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THE INTERPLAY OF TECHNOLOGY ENTREPRENEURS AND REGULATION IN A NEW INDUSTRY: THE CASE OF THE DRONE INDUSTRY

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Introduction:

New tech companies have quickly moved up on the list of largest lobbying spenders, among them, Amazon has recently doubled its efforts to influence legislators. Only in 2015, Amazon spent over $9.4 million (Kang, 2016), and the company now has more than 60 people listed as lobbyists. Apparently, the e-commerce company is very keen on introducing further delivery innovations and gaining more control on the overall delivery process, their flagship initiative is the activation of commercial deliveries using drones (Brueck, 2016). As the company has been driving consumer engagement by offering free delivery options to premium customers, gaining control on the delivery process becomes a strategic priority (Kang, 2016).

Interestingly, the company is testing the drone delivery options in different countries: Canada, the U.K. and the Netherlands (Brueck, 2016); but the current regulation in the U.S. does not allow them to fly unmanned cargo vehicles, the Federal Aviation Administration (FAA) has not yet approved commercial drone regulations. There are substantial safety risk concerns, airline and pilot groups have been reluctant to consider sharing the airspace with other unmanned aerial vehicles such as drones. As a result, drone advocacy groups argue that countries that sustain strict and restrictive drone-use regulations face another type of risk: “losing out to other countries when it comes to drone technology innovation” (Vanian, 2016).
The case of Amazon lobbying for a shift in the regulation on commercial deliveries using drones exemplifies the multiple technology regulation fronts that the emergence of a new industry faces. It opens several questions regarding the impact of regulatory changes on other uses of the technology, and on the overall development of the technology and its components. The regulatory response to the emergence of the new technology can create new opportunity spaces for entrepreneurs, pulling in new entrants; but it can also create an innovation push forcing existent and new entrants to change how they use a given technology (Männer, Bilgram, & Brem, 2012). The worst scenario is when the regulation remains unclear, generating additional uncertainty on the technology and market readiness (Solberg-Hjorth & Brem, 2016).

The case of the drone technology poses a significant challenge to the regulators, the technology trajectory has had substantial application leaps. Although some of the military drone components can be like those in smaller commercial drones, the regulatory framework for each technology is fundamentally different. As a result, entrepreneurial firms manufacturing commercial drones, or techno-entrepreneurs searching for applications of the new small drones in multiple fields, do not share the regulatory framework of military manufacturers or users (Giones & Brem, 2017b). Thus, there is a governance void and a regulatory gap that needs to be addressed.

The emerging commercial drone industry promises to grow from the actual $2 billion (driven by small devices sold to hobby users) to over $120 billion by 2020 (Moskwa, 2016). A plethora of new companies are exploring innovations that promise to disrupt existing industries and create new markets for drone-based solutions. The uneven response from regulators across the world offers a unique opportunity to explore how the technology and market are emerging as entrepreneurial activity interacts with the different regulatory frameworks. A further understanding of the technology, market, entrepreneurial dynamics, and regulation provides valuable clues to the different stakeholders involved in the emergence of new technological industries.

The chapter is organized as follows: first, we cover the evolution of the drone industry, from a technology perspective, from the first breakthroughs to its current forms; second, we provide a perspective on regulation and new technology emergence, aiming to clarify how they interact; third,
we explore three profiles of new entrants in the industry to understand how the regulation impacts on the technology and market combinations; finally, we discuss insights and implications for researchers and policy makers on how technology, markets, entrepreneurship and regulation can co-evolve to support the emergence of new innovative industries.

**From military to commercial drones, a technology-meaning transformation story**

The origin of the technology trajectory behind the commercial drones goes back to the early years of the past century. The development of unmanned aerial vehicles (UAVs), mostly for military operations, and the introduction of autopilot functions in regular airplanes, set the technological ground for the further technological development that resulted in current military drones (Anderson, 2012). While in early last century military drones were being used as decoy for armed conflicts, the rapid technological evolution resulted in plane sized military drones like the “Predator” with almost complete autonomous capabilities, remotely-operated from thousands of kilometers. As figure 1 describes, there has been a staggering growth in the use of military drones, i.e., the Pentagon is said to have over 7,000 aerial drones in use (in 2011), when they only had 50 a decade before (Bumiller & Shanker, 2011).

