these advancements like Newtonian physics, and new scientific instruments being developed, like the microscope. Those scientific discoveries in turn made possible all of the practical technologies that fueled the industrial revolution.

How much truth is there to that story?

Gregory Clark: Well, unfortunately, it's actually quite difficult to link the industrial revolution in any direct way to the scientific revolution. I mean, the first problem you're going to run into is the scientific revolution was well underway by the mid-17th century, more than 100 years before the industrial revolution. In history, time gets compressed. That's the equivalent of three and a half generations. Yet, initially, as far as we can tell, it had really very little impact on that breakthrough towards relatively rapid technological advance.

For example, the Netherlands, the richest country in Europe in the 17th century, was at the forefront of the scientific revolution. The Netherlands never experienced that transformative growth. Instead it kind of gently stagnated into the 18th century, and actually began to become more agricultural as we moved into the 18th century.

So there's a timing problem to start with. The second problem with the scientific revolution is: we know a lot about the details of who transformed England in the industrial revolution period. There were some important engineers and scientists. James Watt was the instrument maker for Glasgow University and he helped improve significantly the steam engine.

But most of that advance was concentrated in cotton textiles and then later in other textiles. The innovators there are almost entirely people without any scientific training. Even in the case of Cartwright, who invented the

power loom, he was actually trained as a classical scholar and mathematician. He had no practical scientific training. Allegedly he'd never seen anyone weave before he set out to devise a power loom. He just happened to be a rector in the textile area and he was talking to his parishioners and they said, "Well, someone should now invent a power loom because the wages of weavers have gone up extraordinarily."

It really is very hard at that kind of practical level to connect the innovators to that scientific revolution. Some people such as Joel Mokyr, the big proponent of the idea that this really is an intellectual transformation that took place in Europe... He wants to argue that that kind of elite knowledge actually diffused down, to a surprising extent, through the population in a country like Britain. That there was a lot of popular interest in science, there was a lot of interest in going to lectures and demonstrations. That basically somehow you've got this kind of widespread basic scientific literacy, or basic idea that you could do things scientifically.

Julia Galef: Just to clarify, those are two different things, right? Scientific literacy in the sense of knowing facts about science, being familiar with discoveries, on the one hand... is different than a scientific mindset or respect for science.

I mean, I talked about scientific discoveries at sort of the object level like Newtonian physics, but there were also just advancements in thinking about the scientific method. Or the idea that we can go out and discover things about the world at all, and experiment, and learn things.

I could maybe see more of a role for that general attitude diffusing even if the specific knowledge wasn't diffusing.

Gregory Clark: Yeah. I think the idea would have to be that the people had got the idea of the experiment.

Julia Galef: Yeah.

Gregory Clark: Also, basically, you could change things, that there's lots of possibilities for improvement.

For example, what's very surprising is that agriculture was not really transformed until quite late in the industrial revolution. It was transformed relatively quickly once people started actually doing the experiment. But they only started really doing that about 1842. I just wonder why no one in the 18th century said, I'm going to take my farm field and in plot A I am going to do the following, in plot B, I'm going to do something different, and then let's see what works.

As I said, it is interesting that there ... You don't see a lot of that kind of mindset.

Now it is the case that Stephenson, who was the inventor of the modern railway, actually was a colliery engineer. He was actually self-taught. He was illiterate as a young adult and then became a mine engineer, became self-taught, became literate, and actually did experiments in terms of developing the railway and figuring out, could you actually have steam engines running on iron rails? What would you have to do about the gradient?

Julia Galef: Oh, wow.

Gregory Clark: As I said, the mystery of the industrial revolution is that the majority of the innovation was made by people who had no formal connection to science and no formal scientific education, and who were just instead these kind of tinkerers and mechanics, and really had no access to that kind of high level scientific knowledge.

Again, it is very hard to disprove that this *wasn't* connected to high level scientific facts, but it is very hard to show that there really was any strong connection.

Another problem that you are going to run into as well, of course, is that Britain was not alone in terms of having the scientific revolution. I mean, the French also had an Enlightenment. The question then becomes, why was Britain so much more successful in the industrial revolution period? There are many more French people than there are British people in that period, why didn't this spread all across Northern Europe and result in multiple centers of innovation?

Julia Galef: This is probably a good place to zoom out and talk about some of the other major categories of theory. But before we do that, I realized we haven't exactly defined what constitutes the industrial revolution.

Let me take a stab at it and then you can tell me if this is a good definition: I would say the industrial revolution is distinguished by being the first period of kind of continuous growth in efficiency, in being able to produce more output from the same amount of input. Is that fair?

Gregory Clark: That is exactly the correct definition.

Julia Galef: Okay, good.

Gregory Clark: That is what makes the industrial revolution period different. The 100 years of industrial revolution are different from any previous period in human history in terms of sustaining improvement in output per unit of input. Then we can go further and say that that improvement came from development of new techniques.

It's very easy then to identify exactly what the industrial revolution looks like. It's also easy to see that that process has continued up until the present

day as just a normal part of economic life, but it just didn't exist in the world before the industrial revolution.

