Introduction
As the promise of the next-generation mobile communications technology becomes clearer, policymakers are increasingly focusing on the technological and policy foundations of 5G leadership. The mobile revolution has already delivered unimagined benefits the world over from innovative apps delivering healthcare services to remote villages in developing countries to the equally innovative development of the “sharing economy” with Uber and Airbnb. 5G promises to go even further. It will not be merely a marginal improvement over the previous generations of cellular standards but will instead bring what many have called the “next industrial revolution.” 5G will make everything more interconnected and efficient—from financial services to national defense to power grids to basic utilities provided in smart cities. Estimates predict that by 2035 5G will contribute over $13.2 trillion to the global economy. Given the importance that 5G will have for the US innovation economy, policymakers have focused on promoting and securing 5G leadership. They have also become concerned about the national security implications of 5G leadership for at least two reasons. First, they are concerned about economic and other vulnerabilities being exploited by potential adversaries via foreign entities manufacturing or owning the underlying physical infrastructure. Second, they are concerned about the national security implications of simply falling behind in technological leadership as such. In sum, 5G technological leadership matters both for economic growth and for national security.

The policy discussion about 5G leadership, though, has been mired in confusion. 5G represents a complex technological and commercial ecosystem, and commentary about 5G leadership has been misdirected by mistaken assumptions. In the interest of promoting policy discussions grounded in the proper technological and economic evidence, this Statement highlights two essential facts that must inform all discussions about 5G leadership: (1) 5G hardware and infrastructure is only one of the many layers of a much larger 5G ecosystem, and (2) patent counting is an unreliable methodology to identify the leading 5G technological innovators.

5G Infrastructure is Only One of the Many Layers of the 5G Ecosystem
Many commentators and policymakers focus on the hardware and telecommunications infrastructure when discussing 5G leadership and national security. Hardware and infrastructure are important. But they are not the only components of the innovation ecosystem represented by 5G, nor are they the only important ones when it comes to national security.

5G represents a multi-layered technological ecosystem. The foundation of this ecosystem is the 5G transmission technology—the technical standard developed through the
The 5G technological standard will make possible new capabilities that do not currently exist in 4G, just as 4G made possible new capabilities unrealizable and unforeseen during 3G, such as the rise of Uber, Airbnb, and other gig economy services. In fact, 5G represents effectively a multi-generational leap forward given its technological advances in speed, latency, and reliability. On the top of this foundational 5G technological standard, there will be consequently several layers, from telecommunications infrastructure to communications technologies to the end-user services that ultimately meet a broad range of needs throughout civil society.

Discussions about this multi-layered ecosystem, however, have focused almost entirely on hardware and infrastructure. Articles now regularly report on public and private investments by national governments and private firms in building and installing base stations and other infrastructure components. This is important, but this is not the fountainhead of the innovation ecosystem created by 5G.

**Patent Counting Is an Unreliable Methodology to Determine 5G Leadership**

When commentators do recognize the importance of the 5G technological standard, they have been making another profound error: they are relying on simple counts of the total number of patents for measuring 5G leadership. As a result, Huawei is often proclaimed to be the global winner of the 5G race. It is undeniable that Huawei is one of the leading contributors to 5G technological innovation. But the “world leader” status bestowed on it is a byproduct of an overly simplistic and unreliable methodology.

There are important limitations with using patent counting as a measure of innovative output, as economists and statisticians have long recognized. The fundamental flaw in this method is that it assumes that all patents have equal value. However, numerous empirical studies have shown that the value of patents varies enormously, i.e., a small percentage of patents cover technology of great importance and other patents cover technologies of more marginal value. The nature of the technology, the commercial sector in which this technology is being deployed in the marketplace, the nature of the firms using these patents, and many other heterogenous variables all impact the value of specific patents. Simply counting the number of patents fails to account for this heterogeneity in the value of patents and it can have the effect of diluting the value of significant innovations.

