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THOUGHT PROVOKING IDEAS OF THE GLOBAL ESSAY COMPETITION 2023

Preserving Access to the Infrastructure of the Future

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Introduction

In the late 18th century, two very different European revolutions changed the world. One was political in nature, leading to the establishment of equality as a cornerstone of modern societies. The other revolution was industrial, and it threatened this just-established notion of equality in a new way. The innovation of railroads in particular, despite becoming an engine of a roaring economy, created a problem not seen before: The private control over critical infrastructure, and with it the incentive to raise prices and limit equal access to the benefit of the infrastructure owner, and the detriment of society.

Today, it is easy to forget how much of our economic activity and our private life rests on our ability to access essential infrastructure. Most of us would give anything to continue having access to electricity, roads, or the internet. The fact that we do not have to, that these services are easily affordable everyday essentials and not expensive luxury items, is a central achievement of prior generations' political and regulatory efforts, whether on the topic of the internet in the 1990s, electricity in the 1930s, or railroads in the 1870s.

However, in the infrastructure emerging today we are at risk of losing this equitable access. In the last few decades, another technological revolution has taken place, and action by firms as well as regulators is needed to preserve equitable access to its digital innovations. In this essay I hope to show you that the infrastructure of tomorrow looks nothing like the infrastructure of today, and that the response to this new reality requires not

just regulation, but a new form of coordination.

Infrastructure as an impactful building block

Before talking about the future, we first need to understand the past and present of infrastructure's special status. Defining infrastructure is tricky, but important for understanding where we are headed. Merriam-Webster describes infrastructure as the "resources required for an activity" as well as the "underlying structure" of a system, neither of which being a terribly clear description. Commonly, we might understand infrastructure to simply refer to a collection of things that we have all agreed on being infrastructure: Roads, rail, bridges, tunnels, water supply, sewers, electricity grids, phone lines, mobile networks, and so on.

All of these examples have a couple things in common, which lends itself to a more precise definition of what infrastructure is and what it does. First, infrastructure is really important. Each item in the above list, were it to go missing or even just stop working for a while, would lead to people, businesses, and society being greatly harmed. Second, infrastructure functions as a fundamental, homogenous building block. We do not use railroads for the beauty of trains or electricity for the pretty sparks it can create, but instead, we use them to enable other activities: Shipping goods, sharing knowledge, powering devices, meeting friends. In doing so, all of us use the same, or at least highly similar infrastructure: there is little need to create different electricity grids or railroads for different purposes. The variety of uses enabled by infrastructure comes from the applications that are built on top of it, not from a variety inside the infrastructure itself. Third, and more problematic, is that infrastructure requires customer-specific investment. Roads would be useless if they did not lead to your house, as would electricity without someone building the lines that connect it to where your devices are. This separates infrastructure from other public goods, like a police force, and opens the door to problematic opportunities for the firms that control our infrastructure.

Investments into infrastructure are sunk at the time that they are made, meaning that they are non-recoverable. This sunk cost nature of the customer-specific investments means that there are enormous switching costs when changing out infrastructure – as well as when changing infrastructure providers. Therefore, an infrastructure provider, like a rail company that controls the only rail line into town, or a grid operator that owns the single power line going to a property, can charge whatever prices they desire without fearing competition: No customer or competitor would build a second power line to a house that already has one. Whether through creating a monopoly or through other collusive action, the firms that control infrastructure would be able to capture large value. This is problematic as the high prices charged would not only redistribute wealth, they would also stop many users from being able to afford access to this infrastructure. The infrastructure-owning firm might also use their dominant position to shut out other businesses from using its infrastructure, for example because those businesses might belong to a rival of the infrastructure owner.

Luckily, we have found policy solutions to these problems, aimed at ensuring equitable access to infrastructure. Firms that control infrastructure can be regulated to have capped profits,

meaning they cannot set prices higher than what is needed to earn more than a small profit. This solution has ensured inexpensive access to water, electricity, and phone networks for generations. A second policy solution is for the government to simply provide all infrastructure itself, as is done with roads. Beyond policy, some infrastructure industries have become simply more competitive through technological progress; rail shipping for example has experienced enough increased competition from trucking, ocean shipping, and airplanes, that the industry is largely deregulated today.

Tomorrow's infrastructure has promise and problems

What might be called the "digital revolution" has been going on for decades at this point, but it is still in the process of changing our world. This is not surprising; electronic computing and the internet are "general-purpose technologies", and general-purpose technologies often take decades until their main effects are felt (David, 1990). A large reason for this is that the new technological paradigm needs to evolve to a point where it is standardized enough to be easily employed in products and production (Bresnahan & Trajtenberg, 1995). With digital technologies, we are just now getting to that point of standardization, represented by APIs.

