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Does judicial independence lead to more risky corporate R&D?

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1. INTRODUCTION

What do Airbnb, penicillin and the Tik Tok recommendation algorithm have in common? Well, all the above mentioned belong to the so called "breakthrough innovations." This is certainly not a new term; indeed, this expression has been already used before the 2000s in the scientific literature, during the era of emerging ICT technologies, in order to define radical innovation; this word is used as a synonym of radical or discontinuous innovation. The main characteristic of this kind of innovation is that “it describes a process by which a product or service initially takes root in simple applications at the lower end of a market, since it is generally less expensive and more accessible, and then relentlessly moves into the high-end market, eventually replacing established competitors.” this is the definition given by the developer of the "disruptive innovation" theory Clayton Magleby Christensen at the MIT Sloan management review. The three aforementioned innovations have indeed retraced the stages that Christensen stated; Airbnb earlier when it was founded in 2008, was only focusing on low-value customers. But in the present, thanks to its innovative approach to tourism accommodation, during the third quarter of 2022 had managed to register its most profitable period ever despite widespread inflation. Closing out 2022 with its first annual profit in history of $1.9 billion[1], now the platform is the nightmare of the hotel industry, which hadn't been disrupted for decades, only to be utterly caught off guard by Airbnb. Penicillin itself, accidentally discovered in 1928 by Fleming, was not widely distributed until after World War II, when antibiotics became the solution to many previously fatal illnesses. The circumstances of the war effort of the 1940s certainly provided a boost to the commercialization of the product, with the transition from laboratory to mass production in an incredibly brief time frame and with productivity improvements of two orders of magnitude. By jumping forward more than 50 years, we find ourselves in China, in 2016, where Tik Tok was born. The app follows the standard pattern of Clayton Christensen's "Innovator's Dilemma": it supplies an affordable (in the present case free) service to an underserved segment of the market (teens and young adults). Yet this simple approach, in combination with favorable circumstances for its rapid bursting expansion in the last few years, has made TikTok a competitive player against the big tech giants, such as Facebook and Google.
But the reason why it has been named by MIT among the 10 breakthrough technologies of 2021 is more specifically related to its algorithm; in fact, this aim to be the world's first platform in terms of interactions and average time spent by users. to achieve these goals, it needs to propose a stream of content capable of conveying interest to the viewer; therefore, TikTok's algorithm is somehow "educated" by the users themselves. Contents are in fact sorted by the algorithm based on a combination of factors, beginning with the interests that the user declares enrolling in the platform and then going on to "adjust the focus" as the user utilizes the platform. This is significantly distinct from what occurs in other platforms where the algorithms are more oriented toward emphasizing content that gathers mass endorsements. The fact that it was first considered a social exclusively for the use of the new generation (generation Z: users born between

[1] Data stated by Airbnb

1997 and 2010), has enabled it to earn time for successfully establishing itself as a colossus, and when by now it has 1.2 billion users, it is too late for other companies to try to replicate these characteristics in their own applications.

Such examples are just a few breakthrough innovations that have arisen over the years. The core feature of these types of innovations is the fact that firms that develops them mature a unique and valuable economic advantage. The breakthroughs forge new paths and, above all, reshape the technological landscape. These factors are not only beneficial for the company that succeeds in commercializing such innovation but also, and hence the real importance of this topic arises, towards the surrounding competitive landscape.

Indeed, they are defined as the basis for future technologies (Ahuja and Lampert, 2001), and the theory that they generate both private and public wealth is confirmed by investigations that identify in breakthrough innovation (BI) generation of streams of Schumpeterian rents for their inventors (Harhoff et al., 1999).

BI in fact allows competing companies to pursue research and development with a renewed avenue to explore, this only boosts innovation globally by continually driving technology to new limits to overcome. (Phene, Fladmoe-Lindquist and Marsh, 2006).

Since they are thus considered the core of entrepreneurial activity and wealth creation (Kirchhoff, 1991; Schumpeter, 1975), the amount of attention that is paid to such innovations by scholars is quite agreeable; understanding the characteristics that lead to the discovery of such innovations is a topic of primary interest for all strategy theorists. (Ahuja and Lampert, 2001).

While it is true that for some scholars, innovation is indeed created in environments that promote freedom and serendipity (Cerf, 2006), the school of thought on which this work seeks to place itself is the one that consider the process of disruptive innovation more as a planned activity than a fortuitous event (Rakic, 2020), and which deals with the debate on technological research and development by investigating elements that can foster innovation or not.

Although this is a complex and certainly completely nonlinear process, the literature has investigated numerous elements looking for possible features that could accelerate such research processes or increase the frequency of these innovations. Even according to scientific studies, in fact, innovations resulting from research projects do not always follow a linear course; results can sometimes take longer to arrive depending on the surrounding conditions. For example, when confronted with inflationary pressures, a pending economic crisis, supply chain disruptions, and increases in energy and raw material prices, many brands will instinctively restrain innovation, perhaps refocusing on their existing portfolio. Indeed, recent NielsenIQ data record and quantify a decline in the number of innovations in recent years: from nearly 54,000 innovations in 2019 to 38,000 in 2021 in Germany, France, Spain, Italy, and the United Kingdom. A downward trend that continues in 2022.

To date, the literature has produced interesting results investigating specific factors; indeed, there are frequent scientific studies that have analyzed the effect of combining formerly uncombined but familiar technology components (Arts & Veugelers, 2014), and have found that the creation of new combinations not

only increases average utility, but also leads to a significantly higher probability of breakthroughs, while reducing the probability of failure. Analysis that finds familiarity with the findings of Fleming (2001), who claims that the origin of technological novelty and uncertainty lies within new configurations of formerly combined components. The literature also finds studies regarding whether firms should use sources of external knowledge or not in order to foster BI (Phene 2006, Kamuriwo, Baden-Fuller, Zhang 2017), and the adoption of open innovation and absorptive capacity as tools that can improve the innovation performance were also assessed (Flor, Cooper, Oltra-Maestre, 2018). Moreover, the literature has also collected studies regarding the characteristics of innovation teams or the individual inventor (Singh & Fleming, 2010), analyzing more or less positive correlations depending on background, and whether inventors' past stock of inventions affects the rate at which they produce technological breakthroughs (Conti, Gambardella, Mariani, 2014).