Another thing that makes the industrial revolution so hard to actually explain is that a lot of the innovations that were initially made were actually very simple. The earliest innovation to textiles were simple enough that an ordinary mechanic could actually copy the devices. It's actually very hard to earn an income from making these innovations, because it was so easy to copy them.

Again, the mystery is why did we wait till 1770 for this innovation? All the greater because it would seem that even in medieval Europe or Roman times, people could have made some of these similar types of innovation.

Again, it actually gets back to another idea, which is that maybe there was actually kind of subterranean development of just the level of precision and technique that craftsman had in the society that made it impossible. Now you have 100,000 potential innovators in England, people who have that kind of ability to work with wood and metals and fabric, where now this becomes possible.

But it's very hard to quantify, well, how do we know that a craftsman in 1750 is that much better than a craftsman back in 1300?

Julia Galef: When used the phrase "subterranean," did you mean, sort of, below our ability to observe it?

Gregory Clark: That's right. Yeah.

Julia Galef: Okay.

Gregory Clark: There has been some recent work that really emphasizes that even before the formal industrial revolution they were, in some areas, actually becoming surprisingly better able to do things. In Adam Smith, watches are cited as a classic kind of industry of the industrial revolution period, but until recently, we haven't really know much about how much technological advance there was in watch making. We just didn't have the data.

Now there's an interesting paper by some colleagues in Ireland, Cormac O Grada and Morgan Kelly, where they used the records of the old bailey in London to actually estimate how much productivity growth there was in watch making in the 100 years leading up to the industrial revolution.

They can do that because watches were frequently stolen. They were the iPhone of the 18th century. When people get drunk in pubs or had assignments with prostitutes, they lost their pocket watch, and then that was valued in court. So you get all these state records on, What's the price of a watch?

Julia Galef: That's funny.

Gregory Clark: Right. They can use that to show that the efficiency with which people could make watches probably almost doubled, I think, in the 100 years leading up to the industrial revolution.

Julia Galef: Interesting.

Gregory Clark: It's suggesting that even though in other ways the society looks kind of static, that here in watches there are actually quite detailed and quite elaborate elements of precision going into making these things. It's saying, "Look, you had this large scale industry where people really are innovating, just as later came in cotton textiles."

It didn't have a big kind of economy-wide impact, but it is suggesting that the industrial revolution is actually much more stretched out, that there are kind of maybe accidental elements that focused on a particular year, 1770. Because it turns out an innovation in watches can't do that much for you -- because it's still a luxury item, it's relatively modest in expenditure.

But clothing is a very substantial share of people's expenditure, maybe 10%. When you innovate in clothing, you affect the economy much, much more. But there's some arguments, well, maybe that's just kind of accidental element. So one of the things-

Julia Galef: Accident being that the innovation came first in watches, which is a relatively small industry, and not in textiles?

Gregory Clark: That's right. And watches are not the only example. I mean, the introduction of printed books was a dramatic productivity advance in that area, as textiles were later.

Julia Galef: When did that happen?

Gregory Clark: That occurred right about 1450.

Julia Galef: Okay.

Gregory Clark: It turns out that that had no measurable impact on the economic output of those societies.

Julia Galef: Because printing is small?

Gregory Clark: Yeah.

Julia Galef: Interesting.

Gregory Clark: We haven't invented yet the novel. We haven't had Shakespeare yet.

That's why I say that it's so hard to explain the industrial revolution, because there's so many potential interesting ideas. One is that there's just this huge luck element. That all of these different innovations were occurring long before the formal industrial revolution, but it just took the element that someone stumbled on something that really mattered a lot to people.

That's why we date it from that point. If you dated the industrial revolution, for example, by someone who only consumed books, who's a scholar or something, they might say, "No, no. It's 1450. That's when the world dramatically changed."

Julia Galef: I mean, do we really have to immediately jump to luck? Couldn't you look for reasons why there might have been, I don't know, an incentive... I mean, it seems like there should be some explanation for why these innovations happened in the sectors they happened in, or in England as opposed to other countries.

...Like maybe – England was going around being imperial, and they built this empire. And so maybe by the time there were all these innovations in the textile industry, that happened right around the time that they had developed this huge market of people around the world that they could sell cheap cotton to, for example.

Gregory Clark: Yeah. I'm not saying that there is ... I believe there is a reason for the industrial revolution. But it's a unique event in history and so the puzzle does actually arrive, will we ever know enough to be able to say for sure what that reason was?

Julia Galef: Right.

Gregory Clark: It also I think is the case there are going to be chance events in the course of the industrial revolution as well.

Julia Galef: Yeah.

Gregory Clark: For example, why was textile transformed in the way it was? It turns out that the transformation first occurred in cotton textiles. Cotton textiles didn't exist really in any scale in medieval Europe. It turns out that the cotton, it's easier to transform that as a fabric than lots of other things like wool or linen. There could be this connection then, that basically what's happened the British were taking over much of India, they're developing their trade with India, they're importing all of these cotton cloths with high value and it creates this opening.

