



COMPETITION POLICY IN THE DIGITAL ERA

with a special focus on the challenges raised by

ALGORITHMS

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OECD, Competition Division



OUTLINE

- DIGITALISATION
 - OECD's WORK ON DIGITALISATION
- ALGORITHMS
 - RISKS AND BENEFITS
 - ALGORITHMS & COLLUSION
 - CHALLENGES
 - REMEDIED?
- POLICY IMPLICATIONS





DIGITALISATION





*“Digital transformation is characterized by **a fusion of advanced technologies and the integration of physical and digital systems**, the predominance of innovative business models and new processes, and the creation of smart products and services.” - European Commission*

*"**The industrial revolution of our time is digital.** We need the right scale for technologies such as cloud computing, data-driven science and the internet of things to reach their full potential. As companies aim to scale up across the **Single Market**, public e-services should also meet today's needs: be digital, open and cross-border by design. The EU is the right scale for the digital times.“ - Andrus Ansip, EU Commissioner, Vice-President for the Digital Single Market, Brussels 19 April 2016*



*“The digitalisation of our economy, of our society, of our daily lives is, as we all know, having a huge effect on all aspects of human endeavour. It’s surely not surprising, then, that **this should include our own field of endeavour, competition or ‘antitrust’ law and policy.**” - CMA, 15 November 2016*

*“**Competition rules can't solve every problem on their own. But they can make an important contribution to keeping digital markets level and open.** So that consumers get innovative products at the right prices. And so that digital entrepreneurs, however big or small, have a fair shot at success.”
- Margrethe Vestager, Munich, 17 January 2016*



DIGITAL ECONOMY

- Umbrella term

“...the part of an economy that enables and conducts the trade of goods and services through e-commerce” (OECD Hearing on the Digital Economy, 2012)



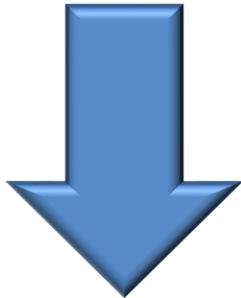
BUT

- Traditional (offline) vs digital (online) world is interconnected and integrated -> **no clear boundaries**
- **Impacts** of the digital economy **spill over to other areas** and to the society



CROSS-BORDER DIGITALISATION

- Cross border digitalisation leads to **market integration**, promotes **international trade** and enables new **data-driven business models** that promote competition and economic growth.



Potential benefits from enhanced competition:

- Lower prices
- Quantity, quality & variety of services
- Product and process innovation





CROSS-BORDER DIGITALISATION PROMOTES INNOVATION AND LEADS TO ECONOMIC GROWTH

- Digital platforms have served as the basis for many disruptive innovations (taxis, hotels, financial services, legal services...):
 - Cutting out intermediaries and reducing costs
 - Providing flexible employment opportunities
 - Addressing market failures normally dealt with by regulation
- Data analytics has enabled multiple innovations with benefits for firms and consumers:

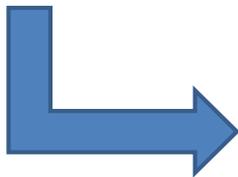
Applications of Big Data & Algorithms

- New products & services
- Personalised recommendations
- Supply-chain optimisation
- Product recommendations
- Dynamic pricing
- Fraud prevention
- Risk management
- Product customisation
- Real-time supply
- Consumer information



CROSS-BORDER DIGITALISATION CAN BRING **BENEFITS FOR ALL**

- Gains from digitalisation can also be captured by developing economies:
 - Countries without the infrastructure can benefit from the computational power and software developed elsewhere
 - Dissemination of data promotes **economic convergence** (e.g. data from country A can be analysed by country B to improve policies in country C)
 - Cross-border digitalisation exerts competitive pressure on established national monopolies



Inclusive growth



BUT CROSS-BORDER DIGITALISATION ALSO BRINGS NEW **CHALLENGES** FOR COMPETITION POLICY...

**Dominance of
online platforms**

**Non-price
competition**

**Concentration of
data holdings**

**Blurring of market
boundaries**

**Competition for the
market**

**Rapid market
changes**

Algorithmic pricing

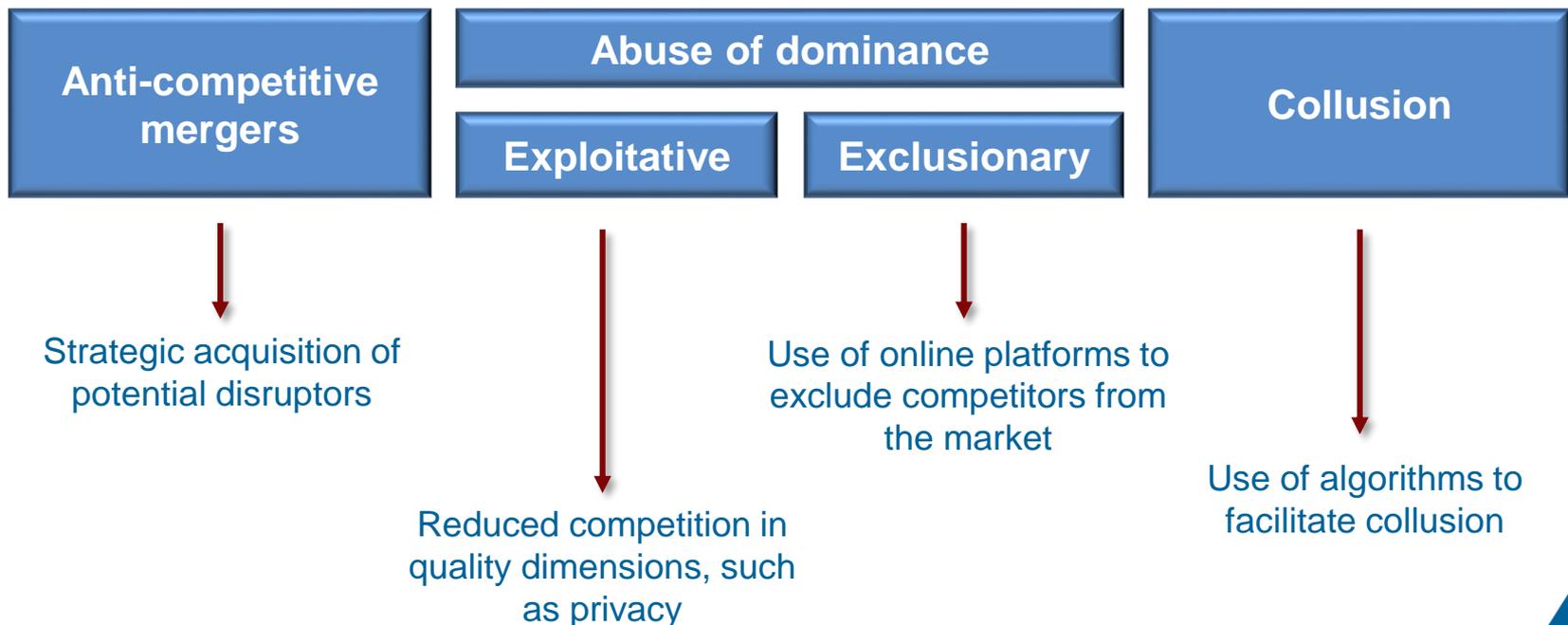
High transparency

**Disruptive
innovation**



COMPETITION CONCERNS STEMMING FROM CROSS-BORDER DIGITALISATION

- Digital markets are characterised by **economies of scope**, **economies of scale** and **network effects** that can lead to market power and enable new anti-competitive strategies:





OECD's WORK ON DIGITALISATION

(1) OECD-wide work: GOING DIGITAL

GOING DIGITAL

Making the transformation work for growth and well-being

Our ambition



“The OECD's Going Digital project will give policymakers the tools they need to help their economies and societies prosper in a world that is increasingly digital and data-driven.”