*Figure 1. Representation of the evolution of the drone industry in market value (1900-2020)*

![Diagram showing the evolution of drone industry in market value from 1900 to 2020](source: authors’ elaboration based on industry reports (Marsh, 2015a; PwC, 2016))
The emergence of the commercial drone market is much more recent, and even more rapid than the military drones’ surge. As the co-founder of 3D Robotics, Chris Anderson, describes “just as the PC emerged from the Homebrew Computer Club hobbyists and eventually overturned mainframe-based corporate computing ..., I suddenly saw how the same sort of movement would bring robots to the skies” (Anderson, 2012). 3D Robotics was one of the firms that in the years before 2010 brought to consumers the possibility to build their own small drones. The company enjoyed a temporary success, until facing the increased competition of new global techno-entrepreneurs like DJI or Parrot that started offering commercial version of the small drones to consumers (Mac, 2016).

Most of the early industry dynamics in the non-military drones was out of the scope of regulation. Hobbyist and other amateur operated within the scope of personal use of the drone, fitting the profile of radio-control hobbyists. The small drones had to stay within the line of sight of the operator, and they could fly in a restricted operating space, in the U.S. this meant no more than 400 feet (120 meters) height (Stuart & Anderson, 2015).

The technological trajectory that resulted in the miniaturization of the technological components behind the first non-military drones, continued pushing the technological capabilities of the small drones forward. The complex components structure of a drone makes it possible to see continued evolution of the overall capabilities of the system, even if technological progress in some of the components slows down. The main elements: quadcopter motor, flight controller, video & image, and power battery, are diagramed in figure 2. Behind each component there are examples of specific components or elements that are driving the evolution on the capabilities of the drone.
As an example, the generation of new smaller and more precise sensors impacts on the flight capabilities of the drone; similarly, the improvements in the processing units that Intel, Nvidia, Qualcomm or Ambarella have introduced, generate an upgrade in the overall performance of the commercial drone. Most of these technological improvements come from industry spillovers, they are often deployed in larger technological markets, such as smartphones, and then directly transferred or adapted for the drones (Woolley, 2010). For example, Qualcomm has extended its leading position in smartphones chipsets to get agreements with drone manufacturers to include their chips, and Ambarella has benefited from their leadership in video processing units for action cameras to also enter in the drone cameras market.

But the emergence of the commercial drone industry is not only about technological resources. As the story of 3D Robotics in the U.S. illustrates, techno-entrepreneurs have been driving the innovation process to experiment and find valuable applications that can result in solid business models (Priem, Wenzel, & Koch, 2017). The hobby users of small drones captured the attention of DJI Innovations, a company based in Shenzhen, China, that started producing consumer drones. The innovative French company Parrot created a new product line to also start offering consumer drones.
These first steps of the non-military drones market, the manufacturers benefited from the available technological resources to offer affordable "toys". An indirect effect of this technological trajectory towards miniaturization was that it made possible to explore potential new applications for drones that only a few years ago would have not been imaginable. Figure 3 describes the connection between technological resources, early hardware-focused entrepreneurial activity and the resulting emergence of application developers offering drone-based solutions.

Source: authors' elaboration

There is a continued interplay between the technology evolution and the entrepreneurial activity, which suggests the existence of technology push and demand pull cycles (Brem & Voigt, 2009). As the entrepreneurs behind companies like Drone Thunder explore for new uses of drones to offer industrial inspection or security services, they also eagerly expect that the new generation of chips or motors offer the possibility to introduce improvements in the video streaming capability or the flight duration of the drone. Other entrepreneurs pushing for new applications come up with their own version of commercial drones, or even create specific designs: AerialTronics needed to increase the robustness and resilience of drones as it offered inspection services in offshore wind turbines, or
Wingtra ended up creating a long-range drone that is easy to operate for farmers that want to monitor their crops. There is an overall process of search for potential meanings of the technology (Norman & Verganti, 2014), techno-entrepreneurs take the role of explorers to find how a “toy” can become a “professional tool” (Giones & Brem, 2017b).