These features although important in the research and development landscape, all concern aspects over which companies have direct control. Consequently, it would be interesting to investigate features that fall outside the competence of companies such as institutions, which play an important role in society since they set a guide for the behavior of entities and people. Furthermore, they are supported by laws, regulations, or rules that define their role and responsibilities.

The investigation will then look at the institutional landscape and how this may affect these processes in the U.S. scenario.

The analysis focuses on a particular branch of institutions: jurisdiction. In detail, the work investigates the correlation between judicial independence (JI) and innovation within companies. Although they are two apparently distant topics, it has been demonstrated how the independence of judges has a determining effect on aspects related to the world of business and economics (Conti, Valentini, 2010). The presence of not super partes judges is an issue that has concerned many fields, and it needs to be addressed also from a research and development perspective.

The law surrounding patents is very complex and leaves room for interpretations of various kinds. In this scenario, judges have the task of firmly maintaining the legal principles that guide research and development and patenting issues. Moreover, the subject of patents is an area where lawsuits and trials are often used to solve conflicts over permissions for experiments, validity of patents, and especially patents' ownership. It is therefore evident how judges, through their decisions, can really delineate the limits of corporate research and development. Their decisions in fact create standards of criteria for patentability, granting, and evaluation of licenses. This power influences the research and development strategy of companies. It is precisely for this reason that the analysis investigates the relationship between judges' independence and corporate's research and development outcomes. Through the difference-in-differences statistical regression model, the research shed light on the type of correlation and the intensity of it with extreme outcomes, i.e., those that most often allow to arrive at innovations of particular relevance. The results shown agrees with the

first hypothesis stated, confirming that breakthrough innovations and failures outcomes are encouraged by independent judges.
The analysis will be thus organized into a review of the literature, explanation of the data and model, then discussion of the results and conclusion.

2. LITERATURE REVIEW

Breakthrough innovation refers to a significant and radical advancement or improvement in a product, service, technology, or business model that creates a new market or changes an existing one. It is characterized by a disruptive nature, challenging the traditional ways of doing things and providing a new and better solution to existing problems.
Breakthrough innovations often result from significant investments in research and development and require a high degree of creativity and risk-taking. They are distinguished from incremental innovations, which are more modest improvements to existing products, services, or technologies. Utterback (1994) defines breakthrough innovations as "change that sweeps away much of a firm's existing investments in technical skills and knowledge, designs, production technique, plant and equipment".
Some examples of breakthrough innovations include the development of the personal computer, the internet, smartphones, electric cars, and gene editing technologies. These innovations have significantly changed the way people live, work, and communicate, and have created new markets and opportunities for businesses.
Breakthrough innovation often demand long-term commitment without a clear understanding of whether the innovation will be successful or not. However, if the innovation is successful, it can lead to significant rewards, such as market leadership, increased profitability, and competitive advantage. Therefore, organizations that are willing to accept the high degree of uncertainty (Edwards-Schachter 2018) and invest in breakthrough innovation are more likely to achieve long-term success and remain competitive in the marketplace.

The reasons why this kind of innovations and its drivers are a wide discussed matter in literature is because breakthrough innovations are considered responsible of a series of phenomenon that irreversibly change the economic and social scenarios as creating new markets that did not exist before, disrupting existing ones, enhance competitiveness of firms and opening new opportunities for upcoming growth and development. Indeed, Ahuja and Lampert (2001) defines breakthrough inventions as the basis of 'future' technologies, products, and services.

Nevertheless, breakthrough innovations are not so easy to achieve; the discovery of an innovation that marks the present and will serve as basis for the future is often a path punctuated by numerous failures. Breakthroughs and failures are indeed connected, as they both represent extreme results of the R&D process. In fact, it is often through failure that breakthroughs are ultimately accomplished. For example, the

development of penicillin, one of the most important medical discoveries of the 20th century, was the result of a series of failed experiments. It was only by carefully analyzing those failures and adapting the experimental process that the breakthrough was ultimately achieved.
Similarly, many successful products and technologies have emerged from failures that led to unexpected insights and discoveries. As a matter of fact, the probability of innovation failure increases with innovation intensity (Kamoto, 2016).

R&D is all about taking risks and trying new things. Sometimes those risks pay off and lead to breakthrough innovations, while other times they result in failure. This is because truly innovative ideas are often untested and unproven, which makes it difficult to predict the outcomes with certainty. As a result, many R&D projects aimed at breakthrough innovations can be considered risky.
For instance, Apple's development of the iPhone was a risky R&D project that could have failed. Yet, the company persisted and ultimately succeeded in creating a game-changing product that revolutionized the smartphone market. Similarly, Google's development of the search engine was a risky endeavor that required significant investment and time, but it ultimately transformed the way we find and access information online.

Overall, while risky R&D projects can lead to failures, they can also be the catalyst for breakthrough innovations that can shape the future of industries and markets. Companies that are willing to take calculated risks and learn from their failures are more likely to achieve breakthrough success in their R&D efforts.
The two extreme results are the tails of the inventions' value distribution (Conti, 2014), what fattens these two tails is the variance, greater variance can increase the chances of a breakthrough because the associated increase in the mass in both tails implies a greater number of breakthrough outliers (Campbell 1960, Simonton 1999). Therefore, that means that only by undertaking risky R&D projects the results will bring both more breakthrough innovations and failures, two results, two sides of the same coin, part of a larger, iterative process of experimentation, learning, and innovation.

Research on breakthrough innovation has taken various perspectives, ranging from a micro focus on the role of lone inventors in driving innovation, to a macro examination of the institutional and environmental factors that support breakthrough innovation in firms. In this dissertation, we will explore the literature findings on breakthrough innovation from both micro and macro perspectives, in order to gain a comprehensive understanding of the factors that contribute to breakthrough innovation in different contexts.