#Going Digital

Just released

OECD Digital Economy Outlook 2017:
What artificial intelligence really means for
policy makers

Published on October 11, 2017





OECD'S WORK ON DIGITALISATION

(2) COMPETITION PERSPECTIVE

- DIGITAL ECONOMY -> long-term strategic theme of the Competition Committee

Sub-streams:

- (1) Relationship between the digital economy, competition law and innovation
- (2) Challenges posed to antitrust tools and approaches
- (3) Practical challenges to competition enforcement
- (4) Detailed industries and sectors
- (5) Role of competition vs regulation



<http://www.oecd.org/competition/digital-economy-innovation-and-competition.htm>



OECD'S WORK ON DIGITALISATION

(2) COMPETITION PERSPECTIVE CON'T

- Policy discussions, hearings, roundtables related to the Digitalisation

General policy issues

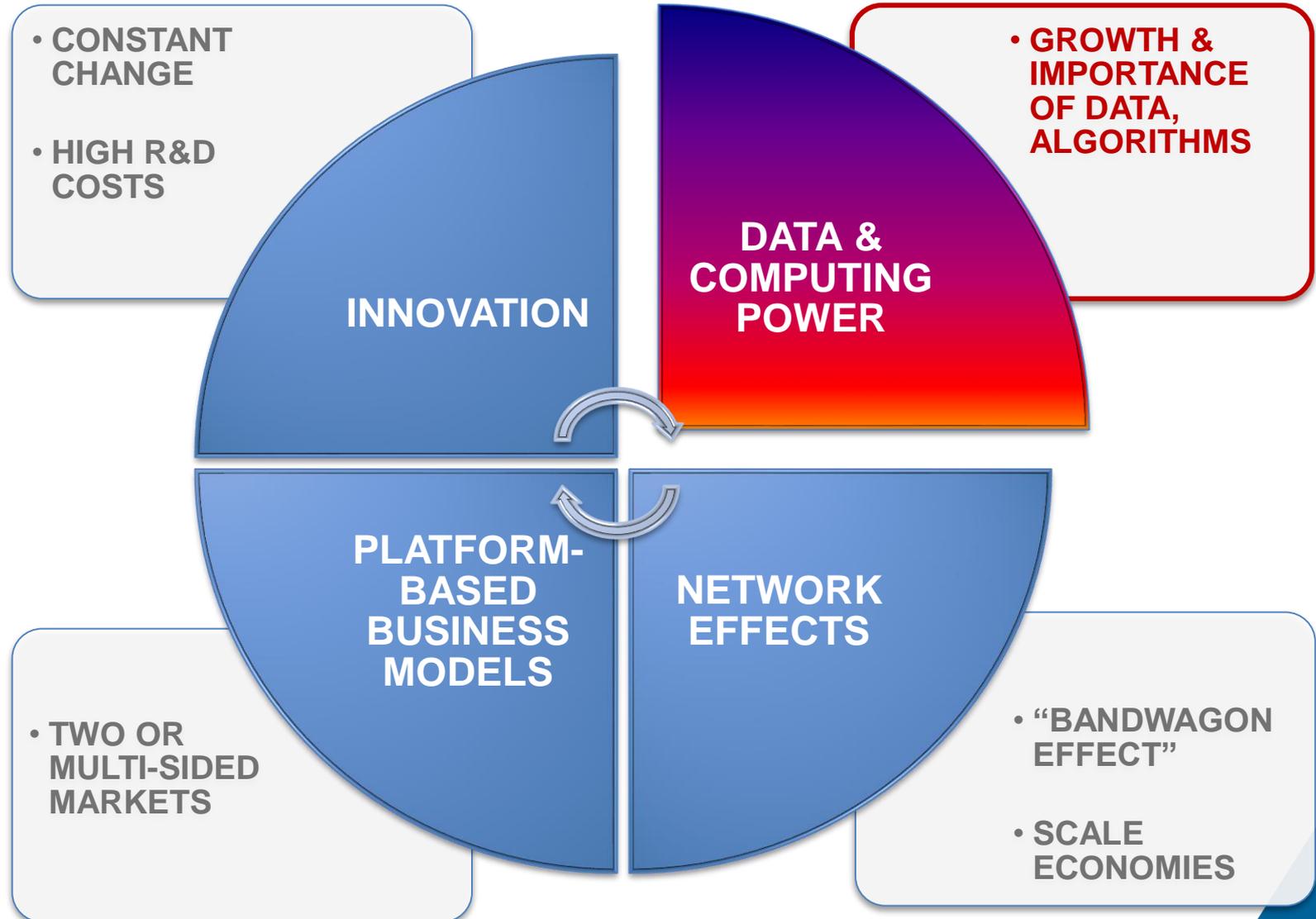
- ✓ Merger review in emerging high innovation markets (2002)
- ✓ Competition, patents and innovation (2006, 2009)
- ✓ The digital economy (2012)
- ✓ Disruptive innovation in competition law enforcement (2015)
- ✓ Disruptive innovation and their effect on competition (2015)
- ✓ Big Data: Bringing competition policy to the digital era (2016)
- ✓ **Algorithms and collusion (2017)**
- ✓ Rethinking the use of traditional antitrust enforcement tools in multi-sided markets (2017)

Sector specific topics

- ✓ Vertical restraints in online sales (2013)
- ✓ Disruptive innovation in financial markets (2015) in legal services (2016) in land transport (2016) and in the electricity sector (2017)

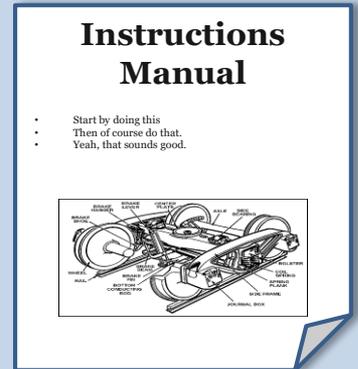


SPECIFIC FEATURES OF THE DIGITAL ECONOMY





DEFINITION OF ALGORITHM

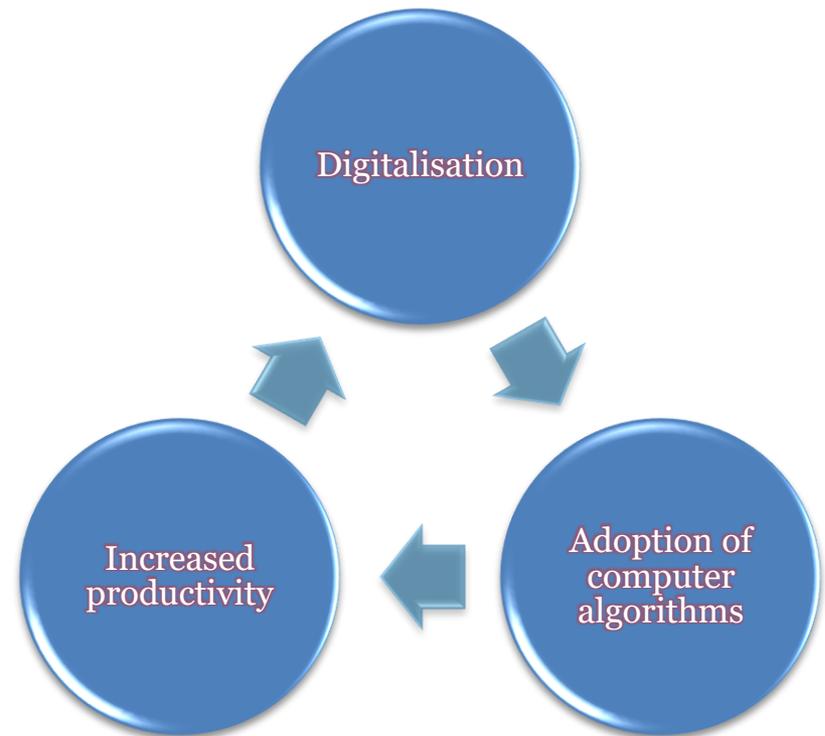


“An algorithm is an unambiguous, precise, list of simple operations applied mechanically and systematically to a set of tokens or objects. (...) The initial state of the tokens is the input; the final state is the output.”
Wilson and Keil (1999)



HOW CAN ALGORITHMS BE REPRESENTED?

