

*Structured Conversation III*

**Geopolitics and the Economics of Innovation**

**Online individual interviews conducted by**

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- A. In recent years, the US-China trade (and rhetorical) dispute escalated. Despite an indication, in December 2019, that both countries would remove trade tariffs imposed on each other's imports, the outbreak of the SARS-CoV-19 pandemic seemed to break up the truce. The pandemic further put into question the prevailing global division of labour, in which China became the manufacturing powerhouse for products researched, developed, designed and later distributed and marketed in the rest of the world by (mainly Western) transnational corporations. In this context, analysts predicted if not a full at least a partial decoupling of the global value chains (GVCs) formed in the previous cycle of industrial globalization, with Western economies reshoring the manufacturing activities of their corporations. How do you evaluate the decoupling hypothesis? Do you believe that these changes are, in fact, happening and on a scale sufficient to justify a significant turnaround in the configuration of global value chains? Could this possible decoupling mean a new bipolar world? What would be the implications for the global periphery?**

**Dan Breznitz:** A few things have happened in this sort of division of labour. One is – and I think most people don't realize – how strong and how difficult it is to imitate innovation or to create capacities in other stages of production, not just the R&D, and what kind of competitive advantage this has given Chinese firms. And, in the SARS-CoV-19 crisis, this became evident in terms of how much more resiliency and ability to secure the basic necessities of its own population China has. On the other side, and I think that is also important to understand, China itself changed. It gained a lot of power, especially after the financial crisis. But even more so since 2012, 2013, when it became a lot more authoritarian. If you think about China since Deng, you would think that there are certain norms about change of power, right? Remember, everybody gets only 10 years, you know, in advance. All of this has completely changed, first with Hu, and now with Xi, who completely centralized power. China has moved back to becoming much more authoritarian internally than ever before, since Mao...

So, if you think of it, this clearly fits the trend of other countries like Brazil, Hungary, Russia under Putin... What Trump tried to do maybe in the US. But that also came together with the Communist Party bringing in the ultranationalism, whereby they might have overplayed the external threat. It is certainly clear that they no longer accept being number two or, if you think about how the European treated them, probably be treated as a number 12. And it is not just in technology, but you can see it in the security around the South China Sea and see what

happened in Hong Kong, aggressive moves into Central Asia and Africa... We cannot untie these moves from the issues of technology, but it is not only about technology. And then to completely open the eyes of Western countries and Western companies, SARS-CoV-19 happened, and the US and Europe, but especially the US, discovered they cannot even produce ventilators and masks! And Trump became very, very aggressive first to ZTE, if you remember, and then to Huawei. And it is not going to change now.

China now has the biggest navy fleet if you count it by tonnage. For the first time since maybe the end of World War One, in terms of the capacity you can put on and under water, the US is actually number two. All of those things come together and SARS-CoV-19 make it very clear to people in the street. So, this is not just about technology, *per se*. What happened now, which never happened in the past, is we actually have a very successful interdependence of what I call a globally fragmented production. If in the past it was very easy for Russia and the US or Germany and England to break it apart because they could produce everything, now it's going to be absolutely messy. And that is an interesting question, what could actually happen: a more cool-headed behaviour and keeping the rules of game or, actually, because the stakes are so high, something more vicious and nastier...

Decoupling or attempts to decouple are indeed happening. However, it also means a few missteps, political missteps, on both sides and... And God only knows how fast and how bad it would be. I hope not. I don't think so, but I can certainly see moves. I think also we have started to see changes, which will be interesting to see, about different standards, different product markets to a certain degree, different technological trajectory, because China, for example, will not let Huawei just crash. And I don't see how they do it without flaunting certain laws, international laws about the use of IP and all the rest.