2.1 Individual dimension

The first element to analyze is the individual dimension of inventors, and how this has been treated in the literature, Nobel-prize winning author John Steinbeck (1952) championed the creative abilities of the individual in his writing: “Our species is the only creative species, and it has only one creative instrument, the individual mind and spirit of a man. Nothing was ever created by two men. Once the miracle of creation has taken place, the group can build and extend it, but the group never invents anything. The preciousness lies in the lonely mind of a man.”

However, there is ongoing debate among scholars about whether lone inventors are more likely to generate breakthroughs than those who work in groups. Proponents of the lone inventor argue that individual creativity is unencumbered by the politics and bureaucracy of group decision-making. (Diehl and Stroebe 1987, Mullen et al. 1991, Dougherty 1992, Runco 1999, Paulus and Brown 2003). They point to examples such as Thomas Edison, who is often credited with inventing the light bulb and phonograph through his individual efforts. Independent inventors can make radical inventions that challenged established technological systems because they are not constrained by the needs and problems of existing organizations. (Huges, 2004). The lone inventors are more likely to strike for the breakthroughs or improvements in nascent systems rather than for the incremental improvements in well-established technological ones. One of the main considerations that support the thesis of this strand of literature is that breakthrough innovations are extremely limited in an organization since the loner inventors’ radical ideas upset the existing status quo, and their inventions did not fulfill the needs or solve the problems of existing organizations. Large organizations often rejected their inventive proposals as technically crude and economically risky (Huges, 2004). Dahlin et al. (2004) show that independent inventors have produced the patents with the greatest impact in the population, emphasizing their ability to create breakthrough inventions.

On the other hand, the statement has also highlighted how lone inventors are also more likely to patent inventions that have little impact. The explanation for this apparently contradicting result is that pursuing radical innovation involves a great deal of uncertainty, and this uncertainty is clearly more characteristics of independent inventors (those who do not work for an organization) which are over-represented in the tails of creative distributions (Dahlin 2004). As a matter of fact, the variance of creative outcome distributions has been widely discussed in literature, since this could outline the features that support breakthrough innovations. Fleming (2007) uses mean variance decomposition models (King, 1989) to show a lower average and greater dispersion of creative outcomes by individuals who work alone; this supports the thesis about lone inventors because when there is more variability, there are more outliers or unusual results, which can lead to breakthroughs. This idea is similar to the argument made by March (1991) saying that the methods and strategies that lead to average performance may be different from those that lead to breakthroughs.

Ultimately, the question of whether lone inventors are more likely to generate breakthroughs is complex and context dependent. While individual creativity can be a powerful force, collaboration can also offer important advantages.

2.2 Collaboration

Scholars who support collaboration argue that working in teams can lead to more diverse perspectives and increased resources, which can facilitate breakthroughs.

Collaborative teams have the advantage of being able to draw on the collective knowledge and experience of their members, which can lead to a more thorough evaluation of ideas and potentially identify hidden issues or shortcomings that an individual may not have considered. The diversity of perspectives can also lead to more innovative and creative solutions, as team members bring different skills, backgrounds, and approaches to problem-solving, this can save time and resources by preventing the pursuit of ideas that may not be viable in the long run.

Singh and Fleming (2010) have studied how and if the collaboration can influence the breakthrough results. They considered the independent inventor as an individual worker and not as single inventor that works within an organization, since he or she will still enjoy greater social interactions (among colleagues and technical experts). This assumption is consistent with the perspectives that the ability to accumulate and exploit knowledge is a fundamental reason for the existence of firms (Nelson and Winter 1982, Grant 1996). Consequently, firms can be viewed as social communities that are a natural extension of teams when it comes to creating new knowledge (Kogut and Zander, 1992).

The authors compared the relative success of lone inventors versus teams, by the number of citations received by patents. That number was read as a measure of impact and success, furthermore the citations' number has been shown to be correlated with several measures of value, including consumer surplus generated (Trajtenberg, 1990), expert evaluation of patent value (Albert et al.,1991), patent renewal rates (Harhoff et al., 1999), and contribution to an organization's market value (Hall et al., 2005).

The result of the study shows that the difference in citation rates between team and individual patents is estimated to be 28% in favor of team patents. This means that team patents are 28% more likely to be among the top 5% most cited patents compared to individual patents. The statement suggests that lone inventors are more likely to have lower levels of success than inventors who collaborate with others. Therefore, the statement implies that lone inventors are more likely to fall into the left tail.

The second statement summarizes the evidence presented in the study and rejects the idea that being a lone inventor increases the probability of achieving either extremely good or extremely bad outcomes. Instead, the evidence suggests that collaboration is beneficial at both extremes of the distribution of outcomes. In

other words, working with others increases the likelihood of achieving breakthroughs while also decreasing the likelihood of experiencing particularly poor outcomes.

The research emphasizes the importance of considering both the positive and negative outcomes of innovation when evaluating the impact of collaboration. It suggests that an analysis of working alone versus collaborating is not sufficient because it fails to account for the fact that breakthroughs can come at the expense of increasing the likelihood of poor outcomes. Therefore, it is necessary to consider the full range of outcomes when evaluating the impact of collaboration on innovation.

Furthermore, the analysis has brought up two interesting "moderation factors": Experience diversity and network size, The study suggests that diversity has a greater impact on improving poor outcomes compared to fostering breakthroughs. This means that having a diverse group of individuals with different perspectives and backgrounds is more effective in addressing and resolving problems and challenges that lead to negative outcomes.

For what concerns network size, extended social networks are found more beneficial in fostering breakthroughs. This means that having a broad network of connections and relationships can lead to new and innovative ideas that can push the boundaries of what is currently known or possible.

It is important to note that both diversity and extended social networks can contribute to both trimming poor outcomes and fostering breakthroughs. However, the research suggests that diversity is relatively more effective in addressing poor outcomes, while extended social networks are relatively more effective in promoting breakthroughs.
These results are interesting since not only they create solid evidence for all scholars who support collaboration but more importantly because they introduce other noteworthy elements that can influence breakthrough innovations such as team size and composition.