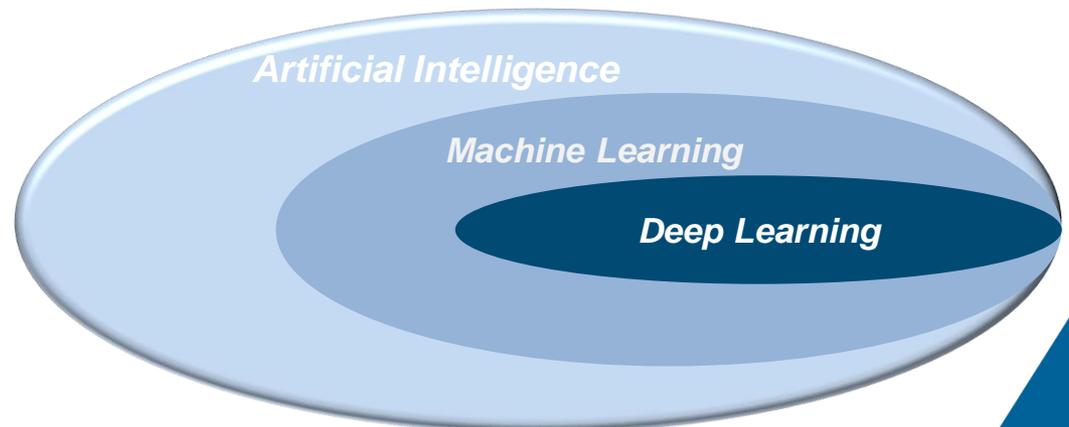
- Plain language
- Diagrams
- Voice instructions
- Computer codes
 - Automatic
 - Fast processing
 - Complex calculation





PROGRAMMING PRINCIPLES

- **Artificial intelligence**
 - Detailed algorithms that mimic human intelligence, “*the science and engineering of making intelligent machines*” (John McCarthy, 1956)
- **Machine learning**
 - Algorithms that iteratively learn from data, “*the ability to learn without being explicitly programmed*” (Samuel, 1959)
 - Learning patterns: supervised, unsupervised, reinforcement
- **Deep learning**
 - Artificial neural networks that replicate the activity of human neurons...



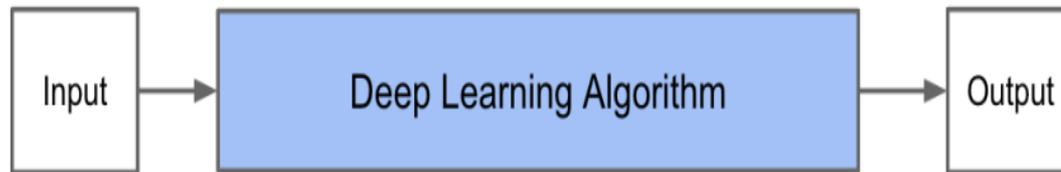


MACHINE LEARNING (ML) VS DEEP LEARNING (DL)

- Difference: ability to process raw data
- ML requires manual features engineering, while in DL feature engineering is automatic...