Then at the same time the Americans are developing the slave system in the South and are improving enormously the efficiency with which they produce cotton. And that reduces the cost of the material, for the consumers in Britain. There are all of these elements that in some sense may help explain why the innovation occurred at that time, and also may explain why that has

such huge impact, and where you could say in some sense this is just kind of a historical chance element. Right?

Julia Galef: Yeah.

Gregory Clark: It was this important chance element that the South was a good place to grow cotton. It is an important chance element that Britain had opened up this substantial trade in cotton goods with India. But again, we just don't know for sure.

Another thing I should say is, within the industrial revolution -- say, 1770 because that's the period when you start getting sustained growth of efficiency -- the people who first mechanized spinning were actually the Italians in the 17th century. They mechanized silk spinning.

Julia Galef: They couldn't generalize that to other fabrics?

Gregory Clark: Silk, it turns out is the easiest of all to do this because it has very long strands. It's actually relatively easy to spin.

But it's a very limited market. It's a luxury product. Actually interestingly, the Italian had these silk spinning mills, and they were trying to protect the technology -- the British actually sent spies who took technology in the early 18th century from the Italians.

Again, it's another element that comes into the story. In Britain, when they mechanized cotton spinning, they actually already had a model of this. In fact, the first attempt to mechanize cotton spinning occurred within 10 years of that Italian technology, stolen Italian technology, actually arriving in Britain.

It has these tantalizing elements of saying, well, maybe it really was this kind of European-wide thing of the industrial revolution. But what happens is the British, because of their imperial activity, because of the particular location, because of the strength of their navy, are able to take this kind of upturn that's going on in technology all across Europe and to transform their economy through that. There's going to always be this issue of, what is the precise timing?

The other thing I should say is the timing in 1770 in Britain makes it very, very difficult to explain the industrial revolution. The reason for that is that Britain at that time was institutionally a very stable society, and essentially had very little institutional change in the previous 80 years.

When you're trying to explain this event, it's occurring against the kind of unchanged background of a society... with stable institutions. Very small government that mainly exists to fight more abroad. You have very stable

wages within the society, they're really not changing, the cost of capital was not changing.

Julia Galef: Interesting.

Gregory Clark: It's an economic environment which just looks very flat. Suddenly, in the middle of all of this, you've got this transforming event occurring.

That's why I say, in some sense, if we could push back the industrial revolution into the 17th century, it would be more plausible to marry it then with the intellectual and scientific advances that were going on in this time.

Also, if we could find that it wasn't just the British phenomena, it was also shared. The Italians were doing their part... Again, it would make it easier to kind of marry that with the idea that there really was this kind of intellectual scientific advance that's pushing underneath the industrial revolution.

Julia Galef: Right. Does that mean that the two main theories, or categories of theory, that are consistent with this pattern of "stability, stability, stability, then pow!" are either: Accident; or some kind of, as you were saying, "subterranean" variable that was in fact building on itself below our abilities to observe it, until it reached some tipping point and set things off?

Gregory Clark: Yes. Basically, those are the two ideas. That there's this cosmic accident... Or that there really is something that's actually changing about the society that just we're not particularly good at observing, and our measures are not capturing.

Julia Galef: Yeah.

Gregory Clark: Now in my own book, I have an argument that maybe *people* were changing.

The idea here is that pre-industrial demography in a lot of Europe had this interesting feature that it's the wealthy and the successful who are producing most of the children in the society. That fertility is very strongly balanced in favor of the upper classes. It turns out ... I have a later book which looks at this. It turns out social status is very strongly inherited. Also, there's a lot of genetics involved in that inheritance as well.

Julia Galef: Yeah. To clarify, when you talk about it being inherited, we aren't necessarily talking about genetic influence, we are just talking about the correlation between the social status of the later generation and the previous one. Right?

Gregory Clark: Right. Yes. It turns out there could be many different mechanisms with inheritance. We do observe it's strongly inherited, but it's also the case that there's actually good evidence from a variety of sources that the majority of people's social status is actually genetically determined. The debate really is,

is it about 50% or 100%? Because between studies of adoptions, studies of the pattern of correlation amongst relatives in terms of their social outcomes, they do suggest that there actually has to be a significant genetic component.

Anyway, the idea of my book then was, well, maybe what's actually happening is that the society, by kind of demographic means, is essentially becoming a more middle class society. That a lot of these middle class people are eventually forced down into the laboring classes because there's only so many upper class, middle class jobs available in the society.

That essentially, you have, by kind of demographic imperative, changed the structure of your society... towards a different kinds of imperative. I mean, the thing that made people successful at business is now being transmitted into wide class of society, and that that's kind of a subterranean force that's operating. Right?

Julia Galef: That seems to help with the timing question, of why we would see that pattern. But why England? And not other, say, other European countries, just to keep the comparison easy.

Gregory Clark: Yeah. I'm afraid it doesn't help with that much. Because these other societies, northern Germany, the Netherlands, they all seemed to have the same patterns. China also had this pattern. Japan had this pattern.