2.3 Team size and composition

In order to go deeper into understanding which factors contribute most to the reaching of breakthrough innovation, starting from the two hints given by Sigh and Flaming, this paragraph is going to analyze the scholars point of view on the dynamics and characteristics of the team that can help boost collaboration and creativity, leading to the discovery of radical innovation.
There are several studies that state how multidisciplinary collaboration increases the variance of the outcome (Fleming, 2007), having a team composed by experts in different subjects could make the difference in the creative process.

Fleming's work brings to light a detail not previously noted about multidisciplinarity. It states that it is more productive to look within established disciplines. Or, when trying to cross-pollinate between fields, the most productive approach is to combine areas that have common ground. Companies should go for depth, not breadth, when assembling a diverse team. In general, individuals with deep expertise will be more likely to see potential synergies between fields than those with broader but less deep knowledge.
The lab led by Robert S. Langer at MIT is a prime example of this. Langer's background is in chemical engineering, but his lab has a range of Ph.Ds. from different disciplines. This has resulted in a highly successful innovation factory responsible for hundreds of papers, patents, and start-ups.
This element can be defined as a "common ground" (Paulus and Coskun, 2017), and this specification helps to encircle the impact that multidisciplinarity can give to breakthrough innovations.
Despite this, multidisciplinarity also brings challenges in the team, to overcome these challenges and leverage the potential benefits of diversity, team members must be motivated to learn about each other's areas of expertise and carefully integrate and align this knowledge with their own. The elaboration model of Van Knippenberg and Schippers (2007) emphasizes the importance of this integration process for creativity to flourish in diverse teams.
In addition to the willingness to learn from each other, a positive attitude towards diversity is also essential for creativity to emerge. Research has shown that diversity can enhance novelty of ideas, but this is only the case when group members have a positive attitude towards diverse groups. Overall, knowledge diversity can be a powerful tool for creativity and innovation in interdisciplinary teams, but it requires intentional efforts to overcome potential challenges and leverage the benefits of diversity.

Going to analyze another key aspect of teams, namely size, it should be noted that Studies on long-term creative collaboration have primarily focused on descriptive analyses of groups. Farrell (2001) analyzed circles of authors, poets, artists, psychoanalysts, and activists, noting that much of their critical interaction occurred in dyads. These groups went through several stages, including rebellion against authority, constructing a new vision, creative work, collective action, separation, and reunion.

Effective creative groups tend to be relatively small, consisting of 3 to 5 members (Paulus and Coskun, 20017), and work in pairs during the vision stage. During the creative work stage, members alternate between working alone, working in pairs, and meeting as a circle, which aligns with the stimulation/incubation perspective of group interaction in brainstorming environments.

A similar result was obtained from the study conducted by Hackman and Vidmar (1970). They led the experiment where the purpose was to systematically evaluate the effects that group size has on group performance and members' reactions.

Three independent variables were included in the research design. They are group size, task type and experimental laboratory.
Group size. Six different group sizes were used, from size two to size seven.
Task type. The three task "types" identified by Hackman served as an additional factor in the study design. All the tasks required the group to produce a written piece (or "product") and thus can be characterized as requiring intellectual (rather than motor) activities on the part of group members. None of the tasks had a unique solution.
Two classes of dependent variables were used in the study: members' reactions to the group experience (a questionnaire was administered to each group member immediately after each task) and the characteristics of the written products prepared by the group (length, originality).
Groups were given 15 minutes for each task. When the time expired, the groups were told to stop working on the task and were asked to complete the questionnaire on members' reactions. When all members finished the questionnaire, the group immediately began the next task. After completing the three tasks, the subjects gathered to discuss the experiment and then were dismissed.
The researchers examinate the unique characteristics of dyads (pairs of individuals) compared to triads (groups of three individuals) and other group sizes. They wanted to determine if the differences observed in certain dependent variables (e.g., measures of behavior, attitudes, etc.) between dyads and triads were significant and greater than the differences observed between other adjacent group sizes.

To do this, the researchers calculated the difference in mean scores between dyads and triads for each dependent variable, ignoring the sign (i.e., whether the scores were positive or negative). They then compared this difference to the average difference in mean scores between other adjacent group sizes (e.g., 3 vs. 4, 4 vs. 5, etc.) for all dependent variables.

The researchers found that for 13 of the 27 dependent variables, the difference in mean scores between dyads and triads was more than twice as large as the average difference in mean scores between other adjacent group sizes. This suggests that dyads have unique characteristics that are different from both triads and other group sizes.

To further confirm these findings, the researchers conducted additional analyses comparing the scores of dyads to the average scores of all other groups. They found that for 11 of the 13 dependent variables where the difference between dyads and triads was significant, the differences between dyads and all other groups were also statistically significant ($p < .05$, two-tailed). Dyads scored substantially higher than other groups on four of the seven product dimensions.

Overall, the researchers concluded that dyads have unique characteristics that distinguish them from both triads and other group sizes, and these differences were observed in several different dependent variables. Members of dyads reported at the Member Reaction Questionnaire that they made good use of time, had considerable influence, and produced high-quality solutions. There was little competition, disagreement, or need for a strong leader in dyads. However, members still felt that dyads were too small for optimal performance.

The first and second items of the Member Reaction Questionnaire express two opposite types of dissatisfaction with the group size. One item states that "the group is too small," implying that members feel the group lacks sufficient size to meet their needs and might feel more “exposed”. The other item states that "the group is too large," indicating that members feel the group is too big to provide effective communication and collaboration. Item scores were standardized (assuming interval data) and the result will indicate the point of optimal reported satisfaction with the size of the group: between four and five members. The result has also been clear about larger groups. In these groups, members are unhappy and showing disunity, and the reasons center around the coordination difficulties they encounter.