**Rainer Kattel:** What I find really interesting is that this decoupling hypothesis sort of coincides with the re-emergence of industrial policy. Well, maybe it is not a coincidence, maybe industrial policy needs to have this more national focus, if you will, which can take quite nasty forms as in the case of the US. Here it is not just a national focus, but it is a nationalistic focus. I think in some ways you see the same movement taking place partially in the UK with Brexit. You can argue it is the sort of the same kind of counterreaction to "globalization going too far" and then it is quite difficult to calibrate your responses. Some countries do it rather well, like Germany,

where you have also the re-emergence of the industrial policy as a very important political agenda item. Partially it has to do with the climate emergency and other societal challenges, but it is really also about geopolitical motives – positioning Germany and Europe between China and the US. Those are the extreme models: one being the silicon-valley-venture-capitalist-driven, the other being clearly state-led. I think EU is now trying to fit somewhere in the middle in a more democratic capitalist model. The idea of a return of industrial policy is for me the most interesting here actually.

**Yan Li:** I look at decoupling from the perspective of science and technology and innovation. You mentioned the decoupling as a hypothesis, but I think that decoupling – from this perspective – is already happening. It is very much against the will of the Chinese government and the Chinese industry; it may also be against the will of the US industry and their businesses and firms, but it is happening. Yet, the problem is that China and the US have been in cooperation for years in the global value chain. And all of a sudden, the US realized “we can't continue this kind of division of labour anymore, because we've lost millions of jobs; we're outsourcing our manufacturing industry to China”. So, for China it would be rational and appropriate to continue this division of labour, but the US simply doesn't want to continue this. Decoupling is thus happening, but it is very difficult. China and the US have formed a multi-faceted innovation system with both countries being part of it. So much so that we can talk of a China-US innovation system. The two countries actually formed one innovation system, for instance, with Chinese researchers going to the US to further their studies and then coming back to China to continue the research. That creates a kind of knowledge spillover effect from the US to China. This kind of collaboration has been going on for so many years and the connection and the linkages have been so profound, that it is difficult to really separate them within a short time. It is very much against the will and interests of both sides, but it is happening already.

The key difficulty lies in for the US side, because if you really think about the current situation from the perspective of industrial supply chain, you could soon realize how difficult it is for a single country to maintain the whole capacity of even one single, verticalized industry. For example, let's look at the semiconductor industry: the US would very much like to stop providing Chinese companies with US chips, but for the chip industry the fundamental and most critical factor is the size of the market – only with a huge enough market will companies like Qualcomm be able to afford the research and innovation expenditure to develop the latest generation of

their chips. So, losing the Chinese market and other markets, likewise, could also cost the possibility even for Qualcomm to develop their products. It is the same for China. It is also impossible for China to develop a full and complete industrial chain alone because the high-tech industry is very different from a traditional, let's say, from the textile industry. Making a chip or a plane is fundamentally different from making a pair of socks. If you have a shorter and simpler supply chain, it could be a much easier job, for not only China, but for any country, even Philippines, Vietnam... But if you're going to make very sophisticated and high-tech products, you have to collaborate internationally, because the resources and technologies and talents are simply not in one country and the deciding factor – let's say the technology, the talents, the market and the basic research – are simply not in the same place.

**Raphael Padula:** Well, let's look at what's behind this decoupling hypothesis. The dispute between the US and China takes place in areas which are critical to military technological leadership and it is not merely an economic-commercial battle. Even if China intends a peaceful rise and does not presume to itself the role of hegemon, its advance is perceived or instrumentalized as a threat by the USA, to justify expansionist policies in the military and economic field. Since the Obama administration, the US strategy papers have looked to the Chinese rise and its alliance with emerging countries as a force in favour of a more multipolar distribution of power, thus a threat to the unipolarity of the United States.