This is an interesting feature though, that a lot of discussion about the industrial revolution assumes that basically the people in 1800 who had the industrial revolution are essentially exactly the same people as a 1 AD or 5,000 BC.

Julia Galef: Genetically the same?

Gregory Clark: Right, and have the same capacities... The interesting thing is only animals are associated with this. Domesticated animals have all changed dramatically. But people are assumed to be the one remaining wild animal in society.

There's actually beginning to accumulate some good evidence that people did actually adapt genetically towards the new environment that they'd created for themselves through the early neolithic revolution which established agriculture. For example, it's now known that, genetically, northern Europeans are somewhat taller than southern Europeans. That's actually a change that occurred within the past 5,000 years, driven by some kind of selected survival. I have to say it's just kind of an interesting side issue.

Another kind of element in the story is that it's not obvious that when trying to explain the industrial revolution, you can take what economists normally like to take as a given, which is that everyone is the same everywhere. That

it's just a matter of the incentives and the interactions and the knowledge that they have, what it's going to be.

Julia Galef: Right.

Gregory Clark: It turns out it's another question that kind of sits there, which is -- is it part of the delay in the industrial revolution, because people in some sense have to, to adapt to new world they've created? Are we actually *evolved* capitalists? That actually helps explain why we behave differently.

One interesting feature of modern people is that, since the industrial revolution, we're about 20 times wealthier than we used to be. We could have consumed a lot of that wealth in the form of more leisure, we could have more poetry, more art. Instead we chose to consume it all as material consumption. We work almost as much as we did in 1800. We live in impossibly big houses, we drive impossibly big cars, we're addicted.

Julia Galef: Right. It is really interesting to look at some of the science fiction or speculative visions of what the future would be like when we had all this incredibly productive new technology. The stories usually involve tons of leisure. The authors all just assumed, well, of course, if we can be incredibly productive, why would we keep working? Yet, somehow we keep working.

Gregory Clark: Yes. I have to say there is some kind of possibility that that's not an actual behavior. It's interesting. If you look across different animal species a lot of them are sedentary for most of the time. They're just doing nothing. If you go to hunter-gatherer times, these people spent a lot more time just doing nothing in those societies.

But somehow within the industrial period, by the time you get to 1800, the average British male is working about 3,000 hours a year, and they do not do any domestic work in that period. If we look at modern males they work less in the workplace but they do more commuting, they do more child care, they do more home care.

It's a very high labor society in the industrial revolution. Again, that's something that marks that as being pretty different from the earliest hunter gatherer society.

Julia Galef: Right.

Gregory Clark: Again, there's this issue about, was there significant change in terms of the way people behaved, as we moved towards this new world?

Julia Galef: Can we maybe start to explain why this happened in England -- or why, if this demographic change were happening across all of Europe, across all of the world to some extent, why we saw the striking results of that change in England, but not elsewhere... Maybe we can start to close that gap by

bringing in some second factor. Like you need *both* changed demographics or culture, *and* some kind of geographic feature or institutional feature or something. Maybe you need lots of coal, which England had. Or maybe you need a certain kind of patent law or a bank system or something like that.

So, there has to be that prerequisite -- and then once your culture or your demographics change sufficiently, then *if* you have that prerequisite, *then* you get the industrial revolution.

Does that general template make sense? If so, what are some of the features that could play that second, that prerequisite role?

Gregory Clark:

Well, in terms of explaining "why England", that's actually something that's very difficult. It's easier to explain why somewhere in northern Europe would have an industrial revolution than it is to specifically locate it in England.

One thing we can say is that England did have this relatively unique position in the world. And some of that actually helped magnify the effects of the technological changes that were occurring.

One of the things that can explain why the industrial revolution was so dramatic, is because one feature of Britain was that it had used almost all of its available land prior to the industrial revolution and it was going through a massive population boom in the period of the industrial revolution. British population practically quadrupled between, say, 1700 and 1860.

What that meant then was that Britain had to export manufactured goods and import raw materials and food to supply and feed itself. That meant that things like the cotton industry grew to be two or three times the size they would have been had they actually just being supplied in Britain alone. That magnified the effect of all those productivity advances because so much of the output was being exported.

It also meant that the whole world actually gained from the industrial revolution in the form of cheaper product coming from Britain.

Julia Galef:

Right.

Gregory Clark:

Even in the Napoleonic war period, there was this desperate struggle for mastery in Europe. If the French had won and had driven the British to the seas, they would have ended all of this export trade.

Julia Galef:

Yeah.

Gregory Clark:

It would actually have meant a much more constricted industrial revolution within Britain. There is this interesting marriage between British naval power and prowess, and the size and force of the industrial revolution. The

British exported by power... the goods of the industrial revolution. I mean, they opened up India by force, they opened up China, and it magnified then the effect of the industrial revolution.

I have to say, that is again an interesting element where the story is so dramatic because of that intermingling of British ability elsewhere in the industrial revolution.

