Key Note: Competition and Innovation in the Digital Environment

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I. Introduction

We live in formative times. Digital technology is changing our markets and lives to an extent last seen in the industrial revolution.[1] Some of the changes have already taken place and some are even taken for granted (does anyone remember the days when communication between producers and buyers was mainly by phone or snail-mail? Or when comparisons between products required going to distributors or comparing catalogues?). Other changes are gaining momentum fast. Let me give some leading examples:

- The ability to collect, analyze and store vast amounts of data (often called big data), which, in turn, enables us to have access to more information and also detect correlations (rather than causalities) between variables that reveal patterns and trends in many areas of our lives, from healthcare to the most popular present for Xmas. This, in turn, increases our predictive abilities about issues from consumer preferences to the outbreak of diseases.
- Interestingly, data tools are sometimes used not only to extract information, but also to create or affect it. One known example is Facebook's experiment with how to change user's emotions (not only detect them). This, in turn, may affect our wellbeing in ways we do are not even aware of;
- The increasing role of algorithms in making decisions for us; For example, in some smart cities the lights are synchronized to the amount of traffic at a given time; navigation apps such as Waze tell us what is the best route to take at any given time; and suppliers, such as Uber, use algorithms to determine the price of taxi rides at any given time, so as to maximize their revenue at given market conditions;
- The ability of "things" to communicate with each other through the internet, without a need for a human intermediary. Soon enough, our driverless car would be able to go fill itself with the cheapest gas it finds in a given radius, or communicate with a robot mechanic and relieve us from the need to spend hours waiting at the garage for our car to be fixed; or our watch will let our fridge know what vitamins and minerals we lack, so that the fridge can order from the online supermarket the ingredients necessary for a meal which suits our health requirements.

[1] The European Commission ("Commission") has recognized that "The global economy is rapidly becoming digital. Information and Communications Technology (ICT) is no longer a specific sector but the foundation of all modern innovative economic systems." Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Digital Single Market Strategy for Europe, Brussels, 6. 5. 2015 COM(2015) 192.

And this is just the beginning. So that we can surely say that we- and especially the next generations -will live in a world which is much different from the one we know. Already it is predicted that many of the jobs we hold today will be gone, and many will change their focus and methods. For example, sophisticated healthcare products would be privately-administered. Already scientists are developing kits for home use that measure bodily parameters and reduce the need to use labs or lengthy processes for diagnosis, and doctors can work with more personalized information about their patients.

While the focus of this conference is on the economic effects of such changes, it is worth mentioning that effects may also be social and psychological. To share with you one thought, would we be necessarily happier in a world in which most of the decisions are made for us by machines- so that we make the meta-decisions (e.g., which car or fridge to buy) but most of the everyday decisions and actions (even going to the supermarket to decide what to buy and prepare to eat) would be performed by robots and algorithms? I am not sure the answer is positive, even if our lives will be more efficient and the "right" decisions will be made. How would this affect people's self-esteem? And what would they choose to do in their spare time? Also- It is important to rethink the effects of such technologies on accelerated economic and political inequality, as "[t]hose who own the robots and the tech are becoming the new landlord[s]."These issues, which are of no less importance than the economic consequences of the digital revolution, are a basis for another discussion.

So-how does this brave new technological world affect competition and innovation, and what role should regulation play in it? This is the question I have been asked to address today. The question is not new. As early as the 1990's there was an abundance of writings on how digitization affects our lives, spurred by the Microsoft case. Yet as technological advancements increase exponentially, so does the need to ensure that the benefits of our brave new world are not outweighed by its costs.

The effects of the digital environment on our economy are, of course, not similar across markets. Yet some trends can nonetheless be recognized. I shall focus on three disruptive effects, which are relevant to our discussion:

- The lower costs of production and supply of some products and services. These range from essential cross-market inputs (e.g., telecommunication) to industry-specific (e.g., a special part for certain product, that can be printed by a home-based 3d laser printer, with no need to seek the part in special stores);
- The increased role information plays in the new economy, both for consumers and producers;
- The increased role algorithms and mechanical devices (such as robots) play in making decisions and taking actions.