By the way the facts that between four and five members was found the optimal reported satisfaction for the people involved in the experiment does clash with the results of the performances, as a matter of fact it appears that members of dyads may have responded to their "exposure" for being part of the smallest group by pouring their energies into task performance, while, middle-sized groups are, in a sense, too comfortable for their own good.

This phenomenon can be defined as “social loafing” that is, individuals in groups simply exert less effort than when they are alone (Letane, Levinger, Graves, Peckham, 1979), and it was studied by Mao, Mason, Suri and Watts (2015) in an experimental study of team size and performance on a complex task. They tried to understand why per-capita productivity decrease with team size.

To investigate the possibility of individual effort, the researchers looked at how much time each person spent on their work. They measured this time in effort-hours, which is the amount of time it takes for one person to complete a certain task. Then they compared it to the time it took for them to complete the same action previously. They called this time $\tau_{a,k}$, where "a" represents the type of action and "k" represents the instance of that action.

They then found the average time it took for all instances of the same action type, denoted as "t". This was calculated by adding up all the times it took for each instance of that action and dividing it by the total number of instances.

Finally, individual’s total effort was calculated in effort-hours, to do that the authors have multiplied the average time needed to complete a certain action by the number of actions occurred. This was denoted as

"Ej" and was calculated using the formula: Ej = ∑a τa ma,j, where "ma,j" represents the number of actions of a certain “a” type adopted by an employee "j".

Effort-hours measurement allow the researchers to have a more reliable analysis between individuals and teams without any bias. After analyzing the data, the researchers found that there was a loss of the 30% of effort in the largest groups.
It is important to note, however, that these findings are based on the specific context and conditions of the study. Results may differ in other settings or under different conditions, and further research may be needed to fully understand the implications of these findings.
In conclusion, empirical evidence suggests that small groups may be more effective than large groups when it comes to innovation and performance.
Small groups are well-suited to achieving breakthrough innovation because they tend to have higher levels of cohesion and communication, which can foster creativity and collaboration.
Additionally, small groups can be more agile and adaptable, allowing them to respond quickly to changing circumstances and to make decisions more efficiently. While larger groups may have advantages in terms of access to resources and diverse perspectives, the benefits of small groups may outweigh these advantages in certain situations. To achieve breakthrough innovation, organizations should focus on building strong, cohesive teams and fostering a culture of collaboration and risk-taking.

Overall, the findings suggest that organizations should carefully consider the size and structure of their teams when seeking to optimize innovation and performance. While there is no one-size-fits-all solution, the evidence suggests that smaller teams may be a promising approach for achieving these goals. By continuing to investigate the factors that contribute to effective team performance, we can continue to refine our understanding of which other elements can lead to a breakthrough organization.

2.4 Dimension and characteristics of the firm

Widening the analysis to more macro factors, in this section, we will delve into the correlation between the dimension of the company and breakthrough innovation. We will explore the idea that the size of a company can has both positive and negative effects on innovation, and how certain factors such as organizational structure, culture, and leadership can play a significant role in determining the impact of size on innovation.
Many scientific articles have been published on the relationship between firm size and breakthrough innovation. It’s worth observing that the findings are not always consistent, and that the relationship between firm size and innovation may vary depending on the industry, the type of innovation, and other factors.

Zoltan and Audretsch (1988) investigates the relationship between firm size and innovation in the United States. Specifically, the study examines the hypothesis that smaller firms are more innovative than larger firms.

To test this hypothesis, the authors use a dataset of 548 manufacturing firms in the United States, which were surveyed in 1982 and 1984. The dataset includes information on the firms' size, age, location, industry, and innovation activities.

The authors use regression analysis to estimate the relationship between firm size and innovation, controlling for other relevant factors such as firm age, industry, and location. They use several measures of innovation, including R&D expenditures, the number of patents, and the proportion of sales derived from new products. Statistical tests were used to assess the robustness of their results and to test for potential biases or confounding factors.
The results of the analysis suggest that smaller firms are indeed more innovative than larger[2] firms. Specifically, the authors find that smaller firms have more patents per employee and derive a larger proportion of their sales from new products than larger firms.

It was also investigated whether the relationship between firm size and innovation varies across industries. They found that the positive relationship between firm size and R&D expenditures is stronger in industries with high R&D intensity, while the positive relationship between firm size and the proportion of sales derived from new products is stronger in industries with low R&D intensity.
The innovative benefits of major enterprises are primarily related to their relatively higher financial and technological resources, i.e., they are physical benefits; the advantages of the smaller enterprises are characterized by entrepreneurial dynamism, internal flexibility and responsiveness to mutable surroundings, i.e., they are behavioral advantages. (Rothwell, 1989).
Indeed, smaller firms are relatively more innovative in industries that are less capital-intensive (Zoltan and Audretsch, 1987).
The result was achieved utilizing a model where the dependent variable, DIE, was defined as the difference between the large-firm innovation rate (LIE) and the small-firm innovation rate (SIE), DIE = LIE – SIE, and the innovation rate was defined as the number of innovations per-employee (thousands) in a four-digit SIC industry. Were also included in the analysis explanatory variables in order to analyze different correlation between various elements as, capital-output ratio and firms concentration ratio.
The explanation of the result might be because these industries may require less initial investment and may be more conducive to experimentation and risk-taking, which smaller firms may be better equipped to handle. While larger firms are more innovative in capital intensive market. (Zoltan & Audretsch, 1987).

[2] Large firms are defined as firms with at least 500 employees and small firms are defined as firms with fewer than 500.

This statement lends support to a slightly reinterpreted Schumpeterian view[3]: Where capital- intensity plays an important role in the industry, innovation tends to be promoted in large firms and impeded in small firms.