China has followed the model of the US military-industrial complex to advance critical technologies, at least since the 1980s. Inspired by President Reagan's 1983 *Strategic Defense Initiative*, the *863 Program* was created in China by Deng Xiaoping. *Made in China 2025* was another State program announced in May 2015 with the aim of transforming China into a world leader in high technology and industrial production. In part, the *Made in China 2025* reflects China's shift in focus from cheap low-tech to high-tech manufactures. But above all, it is a Chinese reaction to its external vulnerabilities revealed by the leadership of other countries (including the United States), especially in areas sensitive to national security, such as semiconductors or information technologies of future generations (such as 5G), for example. The document reveals how relevant national security concerns and the use of dual technologies are. The *Made in China in 2025* raises the question of internationalization of technical standardization as a key element in the Chinese advance in cutting edge technologies. Diego

Eugenio Pizetta, in a thesis defended at PEPI-UFRJ, notes that China has been increasing more and more its presence in institutions linked to international technical standardization.

China has also been consolidating a strategic partnership with Russia. Bilaterally, China and Russia have been establishing cooperation in strategic areas such as the military, energy and financing (without using the dollar). But it has also been working in regional strategic institutions such as the Shanghai Cooperation Organisation. China has been seeking reforms and increasing its participation in institutions created by the United States, such as the IMF, and also building parallel institutions under its control. But the most critical is that China rhetorically appropriated the US ethical-liberal discourse, promoting free trade and the environment, while the US with Trump began to resort to a discourse that discredits the institutions created, shaped and controlled by USA, even seeking agreements outside the WTO to extend, for example, intellectual property rights, and explicitly puts the use of nationalism at the forefront. Still, this battle takes place in a clear way in the healthcare industry, but it is closely connected to security technologies. During the pandemic, the US escalated its military manoeuvres and displays in the South China Sea. The process that leads to this “decoupling hypothesis” is a technological dispute in strategic areas and a dispute for governance and legitimacy through a global ethical discourse.

- B. An immediate effect of the SARS-CoV-19 pandemic is a renewed interest in active industrial policies, with many nations announcing ambitions to scale up or create productive capacity at least for strategic products (like medical equipment). In the case of China, it has been successfully implementing its industrial policy plans, upgrading its manufacturing base and even innovating, but at the margin or incrementally. One could say that China, until recently, has been a very fast follower but did not have the ambition to push the technological frontier. It seems, however, that in the new five-year plan, which is being developed, China has the objective of defining its own regulatory and technical standards, in a way pushing the frontier. For example, in the battle for the fifth-generation mobile telephony (5G). How do you see China’s new strategy? What has changed in China’s development trajectory and what are the consequences of these changes for the rest of the world? And about the new wave of industrial policies: has industrial policy definitely become fashionable again? What is really new about those national industrial policies plans? And what are the implications for developing countries in terms of opportunities for development and associated policies to seize them?**

**Dan Breznitz:** In my book with Michael Murphree *Run of the Red Queen: Government, Innovation, Globalization, and Economic Growth in China* (2011), we argued, precisely, that China was a fast follower but not an innovator in the frontier. China entered a new stage in its development and industrialization trajectory. The game China is playing is exactly the next stage of *Run of the Red Queen*. In other areas, however, China can leap ahead. It is very clear that the best place in the world for the last 15 years and probably for the next 15 years, if you want to deploy what we call alternative energy, is going to be China. And if you look at the history of technology and industrialization, where you deploy new technologies *en masse* also becomes the place that is the most innovative. Because it is really nice to develop them in the lab. It is really nice to try them on a city of 150,000 persons. But now, for the first time you put it in use for a billion and a half people... This is a big advantage! The same applies, by the way, in telecommunications: China now has, strangely enough, a much more sophisticated mobile telephony infrastructure and therefore apps – if you think about the apps that now come in from China for mobile, anything mobile, from commerce to whatever, China is ahead. I mean, there is a reason why TikTok is so popular. There is a reason why we all use Zoom. By the way, all of them, the founders of Zoom, used to work for Cisco, in the WebEx division. But again, even Zoom is not, you know, earth shattering... It is WebEx for dummies! In other areas, like AI, China might take the lead. But think for a moment again, it is not because they have invented the algorithms and especially not the technology. It is because they have much better data and a lot more of it. So, again, it is the next stage in their development trajectory. It is not the first stage...