Traditional Machine Learning Flow



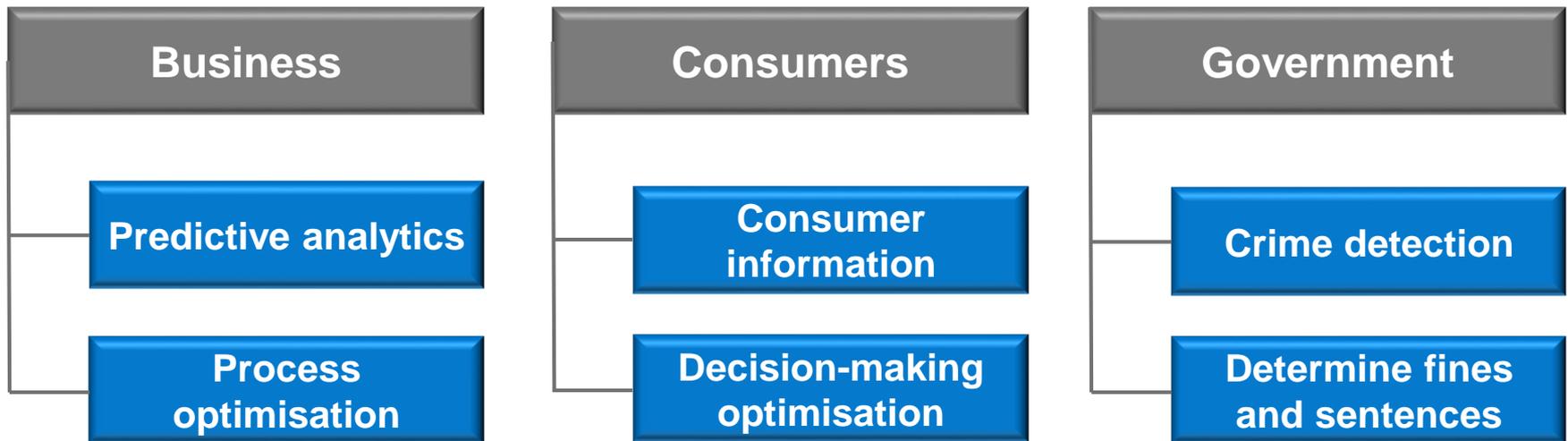
Deep Learning Flow



MAIN AREAS OF USE - APPLICATIONS



Widespread use of algorithms in every aspect of our life



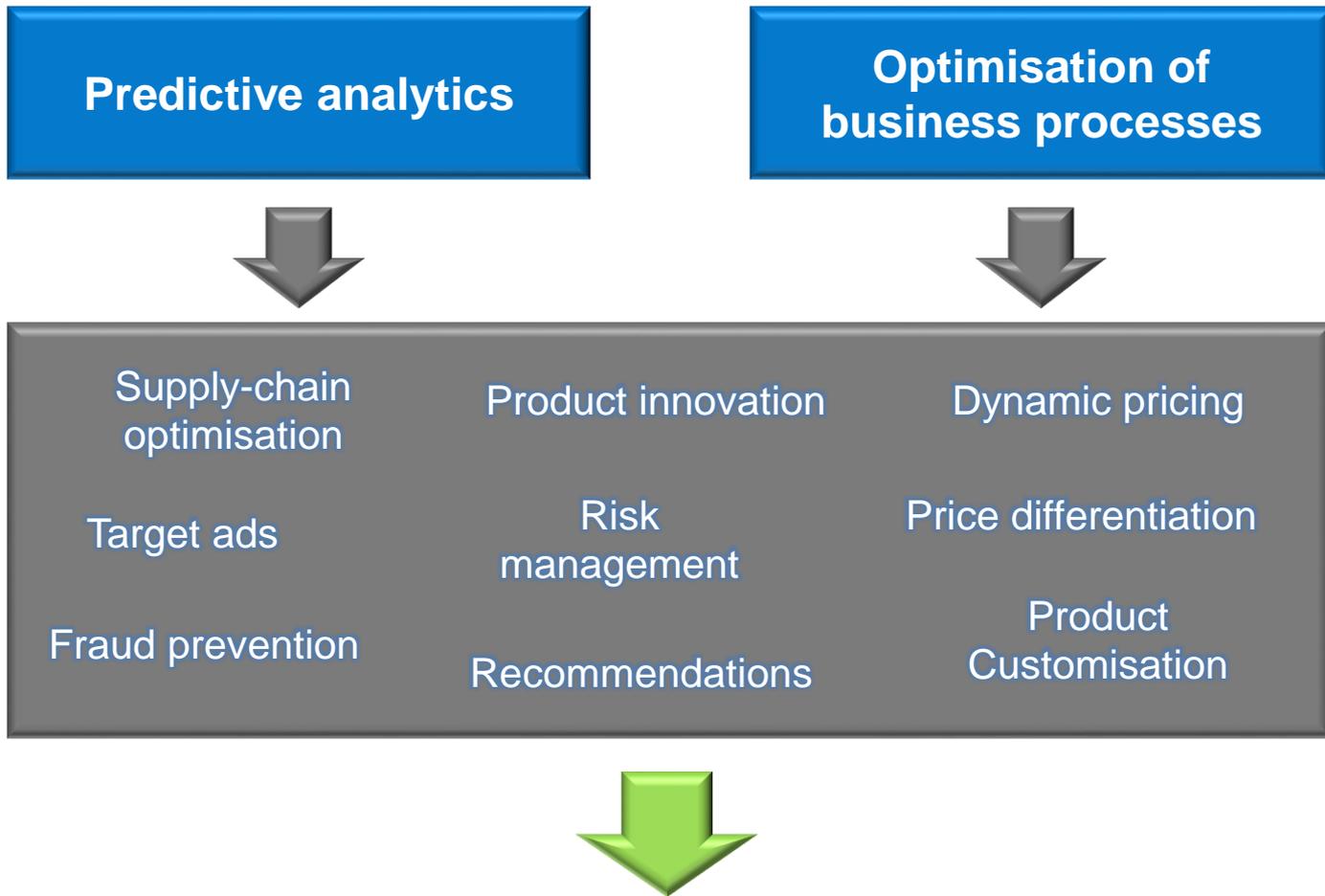
SIGNIFICANT IMPACT ON

- ✓ day-to-day business operations
- ✓ commercial and strategic decision-making



POSITIVE IMPACTS -> BENEFITS

- Pro-competitive use of algorithms by businesses

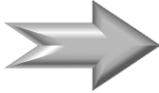


Positive impact on static and dynamic efficiency !!!!



NEGATIVE IMPACT => RISKS

ALGORITHMS may transform business models, decision-making process and commercial interactions

- ✓ They can facilitate the exercise of market power  Abuse of dominance
- ✓ algorithms change certain structural characteristics of the market -> increase the likelihood of collusion
- ✓ enable new forms of collusion  “ALGORITHMIC COLLUSION”

“Algorithmic collusion consists in any form of anti-competitive agreement or coordination among competing firms that is facilitated or implemented through means of automated systems.”

OECD: Roundtable on Algorithms and Collusion, June 2017





ALGORITHMS AND THE RISK OF COLLUSION

- Preconditions of collusion
 - 1) Common understanding / common policy
 - 2) Internal stability – monitor the adherence to this common policy; and enforce the common policy by punishing any deviations
 - 3) External stability – monitor and target new entrants
- Relevant factors that increase the likelihood of collusion
 - ✓ structural characteristics
 - ✓ demand-side variables
 - ✓ supply-side variables





ALGORITHMS - THE RELEVANT FACTORS FOR COLLUSION

Relevant factors for collusion		Impact of algorithms on the likelihood of collusion
Structural characteristics	Number of firms	±
	Barriers to entry	±
	Market transparency	+
	Frequency of interaction	+
Demand variables	Demand growth	0
	Demand fluctuations	0
Supply variables	Innovation	-
	Cost asymmetry	-

Legend: + positive impact; - negative impact; 0 neutral impact; ± ambiguous impact



ALGORITHMS - THE RELEVANT FACTORS FOR COLLUSION

- Despite the ambiguous effects on the some factors for collusion - algorithms change certain structural characteristics of the market, such as **TRANSPARENCY** and **FREQUENCY OF INTERACTION**
- Intuition:
 - If markets are transparent and companies react instantaneously to any deviation, the payoff from deviation is zero -> **COLLUSION CAN ALWAYS BE SUSTAINED AS AN EQUILIBRIUM STRATEGY**
- **Clear risk** that current changes in market conditions may facilitate anti-competitive strategies
 - similarities with the classic ‘oligopoly problem’ **BUT** tacit collusion could become sustainable in a wider range of circumstances -> expanding the oligopoly problem to non-oligopolistic market structures



ALGORITHMS and “TRADITIONAL” CARTELS

Coordination

Algorithms coordinate parallel behaviour by programming prices to follow a leader; or using the same third party algorithm.

Monitoring & punishing

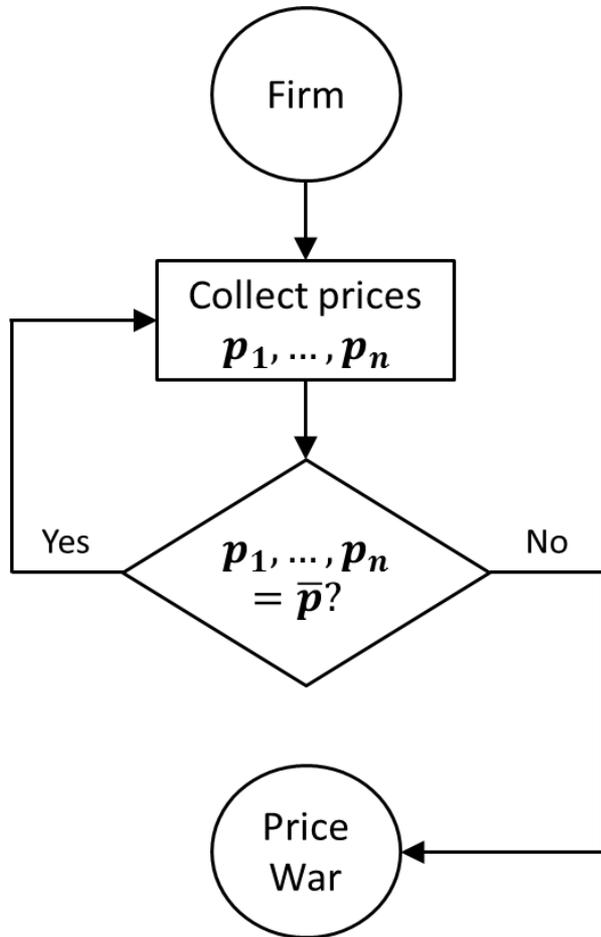
Algorithms collect and process information from competitors and punish deviations

Signalling

Algorithms disclose and disseminate information in order to announce an intention to collude and negotiate the common policy.



MONITORING ALGORITHM



C:\ Monitoring algorithm

Description : Collect and process information from competitors to monitor their compliance and, eventually, to punish deviations.