The most interesting result, however, that helps our analysis related to breakthrough innovations is reached by Wesley M. Cohen and Steven Klepper (1996). It is indeed of considerable relevance the evidence that in their research small and large firms face the same R&D project productivity schedules and have the same costs of performing R&D. The only way they differ is in terms of incentives that are the consequence of limited appropriability and growth due to innovation. Notwithstanding that large firms have a greater incentive to pursue all types of innovation, this incentive is relatively greater for types of innovation that depend more heavily on existing output for their exploitation. These include process and more incremental innovations which we claim to be less saleable and less likely to spawn rapid growth than other innovations. to imagine that an innovative process requiring a high degree of uncertainty does not find.
It has also been observed that one of the organizational features of greatest influence in the research and development processes results is the traditionalistic approach to experimentation. This element is typical of mature enterprises. In this case it is easy to understand that breakthrough innovations do not find an optimal environment in conservative leaning surroundings. (Choi, Ravichandran, O'Connor, 2013).

Furthermore, it is well known that incumbent firms are not prone to develop breakthrough projects because their profit would benefit more from the sale of the established product than from a new technology (Reinganum, 1983). This analysis was conducted through a mathematical model that however deems to not consider is the dynamic nature of radical innovations that have the potential to render old products obsolete and entirely replace the current market in the long run.
The explanation about why incumbents may be reluctant to introduce radical innovations has been articulated by Chandy and Gerard (2000). The theory they suggest is that technologies evolve along a series of successive S-curves that drive different new product introductions (Chandy and Tellis, 1998). This type of curve arises since there is a gradual growth of the consumer benefits when the technology is first introduced, an increasing consumer benefits as it is developed, and finally the consumer benefits decline as the technology matures.

The reason behind the aversion of incumbent firms in introducing breakthrough innovations can be that they derive a significant stream of rents from existing products based on the current technology, whereas nonincumbents derive no such rents. Thereby they may recognize lower incentives to introduce radical innovations than nonincumbents.

[3] Schumpeterian hypothesis is that the large firms should have the relative innovative advantage in concentrated markets imposing significant entry barrier. According to Schumpeter, "What we have got to accept is that (the large-scale establishment) has come to be the most powerful engine of progress..." (1950, p. 106).

This theory acknowledges the more analytical view of Tirole (1988), who comment Arrow's original comparison of the gains to a monopolist versus a firm in a competitive industry to obtain a patentable cost-reducing innovation when the alternative is no innovation by anybody. It states that since the monopolist is earning profits from the so called “replacement effect”, he has a lower incentive to innovate. Nevertheless, the monopolist's behavior would rather innovate than allow a competitor to enter the market, because now the alternative to not innovating is to have a rival obtain the innovation. The monopolist's maximum bid is the monopoly profit with the innovation minus his share of duopoly profit when the entrant has the innovation. The entrant bids his expected duopoly profit. By the ‘efficiency effect’, the monopolist's bid is higher.

Nevertheless, there are scholars who have proven a different reality. When analyzing how the combination of size and incumbency affects radical innovations, the interaction of these two variables is unexpected. The results for smaller nonincumbent firms have stated that they are four times more likely to become radical innovators than large nonincumbents. In contrast, large incumbents are almost twice as likely to be the radical innovators than are small and medium incumbents. Thus, size seems to favor incumbents and dis-favor nonincumbents (Chandy & Tellis, 2000).

The inquiry conducted by Chandy and Tellis (2000) considered both pre-World War 2 innovations (older innovations) and post- World War 2 (recent innovations), in the interest of observe if the pattern remained steady overtime. Older innovations in the sample were found to be mostly from nonincumbents (73%) while relatively few were from incumbents.

But a very different picture emerges when the focus shift on recent innovations: Incumbents significantly outnumber nonincumbent recent innovations in the sample (74% to 26%).

These results indicate that whereas the incumbent's curse may have been a problem in the late nineteenth and early twentieth centuries, it is not common in recent times. As with incumbency, the reversal over time also occurs for the size of innovators. Small and medium firms accounted for a majority (83%) of old innovations in the sample relative to large firms (17%). The pattern changes dramatically in recent times, when smaller firms account for only 26% of the innovations compared with 74% for large firms.

Results suggest that small firms or nonincumbents were more radically innovative previously, probably because of their nimbleness or lack of inertia relative to the complexity of prevailing technology. However, in recent times, large firms and incumbents account for more radical innovations, probably because their large financial, technical, or market capabilities enable them to master the complex technologies better.

This finding dovetails with research that suggests that a considerable proportion of dominant firms in today's high-tech industries are willing to cannibalize their own past investments to introduce radical product innovations (Chandy and Tellis, 1998).

As it emerges it is therefore difficult to find unambiguous answers, the topic is still widely debated in the literature but what seems to be clear is that it is a combination of factors that makes the environment more prone to breakthrough innovations, and not the presence or absence of a single element.

2.5 Environment

The environment in which firms operate plays a crucial role in fostering or hindering breakthrough innovation. This section explores the relationship between the environment and breakthrough innovation, with a focus on how firms can create a supportive culture and adapt to changing circumstances to achieve groundbreaking advancements. By understanding the role of environment in innovation, firms can better position themselves to drive growth and create value for their stakeholders.

Creating an innovative environment requires certain attributes that foster a culture of experimentation and exploration. Among these attributes is the freedom to fail (Cerf, 2016), as many scientific experiments don't yield the desired results. Especially the ones that aims to discover breakthrough innovations.

Embracing failure and learning from it is a crucial step towards achieving breakthrough innovation. Additionally, an environment that encourages interaction and gives individuals the freedom to explore can also foster innovation. Breakthrough innovation depend upon unquestionably complex processes that requires the right environment to flourish. While this environment may vary depending on the company, product area or technology, there are some constants that apply across the board. One of these is the freedom to experiment with new ideas, without fear of failure. This encourages risk-taking and the possibility of significant rewards.

Another constant is the importance of interaction and collaboration. Casual contact between individuals can lead to new perspectives and solutions to seemingly intractable problems, this happens in firms like Google where also the physical design of the facility endorses casual space where people can encounter each other and exchange ideas. The environments that develop these kinds of interconnections are often the ones where cooperation is spurred between different units of the same company, different companies, and larger organizations.