But it is reasonable to expect that most American and European multinationals will try to create at least two more areas in the world, where they can do whatever they now do in China, even if just as a hedge. This seems to be a positive implication, a new opportunity for development, for developing countries. And the other positive implication is that it makes the world much more resilient. Because imagine that a catastrophe, either manmade or not manmade, is also a possibility... Just think about what happened in Japan or that a massive earthquake happens in China, which is not out of question. Or that the Three Gorges Dam crashes down and then Southern China is out for several years. If new areas develop, the world sort of has a small hiccup instead of, you know, basically coming to a standstill. But that is a positive scenario. A bad scenario is politics, ultranationalism, egos of leaders that are not accountable or think that they are not accountable... And then it is a really bad scenario.



**Rainer Kattel:** I think what is new in this wave of industrial policies is where this impetus comes from: you can argue there are three sources or drivers of industrial policy at the moment. One of them is geopolitics: look at the UK, at the US, even Germany, France... a geopolitical repositioning after the Cold War is over, but also neoliberalism is over, and the globalization as we knew it is over. This geopolitical re-ordering is one of the key drivers, industrial policy as a way to (re-)position your country in the global power structures. The other one is the climate emergency: the realization of its urgency and the trend towards addressing challenges or missions or trying to solve the problems through industrial policy, rather than just do horizontal policies. This is really another important driver. And the third one is a growing understanding that we have this very disjointed policy landscape: on the one hand, you have macroeconomic policies of combating inflation, unemployment etc., on the other, you have innovation policies and science policies – and there is just a big hole in the middle. This creates a big coordination gap. The new industrial policies come with the re-emergence of the realization that the State actually has a huge leading role in coordinating various sectors and aligning investments and private initiatives. These three drivers are what makes the new industrial policies somewhat unique. If you go back 10 years ago, we didn't have that realization, it wasn't that strong. I think it was already emerging back then, there was an anticipation of “the state is coming back”, of industrial policies coming back, but it wasn't that strong.

For developing countries, I think you can argue that, yes, there is a window of opportunity to restore some of the production, let's say into Europe or maybe into Latin America, and to focus on domestic markets more and diversify them. But being realistic, I think most countries are not able to use this window of opportunity. That's because over the past 20, 30 years you have really focused on a very simple policy recipe: essentially liberalizing trade relations, liberalizing finance, focusing on macro-economic targets... so, you don't really have that much capacity and you don't have the structural conditions to develop industrial policy – they simply are not there. If you look at Germany, for instance, you have large industrial associations, labour unions, you have all the structural actors that the country can rely on to do the negotiations and discussions, but if you look at Brazil or Estonia, you don't have that industrial coalition. I mean, in Brazil, in some areas you might have stronger structural actors and the same in Estonia, maybe in ICT, where it has a relatively strong standing. But towards the average industry, these countries don't have the necessary capabilities in the public sector to actually coordinate the initiatives. And that I think is really a big thing; for 30 years, main developed economies said that “industrial



policy doesn't matter". And, at the same time, they really kept many of their capabilities in place: they have big ministries and big business associations doing actual industrial policy, even if they didn't say it was industrial policy. Now the peripheral and small countries are without any capabilities to seize the new opportunities for development, because they believed the rhetoric from the developed countries...