Each of these technological changes opens a Pandora's Box of questions. The issues that arise are fascinating and challenging, since they involve the adjustment of

traditional remedial tools, designed for relatively static goods, to a new technologically-driven world. Let me offer some thoughts on each of them, in order to fuel the discussion.

II. Lower costs of production and supply

Lower costs of production and supply of many goods and services in the digitized environment are a dream-come-true for market supporters. This is one of the main goals of the competitive process, especially when lower costs result not only from static efficiencies, but rather from dynamic and productive efficiencies that save costs of production and supply and thus lower the dead-weight-loss.

What enables these lower costs? Investments in technology have resulted in tremendous efficiencies. Today, robots and algorithms can perform more cheaply, efficiently and effectively many of the tasks of the past, as well as new tasks that we could not have even dreamt of. Some goods may be produced at or near a marginal cost of zero – and even fixed costs of some goods are falling rapidly. This phenomenon is so important, that some commentators call it a "world-of-abundance", (or a "post scarcity" world), at least for some parts of the world population.

Philip Sadler,[2] for example, describes "[t]he world's most highly developed economies [as] moving at an accelerating pace towards as state of post---scarcity, an age of abundance, a state in which an ever wider range of economic goods and services are available in abundant supply and at extremely low cost".

Relevant technological advances include, inter alia, 3D printing, robotics, synthetic biology, and, the internet which adds value by knitting all of these together.[3]

Just think about the book printing industry. As the U.S. court noted in the Apple ebooks case: "while the printing press had been a constant of book publishing for centuries, ebooks "had the potential to change the centuries-old process for producing books by eliminating the need to print, bind, ship, and store them."

Or think about the great potential that 3D printing offers: the possibility of a 3D printer in millions of private homes that prints objects based on information available over the internet. Finding a unique machine part to replace one that just is now easier, more efficient and cheaper than ever. This, in turn, significantly reduces the costs of distribution, communication and production.

Similarly, advances in robotics may allow general-purpose robots to serve as generative platforms that allow owners to use them for many tasks, depending on the software

[2] Philip Sadler, SUSTAINABLE GROWTH IN A POST---SCARCITY WORLD (Gower 2010); Jeremy Rifkin, THE ZERO MARGINAL COST SOCIETY (Palgrave MacMillan 2014), p.11.

[3] See, e.g., Mark Lemley, IP in a World Without Scarcity, 90 NYU L Rev. 461 (2015); James Grimmelman, *Indistinguishable from Magic: A Wizard's Guide to Copyright and 3D Printing,* 71 Wash. & Lee L. Rev. 683, 696 (2014); Salil Mehra (2015)

(apps) available. People worldwide will be able share instructions for how to use these technologies, thereby reducing labor costs dramatically.

As Lemley writes[4]

> "[N]ew technologies promise to do for a variety of goods and even services what the Internet has already done for information . . . Combine the[] four developments – the Internet, 3D printing, robotics and synthetic biology – and it is entirely plausible to envision a not-too-distant world in which most things that people want can be downloaded and created on site for very little money."

Analysts suggest that technologies such as artificial intelligence, big data, and the Internet of Things "all destroy existing systems and replace them with new ones" that will "increase living standards by lowering costs and improving quality."[5]

So why worry?

The concern is that such advancements will not bring what they can offer, due to strategic behavior of market players. One concern is that firms will protect their profits by stalling efficiency. This can be done by unilaterally deciding not to develop or advance a disruptive technology, or by (tacitly or explicitly) colluding with others which have the potential to create similar breakthroughs, not to invest in such technologies, thereby creating a socially inefficient technological status quo.

Another concern, voiced by Krugman, is the creation of "artificial scarcity" by those that control the new technologies, whereby "profits increasingly reflect market power rather than [costs of] production."[6] Some commentators have also raised the possibility that firms will use their power to create political economy pressures on legislators and regulators to erect barriers to new technologies.