APIs, or application programming interfaces, is a computer science concept that has recently received wider attention, and for good reason. To simplify the concept, APIs are a simple, standardized way that two pieces of software can talk to each other. In practice, this not only enables simplified programming, but a modularization of software, digital services, and even work itself. This modularization is visible in the plethora of start-ups and more established firms that have recently started to sell services through APIs: High profile examples range from cloud services (AWS, GCP, Azure) through payment processing (Stripe) to messaging (Slack). In essence, these firms are selling single functions as homogenous products, and all that is needed to buy them is a few lines of code.

However, purchasing a service through an API is different from going to the supermarket and buying a carton of milk. While setting up an API is easy, firms then invest in building on that API functionality. This creates significant lock in to a certain service provider, as switching out an essential function like cloud computing and storage services will require reworking everything that has been built by the firm on top of it. This leads to an important conclusion: These firms are selling products that exactly fit the above definition of infrastructure, meaning essential functionality that is built on to enable other activities in a way that requires customer-specific investment. This is infrastructure, only it is completely unregulated.

The story of this new infrastructure could be a story of great technological advancement. After all, the firms selling it thrive because the building blocks they offer are so much better than what we used to work with. And building blocks, by their very nature, enable creativity and the development of novel solutions. But for that to happen, we need to fix something first.

Existing regulation does not apply

The dangers of unregulated infrastructure are explained above, but what does an example of unregulated digital

infrastructure look like? APIs may have supercharged the phenomenon of digital infrastructure, but it has already existed before at a smaller scale. Consider Microsoft Excel, an application which is being sold for about 100 USD a year. This price can be surprising, given it is a lightweight application whose core functionality has not changed in decades and competitors often give away similar software for free. The reason for this curious value appropriation by Microsoft is that Excel has become infrastructure for many, many businesses. When firms have built their entire work processes on top of Excel, then switching costs are now so high that Microsoft has enormous pricing power. And increasingly, other examples of infrastructure pricing power are visible, as in the cases of Apple and Google keeping 30 percent of all app store revenue.

These kinds of examples evoke calls for antitrust authorities to respond. However, while regulators have been able to rule on related issues, like firms promoting their own products, the pricing question is out of reach. This is because two aspects of digital infrastructure pricing power withstand easy economic analysis: One, unlike in traditional infrastructure, where a company invests in each customer's access (like when building electricity lines), in digital settings each customer bears their unique investment and the potential switching costs to a competitor. This makes it hard to tell whether customers keep buying a product because they are locked into it, or because it is simply a better product. Two, while traditional infrastructure does not change after creation, there is active innovation happening in digital products. Therefore, it is not possible to just take the operational costs into account when regulating margins, and it is unclear what a standard level of service is. As a result of these two factors, existing policy cannot be applied to digital infrastructure.

When there is a single application that is unregulated infrastructure and charges many times its cost it is annoying, but when this lack of regulation becomes a norm in API-enabled infrastructure, it will be highly problematic for our economy and society. First, everything being more expensive than it needs to be will reduce what people can afford and which businesses can operate. Imagine if transportation was many times more expensive than it is today, how much fewer economic activity we would have, but also how much less interaction with other people. Second, unregulated building blocks have disastrous effects on innovation. Once a firm has established their infrastructure as the one being widely used, they will both lose the incentive to keep innovating, and they start being in control of what can and cannot be built on top of their infrastructure. This control stifles down-stream innovation: Building blocks become much more useful when they can be stacked, switched, and recombined – imagine playing with Lego but being only allowed to build what the packaging says. As well as paying ten times as much for it.

Solution: Stakeholder-driven standardization of interfaces

The solution I suggest brings changes to a core aspect of digitally enabled infrastructure seen above: APIs. These are the interfaces that connect building blocks, but they are also what keeps switching costs to competitors high. If APIs were specified the exact same across all infrastructure products inside a category, then customers could freely mix and match different products, using whichever (or whichever combination)

offered the best functionality or the lowest price.

In innovating industries, API specifications cannot be made by regulators alone; it would likely be too slow and bureaucratic. Instead, standards are best set by those firms and other stakeholders involved in each specific industry. What I suggest is that we start recognizing this need to set API standards before certain applications become established and too costly to change. Because early stage technologies are often little-known, we need firms to become aware of the digitally enabled infrastructure they use, and start talks with their suppliers, competitors, and customers about how to proactively shape the standards of the future. It would be best if firms have a role for this inside their organizations. Regulators and rule-makers have a part to play as well: The process of collaboratively figuring out compatible APIs should be supported by a set of rules and best practices, as well as regulatory oversight to ensure that the standards set are truly common and comprehensive. If we do so, firms and consumers will benefit from wider access to new technologies, lower costs, and much more future innovation. In creating these new rules, we will adapt to yet another revolution in our economy and preserve what we have inherited from those who came before us: The equitable access to essential infrastructure.

References

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