A second very interesting feature of this is, it is interesting that Britain was a much smaller nation than France, but defeated France from mastery of Europe. What is interesting is that Britain just seemed to have a very high level of competence in this period, at almost all of the big things that they endeavored. With less resources than the French, they just developed a mastery of naval warfare. It was quite a brutal mastery as well. The British actually in this period executed an admiral for failing to be vigorous enough in battle.

Julia Galef: Wow. It wasn't even that he deserted, or lost a battle --

Gregory Clark: No.

Julia Galef: He just succeeded *less vigorously* than he should have?

Gregory Clark: Yes. He was executed for failing to attack strongly enough. I have to say they had a remarkable discipline.

The government, again, in the industrial revolution showed a remarkable solidity and lack of fear of dramatic changes, of revolution, from below. All of these new innovations inevitably brought riots, attacks on the innovators, destruction of factories. And the government just called out the troops.

Julia Galef: Really?

Gregory Clark: Yes. It had to, to defend these-

Julia Galef: But I could have sworn that I've read about some of these great inventors, who kicked off the industrial revolution in the textile industry, dying broke. Essentially because machine breakers had set upon their homes and their factories.

Gregory Clark: Yes, that is the case. The machine breakers did actually result in some of them losing out. What I'm saying is when the government could, as soon as they could, it would bring in people that would hang the rioters.

Whereas in other countries, for example, India, after their independence, the factory textile industry there was threatening the surviving handloom industry. India just then closed down a bunch of the factory industry and subsidized the handloom industry.

The interesting about the British government is that it was innovatively very bold. It enclosed the common field that covered about a quarter of Britain in late 18th century. Again, often with significant local authorization. It created a whole system of paid roads, where people had been able to freely walk up the roads before. When the railways came in, it changed property laws so they could run on a straight line between any two cities.

You actually see in Britain in this period that the industrial revolution, it has allied with what seems like quite significant administrative competence within the society in that period. That kind of pushes you towards the idea that there's just some general kind of "energizing force" that sometimes strikes societies.

Julia Galef: Well, it sounds like you're saying, look, there are these examples of strong competence on the part of inventors in Britain, and there's also this competence in the part of the government, and so that suggests a general factor of competence.

But couldn't those two just be causally related -- and, therefore, not require some general factor explanation? Couldn't you say that the fact that we saw these examples of general competence on the part of private citizens inventing things was a *result* of the government creating conditions that protected inventors? By sending in troops to protect them if machine breakers came to their house, that kind of thing?

Gregory Clark: Yes. Except that the government didn't do that much very directly to help these innovators. Right? I mean, it wasn't the French government, it was much more interventionist in terms of rewarding innovators, trying to stimulate and encourage innovation. I mean, another kind of excellent factor also that I should mention here is, the French actually had significant numbers of innovations in the industrial revolution period.

Julia Galef: Oh, what happened?

Gregory Clark: It just turned out that they didn't have big economic consequences. The French invented the hot air balloon.

Julia Galef: So cute!

Gregory Clark: The French made the first parachute jump from a hot air balloon.

And they invented an optical telegraph that transmitted the stock prices. This is around 1800, between Paris and Marseilles. It just turns out that in the end they could only transmit a very limited quantity of information using this kind of system.

They had developments in... lighting and fruit preservation. In textiles, they invented the Jacquard loom, which is more sophisticated than any of the

British textile innovations, but it's used very much in the high-end of the textile market. The Jacquard loom involved the idea of the punch card, which would be used later in computers.

Gregory Clark:

So, it was a very significant innovation. I have to say again, you're always kind of pushed back and forth between this idea of, were the French just unlucky? The Germans in the 18th century made tremendous advancement in classical music, were they just in the wrong area? The British did nothing in terms of music in this period. Again you get kind of tossed back and forth.

One thing we could say is the industrial revolution wasn't just one innovation or one industry. There was significant advances in iron, steel, in agriculture. There was some significant improvements in textiles, in lots of areas of the economy. That seems to suggest, well, there's got to be some general factor in Britain, it's not just one lucky strike.

On the other hand, it's very hard to pick out stuff that kind of uniquely identifies Britain. I have to say, it's as surprising that there *wasn't* an industrial revolution in the Netherlands in the 17th century as it is that there *was* one in England in the 18th century. The Netherlands in the 17th century was a commercial society, with very stable government, very little interest in capital, of training society. Again, militarily, surprisingly powerful in that period. It actually beat Britain in middle of the 17th century in a number of naval battles.

Again, the puzzle is that if we try and say, "Here's something that's unique about Britain," we can find other places that do pretty good. Even Venice, if you go back a little bit further, in the 14th, 15th century, again looks like a very good candidate to have these kind of breakthroughs.

One thing I will say is, I still ... I've moved on a little bit in terms of the kind of center of my research interests. Now I'm much more interested in social mobility, nature of social mobility. But I still sometimes wake very early in the morning thinking there must be *some* way of figuring out exactly what created the industrial revolution! Honestly, now I'm realistic enough to say that I fully expect to go to my deathbed without having anyone have solved the problem of the industrial revolution. Because once you've set up the parameters, you just think it's really going to be impossible to find any satisfying explanation.