**Yan Li:** I think we have to differentiate two angles. If you look at the international division of labour, from a strategic perspective, it makes perfect sense this renewed interest in industrial policies. From an economic perspective, however, behind the formation of the prevailing division of labour, it was the force of international capital. The international capitalists would very much love to allocate resources internationally according to costs and benefits. That has been the driving force of the internationalization of production during the past decade or even several decades. But now many countries have started looking at the security of their supply chain individually and the role played by China. It didn't really happen only due to the pandemic. It has actually been the case for several years. If you look at the Chinese policy documents, the 13<sup>th</sup> five-year plan or the 12<sup>th</sup> five-year plan, you will notice there is an emphasis on the security of supply chains. We call it "strategic industries" and "strategic technologies". The pandemic has somehow made people even more worried about the security of their own supply chains. It is the same case for the US, because they found out, when a pandemic like COVID-19 breaks out, there is a very big problem for the supply of their medical equipment, for instance. This kind of phenomenon sort of pushed people forward to feel the intensity of this security problem.

**Mario Salerno:** I don't believe on this new opportunity of development for laggard countries. The likelihood of this happening, of a new round of development by invitation, as a hegemonic movement, seems low. Transnational corporations are in China not because of cheap labour, also because their labour is not that cheap – other Asian countries like Vietnam offer cheaper labour. They are in China because of the Chinese market! And how much does the cost of labour weigh in the economic calculation of an individual company? Very little. China's attractiveness in this regard is not only the cost of labour, but the qualification, bureaucratic agility to import and export, lack of labour and environmental regulations... But what really matters is the Chinese market: if you are not there, if the company does not produce there, it does not enter this gigantic market. This is not the case in the Indian market, for example.

Still, assuming a turnaround and that there is a decoupling of value chains, Latin America would be far behind in its ability to take advantage of this hypothetical opportunity. To do assemblage and act as a *maquiladora*, the Brazilian industry can succeed. But what would happen? There would be greater production in the Manaus Free Trade Zone, yet, importing the set of parts and components with greater added value, and doing only the assembly. Could Brazil do that? Yes. What is the benefit? Not much... not to say it is zero. The “hot” activity that would have a positive impact would be software development. It is not *stricto sensu* manufacturing... The valuable aspect in this value chain is not the hardware for 5G or digital technologies, but software development, the transnationals will hold for themselves, they will develop in the headquarters. We are weak in artificial intelligence; we are weak in software development in general. And take into account that the necessary capital is low, either to develop, or even to commercialize (which is where there are higher capital costs). From this point of view, India would be better positioned, and the group of Asian countries, with a better education and better qualification, is better positioned than we are. Even though the majority of the Indian population is poor and not educated at all, given the size of the population, a fraction qualified in programming is significant. Brazil is on a route completely outside not only of the global value chains, but of any vision of technological development. The current ideology that prevails in Brazil does not contribute... Even Itamaraty abandoned the so-called “innovation diplomacy”. That stopped. The creation of an image of Brazil beyond football – and even in that we lost our prominence – is very weak. The economy is in crisis...

And think about it: companies, when faced with something disruptive, close themselves. This comes from military strategy: if there is a crisis on a ship, it closes itself and the commander becomes the policeman, judge, fireman... he is the supreme commander. When there is a fire in a petrochemical company, the boss is the production manager, not the CEO. Anyway, there is an explanation for the rationality of this, but you can make a parallel with disruption: first, companies want to control the variables; second, they are afraid to be left behind – by centralizing, companies have more control. Therefore, they will not transfer the most valuable tasks to peripheral areas. If we look at the few transnational companies that do some R&D in Brazil... they are not very few! Car manufacturers, for example, do some R&D here, but it is not in the area of electric mobility, which is where disruption is coming from.

That open innovation is something new is a myth... even the Roman Empire should have done open innovation to develop its swords! Companies do a cost-benefit calculation on what is best to develop internally and what can be developed outside. This has to do with cost of capital and for publicly traded companies calculating the return on fixed capital (the more you outsource, the better). Within this generic reasoning, there is a lot going on in the field of open innovation. For example, something that is happening more and more in Brazil, but that has been happening in the USA for years: corporate involvement with start-ups, corporate venture capital. There are some companies that invest in start-up to make money, others to improve their business, and others to diversify – and there is a mixture of these three. There are even small consultancies in São Paulo that set up an investment portfolio in start-ups for large companies. And there is another, heavier co-development movement. The point in disruptive innovation is not that everything is done by the headquarters, but that control is in the headquarters. This is the point. Companies go after those who have competence but remain in control.