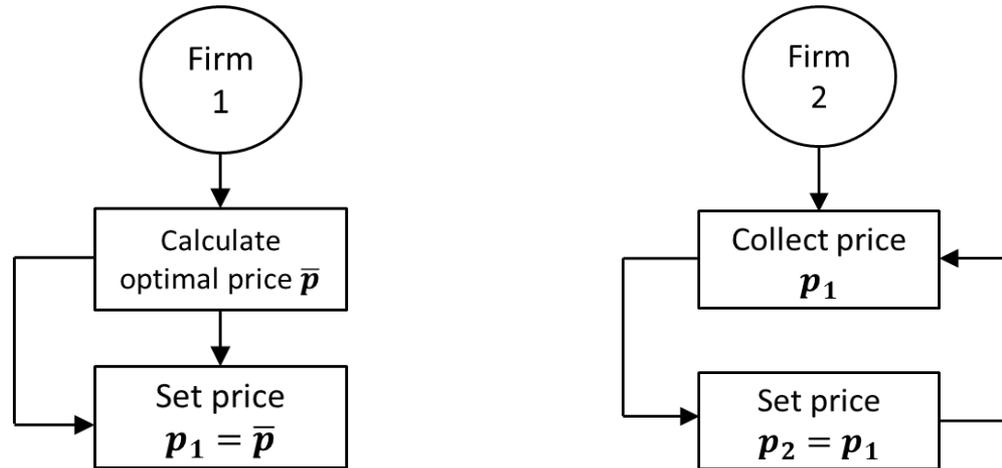
Legend :

\bar{p} <collusive price>

p_i <price set by firm i >



PARALLEL ALGORITHM



C:\ Parallel algorithm

Description : Coordinate a common policy or parallel behaviour, for instance by programming prices to follow a leader

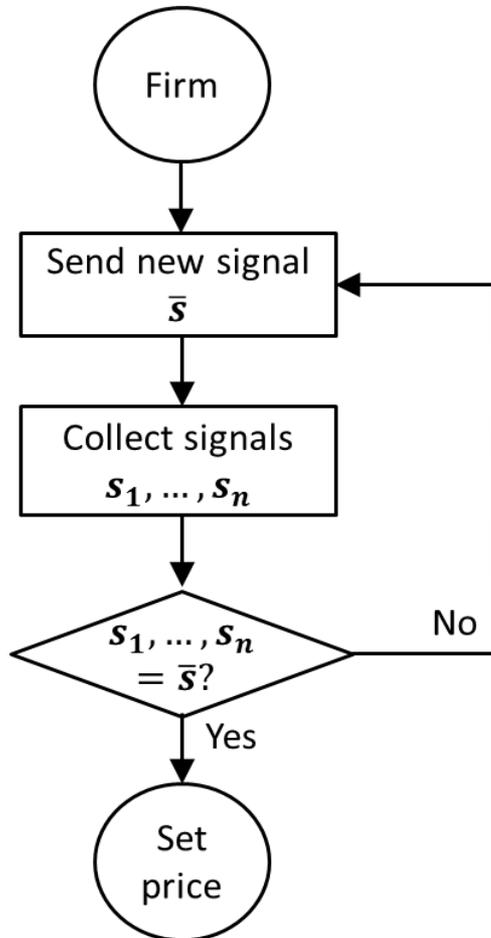
Legend :

\bar{p} <collusive price>

p_i <price set by firm i >



SIGNALLING ALGORITHM



C:\ Signalling algorithm

Description : to disclose and disseminate information in order to announce an intention to collude or negotiate a common policy

Legend :

\bar{s} <tentative signal>

s_i <signal sent by firm i >



ALGORITHMS and “TRADITIONAL” CARTELS – WHAT ARE THE CHALLENGES?

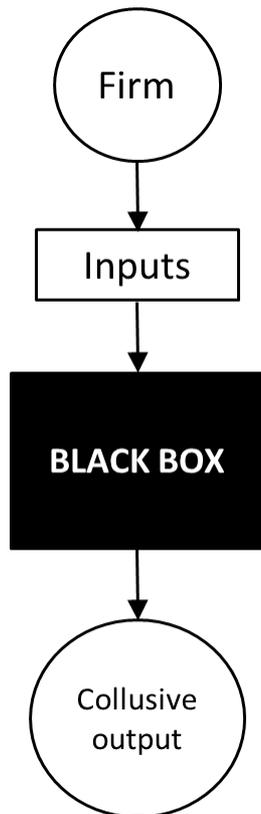
- Is the legal framework on anti-competitive agreements suitable to assess algorithms?
 - => Agencies can rely on existing rules on anti-competitive agreements
 - => Algorithms ought to be assessed together with the main infringement that they help enforcing.
- Challenges relate to:
 - Detection and evidence
 - Understanding how the technology works



ALGORITHMS and “NEW” FORMS OF TACIT COLLUSION?

Cooperative equilibrium

Algorithms maximise profits while recognising mutual interdependency and readapting behaviour to the actions of other market players.



C:\ Self-learning algorithm

Description : maximise profits while recognising mutual interdependency and readapting behaviour to the actions of other market players

...



ALGORITHMS and “NEW” FORMS OF TACIT COLLUSION? – WHAT ARE THE CHALLENGES?

- Is the legal framework on anti-competitive agreement suitable to assess algorithms?
 - => Tacit collusion is not covered by the legal framework
- Policy question:
 - => Should we adjust the legal framework?
 - => How?



THE POLICY QUESTION

The only time we look at tacit collusion is when we look at ex ante analysis of mergers. Here we have an interesting question about legality and policy (...) The fact that [algorithms] can change the market characteristics gives rise to concern. That concern cannot be attacked under 101. Should we do something about it?

Ariel Ezrachi

(...) if we don't know the importance and the magnitude of the problem then it is very difficult to conclude that there is an enforcement gap.