What can be done to ensure that consumers enjoy the benefits?

Let me share some thoughts:

- Recognize the transition and the forces that might fight against it: Actively seek instances which create artificial scarcity;
- Rethink legal barriers- most importantly IP and its relationship with dynamic efficiency in such markets; Indeed, some IP scholars are already rethinking the balance; But also rethink other types of regulations that might erect barriers.
- Adjust existing tools to the new environment. For example, avoid a new type of Cellophane Fallacy by assuming that the current cost level is competitive;[7] or recognize that price regulation will be more difficult, because it must account not only (or mainly) for marginal costs of production.
- An interesting idea in this regard, worth thinking about, raised by Hovenkamp and Bohannon, is to apply a different approach to cases in which the defendant

[4] Lemley, supra.

[5] Salil Mehra, "Antitrust and the Robo-Seller: Competition in the Time of Algorithms" 100 Minnesota L. Rev. (2015); Salil Mehra, "Competition Law for a Post---Scarcity World" 2016 ("Post Scarcity"), available online.

[6] Krugman, June 13, 2013, "Sympathy for the Luddites".

[7] Mehra, Post Scarcity, supra.

actually created the cost-reducing disruptive technology and seeks to exclude others by otherwise legal means, and cases where the excluder does not fit into this category, and in particular apply the essential facility doctrine only in the latter.[8]

- Rethink the employment of new tools. For example, use government-supported mavericks to change the status-quo:[9] give subsidies (not in the form of IP) to the first to introduce a disruptive technology that would incentivize others to enter this market.

III. Increased role of information[10]

The advent of new technologies has led, inter alia, to the ability to collect, store and analyze vast volumes of real-time and constantly updated data regarding conditions and actions that take place around the globe. Such data is wide-scoped, including natural conditions (e.g., temperatures and the amount of rain fall) and user's conduct, thoughts, emotions, characteristics and preferences. The "Data Religion" practiced by many, which worships sharing and transparency and whose main principle is more transparent data is better, and the willingness of most users to share data for only a small discount or benefit, further increase the amount of data that can be collected. This, in turn, has led to the creation of big data intermediaries which specialize in the collection, management, analysis and visualization of big data.

In order to make such data more valuable, data collection is not only passive (e.g., collecting what the user has chosen to make public), but is becoming more and more active (e.g., inducing consumers to react to certain kinds of information or experimenting with induced changes of emotions on consumers' preferences). In addition, firms compete for user's attention- which creates data- by creating new, improved or free web applications.

And this is just the beginning. New developments further increase the ability to gather large amounts as well as more accurate and structured data from new sources. For example, the development of the internet-of-things enables the collection of more data regarding actions in real-time (e.g., the fact that an individual is looking into the fridge for something to eat, and the fridge contains known products).[11] Indeed, there are countless digital sensors worldwide in industrial equipment, automobiles, electrical meters and shipping crates. They can measure and communicate location, movement, vibration, temperature, humidity, even chemical changes in the air. Another example involves the development of psychological-research-based algorithms to increase the ability of "things"- such as e-book readers- to determine readers' moods and suggest products that might fit such moods. And these are two technological advancement that we know about. While it is estimated that currently the amount of data available is more than doubling every two years, new developments may further increase this rate

[8] Hovenkamp and Bohannon.

[9] Michal S. Gal, "Reducing Rivals' Prices: Government-Supported Mavericks as New solutions for Oligopoly Pricing," (2001) 7 *Stanford Journal of Law, Business and Finance* 73.

[10] Largely based on Dan Rubinfeld and Michal S. Gal, "Barriers to Entry in Big Data Markets" (work in progress).

[11] OECD, Supporting Investment In Knowledge Capital, Growth And Innovation 320 (2013).

dramatically. Every day, Google alone processes about 24 petabytes (or 24,000 terabytes) of data.