In Brazil, the production chains end up being dominated by transnationals, there is no national R&D, and the decision-making centre is not here. In the pandemic, this problem is perceived. The idea that the origin of capital does not matter is small talk. Note that in this pandemic the banks that made donations were those with national capital - no foreign bank did it. No foreign company has helped to develop medical machines and equipment in Brazil. In the case of the respirator developed by USP, Brazilian companies helped, but not the foreigners.

Finally, there is an institutional and political tie that also matters, legislation, subsidies that encourage research and development in the country. What foreign companies do is a calculation, and that includes the variables of the institutional framework, of the incentive structure such as *Lei do Bem*, plus variables related to the subsidiary, such as number of engineers. And we are not attracting R&D to our branches... I visited Bosch do Brasil and picked up those corporate brochures available in the waiting room. When I got home, I went to the Bosch headquarters website in Germany: it is another company! There, they only talk about Internet of Things – here it is only things, but no internet...

- C. In what concerns the digital economy, the US-China competition sharpens the differences in technological strategies, while creating divides between business models and firm choices, making more difficult an agreement over standards and practices, postponing the emergence**

of dominant designs for emerging innovations. As a consequence, the policy space for multilateral governance seems diminished. Put it another way, the competition between US and China in terms of products and business models would tend to reproduce itself in disputes regarding standards and regulations. How do you see the possibility of emerging two technological standards and regulations, one Chinese and one American? What are the prospects for the establishment of a global regulatory or technical framework? Would you consider that “regulatory battles” inside global institutions (including the WTO) might be nowadays in the making? What are the implications for emerging and developing economies?

**Dan Breznitz:** In the book *Run of the Red Queen*, we talked about standards as a tool that China uses to change their position of power within global production chains. China has become better and better and better, and they actually play the standard games now much better than Europeans and Americans. However, after all this hype, let us look at the fight right now on the fifth-generation mobile technology (5G), which tells you exactly where China is very good at. This is not the first generation. This is not, you know, inventing. This is fifth generation. It is very clear what the market is. It is very clear what will be at least some of the most successful products. It is very clear what the technology is supposed to do. It is very well defined. And in this game, the Chinese are extremely good at, partly because they are the only ones who even know how to produce this stuff. They are still not coming up with a completely new way of communication. It is not that China cannot do that; but the way they are doing it is due to the structure, incentive structure, especially for Chinese companies. In the end of the day, Huawei is so powerful because it has been laser-focused on making money – not on helping the Chinese military to conquer the world. They might say this in Washington, but Huawei is so powerful, because it is so profitable and because it conquered so many of the activities that an innovator needs in their sector. So much so that, for example, if the US now want to have equipment from a different manufacturer, we already know it will not be an American manufacturer, because there is none left. At best, it will be European.

**Rainer Kattel:** This is where we go back to the beginning: the US-China standoff. We already see very different paradigms and regulations emerging. The way China is dealing with that and the way the US and the West are dealing is quite different. It is probably quite unlikely that there will be a global regulation anytime soon. We will probably have maybe regional regulations like

we already have in the EU, like a Latin American GDPR [General Data Protection Regulation], but I find it very unlikely that there will be a global framework.