The expansion process of the professional drone is only beginning, industry reports point that current applications of drones (movie or action sports filming) will only be part of a times bigger market (Marsh, 2015b; Moskwa, 2016; PwC, 2016). The continued experimentation and search for innovative uses for drones do however generate concerns. The highly visible accidents and/or misuses of commercial drones (flying drones in crowded public spaces or crashing in a national park preserved space, among others), have triggered regular media attention waves suggesting the need to regulate the use of drones (Goldman, 2015). The regulator approach to the emergence of the commercial drones has mostly been reactive, in some cases leaving a regulatory void that generates uncertainty to the entrepreneurs and other potential new entrants in the industry (Brueck, 2016).

Some exceptions include countries where the regulator has taken a position to favor the experimentation with the technology creating spaces for entrepreneurial activity, for example the Netherlands have been much more supportive to initial tests on the use of drones for parcel deliveries (Vanian, 2016).

Overall, this poses a relevant question on what is the role of regulators and the regulations they enact in the emergence of a new tech-based industry. As observed by the early dynamics in the drone industry, the interaction between technological possibilities and techno-entrepreneurs’ ambitions can be sufficient to take-off, but might not be enough to overcome the regulatory obstacles that could withhold the drone industry potential.

What is the contribution of regulation in the emergence of new technology-driven markets?

The drone industry is an example of how difficult it might be to categorize a technology. The technological trajectory behind the actual military drones might be a story of continued incremental
innovation, from the early simple decoy aerial vehicles to the sophisticated military drones (Giones & Brem, 2017b). But, when it comes to the non-military drones, we see technological leaps and discontinuities in the technological trajectory. The drones used by radio-control aficionados hardly qualify as autonomous unmanned aerial vehicles, they have a limited range and their use is mostly recreational. As sensors, processing units, new motor designs, and batteries are integrated, the “toy” gains unexpected capacities and still-to-be discovered potential uses. The regulator faces the challenge to respond to complex technology trajectory with still unrealized market applications.

The general definition of an industry regulator is that it is an independent, state agency that acts as a referee to monitor market activity and the behavior of private actors in the economy (OCDE, 1997). Regulatory decisions involve critical processes in various industries, such as investment, pricing, and entry in sectors like utilities (Russo, 2001); product standards and testing requirements in pharmaceuticals (Mathieu, 1997); and environmental and worker safety rules in manufacturing (King & Lenox, 2000). While deciding these and other policies, regulators can adopt policy positions that are friendly or hostile toward regulated firms’ interests (Deephouse, 1996; Dobbin & Dowd, 1997). Regulated firms, in exchange, can directly pursue support of the regulatory agency for a more favorable ruling (e.g., by lobbying), and/or they can wield pressure indirectly on regulators (e.g., by grassroots efforts) by targeting other political actors, such as legislatures and executives, who oversee and monitor regulatory agency decisions (Holburn & Vanden Bergh, 2008).

There are few interesting issues when considering the role of regulators coping with new technologies, but of particular interest for us is the context of emerging and disruptive technologies since these can bring large-scale changes over a large number of people in relatively short time. Because, by their nature, such changes often outpace existing legislation and there can be a governance void as observed in the case of genetic engineering, the development of new biotechnology-based food and medicinal products.

Extant literature postulates that while new technologies often cause uncertainty (Hargadon & Douglas, 2001; Tushman & Anderson, 1986) they also need a defined institutional space to prevail
When technological advancements are taking place, especially in the case of disruptive technologies, regulatory agencies are typically forced to confront this unknown and are likely to be subject to various kinds of cognitive biases in the process (Thomas, Clark, & Gioia, 1993). In addition, since regulators often operate in politically contested settings, they are often subject to influence from their environment while working to regulate these new technologies. In many cases, any technological alternative is unlikely to meet the preferences of all interested groups. Thus, deciding on a dominant technology standard will inherently involve political processes (Mahoney, McGahan, & Pitelis, 2009). As a result, technological trajectories are subject to political actions and deliberate and discretionary activities by owners of these disruptive technologies and incumbents who want to protect the status quo (Aldrich, 1999). For instance, founders of disruptive technologies are likely to engage in activities that will help external stakeholders make sense of their innovations (Weick, 1995) by employing influence tactics such as social movements for altering their institutional environment in ways that accommodate their innovations (Gurses & Ozcan, 2015). Something we observed with the emergence of the DIY movement with the drone technology in the early stages of the industry (Stuart & Anderson, 2015). Market incumbents who wish to keep the status quo will retaliate by battling new market entrants through lobbying and grassroots mobilization (Gurses & Ozcan, 2015; Ingram & Rao, 2004), for example logistics operators that might feel threatened by Amazon intentions to replace them with their own drone delivery fleet (Kang, 2016).