Yet data, by itself, is often of low value. What gives it its value is its analysis, turning unstructured data into information (e.g., by using data aggregations) and derived information (i.e., information that was achieved by applying reasoning mechanisms to create new information that cannot be gathered directly from the data itself). The rapidly advancing techniques of artificial intelligence like natural-language processing, pattern recognition and machine learning, provide better analytical tools.

Such information has become an important input in our digital economy. It is valuable to commercial firms (e.g., it enables them to better target consumers by the creation of tailor-made ads to products they are likely to buy, to price discriminate between consumers based in their revealed preferences, and to know in advance more about potential employees and suppliers),[12] to governments (e.g., locating terrorist cells, predicting and possibly reducing the harmful effects of outbreaks of diseases, climate impacts, economic development or even governmental corruption), and to individuals (e.g., what do my friends think of certain issues, where should I spend my free time). Indeed, a report by the World Economic Forum, "Big Data, Big Impact," declared data a new class of economic asset, like currency or gold. In such a world, access to data collected and to the information created becomes a strategic and valuable asset. [13]

Regulatory challenges

Big data intermediaries or collectors raise a plethora of highly challenging questions for regulation, some of which have already been recognized in cases such as Google and Apple, and some of which are only beginning to be realized. In the limited time I have, let me raise some issues that I think are worth thinking about.

Let me start from a basic observation. Before we start debating how to solve regulatory challenges, we should first ascertain whether and where they exist. A first step therefore involves **determining the height of entry barriers into big data markets**. Sounds trivial? It should. Yet once you start reading the literature on regulation of big data markets you might observe that it is largely based on unproven assumptions. This has led Dan Rubinfeld (Berkeley, NYU) and myself to start digging deeper. While our work is still in progress, I can share with you some of our insights from a series of case studies we performed on big data users and collectors:

- Not all markets that collect or use big data are similar. Rather, big differences exist between markets;

[12] One study found that effective use of data and analytics correlated with a 5 to 6 percent improvement in productivity, as well as higher profitability and market value. Brynjolfsson, Hitt, and Kim, 2011.

[13] see, e.g., OECD, Data-Driven Innovation For Growth And Well-Being: Interim Synthesis Report 10 (2014).

- Obstacles generally fall into four categories: barriers to the collection of data, to its fusion, to its use by its "owner", and to making use of data collected and organized by someone else;
- Obstacles may relate to any or all of the four characteristics of big data: Volume (size), Velocity (change rate), Variety (multiple sources), and Veracity (trustfulness). Each of these characteristics has related costs, which may create entry barriers. For volume there are storage costs, for velocity the associated cost is the constant monitoring, variety creates costs of collection and integration, and for veracity the cost may be associated with the need to keep multiple variations of the same data (to support evidence).
- Some obstacles are government-made. For example, limitations imposed on the use of cookies for the collection on information, or limitations on the use of private information;
- Some obstacles are practical: firms do not have access to sources of information (e.g., records of how patients react to a certain treatment that could only be gathered from hospitals), or to past information, that might indicate trends. This obstacle an especially important barrier where meta-information is created by fusion of different sources;
- Other obstacles are technological. For example, an inability to store vast amounts of information, or differences in the quality of the algorithms used to analyze the data, especially where deep learning must be performed;
- Interestingly, some of these obstacles are beginning to be solved by the markets: for example today it is easier than ever, using the cloud, to buy additional storage capacity; or the availability of free-for-all algorithms that perform analysis of data, at least to some extent (some of which were created by social networks over the web such as FOSS communities);
- Observe that the analysis of entry barriers helps determine the boundaries of the market, as well as the market power of firms operating in it, issues that the EU, for example, has been grappling with in the case of Google.

Surprisingly there is not much in-depth research that has been performed about entry barriers into big data markets, and this is a role that economists should take upon themselves.

Another set of questions regards **the effects of such markets on competition and welfare**. If no negative effects are created, then why intervene? Indeed, the advantages of some firms in data gathering have triggered investigations around the world centering, inter alia, on privacy issues and on competition law concerns centering on the abuse of a dominant position. While the U.S. FTC has closed the investigation against Google,[14] the investigation in the EU is still on-going.[15] To violate the competition laws, Google would have to be found to enjoy a dominant position in EU markets (e.g., the market for on-line search, so that "competition is [not] a click away"), and to have abused this position (e.g., by designing its search algorithm to give unfair priority to its own websites over those of others, in order to ensure its continuing and expanding access to information).

