

# Innovation in 5G technology: leadership, competition and policy issues

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## My contribution today

- To provide an overview of the *Telecommunications Policy* Special Issue, with the aim to highlight some common themes emerging from a joint reading of the papers
- To present a capsule summary of my own paper in the Special Issue

# The approach taken in the SI: 5G as a GPT

## GPTs are technologies...

- (1) pervasive in their use;
  - (2) intrinsically capable of self-regeneration and ongoing technical improvement;
  - (3) enabling further downstream innovation in application sectors
- (2) + (3) = “innovational complementarities”

- This [motivates interest in 5G](#), as adoption of GPTs is key to productivity improvements – a theme relevant for most countries, and particularly for those experiencing productivity slowdowns
- It [provides a lens through which organizing thinking around 5G innovation](#):
  - generation of knowledge and technologies that are progressively incorporated in the 5G standard – can be analysed quantitatively, as a wealth of data is now available
  - downstream innovation – can be analysed with a comparatively more speculative approach, and a focus on policy levers that may influence overall value creation

# Innovation in the 5G standard: overview of contributions

3 contributions aim to identify **leadership patterns** and to explore the **geography and dynamics of 5G-related knowledge creation**

Value added from these contributions:

- (1) They go **beyond mere count of patents and standard contributions** as measures of companies' and countries' relative position in the "5G race"
- (2) They **broaden the set of measures to encompass publications**, which provide a different view of participation to 5G development

## **Parcu, Innocenti, and Carrozza, "Ubiquitous technologies and 5G development. Who is leading the race?"**

- Focus on EPO and USPTO patents (2010-2019)
- Provides relative positioning of countries w.r.t. 5G innovation as captured by two measures of technological complexity (diversity and ubiquity), useful to capture competitive advantage in 5G innovation

## **Buggenhagen and Blind "Development of 5G – Identifying organizations active in publishing, patenting, and standardization"**

- Considers patents, standard contributions (technical/non-technical) and publications (2010-2021)
- Offers overview of companies/countries' position and highlights correlation between the 3 measures for SEPs licensors

## **Mendonça, Damásio, Charlita de Freitas, Oliveira, Cichy, and Nicita "The rise of 5G technologies and systems: a quantitative analysis of knowledge production"**

- Bibliometric analysis of scientific publications through time (2005-2020), with info on their quality (e.g., citations, content)
- Finds prominence of China in terms of total citations, of the US in terms of citations/publication. Both are only in middle position in terms of Scimago journal ranking metrics

## Innovation in the 5G standard: what do we learn from a joint reading of the contributions?

- **Increasing complexity** of 5G technologies through time
- **Increasing concentration** of patents and standards in few countries/companies, decreasing concentration of research

	Share of 5G peer-reviewed articles	Share of all citations to authors in a geographical area	Share of 5G patent families	Share of 5G accepted weighted standard contributions
<b>China</b>	25%	19%	41%	38%
<b>US</b>	11%	16%	16%	18%
<b>EU</b>	25%	29%	11%	24%
<b>South Korea</b>	6%	7%	22%	9%
<b>Japan</b>	2%	1%	8%	4%
<b>Others</b>	31%	27%	2%	8%

Source: Buggenhagen and Blind Mendonça et al., this SI

- When considering EU countries together, under the hypothesis of coordinated action, EU position in the global “5G race” improves significantly
- The EU appears relatively more focused than the US and China on contributing to the less appropriable part of 5G innovation

# Downstream innovation: overview of contributions/1

5 articles address policy issues that influence innovations complementary to the 5G standard

Value added from these contributions:

- (1) They address a **wide range of policy levers** relevant to 5G innovation
- (2) They **deepen our understanding of ongoing policy debates**

## ***Kú's and Massaro "Analysing the C-Band spectrum auctions for 5G in Europe: Achieving efficiency and fair decisions in radio spectrum management"***

- Analyses impact of a range of choices in the design of spectrum assignment on network availability
- Highlights heterogeneity of NRAs' choices in terms of equity and efficiency

## ***Knieps and Bauer "Internet of things and the economics of 5G-based local industrial networks"***

- Explores how spectrum policy choices influence cost-benefit profiles of alternative solutions for implementing 5G industrial networks
- Argues in favour of a hybrid spectrum policy approach that fully preserves the possibility of trial-and-error processes

## ***Nikolic and Galli "Patent pools in 5G: The principles for facilitating pool licensing"***

- Highlights why benefits from patent pools are particularly sizeable with 5G licensing
- Proposes a set of five policy principles meant to facilitate pool licensing in the IoT

## Downstream innovation: overview of contributions/2

5 articles address policy issues that influence innovations complementary to the 5G standard

Value added from these contributions:

- (1) They address a **wide range of policy levers** relevant to 5G innovation
- (2) They **deepen our understanding of ongoing policy debates**

### **Bauer and Bohlin “Regulation and innovation in 5G markets”**

- Addresses a wide set of regulatory instruments that may affect horizontal and vertical business relationships along the 5G-enabled value chains
- Proposes a new approach to regulation in 5G-related domains: innovation-centered and general equilibrium

### **Rossi “The advent of 5G and the non-discrimination principle”**

- Explores how the non-discrimination principle, which informs aspects of both upstream and downstream regulation relevant to 5G, should adapt to technological evolution in order to maximize the value created through innovation
- Cautions against overly rigid interpretations of the principle in a context characterized by significant uncertainty

# Innovation in applications: what do we learn from a joint reading of contributions?

Two common themes:

- **Uncertainty** in the evolution of 5G-related technologies should be taken seriously in any policy attempt at reaping the benefits from 5G innovation.
  - committing to rigid interpretations of rules, mostly backward-looking and derived from past practices, risks jeopardizing “innovational complementarities” in a context characterized by radical uncertainty.
- The prospective evolution of 5G innovation requires a **much greater extent of differentiation in the type of policy tools adopted and the acceptable contractual arrangements** among different players.
  - this is connected to the GPT nature of 5G and holds particularly for spectrum assignment and SEPs licensing

# My own paper in the SI: 5G and the non-discrimination principle

- Value added of the paper: to provide a **unified view of non-discrimination across both upstream and downstream regulation domains** relevant to 5G:
  - non-discrimination in FRAND licensing of SEPs
  - network-level non-discrimination
  - technological neutrality
- Focus on **how the design of the principle balances incentives to invest** in common inputs (networks and essential patents) and in their applications
- Main policy insights:
  - Some declinations of the ND principle are technology-dependent and market-structure-dependent and are made obsolete by technological evolution (Smallest Saleable Patent Practicing Unit (SSPPU) in SEP licensing; notion of “specialized services” in the context of network neutrality rules)
  - The opportunity cost of limiting contractual and organizational freedom through rigid interpretations of the ND principle is higher in presence of 5G-induced uncertainty; rules forcing uniformity should be reconsidered (zero-pricing in network neutrality, induced adoption of vertically-separated organizational forms and uniform SEP royalties)

## Concluding remarks

- While one of the themes of the SI is the issue of assessing current leadership in 5G development, it should be kept in mind that 5G is a standard, whose purpose is to maximize adoption
  - The “race” dimension should not be over-emphasized, as the benefits from the 5G standard will in the end have a global reach
- Policy choices may have an important impact on the timing of 5G diffusion and on the extent of complementary 5G innovation that will unfold at the local level
  - These considerations should be incorporated across the many policy domains that affect 5G innovation

# Thank you for your attention!

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