I mean, one more factor I should add in this period is modern economists have focused a lot on the idea that the human agent was changed by the adoption of much smaller family sizes. The amount of care and attention that goes to children now is so much greater than in the pre-industrial world. That really has been very significant in changing the human agent.

So another mystery about Britain in the industrial revolution is that average family sizes were actually *bigger* in the industrial revolution than in any

period in the previous years. Because of this population boom and because of somewhat better survival of children.

Julia Galef: Right.

Gregory Clark: It turns out that, I've recently been looking at very detailed histories, lineages of families in England going back through the industrial revolution period. The interesting thing in those lineages is that large families have no effect in terms of the outcomes of the children -- in terms of their occupational status, their chance of getting educated, stuff like that.

Again, it's something that economists have focused on, the idea of what could be about this transformation towards the modern family that really drives technological advance. But it's very hard to find anything in the data, in the industrial revolution period, that would explain that.

Julia Galef: So-

Gregory Clark: Sorry. Another thing that I want to mention.

Julia Galef: Go ahead, please.

Gregory Clark: One thing that's really interesting is we can also measure rates of social mobility in the industrial revolution period. And you would think that well, maybe this is kind of a disruptive element of society, a whole new class of people emerges. But there's no change in measured rates of social mobility in the course of the industrial revolution. It's still occurring in very slow rates, that were occurring prior to that, and that have occurred since then.

If you look at things like data on social mobility, you can't see an industrial revolution. If look at things like the average family size, you would say, "Oh, something changed in Britain around about 100 years *after* the industrial revolution."

Julia Galef: I've been trying to think about how we could ... I share your pessimism in general about our ability to definitively pin down the one cause of this one-off event, that we can't repeat with different parameters changed.

But it seems like we still might be able to get a *little* bit more clarity, in testing these theories, just in the form of looking at new data. It could either be data that we didn't have before, that we've only just collected, about the past. Or data about the present, or going forward in the future -- that somehow bears on the causal theory that we developed with respect to the industrial revolution?

For example, I was just reading a paper the other day that collected this very comprehensive dataset of rates of industrialization in countries outside of western Europe, in Asia and Africa and the Middle East. This data wouldn't

necessarily tell you much about why there was innovation in England, because this data is about adoption of preexisting innovations. But it could tell you about -- if you thought that education was the key causal factor in England's taking off first, then maybe you could look at whether education rates correlate with times of industrialization, et cetera.

I guess I'm wondering if there's data that you think we could still collect, or that we haven't tested these theories on yet, that would help us disambiguate between them?

Gregory Clark: That's a good question, in terms of what could feasibly be discovered that would actually throw some light on this.

Julia Galef: Right.

Gregory Clark: One thing is if it was the case that there really was recent human evolution and that that played any role in the kind of timing, or the occurrence of something like industrial revolution -- that, we will discover eventually. Because we will actually be able to observe that, and will be able to observe what changed and what happened. Right?

If we're talking about cultural changes, if we're talking about modes of behavior and things like that, my problem is it's very hard to think about what type of evidence could really illuminate this process.

I mean, one thing might be, for example, suppose we discovered that all of the innovators in the industrial revolution were actually descended from very educated people three or four generations before. That might be an interesting revelation. That it turns out that there's family history to the people who were actually doing these innovations, and that maybe that shows that they had acquired much more sophistication than we would expect in terms of thinking about scientific problems, and thinking about advancing technique.

It might be possible that we would actually find some hidden or unexpected fact about the background of the innovators in the industrial revolution. People have looked at this before. They've noticed the innovators tended to be more often from religious dissenting backgrounds, and also from groups of people who are somewhat marginal in the rest of the society. I have to say, yeah, it could be. I mean, if we had a complete social inventory here, maybe we could then say something systematic.

The other thing -- for example, in the textile industry, we know the famous innovators, the initial people. But most of the efficiency advance was then made by subsequent nonfamous followers, who vastly improved these initial techniques. If we had some kind of comprehensive inventory of all of these people in the history, and their background -- then maybe, who knows, we could find that there are some unexpected features that differentiate Britain from other societies. Right?

Julia Galef: Yeah.

Gregory Clark: That there was some pattern here that we're not going to observe within the other societies, in terms of the formation of this class of people.

This is maybe only gently related, but just yesterday I gave a talk at Stanford on a new paper we've been working on, which is actually trying to talk about: Why did the north of England, after they experienced the heart of the industrial revolution, go into almost immediate decline and become an economic backwater?

Because since 1910, it's been a kind of depressed area. England with less education, lower life expectancy, lower output per person. The puzzle is about why would this area have flourished roughly for 100 years before going into this terminal decline?

One thing that shows up, interestingly, is that the north actually had very significant migration of educated people. It really suggests that there may be a strong role to play in economic events of the kind of underlying level of education, or abilities --

Julia Galef: Some kind of human capital.