Additionally, patience is key. Innovation is a long-term process that requires time and investment to reach maturity. Finally, governments have an important role to play in supporting basic and applied research.

By adopting policies and incentives that foster innovation, organizations can increase the likelihood of success and stay ahead in a rapidly changing world. As a matter of fact, in most companies, 20 years of R&D wouldn’t be sustained, let alone 40 or 50 years. Most venture capitalists would refuse to invest in

something for 20 years before it produces any results. Cerf (2016) sustains that only governments can afford to make the long-term plays.

Government and institutions with their policies and initiatives can either facilitate or hinder the growth of breakthrough innovation, thereby several studies have analyzed their involvement. Firstly, it was recognized that one means of spreading innovative capacity is by fortifying and developing institutions, fostering, in effect, what Ash Amin and Nigel Thrift (1994) have termed “institutional thickness.”

Institutions in the innovation system play a crucial role in providing resources for firms, including technological know-how, a qualified workforce, and cooperative labor relations. However, they also have important orientation power and governance functions for local actors in industry, science, and politics. (Fuchs and Shapira, 2005)

Coulson and Ferrario (2007) have conducted an examination focused on Birmingham, England, and found that the city's institutional thickness had both positive and negative effects on innovation and economic development. On one hand, the availability of resources and the strong network of institutions in the region have led to significant economic growth and innovation. On the other hand, the path dependency created by institutional thickness has made it difficult for new ideas and technologies to disrupt the status quo, potentially stifling innovation. As a matter of fact, Fuchs and Shapira (2005) had already shown some evidence on the interrelationships between technical development paths and institutions. Moreover, in their study they have underlined how when institutional thickness increases it gives rise to institutional inertia, an environment that makes more difficult for new ideas and technologies to disrupt the status quo.

Institutional inertia happens when the existing institutions have become entrenched and resistant to change, creating a path dependency where new developments must conform to existing institutional norms.

This result is quite interesting since it is precisely in this type of environment that breakthroughs struggle to arise and is what all governments should avoid. As stated by Staber (1997) , entrepreneurial activities should be led by efforts from political actors to guarantee an adequate institutional framework’s availability to nurse innovation and flexibility. In some cases, institutional initiatives to facilitate innovation such as networking activities or more simply a dynamic leadership that can respond quickly to evolving economic, social, and cultural conditions, may be necessary preconditions for boosting innovations.

Overall, breakthrough innovations are driven by a combination of technological advances, changing market needs, economic incentives, competition, collaboration, and a willingness to take risks and explore new opportunities. However, despite the comprehensive analysis of the various elements that contribute to breakthrough innovation in businesses, remains the fact that policymakers and stakeholders must stand

vigilant in promoting innovation and avoiding institutional inertia to ensure that the innovation system continues to thrive.

There remains a lack of evidence on how institutions can facilitate or hinder this process. Therefore, the aim of this dissertation is to examine the impact of judicial independence on breakthrough innovation, as a means of understanding how institutions can foster innovation.

By exploring this aspect of institutional influence on innovation, I hope to contribute to a more comprehensive understanding of the factors that drive breakthrough innovation and inform policy makers, so that decisions can be taken to support innovation in various contexts.

3. THE INSTITUTIONAL CONTEXT

To better understand the purpose of this analysis, a description of the institution's context must be made. Since the line of argument specifically regard the judicial system, the chapter will expound on today's setup of the U.S.A. in this respect and how it might affect breakthrough innovations according to two assumptions.

3.1 U.S. outlines

The judicial system in the United States is made up of two main components: the federal court system and the state court systems. The federal court system is made up of district courts, circuit courts of appeal, and the Supreme Court while the state court systems have trial courts and appellate courts. The federal court system handles cases that involve federal law or the U.S. Constitution, while each state court handle cases that involve state law or state Constitutions. Since federal courts can only hear cases authorized by the United States Constitution or federal statutes, they have a much-narrowed jurisdiction, in truth most of the litigation brought to the U.S. courts takes place in state courts.

One of the major differences between the two components of the judicial system is the way the respective judges are appointed.

For what concerns the federal judges, the Constitution states that they must be nominated by the President and confirmed by the Senate, once appointed, they hold office for life, unless they resign, retire, or are removed from office through impeachment by Congress for misbehavior. This lifetime appointment is designed to isolate judges from political pressures, enabling them to take unbiased decisions purely based on the law. Because of this very reason, federal judges are commonly considered the main examples of independence (Sheperd, 2009). On the contrary, with regards to the election of state judges, the process is entirely distinct, and it also differs from one state to another. Even if today the combination of schemes used to select judges is nearly boundless, the literature is unanimous in recognizing two main methodologies. The most frequently used classification distinguishes between states that appoint their own judges and states that elect them (Berkson and Caufield, 2004).

The appointive system is where a chief executive, like a governor, has the power to select a candidate for a judicial position. However, this authority is monitored and bounded by certain actions, such as the requirement of confirmation by a legislative body.
Nevertheless, appointment systems generally seem to lean on adjustments of formerly known as "merit-based selection." [4]
Merit selection generally requires a nominating commission in charge of assessing candidates for the open position, identifying as “well-qualified” a prescribed number of applicants, and ultimately submits that list of candidates to the chief executive.

The nominating commission could be:
-nonpartisan (or bipartisan or multi-partisan).
-broadly based, including members from diverse backgrounds.
-composed of members appointed by a variety of sources (for example, the governor, each house of the legislature, the state administrative body of the courts, bar associations, law school deans, public interest, and citizen groups, etc.).

The electoral system, on the other hand, is conducted differently. There are three ballot forms largely correspond to three election systems:
Partisan elections: Judges are elected by the people, the candidates and their relative label designating political party affiliation are listed on the ballot and candidates typically are nominated in partisan primary elections.
Nonpartisan elections: Judges are elected by the people, and candidates' partisan affiliations are not listed on the general election ballot, and the nominations are made from nonpartisan primary election.
Retention election: Judges run in yes-no elections without opposition, with a simple majority of positive votes usually required for retention.
The modality that in the literature and in the public opinion has raised most doubts is definitely the election system.
Several well-known scholars, judges and concerned citizens began assailing elective systems as failures. Major dissidents of the system as early as 1906 made their arguments heard. In that yea, it was Roscoe Pound, dean of the Harvard University School of Law, the man who gave a now-classic speech to the American Bar Association, arguing that "putting the courts into politics, and forcing judges to become politicians in many jurisdictions . . . [had] almost destroyed the traditional respect for the court.” (Berkson and Caufield, 2004).