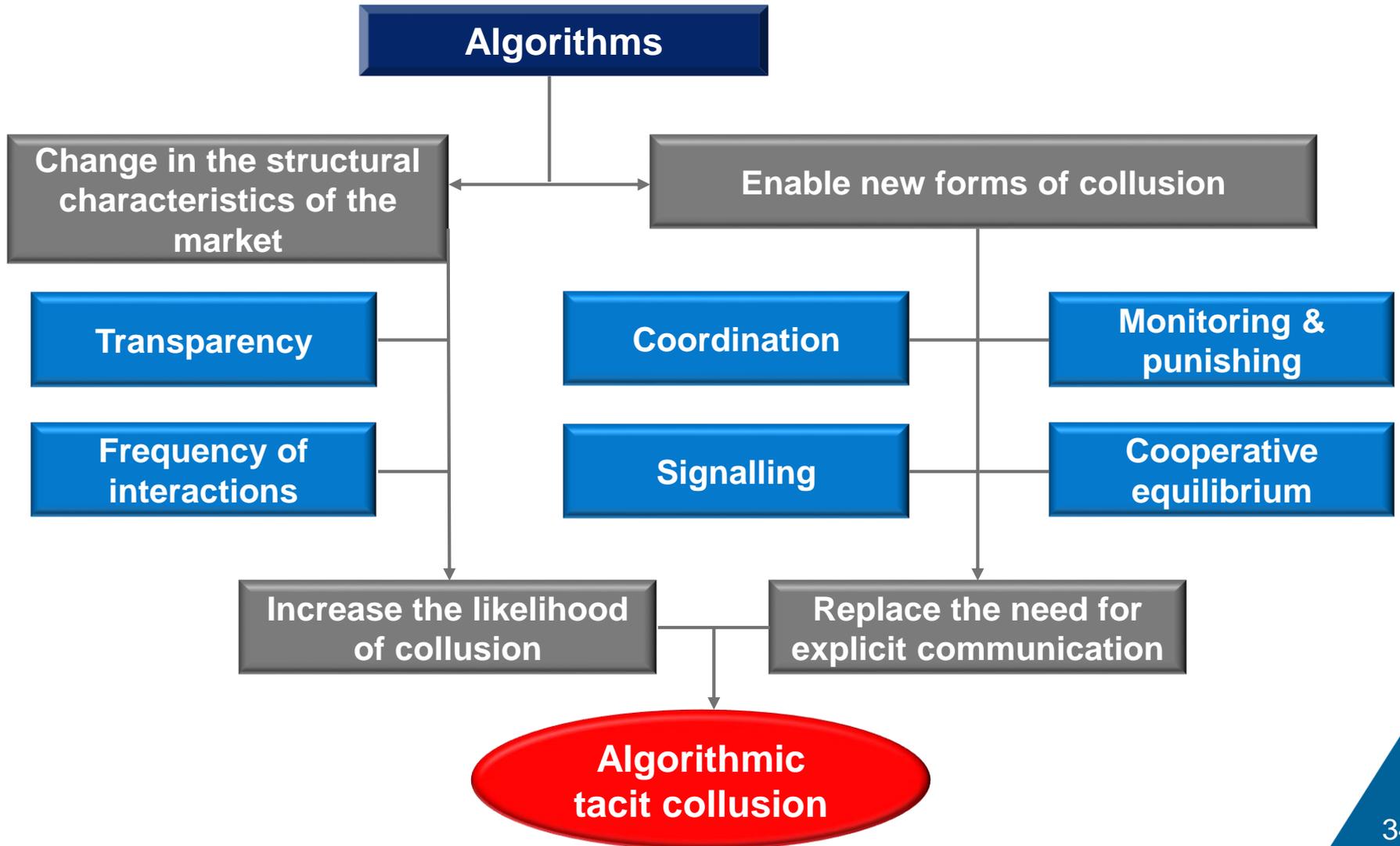
BIAC

Competition laws were designed to deal with human facilitation of parallel conduct. (...) However, in a world in which tacit collusion becomes or is operated on a larger scale, maybe we need to rethink the reasons why we decided not to tackle tacit collusion in the first place.

Michal Gal



SUMMING UP – POSSIBLE RISKS OF ALGORITHMIC COLLUSION





EVIDENCE OF ALGORITHMIC COLLUSION

- The case of online sale of posters on Amazon marketplace (**DOJ & CMA**)
 - The conspirators designed and shared among each other dynamic pricing algorithms, which were programmed to act in conformity with their agreement
 - International co-operation between the DOJ and CMA to solve the case
 - This is the first (and so far the only) case of algorithmic collusion detected by a competition authority and **resulting in criminal prosecution**

“Today’s announcement represents the Division’s first criminal prosecution against a conspiracy specifically targeting e-commerce (...) We will not tolerate anticompetitive conduct, whether it occurs in a smoke-filled room or over the Internet using complex pricing algorithms.”

Bill Baer, Assistant Attorney General, DoJ



FURTHER EVIDENCE: investigations, market studies and sector inquiries

- Investigation of the airline tariff case by the **DoJ** in the 90s
 - Airline companies used a computer platform to signal price changes and exchange detailed information.
 - The case was closed with a settlement agreement.
- E-commerce sector inquiry by the **European Commission**
 - 50% of the retailers reported tracking prices of online competitors, 70% of which use automatic software to monitor and often to reprice their products.
- Two investigations by the **Italian Competition Authority (AGCM)**
 - Online comparison websites and sellers of the advertised products entered into partnership agreements that could raise conflicts of interest.
 - The AGCM accepted binding commitments by the parties to make the comparison website more clear and transparent.



FURTHER EVIDENCE: investigations, market studies and sector inquiries

- Investigation by the **Ukrainian Competition Authority (AMCU)**
 - The distribution networks under investigation were setting prices using private information about competing networks.
 - The exchange of information was supported by a market research agency and it was conducted mostly through online means.
- Information gathering by the **Federal Antimonopoly Service of Russia**
 - Information collected from users and developers of price-optimisation software suggests that resellers are using different price-setting products, some of which pose a threat of facilitating coordination.
 - The FAS Russia is now doing dawn raids based on the information gathered and complaints received.
- Studies by the **Competition Commission of Singapore (CCS)**
 - Economic evidence that algorithms facilitate tacit collusion.
 - The CCS is conducting now further work to evaluate how data collection and analytics are evolving in some selected industries.



THE OECD CONCLUSIONS

*“Although the use of algorithms by companies is widespread in certain industries, the use of complex algorithms based on deep learning principles may still be relatively rare across traditional sectors of the economy. At the moment, **there is still no empirical evidence of the effects that algorithms have on the actual level of prices and on the degree of competition in real markets.** This is an area where future research will be certainly welcomed to inform policy choices that governments will be facing.”*

OECD, Algorithms and Collusion, 2017



IS THIS AN AREA OF LIKELY FUTURE ENFORCEMENT?

*“algorithms play an ever increasing role in a number of fields in which we have to keep our eyes and ears and minds open. That also goes for cartel behavior where algorithms can play a role in collusion. We see this also in other circumstances. [...] So we need to follow up on this. We need to understand how this works. The rules that we have allow us to address the issues stemming from algorithms because **the basic rule is obviously that what is illegal in the analog world is also illegal in the digital world.**”*

Johannes Laitenberger, June 2017

*“Collusion via AI still a cartel - We follow a simple principle. If a conduct is illegal in our brick-and-mortar world – for instance, a price-fixing cartel – it is equally illegal when it is carried out through software. **A company can never hide behind an algorithm.**”*

Johannes Laitenberger, Consumer and Competition Day, Malta, 24 April 2017

*“Illegal collusion isn't always put together in back rooms. There are many ways that collusion can happen, and some of them are well within the capacity of automated systems. [...] So as competition enforcers, I think we need to make it very clear that **companies can't escape responsibility for collusion by hiding behind a computer program.** The challenges that automated systems create are very real.”*

M. Vestager, Bundeskartellamt 18th Conference on Competition, Berlin, 16 March 2017



SO FAR DETERRENCE BY WARNING





AREAS OF POSSIBLE ENFORCEMENT?

Pricing algorithms may increase price competition, but potentially ...

- Facilitate horizontal collusion
- Hub and spoke (usage of same algorithm)
- Incentivize RPM practices
- Tacit collusion?
- Artificial Intelligence?

(from Thomas Kramler, DG COMP)



CHALLENGES POSED BY ALGORITHMS AND DIGITALISATION FOR LAW ENFORCEMENT

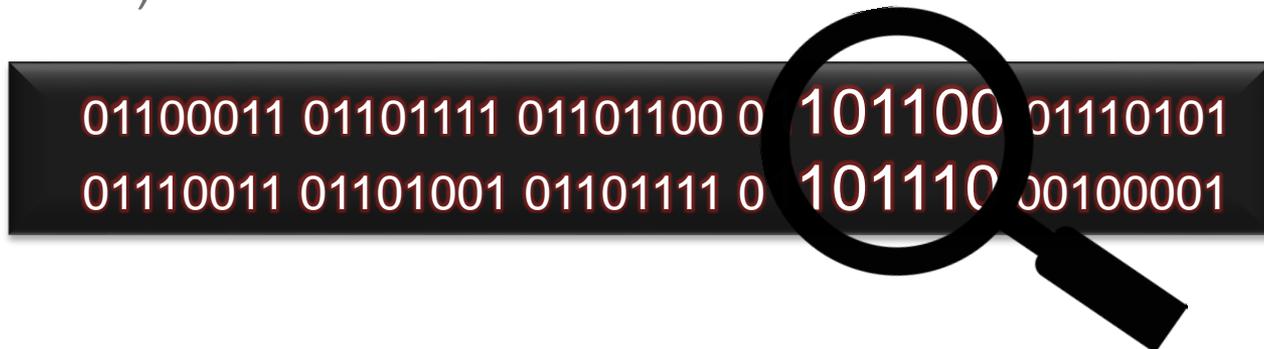


“Hey, my sensors detect that you are scanning my cards!”