Therefore, to understand how technology entrepreneurs contribute to unlock the market potential of drones, we need to keep close attention to the influence of the regulatory framework in their entrepreneurial activities. We explore three different perspectives on the impact of regulation in the activities of new entrepreneurial entrants in the drone industry, their tales depict a complex interaction between regulation and technology entrepreneurship.
Three tales on the impact of regulation on the entrepreneurial dynamics of the drone industry.

We study three different profiles active in the development of the drone industry: the technology product entrepreneur, the innovative market application entrepreneur, the corporate entrepreneurs. These different profiles help to capture both de alio and de novo types of new entrants (Agarwal & Moeen, 2015), prior research in industry dynamics suggest that the influence of regulation in new startups (de novo new entrants) could be different from those established firms that enter in a new market or industry as part of a diversification strategy (de alio new entrants). The prior experience that de alio new entrants might have when dealing with regulatory uncertainty, might give them more chance to survive than the more common de novo entrants with limited legitimacy and resource buffers to deal with the early-stage shifts in the industry regulation (Forbes & Kirsch, 2011).

For each of the three profiles we characterize the type of organization, provide illustrative examples, and discuss the impact of regulation on entrepreneurial activity.

The technological product entrepreneur: DJI, 3D Robotics, and Robsense

DJI and 3D Robotics were pioneers in the development of consumer drones. DJI, short name for Dajiang Innovation Technology Co., was started by Frank Wang in China in 2006. A few years later 3D Robotics was co-founded by Chris Anderson in the U.S., the paths of the two companies have crossed a few times in the last decade. Both companies are good examples of user entrepreneurship (Shah & Tripsas, 2007), Frank and Chris were highly creative individuals that in the process of finding a solution to their personal needs, ended up creating a company. Interestingly, they relied in the contribution of open code communities to develop the software that went into their drones (Stuart & Anderson, 2015). In the case of DJI, it was not until 2012 that they were able to start offering complete drone packages, the simplicity and ease-of-use of their package triggered the exponential market growth from then onwards (Mac, 2015). From that point, the trajectories of 3D Robotics and DJI took different directions, the technological and production capabilities of DJI set them as market
leaders, selling over 400,000 drones only two years later (2014) with a dominating 70% or more of the consumer drone market (Mac, 2015).

This is the profile of a *de novo* entrant that creates a new industry, often unaware of the disruptive impact of the technology, mostly driven by their focus on delivering a better new version of their product. DJI and 3D Robotics have been immersed in a race to introduce new technological advances in their drones, lowering the prices and increasing the performance capabilities of their devices (Mac, 2016). They had a rather reactive approach to regulation, it was only when drones started being noticed as a potentially disturbing consumer technology that they saw the need to engage with regulators (Goldman, 2015). The potential usage restrictions that regulators like the Federal Aviation Administration (FAA) in the U.S. could introduce have and could further damage their market potential. The reactive approach of the drone hardware producers has been to limit the capabilities of the drones, for example introducing flying restrictions depending on the geolocation of the drone. Their engagement in shaping the regulatory context is limited as they take the role of the technology manufacturers. For example, new *de novo* entrants like RobSense (producing flight control boards for industrial drones) focus their efforts on building a sustainable business model; they work to push forward the technological capabilities of the drones, but do not engage in changing the regulatory frameworks that impact the types of uses that their customers can do of their drones (Giones & Brem, 2017b). The business of the technological product entrepreneur is to sustain their technological innovation pace, and broaden the technical capabilities of the products in the market.

**The innovative entrepreneur that creates market applications for the technology product:**

*Dronethunder, Airware, Wingtra, and Aerialtronics.*

In the drone industry, the contribution of the technological product entrepreneurs has been complemented by the innovative applications entrepreneurs. This represents a different profile of technology entrepreneurs, their focus is not only on developing the technological components but also on finding innovative solutions that integrate the technology (Giones & Brem, 2017a). They represent a second stage in the evolution of the technology-driven industry (Adner, 2002), they often combine product and services to create solutions for the different emerging applications.
Examples of this profile are companies like DroneThunder or Airware that have made their mission to deliver commercial solutions to the industry using drones. They are the organizations behind the current hype on the potential of drones for inspection, maintenance, security and surveillance services (PwC, 2016). In some cases, they are pushing the technology into different evolutionary trajectories, for example Wingtra created a specific drone design to fit the farming monitoring needs and Aerialtronics made a more robust and resilient drone to inspect offshore wind turbines in challenging weather conditions.