This is why economists consider information about the number of patents to be a “noisy” indicator of innovative output. This is not to deny that national-level patenting can provide valuable information about innovative activities if one controls for key variables, such as GDP and population. However, merely counting the number of patents in a company’s portfolio cannot provide reliable information about the company’s innovative contribution. What matters is the quality, not the quantity of patents.

Put simply, counting the number of patents in a company’s portfolio is unlikely to provide a reliable estimate of what companies have been leading technological contributors in 5G. Rather, it creates a misleading picture given the incentives it creates, as will be discussed in the next section. This is of particular concern in the context of 5G, which is a sector that is consider of imperative importance for national security and economic progress.

**The Risk of Creating Wrong Incentives for Businesses and Governments**

Undue focus on 5G hardware and infrastructure, combined with the reliance on unreliable methodologies to determine 5G leaderships, produces several problems in public policy and in the private sphere. First, as matter of public policy, if policymakers focus on the incorrect part of the 5G ecosystem, or they rely on a simple count of the total number of patents
to determine 5G leadership, they may enact regulations or legislation based on mistaken assumptions about actual contributions by companies (or countries) to 5G technological innovation. The US government might respond to mistaken assumptions about China’s “world leader” status by adopting policies that could undermine the benefits of global interoperability in the mobile revolution. One example is the call for the US to respond to China’s “world leadership” status by building a government-operated 5G network.

Reliance on patent counting also risks creating “perverse incentives,” as the UK Supreme Court recently recognized. Companies rationally respond to the patent counting methodologies to assess innovation leadership status, and thus they create incentives that lead to further distortions in patent count data. For example, a firm might over declare essential patents at standard development organizations (SDOs) to increase its total number of patents that many now count as essential for 5G. As with patent counts, declarations of essential patents are similarly noisy given the standard development process, incentives for over declaring patents to avoid legal liability, and the reliance of SDOs on the good faith of companies to make appropriate declarations.

Similarly, countries might adopt measures that artificially inflate the number of patents filed by their own citizens or companies, leading to overstatements of a country’s position as an innovator at the global level. For example, some studies show that the recent increase in the number of patents in China is explained, in part, by factors unrelated to actual innovative output, including direct government subsidies to file patents that increase total patent filings and result in a decrease in patent quality. When firms or government engage in such practices, data about the number of patents is not only noisy but actually provides distorted information about innovative contributions.

Finally, patent counting might have negative consequences on firms working in the US innovation economy. This risk is particularly manifested in litigation if judges or regulators rely on simple counts of total patents as a metric for determining the value of patent portfolios. The failure to account for differences in patent quality risks overcompensating some patent holders, namely those with less valuable technologies, but undercompensating those that have developed breakthrough innovation. This creates a feedback loop that impacts R&D decisions by firms developing technologies like 5G. Ignoring the heterogeneity between the value of patents might encourage firms to invest in the development of less valuable, incremental technologies, rather than those that are more costly to develop but provide more valuable innovative contribution.

**Conclusion**

5G technological leadership matters, and the current policy discussions are profoundly mistaken. They are confused about the nature of the innovation that matters most—the 5G technological ecosystem versus infrastructure—and they are confused about the proper metrics to use in evaluating 5G technological innovation itself. This is not a purely “academic” concern. Ensuring proper evidence-based policy making matters for public policy, such as national security, for the innovation economy, and for the firms making the long-term business decisions to invest in creating new technologies like 5G.
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Endnotes


6. See https://www.3gpp.org/.


16 See, e.g., Krisztina Pusok, Nationalizing 5G Is Not the Way to Win, RealClearPolicy (Oct. 16, 2020), https://www.realclearpolicy.com/articles/2020/10/16/nationalizing_5g_is_not_the_way_to_win_580909.html.

17 Unwired Planet Int’l v. Huawei Techs., [2020] UKSC 37 at 44 (UK Supreme Court) ("[T]he process of negotiating rates by ‘counting patents within a portfolio creates a perverse incentive to over-declare.’").


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