ANTI-COMPETITIVE MOTIVES VS NORMAL BUSINESS PRACTICES

- Digital business models blur the lines between legal vs illegal practices
- **ALGORITHMS** expand the *grey area* between explicit collusion (unlawful) and tacit collusion (lawful)
- Establishing a possible infringement requires evidence suggesting that *competitors have not acted independently*
 - Evidence of explicit agreement
 - or
 - Evidence of parallel conduct AND “plus factors” (e.g. facilitating practices)





NOTION OF AGREEMENT

	EU	US
“agreement”	<i>“concurrence of wills between economic operators”</i>	<i>“meeting of minds” or “conscious commitment to a common scheme”</i>

Existing concepts provide little guidance whether more *subtle forms of communication fall in the scope of application of the competition rules*



Should legislators create a more clear definition of agreement, in order to capture *“algorithmic collusion”*?

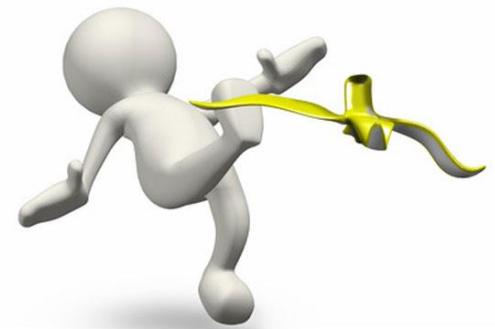
“(...) computer technology that permits rapid announcements and responses has blurred the meaning of 'agreement' and has made it difficult for antitrust authorities to distinguish public agreements from conversations among competitors.” Borenstein (1997)



LIABILITY

Can antitrust liability be established when business decisions are made by machines rather than by companies (human beings)?

- Thin line between the agent (algorithm) and the principal (human being)
- Defining a benchmark for illegality requires assessing whether any illegal action was anticipated or predetermined = > programming instructions, available safeguards, reward structure...
 - Who is liable for the decisions and actions of algorithms?
 - Creators
 - programmers or third party data-centres
 - Users
 - consumers or companies
 - Beneficiaries
 - companies or other stakeholders





ALTERNATIVE (EX-ANTE) APPROACHES

Market studies & investigations

- Obtain empirical evidence of algorithmic collusion
- Identify markets and sectors that are not functioning well
- Define appropriate measures

Ex-ante merger control

- Reconsider the threshold of intervention
- Evaluate the impact of transactions on market transparency and high frequency trading
- Account for multi-market contacts in conglomerate mergers

Commitments & remedies

- Design remedies to prevent the use of algorithms as facilitating practices
- Apply “notice-and-take-down” processes
- Introduce auditing mechanisms for algorithms?



POSSIBLE COUNTER MEASURES

Prof. Ezrachi discusses possible counter measures that can be considered in the future (while recognising their limitations):

- ***De-acceleration** measures restricting the frequency of price changes*
- ***Disruptive algorithms** implemented by competition agencies to destabilise the market*
- ***Sponsored entry** of maverick firms to break cartels*
- ***Secret discounts** systems...*





POSSIBLE MARKET SOLUTIONS

- In addition to possible legal measures, Prof. Gal proposed some market solutions, such as:
 - *“the use of algorithms by consumers in order to counteract at least some of the effects of the algorithmic facilitated co-ordination by suppliers.”*

It takes an algorithm to beat an algorithm





ALGORITHMIC CONSUMERS

Aggregators

- Price comparison
- Quality evaluation
- Information about new products

Digital butlers

- Analysis of consumer preferences
- Product search
- Transaction execution
- Collective purchases



Consumer information

Buyer power

Decision-making

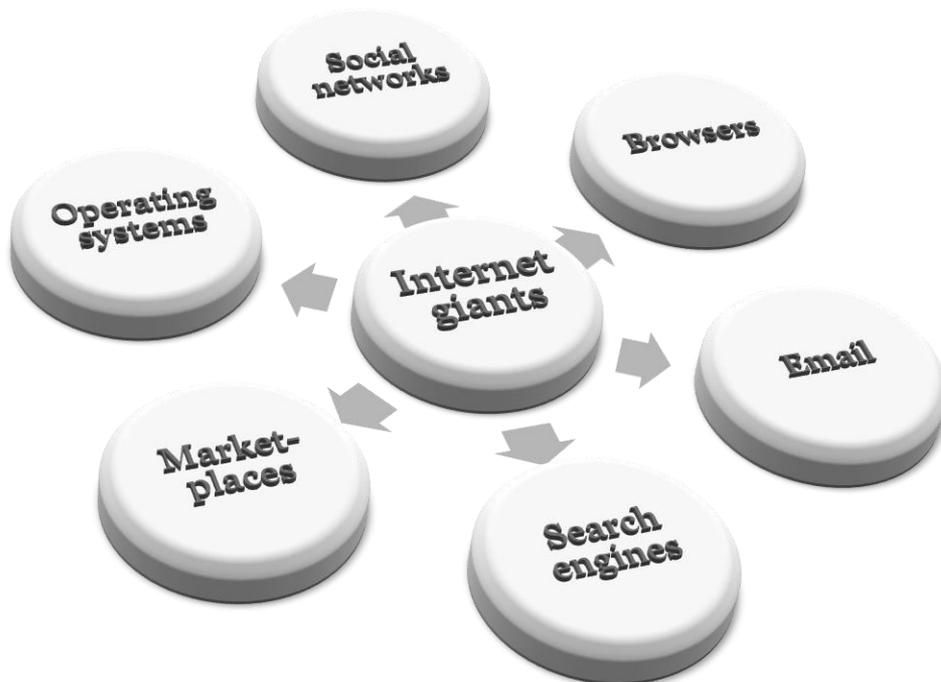


REGULATION OF ALGORITHMS?



ALGORITHMIC SELECTION

The use of automated computer systems to organise and select relevant information affects fundamental structures of the society...



“(...) these days, a third of all marriages start on the Internet, so there are actually children alive today that wouldn’t have been born if not for machine learning.”
Domingos (2017)



REGULATION AS A POSSIBLE SOLUTION?

Information bias

- Social media that results in “echo chambers”
- Product recommendations based on past purchases

Censorship

- Content-control software to block specific information

Manipulation

- Manipulation of feedback scores
- Manipulation of rankings in search engines’ results

Privacy rights

- Automatic collection of personal data for target ads

Property rights

- Collection, use and share of information protected by IP rights, such as music and video

Discrimination

- Price and product discrimination based on social characteristics



CHALLENGES - Potential market failures?

Imperfect Information

- Lack of algorithmic transparency
- Algorithms as trade secrets
- Complexity of program codes