This profile of entrepreneurs build their market position by creating specific value added services, often customizing their solutions to a specific market segment (Priem et al., 2017). Compared to the product technology entrepreneurs, this profile takes advantage of the emerging demand heterogeneity to become an early-player in a market niche. As a result, their business model runs around their ability to service their customers and establish sustainable business relationships.

As those de novo new entrants offer services using the technology they are subject to the technology-use regulatory framework. For example, the flight limitations of drones in public spaces limits the possibilities of companies like DroneThunder or Airware to offer building inspection services in city centers, but it does not limit the possibilities of Wingtra’s drones to fly and take picture in the private farming fields of their customers. The novelty of the technology uses proposed by these innovative entrepreneurs generate often a category conflict: it is difficult to determine whether the solution offer with the drone fits in the same service category as existing options. As identified in prior research on framing and categorization of innovative practices, the regulatory framework of the practice will be a result of the framing process (Gurses & Ozcan, 2015). For instance, the use of drones in the filming industry have gone unregulated as they were seen as part of the filming companies tools, without altering current practices or introducing specific risks (Allianz Global, 2016). On the other hand, companies like DroneThunder are waiting for the Spanish national authorities to take positions on the use of drones for industrial inspections; they experience a similar situation to those U.S. companies that are waiting for FAA statements to approach their potential clients with drone-based solutions.
The absence of regulation or the unclear application of existing laws generates a layer of uncertainty that delays the adoption of innovations, even when the market might be ready to make the effort to adopt them (Solberg-Hjorth & Brem, 2016).

**The corporate entrepreneurs in the market: Amazon, Phase One and the creation of associations.**

The third profile of entrepreneurs are *de alio* new entrants. They are firms that create a business unit or even a spin-off and enter in the market. These firms have a rather different approach, similar to corporate spin-offs they can benefit from the resources and reputation of their parent organization (Clarysse, Wright, & Van de Velde, 2011).

Examples of these firms are companies like Phase One or Amazon. In the case of Phase One the company identified that more of their professional cameras where being integrated in drones; following the growing demand for specific features from their customers, they started launching an aerial photography and filming camera set ready to be used with drones (Giones & Brem, 2017b).

The example from Amazon, already mentioned in the introduction, is the exploration of drones as a delivery option for Amazon’s customers; thus, in this case, it is not part of a product portfolio extension, but the introduction of a new technological use to improve the business processes of an existing organization. Furthermore, Amazon threatens to become a new competitor to logistics companies (Levin & Soper, 2016).

*De alio* new entrants in the drone industry have followed a very different approach to deal with the regulators. Besides the example of Amazon using its resources to lobby in favor of their interests (Brueck, 2016), other *de alio* new entrants have chosen to build associations with other industrial new entrants, research centers, universities, and other stakeholders. For instance, the Small UAV Coalition includes companies like Verizon, T-Mobile or Walmart, interested in supporting the favorable regulation to introduce small drones for commercial uses. This association includes universities like TU Delft from the Netherlands that is also present at the Platform for Unmanned Cargo Association (PUCA), where actors like Airbus, Fokker, KLM and several research institutes and universities promote the development of new drone-based solutions for cargo logistics.
The business model of de alio new entrants builds on the existing customer relationships that their organizations already have. In addition, they can leverage support from institutional stakeholders to create ad-hoc regulations to support their initiatives. For example, in the Netherlands, Amazon has been able to experiment with drone delivery systems using experimental spaces that can also support PUCA members’ activities; likewise, in Denmark the old Odense airport has been converted in the UAS Center where companies and researchers from the University of Southern Denmark have over 800 square kilometers of air space to test the future of the drone industry.

Interestingly, de alio new entrants seem to be better positioned to exploit the cross-country regulatory framework differences; as a result, new startups, de novo new entrants, also experience the benefits of being surrounded by de alio actors as they are more likely to be able to bend the regulatory framework to favor their interests.