At the moment you have two paradigms: one is the big tech, private sector-driven paradigm of the Western countries. This has basically emerged from Silicon Valley, platform capitalism with loads of free stuff like google search but also with huge amount of data being extracted from the users, and this paradigm is really dominating in the West. And then you have the Chinese, very much a state-led, top down paradigm, but at the same time very much an experimental approach as well. So, in regions, in local governments, China is looking to experiment perhaps much more than the West is, because the West really doesn't have the capabilities. And then you can argue that the European Union is trying to create a third paradigm, which is more democratic, more about technological sovereignty and owning the data, and promoting openness. But I think it is very much in rhetoric... the EU is still a union of 27 countries, so you don't even have a common digital market at the moment, let alone a paradigm. Yes, you have these ideas to invest much more into artificial intelligence (AI) and digital technologies, or the GDPR, which is a good example of regulation, but I think it is very much a nascent paradigm. Quite likely, we will be living in the West under the dictate of the big tech companies [e.g., Google, Apple, Amazon, Microsoft] and their platforms. This is the big issue for the next decade: whether there is any political clout and initiative to actually deal with those companies. At the moment, the issue is very much framed as anti-trust regulation – “let's break them up” and all that... but of course this doesn't change the algorithmic nature of what they do, and so I think this is where policymakers have to get much wiser. This is where the innovation systems thinking needs to come in and say that an exclusively anti-trust approach is actually ruining the innovation ecosystem. We need to rethink the innovation ecosystems in the digital sector and especially in AI, but I think there is hardly any thinking around that. And that is really the key to bring the basics of evolutionary economics into this thinking, rather than just look at anti-trust and break them up.

The leaders in this respect, in deploying a different approach, based on technical – and not regulatory – standards, are probably cities, rather than nations. That is because a lot of the important user data is about traffic, pollution and things alike. Even a lot of the private stuff is happening at the city level, like Uber and Deliveroo ... this is all happening at the city level. This is where you will probably see the most interesting things coming into play in the coming years.

The way we can be much more democratic about these things is when the cities become the forerunners in these technical regulations, rather than the nations. Local government can play a role here, not always in a direct way but in a roundabout way, because what is really important is to keep the digital markets really functioning in a sense of not having all the oligopolistic markets at the city level, which is very easy to happen. You need to have a number of small players in digital markets like thousands of small actors, because they are much more cutting edge in terms of technology, but they're also interested in experimenting with data. Data privacy and security rulings can be much more democratic for those firms. I believe a market-shaping approach by the government is super important: not to have a one multi-billion contract but rather having smaller contracts and a much more iterative approach with small firms.

This kind of small-scale experiments are happening at the city. But also at the level of the a nation state this is important, because what really is happening is a lot of incremental ICT development – you don't need to have like big, radical solutions for the entire health system, for instance, but you need to solve specific tasks within the health system, so you need to actually work with smaller companies that are much more agile and provide you better solutions. This way governments can have much more in-house knowledge by keeping a dialogue with smaller firms rather than a big contract with a big provider. In a one big 10-billion-pound contract, the solution is likely to be outdated by the time it will be implemented, because technology moves so fast these days, and big contracts are hard to implement. Otherwise, of course governments have also a role in terms of data openness, for instance. Governments have through procurement an incredibly important role to play and if you look at artificial intelligence, for instance, then governments have the power to lay those algorithms open in the public. An example happened in Amsterdam, where the municipality mandated that all public sector algorithms should be public, which is I think is key. Through procurement you can do that very easily: whatever you procure has to be relying on open standards, open data, rather than proprietary knowledge.

**Yan Li:** Having multiple standards and regulations is certainly a possible scenario. I think people talk about bipolarity politically, but I think economically, especially in terms of how the world is governed by the information and communication technologies, in the coming years, we may well see three different schemes around the world. On the one hand, the US have got its own technological regime with their own standards, where you can use Google or Facebook

platforms; on the other, in China the regime is dominated by the 5G technology provided by Huawei and other Chinese companies. But apart from China and the United States, there are also other countries that do not want to choose side between the US and China, so they may want to use part of the Huawei technology while feeling the pressure of the US politically to decouple from China. They would partially still adopt the Chinese technology. They would be in a sphere of influence different either from the 100% Chinese technology or from the 100% American technology. So, there could be three regimes. From my assessment, I think most of the European countries are very likely to be in the regime of the US. But for the ASEAN countries, the South and Eastern Asian countries, they are very likely to be in the third regime, somewhere in between China and the US. For the countries on the Belt and Road initiative, those West and Central Asian countries, they could well be within the Chinese sphere of influence.