Data-driven barriers to entry

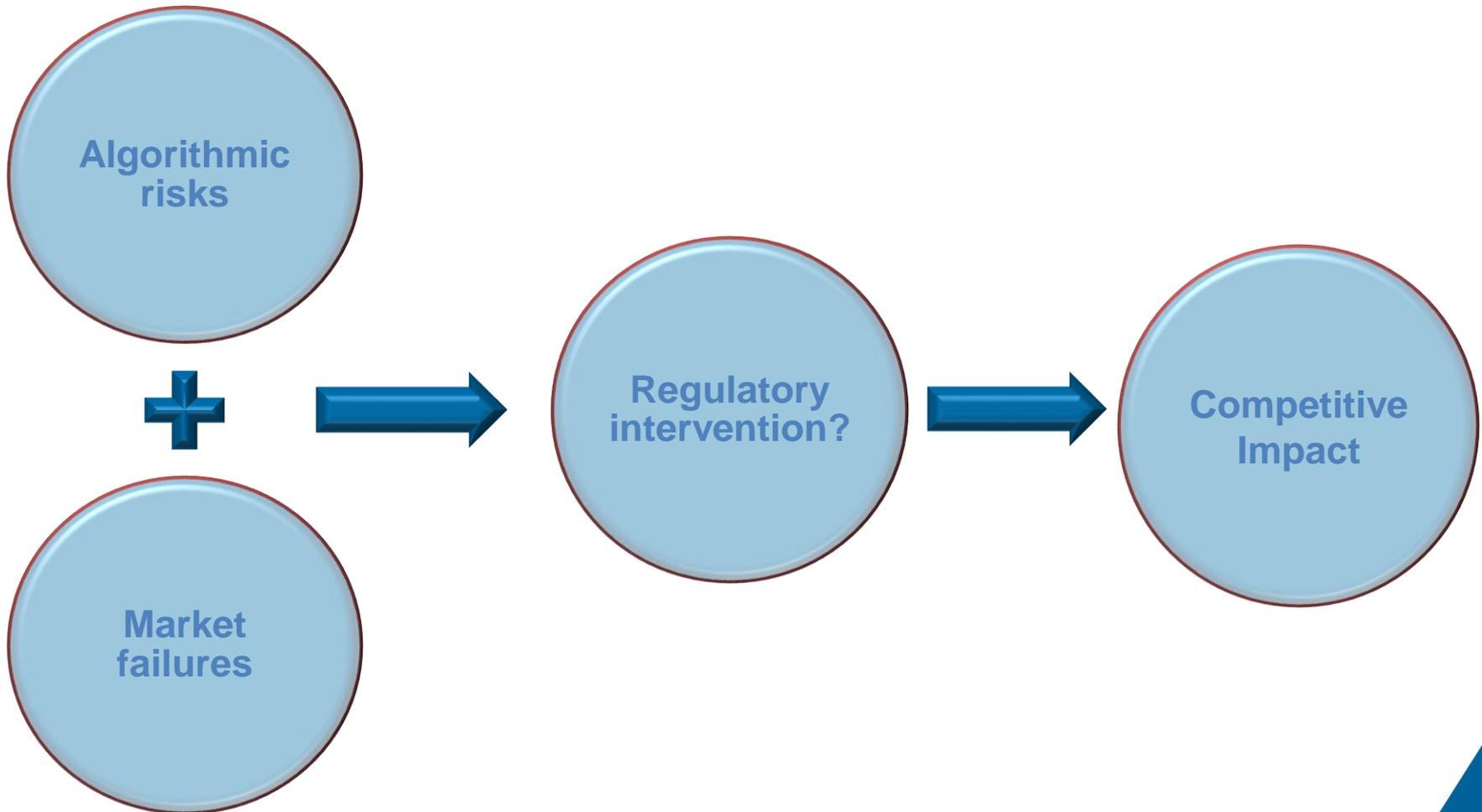
- Scale economies of IT infrastructures
- Scope economies of datasets
- Network economies in online platforms

Spill-overs

- Information and knowledge as a public good

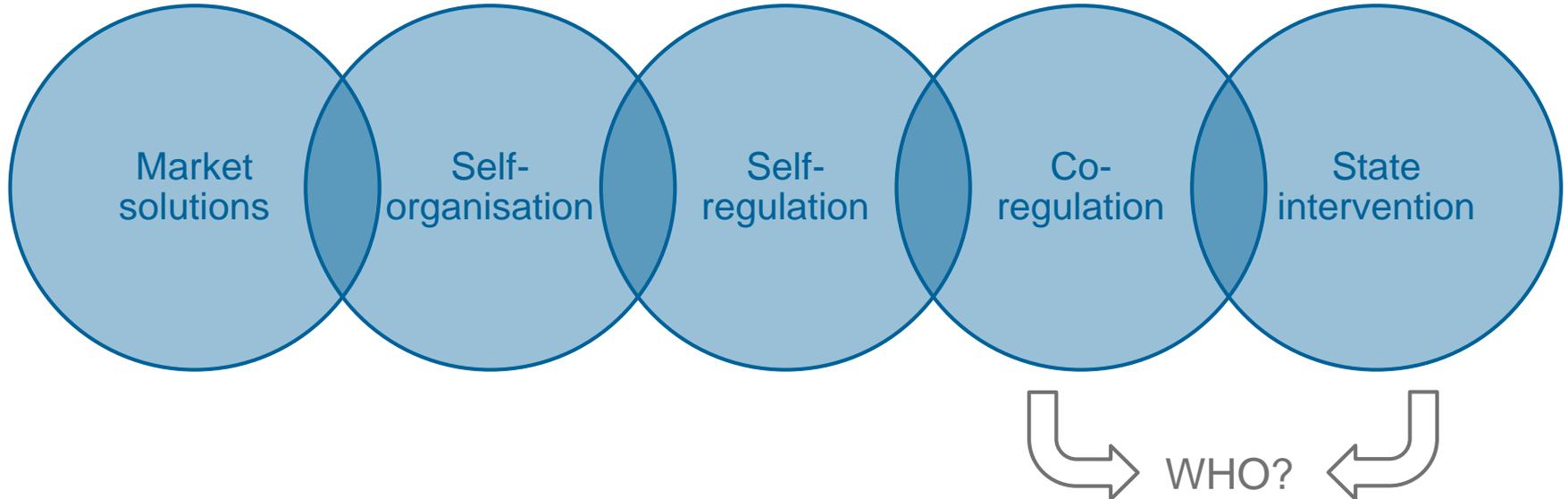


CHALLENGES – Should the digital economy be regulated?





OPTIONS OF ALGORITHMIC GOVERNANCE



Online companies operate at the interface of many laws enforced by different agencies:





FIRST STEPS TOWARDS ALGORITHMIC TRANSPARENCY AND ACCOUNTABILITY

- New FTC Office of Technology Research and Investigation responsible for studying algorithmic transparency
- The European Commission's Directorate-General for Communications Networks, Content & Technology is calling for comments on a proposal to regulate online platforms.
- EU Commissioner Vestager's statement advocating for *compliance by design* with data protection and antitrust laws
- German Chancellor Merkel's public statement:

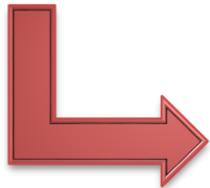


The algorithms must be made public, so that one can inform oneself as an interested citizen on questions like: what influences my behaviour on the internet and that of others? (...) These algorithms, when they are not transparent, can lead to a distortion of our perception, they narrow our breadth of information.



DIFFICULTIES IN ENFORCING ALGORITHMIC TRANSPARENCY AND ACCOUNTABILITY

- Public disclosure of algorithms may reduce incentives for investment and innovation
- Disclosing a complex program code may not suffice as a transparency measure
- Transparency and accountability are challenging when decisions are taken autonomously by the algorithm
- Enforcement cost of reviewing and supervising algorithms



**Risk that
algorithmic
transparency
facilitates further
algorithmic
collusion**





FURTHER INFORMATION

ALGORITHMS AND COLLUSION
Competition policy in the digital age

OECD

The screenshot shows a web browser window displaying the OECD website. The page title is "Algorithms and collusion". The main content area includes a sub-header "Algorithms and collusion" and a paragraph explaining that the combination of data with technologically advanced tools like pricing algorithms and machine learning is changing the competitive landscape. It mentions a roundtable held in June 2017. A sidebar on the left lists related topics such as "Bribery in international business", "Competition", "Abuse of dominance and monopolisation", "Cartels and anti-competitive agreements", "Competition enforcement practices", "Liberalisation and competition intervention in regulated sectors", "Mergers", and "Pro-competitive Policy Reforms". An illustration on the right shows a laptop, a smartphone, and a dollar sign icon.

<http://www.oecd.org/daf/competition/algorithms-and-collusion.htm>



FURTHER INFORMATION

The screenshot shows the OECD website's Competition page. At the top, the OECD logo is on the left, and a search bar with the text "Search oecd.org" and a magnifying glass icon is on the right. Below the logo is the tagline "BETTER POLICIES FOR BETTER LIVES". A navigation bar contains "OECD Home", "About", "Countries", "Topics", and "Français". The breadcrumb trail reads "OECD Home > Directorate for Financial and Enterprise Affairs > Competition". The main heading is "Competition".

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