Conclusions

What started as a hobbyist trying to fix a helicopter or enhance its radio control plane, has become one of the most fascinating new industries. The entrepreneurs behind DJI and 3D Robotics lead the development of the new consumer drones, eventually creating a new category and market. The technological capabilities of the small non-military drones opened a new space for creativity and innovation that has attracted a flurry of new entrants. Those new entrants have been exploring for technological applications, opening new market segments and setting the base for the industry growth.

The fast adoption of the technology by consumers and industrial users has often caught the regulators off-guard. The technological trajectory of the consumer drones is only partially connected to the evolution of the military drones, and their regulatory frames are completely disconnected. Furthermore, the early adoption of drones by hobbyist, mostly for personal recreational uses, was mostly out of sight for the regulators.

Overall, this has created a rather unique context where entrepreneurial activity has been thriving by exploring the possibilities of an evolving technology, but has started to face a quick ramp-up of regulation activity as accidents and risky uses have become visible. The different profiles of new
entrants, *de alio* or *de novo*; the focus on hardware or services and applications business models; as well as their differences when it comes to engage with regulators, has created unique context to observe how technology, entrepreneurship and regulation co-evolve. The impact of their co-evolution dynamics results in shifts of activity from one to another market segment, in search for spaces where there is less uncertainty but still high growth potential.

*Figure 4. Regulatory framework development impact on the technology and entrepreneurial activity*

As figure 4 describes, the responses of the regulator can have a significant impact on the co-evolution of the technology and entrepreneurial activity in the industry. The three entrepreneurial profiles help to illustrate how the initial framing and categorization of a new technology is then followed by a regulatory response. The potential outcomes of the regulatory response can create a bottleneck in the entrepreneurial activity, for example the prohibition of flying drones in urban public spaces, or offer room for experimentation and controlled development as it is happening in some countries with the use of drones for cargo logistics. Understanding the implications of the preemptive regulatory responses become critical for the healthy development of the new industry.
The findings from the co-evolution of technology and entrepreneurial activity in the drone industry resonate with prior research on the evolution of socio-technical systems (Geels & Schot, 2007). The idea that early-stage developments of new industries occur in a niche space, that can take-off as dominant designs emerge, creating new windows of opportunity for further change and innovation captures well the emerging dynamics in the drone industry (Geels & Schot, 2007). However, the insights from the drone industry opens further research opportunities as well as interesting insights for policy makers, we have grouped them in three themes:

- **The influence of standardization in the emergence of new industries.** The consumer drone industry is result of an innovation that built upon the standardization in communication and electronics (Brem, Nylund, & Schuster, 2016). The early entrepreneurs could rely on existing standards to propose their solutions, directing their creative efforts to make the first drone prototypes work. Building on accepted standards also accelerated the adoption of innovation, and recent research suggests that the presence of standards and dominant designs creates additional trust on the market side, favoring a quicker adoption of technological innovations (Viardot, 2017).

- **Digital technologies and entrepreneurial activity.** The speed of change of digital technologies has altered the innovation cycles of industries impacted by digitalization (Brem & Viardot, 2017). The change of paradigm requires that firms and regulators understand how old concepts take new meanings, for example to reassess the role of information technology infrastructures and platforms to support the new forms of digital technologies entrepreneurship (Giones & Brem, 2017a; Nambisan, 2016). From the perspective of policy makers this brings to the table the concept of "anticipatory regulation" (Mulgan, 2017), where regulators have the mission to offer sandboxes and testbeds to support the innovative experimentation of new technology-based solutions. The drone industry is providing examples of the positive impact that such new regulatory approaches could have on the long run, avoiding reactive regulation that would only translate into additional uncertainty.
Entrepreneurial ecosystems and new technologies. The drone industry emergence gives us an idea on how easy it is for digital technologies to spread across existing markets. As part of the ongoing debate on the genesis of entrepreneurial ecosystems (Autio, Kenney, Mustar, Siegel, & Wright, 2014; Autio, Nambisan, Thomas, & Wright, 2018), we can observe how the impact of the regulation is not homogeneous across the ecosystem; while the entrepreneurs manufacturing the technological products might be relatively impacted by the swift reactions of the regulator, the innovative entrepreneurs exploring solutions might face a complete blockade on their activities. Further research could explore how the entrepreneurial ecosystem dynamics are shaped but also get influenced by the regulatory responses, and overall how this results in different technology innovation outcomes.
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