Regarding global regulatory frameworks, it is becoming increasingly difficult to achieve multilateral agreements. The general secretary of the United Nations, Antonio Gutierrez, has a very good assessment of the current situation in terms of multilateralism: we are currently having a surplus of challenges in multilateralism, while we're also having a deficit of solutions in multilateralism. That is a very good way to put it; I think that politically it is correct. But technically, it is very difficult to really separate China and the US into two systems. The real work to decouple these two countries is going to be hard and trying for the US. And for China, I think it is very interesting, there is actually a very positive result, because we have been looking at the security of our supply chain over many years, and the pandemic and the US pressure to decouple their system from us has made it easier for China to see which are the strategic areas we should really be building up capacity independently from the US. That is a very useful angle for China to look at the situation, and it gives China the argument for decoupling itself and then trying to find its own way forward. Indeed, China has the size and the resources to do it.

In short, it is possible that we will have multiple standards, like for 5G – it doesn't look very likely in the short term given the complexity and interdependencies of the supply chain, but that is possible in the long term. Yet again, if we ended up with that situation, I think both the industry and the scientific community are going to waste a lot of energy and time to develop these two different regimes of technologies. But it is a possible scenario that takes years to come. And the whole world is going to pay the price for the high cost incurred.



**Mario Salerno:** The problem with not having a standard is basically volume and cost, considering that in the case of 5G, for instance, volume, scale is fundamental, and more so than economies of scope. Scale is a decisive factor. An interesting case of the issue of not having standards is that of banking automation in Brazil. In the 1980s, I served on a bank automation commission. At the time, each bank had its own standard – Banco do Brasil, Itaú, Bradesco... the most important banks. The commission focused on proposing a standardization of automation. This standardization meant that each bank would have to abandon what it had already done, incurring losses due to sunk costs, and no bank wanted to do so. Thus, at the time, it was not possible to standardize bank automation in Brazil; it was only after technology changed that the standards were unified. Another case: I worked also in the 1980s with a planning project of Itaú, also on bank automation. The bank even created a pilot agency to implement automation. IBM equipment was imported into this agency, with a centralized model, which they later adopted. It was a central computer and all the information, all the data from the Itaú branches, was sent to this pilot branch and then returned. Bradesco, on the other hand, put microcomputers – which at the time were big! – at each branch, and processed the information of the branch's own accounts locally, only sending account information from other branches to a processing centre. These are two different standards which, however, affect the interests of each bank itself and do not influence general technological trajectories. In any case, Bradesco's standard, distributed, won. And Itaú ended up losing a good part of the investment... That is, there were private costs, but the social costs were few or non-existent.

Making a parallel with the dispute for the powertrain of the car of the future: this issue is more political than technological. There is a certain “lobby” for the plug-in battery electric vehicle. But consider this: the smallest total carbon footprint car, in a life cycle analysis, is the Brazilian 100% ethanol powertrain. Even with the forecast of a predominantly renewable European electricity matrix. Predicting the future is very difficult... before the bet was on the hydrogen fuel cell, then the hybrid powertrain, and now the 100% electric. But these are again mostly private costs. The public cost would be if the State started to invest in charging stations, for example. But that is not a function of the state, in my view. It turns out that countries that continue to provide subsidies for private purchase of electric cars do so to support their national automakers, such as France. Anyway, there is this dispute in the automobile industry, but it is different from the dispute for 5G, because the importance of regulation in the case of the automobile is much less than in the case of telecommunications. The strategic-military interest in these two sectors is

quite different as well. Even if advanced countries could possibly hack telecommunication networks regardless of standards or who owns the companies... But beyond that, and more importantly, the issue of 5G is a matter of market dispute, of the countries, the USA and China, defending their companies and looking for economies of scale.