[14] FTC investigation into Google

[15] EU investigation against Google

Some of the questions that we should think about in this regard include the following:

- How to define and prove the existence of significant market power in such markets?
- How to balance the competing interests, including competition, privacy and consumer welfare;
- How to balance a potential injury to competition in a big data market resulting from barriers to entry against the benefits to consumers from the exchange in the cyber economy, in which many goods and services are provided for free, in exchange for access to data and the ability to post targeted ads (e.g., search services and social networks are usually provided for free)?
- Are we looking under the lamp? If we are only applying existing tools such as established competition law doctrines, we might apply regulatory concepts and "boxes" that do not fit the new environment and do not capture conduct that harms welfare;

A final set of questions arises with regard to remedies. Let us assume that it was found that competition and welfare were harmed. What then? **What kind of remedies should be imposed in order to remedy the abuse and prevent its recurrence?**

Let me give one example. Traditionally, the remedy subscribed to deal with strong comparative advantages arising from access to a information that is essential in order to compete, was granting non-discriminatory and fair access to those of need of access which can further welfare (otherwise known as the "essential facilities doctrine"). For example, in the known Magill case, when information regarding weekly TV programs was deemed essential in order to create a weekly TV guide, the TV networks were mandated to provide it to the creator of such a guide.[16]

Yet once we employ this remedy in the realm of big data, a host of difficult questions arises. Some relate to the practical aspects of applying access to data in the real world. For example: should access be granted to all the data or only to part thereof? If the data- and the resulting information- is constantly changing, and its velocity is an important factor in determining users' preferences, how should access be applied- should access be granted at one point in time or on a constant basis? And if on a constant basis, should access to it be granted in real-time, or maybe on a weekly basis or an hourly basis? What if the value of the data - unfairly obtained- increases with its connections with other sources of data that were fairly obtained? Should intellectual property and data protection laws create an excuse for firms not to allow other firms to access their data? If access should be granted to the data, what price should those who are granted access be required to pay to the monopolist?

Jurisdictional issues also arise in the borderless cyber world: Should each competition authority grant access to data that pertains to users in its own territory, even if to fully

[16] EU Magill case

understand it you need data collected about foreign users as well? Should jurisdictions coordinate their remedies and what should be the outcome if they do not do so?

These are just some of the fascinating and novel questions that arise. Looking at past experiences will not provide us with sufficient answers. Rather, what is required is a new analysis which is sufficiently flexible to take into account the unique characteristics of big data.

IV. Increased role of algorithms and robo-sellers[17]

The increased automation of computerized protocols and mechanical devices have changed the way we interact, communicate and trade. Such automated decision-makers can monitor information and react to market changes with an ever-increasing speed. The development of artificial intelligence of computers, especially deep-learning techniques which enable the computer to optimize its strategy following trials and feedback, strengthen such abilities. Indeed, as Stucke and Ezrachi observe, "Sophisticated computers are central to the competitiveness of present and future markets."

How do they affect competition and welfare?

These algorithms may create benefits, to both sellers and purchasers. For one, they save seller's labor costs by automizing activities that would have otherwise been performed by (possibly many) humans. They also enable sellers to react much faster to changing market conditions, thereby once again savings costs (e.g. storage) and increasing sales. They also create benefits for consumers if such lower costs are translated into lower prices, and a better availability of preferred products.

Yet they also change the way firms interact, in ways that might be more difficult to capture under existing laws, given that the law currently considers the nature of illicit conduct through a 'human' prism.