Gregory Clark: Yeah. Maybe there was something special about the demography or the immigration into the north, or something like that beforehand, that led to some kind of critical mass of people.

Now we see it in Silicon Valley and the London area, where everyone comes and where things work, and where they're kind of the incubators of innovations. That's another kind of interesting possible idea that you really can have these kind of external benefits from being around a certain type of person, being in a certain type of market.

Julia Galef: Were the innovators at the beginning of industrial revolution in touch with each other, or were they isolated? Surely we have some info on that.

Gregory Clark: For example, in textile innovation, the successful ones come from a relatively limited area of the country. What's surprising is that the textile industry in general is kind of spread out over Britain -- but the innovations tended to occur in the Lancashire area, and then the whole industry moves to that area. You do see this kind of concentration, and the decline of the various other peripheral areas.

Again, it has this tantalizing idea that well, maybe earlier innovation couldn't occur because industries were too spread out. That there's not a lot of that fertilization that goes on of people talking to each other, meeting each other.

I mentioned that Reverend Cartwright who developed the power loom had allegedly never seen a power loom before he decided to do that -- but he was in a community where everyone's interested in textiles. People say, "Hey, you're an educated guy. You should do something about this."

Julia Galef: Right.

Gregory Clark: We were talking about is there anything that could come out that might help explain-

Julia Galef: Disambiguate, yeah.

Gregory Clark: Right. One of these interesting possibilities is that you're getting these unique gatherings of people with certain type of interests, certain types of talent. And that this is just very significant, in terms of kind of propelling forward the society. Suddenly, I have some interest in why did the industrial revolution spread to the rest of the world. Right?

Julia Galef: Right.

Gregory Clark: The British were running India. They had a free market philosophy. They allowed anyone with capital and talent to come to India and set up production in the Bombay textile industry around about 1900.

I think a tenth of the mills, roughly, were owned by Jewish families from Baghdad, and a bunch were run by refugees from Iran, and the Parsees and the Zoroastrians, I believe. The one puzzle is that it has so little effect in India. That there was so little sign of development under this benign British rule of "not a lot of help, not a lot of intervention either, just keep the markets going, keep the property rights."

There again, it's got to be something about the social interactions of people and the reinforcement that you're getting from being in a particular type of society.

Julia Galef: Yeah.

Gregory Clark: ...That would be another interesting possibility for the industrial revolution, is that there are just different types of social equilibrium. That you just behave in certain ways and interact in certain ways within a certain society. If you move into a different group that can actually immediately change how you operate.

Another idea that I've had is maybe the British, maybe the industrial revolution is about love. It's about love.

Julia Galef: Love?

Gregory Clark: Yeah. Because in these early industries, it's very hard to actually make money by innovating, because it's too easy to have a machine pirated or to get broken. But could it be just the British fell in love with innovation. And, for them, it became romantic, it became something to be admired.

Julia Galef: Isn't this Joel Mokyr's -- Am I pronouncing that correctly?

Gregory Clark: Right. Joel Mokyr, right.

Julia Galef: Joel Mokyr. Isn't this his thesis?

Gregory Clark: I think he's also more about the development of capacities as well, right?

Julia Galef: Okay.

Gregory Clark: As opposed to just kind of-

Julia Galef: As opposed to just inclination or values. Yeah.

Gregory Clark: His idea would just be that, look, the Germans were in love with music and they developed music. They didn't care so much about technology. The British just loved, for a period, technology, in a way that we don't even do in modern society.

Now, I mean, every society has certain things that it promotes and praises. For example, now in Silicon Valley, where I am near, coding is now regarded as a high art in Silicon Valley. It can in fact be one of the most boring activities in the world. But it's acquired a certain romance in the society that's attracted a lot of talented people.

Julia Galef: Sure. But part of the reason it has that romance is that you earn so much money doing it.

Gregory Clark: That's true. That's absolutely true. But could it just be that for the British, what was unique, what would be very hard to document or again explain, would be that for some reason they just got entranced by mechanical or other innovations. That it seemed to them the most fantastic thing in the world, in the way that military honor was what mattered in other societies, or poetry, or literature.

And that was enough to get you through this phase of industrialization where the market couldn't supply the incentive. And that once we were through that crucial breakthrough, then we have large firms and professional innovators and patent systems that worked, and then we were into the business of innovation.

But there had to first be this phase of romance.

Julia Galef: Like in a real relationship, right?

Gregory Clark: Yeah.

Julia Galef: That's where you're going, right? I heard that implication!

Gregory Clark: Yeah. The Dutch were just too practical. They just didn't get interested in innovation in the same way. Actually it'd be interesting to look at, is there any way that you could actually document this in society?

Julia Galef: Right. You could do ... I don't know. You could look at, like, percent of books published that were about science or innovation, versus other things, like religion. Or just percentage of total books published. Or you could look at ... I don't know. You could look at the number of events that were held, like public events in coffee houses or something like that. Or break that down by the topic of the event, or something.

None of these feel all that central to measuring a nation's "passion", but that kind of thing might be the best we can do.