One interesting example involves oligopolistic coordination between algorithmic systems.[18] This may be the case when computer algorithms promote a stable market environment in which they predict each other's reaction and dominant strategy. Such a digitalized environment may be more predictable and controllable. Furthermore, it does not suffer from behavioral biases and is less susceptive to possible deterrent effects generated through antitrust enforcement. Indeed, as Salcedo has shown, "when firms compete via algorithms that are fixed in the short run but can revised over time, collusion is not only possible but rather, it is inevitable."[19]

Moreover, algorithms may make cartels not only more likely to form but also more durable. Economists typically assert that cartels dissolve naturally after members cheat

[17] Largely based on Maurice Stucke and Ariel Ezrachi,"Artificial Intelligence & Collusion: When Computers Inhibit Competition" (2015).
[18] Id.
[19] Salcedo, "Pricing Algorithms and Tacit Collusion" (2015), available online.

or become irrational. When computers are the actors, detection is faster and not prone to human errors or failings, making defection less likely. Automated participants can identify price changes more quickly, allowing defectors who lower prices at the expense of the group to be sifted out earlier. Given this dynamic, participants have little incentive to either "cheat" the group or to leave it. Computers are likely to handle the classic prisoner's dilemma better than humans.

Another issue involves automated pricing algorithms, which are now ubiquitous in many industries including airlines, online retail and high-frequency trading. Optimal pricing algorithms can be highly profitable, as they recognize and take advantage of profitable opportunities. Yet they often lead to price discrimination, or to significant changes in prices. One known example involves Uber's use of its surge pricing algorithm to balance supply and demand when many cars are needed simultaneously. This led Uber, during a snowstorm in 2013, to charge Jessica Seinfeld 415$ to drop off her kids at a sleepover and a bar mitzvah. When Uber was criticized, the C.E.O. responded that "We are not setting the price. The market is setting the price. We have algorithms to determine what that market is".

Regulatory responses

Algorithms may sometimes be used as facilitating devices for illegal conduct. For example, humans agree to the cartel and use the computer to assist in implementing, monitoring, and policing the cartel. Beyond questions of evidence, these cases pose no enforcement problem, yet they might become more abundant, given the ease algorithms create to follow Stigler's three conditions for coordinated conduct. A recent U.S. case exemplifies this type of conduct.[20] The Department of Justice charged several firms with a price-fixing scheme involving posters sold through Amazon. To implement their agreements, the conspirators, according to the DOJ, "adopted specific pricing algorithms for the sale of certain posters with the goal of coordinating changes to their respective prices and wrote computer code that instructed algorithm-based software to set prices in conformity with this agreement."

Yet, as economists note, the need for explicit collusion as a basis for coordinated conduct will be reduced, due to algorithms. This creates a significant problem: if coordination is reached through the use of algorithms without explicit agreement or direct communication, it might fall outside the scope of the current regulatory framework. Absent the presence of an agreement, most competition agencies may lack enforcement tools, outside merger control, that could effectively deal with the change of market dynamics to facilitate tacit collusion through algorithms. This creates challenges of identifying the adequate level of intervention. Some argue that we need an "algorithm police." Yet regulators would have a difficult time regulating the algorithms and limiting attempts to design a machine to optimize performance while instructing it to ignore or to respond irrationally to market information and competitors' moves, or to pursue inefficient outcomes. Another idea worth exploring is algorithms as facilitating devices. Or, we might use different regulatory tools that currently do not exist in our toolbox.

[20] http://www.justice.gov/atr/public/press_releases/2015/313011.docx

Another set of questions regards the legality of surge pricing algorithms- here the EU has a better response than the U.S., in the form of excessive pricing, yet it must be applied in a manner which does not harm dynamic efficiency.

Another regulatory aspect involves algorithms as essential facilities for entering a market. Where the algorithm is the bottleneck to access, regulators should consider applying principles along the lines of the essential facility doctrine to enable access.

V. Conclusion

We live in technologically changing and challenging times. The change requires us to understand its effects in our lives and to design adequate regulatory responses. This requires us to rethink existing tools and think outside the box, in order to ensure that indeed we, as a society, benefit from such changes. I hope I have provoked some thoughts about what lies ahead.