Gregory Clark: Right. One interesting thing is that we know the names of a lot of these innovators of the industrial revolution, and a little bit of their history.

If you go back to the middle ages, there were significant innovations even then. For example, the button was invented in the European middle ages. It was actually unknown to the ancient world. It is actually a significant innovation in terms of clothing. But we have no idea who the inventor of the button was.

Julia Galef: Yeah. Do you think this might suggest that we place a certain prestige in the process of innovation now, such that we want to credit the person who came up with it?

Gregory Clark: Yes. Clearly, in that time, even the innovators who died in poverty in the industrial revolution still had statues made of them later. Their names are still said, and they're known in a way that earlier innovators, just, no one paid any attention to.

Julia Galef: This is one of the last questions I wanted to ask you before I let you go. Thinking about implications of the industrial revolution, for how we should be doing things now -- do you think that one of the implications is that maybe we don't need a strong intellectual property regime?

Because we have this amazing example, or series of examples, of people who didn't really profit from their inventions. And didn't really have reason to expect that they would profit from their inventions. At least not proportionately with the amount of value that they added to the world.

Gregory Clark: Well, this is actually a very hot issue now in economics. The issue about whether the patent system is the friend or the foe of innovation. What I would say is there's actually not, in historical example, there's not that much evidence that patent systems really do that much towards fostering innovation.

Julia Galef: Even when they're being enforced? Or is this with regular use, not official or proper use?

Gregory Clark: Even when they're being enforced. Because we actually have examples of countries that did deliberately chose not to have intellectual property. I think in the 19th century, it could be the Netherlands or Switzerland, I could be wrong about the exact countries, but it turns out that they had innovations as well.

It's also amazing now in our world how much innovation is just done for free by people.

Julia Galef: Right.

Gregory Clark: It's amazing how much people are willing to supply in the form of just free goods. When I go and look up something in Wikipedia, it's amazing the amount of detail that people are doing. The statistical package that we use, called "R", is entirely constructed pro bono, but it's amazingly well-done, it's amazingly detailed, it's amazingly good.

I actually think that there is an argument for experimenting. I mean, we don't need to do it wholesale, but-

Julia Galef: Experimenting with different IP regimes. Yeah.

Gregory Clark: That we could try with some areas, right? For example, now copyright has been extended for an incredible length of time. I think Mickey Mouse is an example...

Julia Galef: Right.

Gregory Clark: It would certainly [be good to] experiment, for example, in literature or art with having much, much shorter periods of copyright. Or making this right much, much more limited. And just seeing what these effects would be.

It's at least the case that the industrial revolution does not provide any strong argument for saying that you only get technological advance when you have strong and effective copyright and intellectual rights protection. Because very little was protected in this period.

One example is that the first steam engine was patented. The patent was extended. But that actually meant that the person who invented the first

working steam engine was never able to get paper rights to it. Because the first one didn't work -- but it was protected. So the second person, who had actually produced a working steam engine, then was prevented from [getting protection].

I have to say I think it's certainly something that we should significantly examine whether we have just moved too far in terms of granting intellectual rights within modern society. And whether those are detracting from innovation.

Julia Galef: From your mouth to the government's ear! Or maybe charter cities, we can pin our hopes all on charter cities, where we can experiment with different IP regimes.

Gregory Clark: Sure.

Julia Galef: I will let you go in just a minute, but before I do I wanted to invite you to recommend the Rationally Speaking pick of the episode, which is a book or article or blog or something that has influenced your thinking in some way. What would you pick be for this episode?

Gregory Clark: Well, it turns out in writing my book I got the pleasure of reading a lot of ethnography by anthropologists. Some of these accounts of hunter gatherer societies, and shifting combination societies, are just fascinating, in terms of just how different humans can be in one culture from another.

Julia Galef: Yeah.

Gregory Clark: My favorites in this area is a book called "Ache Life History" by Kim Hill and Magdalena Hurtado, which is about a hunter gatherer group from South America who have the most amazing social arrangements and the most interesting kind of social structure. Unfortunately, I think it's all kind of obliterated now. But it's a very readable, kind of fascinating insight into a very different world. I recommend it to your listeners.

Julia Galef: Excellent. That's one of my favorite things to get out of anthropology and, in some cases, history, as well. These are single data points, but sometimes a single data point is so far outside your model of how you thought the world worked, that it can still be a very meaningful update to that model. Despite being just one data point.

Gregory Clark: Yes. If you read about the "Ache" you'll see that they really are unique, uniquely organized.

Julia Galef: That sounds like a very good teaser. We'll link to your pick on the website, as well as to your site. Greg, thank you so much for joining us. This was a fascinating conversation.

I will probably eventually end up accepting the fact that we will never know for sure what happened in the industrial revolution, but I'm not quite emotionally at that point yet!

Gregory Clark: Well, thank you very much for inviting me. It was a great pleasure to interact with you. Thank you.

Julia Galef: Likewise. This concludes another episode of Rationally Speaking. Join us next time for more explorations on the borderlands between reason and nonsense.