[4] The found for modern courts, statewide judicial interest organization in New York.

The same theme was supported by U.S. President William Howard Taft disparate years later, who argued that it was "disgraceful" to see men campaigning for the state supreme court.
The main reasons behind this dissent relate to the fact that when judges are elected through the elective system, specifically the partisan election, they must cross the same path as politicians. So, as already mentioned, participating in primaries, preparing campaigns, giving election speeches, and seeking votes. The processes listed above are particularly expensive, especially with the advent of the “New Style" of judicial campaigning (Arbour and McKenzie, 2010), a phenomenon officially identified in 1992 that states how state supreme court campaigns now use large scale efforts in order to reach as many votes as possible.
Over the years, election campaigns have become increasingly expensive which has made it extremely difficult for candidates to win elections without substantial funding (Kang and Shepherd, 2011). Literature reported how in 2000 only, the state supreme court candidates gathered 61 percent more than the amount raised by candidates in the 1998, a total of $45.6 million. In addition, in as many as 14 states there has been an increase in partisan election campaign expenditures of 167 percent from 2000 to 2002, and 163 percent from 2002 to 2004.
The total expenditure required to support this type of election from 1999 to 2006 reached the exorbitant figure of 160 million. (LeRoy 2010).

3.2 Money power

What worries the most is that has been found evidence that expenditures have become more and more a predictive indicator of victory. Indeed, it has been shown that those who spent more on campaigns prevailed in most state supreme court races, in 1997 and 1998. The situation even increased between 2001 and 2002 where the top fundraisers actually won 80 percent of the elections (Kang and Shepard, 2011).
The sponsors of all these expensive campaign activities are the parties with whom judges run for office, but the parties only act as administrators of the economic resources needed to promote the judges’ campaign, indeed parties mostly serve as able brokers who intensify the connection between campaign contributors and judicial candidates.
For clarity campaign contributors are largely business groups. Only in 2006 business groups contributed more than $15 million directly to the candidates, accounting for 44 percent of the total and double the contribution of the second interest group which are attorneys (Sample, Jones and Weiss, 2006).
All of this process undermines the vision of the impartial judge, the newly central role of money in judicial elections may allow wealthy interest groups to influence both the judges who are elected and the way these judges vote after they are elected. Firstly, by donating significant campaign funds to endorse preferred candidates and secondly because judges have an incentive to benefit wealthy interest groups in their deliberations to secure stronger electoral endorsement in forthcoming elections.
There is empirical evidence that justify growing concerns about the influence of campaign contributions in judicial elections. It has been found that elected judges who have previously received campaign

contributions from business groups, are more likely to vote for corporate interests in all types of cases (Kang and Shepard, 2011).

Evidence of particular relevance for this dissertation is the analysis conducted by the Center for American Progress.

To delineate the impact of judicial campaign contributions on the law, the Center screened high-court rulings of the six states that have spent most money in judicial elections from 1992 to 2011. The verdicts in this data set cover cases in which an individual is the plaintiff, and the named defendant is a corporation.

The result is impressive, for 561 total cases analyzed, the courts ruled in favor of corporate defendants in 366 cases. Furthermore, as it was easy to expect, for the states that have spent the most on electoral campaigns between the one in analysis, the shift in favor of pro-corporate decisions is even more powerful.

If money keeps overwhelming judicial elections, Americans will have more and more judges who favor corporations over individuals. (Corrier, 2012)

3.3 The assumptions

But why does this shady mechanism should impact innovations, and especially how should differently elected judges affect breakthrough innovations?

Since the evidence collected shows that in case of partisan election, the incumbent judges are biased in protecting and acting in favor of the business groups that supported their campaign, it is safe to assume that even in the field of innovation issues big business will have the support of the judges.

Incumbent firms are the ones with more economic, financial, and technical capabilities but at the same time they are the ones which would succumb most from breakthrough innovations since the latter would remove a lot of revenue streams they derive from existing products, which usually since we are talking about big corporate are the dominant product/design.

This leads to think that when an innovation is developed by other firms and not by the one which have supported the campaign, it might find resistance from the judges, for example in litigation concerning the possibility of experimenting with new technologies, property rights to patents, intellectual works, and especially forms of liability that may arise from the introduction of technological innovations related to the company's business. This would lead to a restriction of the innovative activity, granted "exclusively" to the incumbent firms that are allowed to experiment.

While independent judges would be more open about innovation since they have no firms to foster or protect. For this reason, the first hypothesis is that in presence of judges named by nonpartisan election, is expected an increase in innovative activity, more specifically of breakthrough innovations since this are the ones that would cause greater worriment within large companies, and the ones that will find more resistance from non-independent judges.

The second hypothesis is that instead, since the judges are encouraged to favor incumbent companies, this type of attitude can lead to an increase in breakthrough innovations. This might happen since even when companies may have undertaken too risky innovations and have to pay the consequences, the judges could still protect them in court. As a result, with judge having their backs, large companies can feel free to experiment without having to mind the consequences. It leads to expect an increase in risky innovations and breakthroughs in states with judges elected through partisan elections.

4. METHODOLOGIES, SAMPLE AND DATA

The analysis has two main themes: judicial independence and innovation in research and development. The approach chosen was to proceed by analyzing two datasets from different studies and then merge the information needed into a new dataset to work on.

The first dataset comes from a scientific paper regarding the influence of non-compete agreements on the nature of research and development (R&D) activities undertaken by firms (Conti, 2013).

Specifically, non-compete agreements were investigated through the ability of limiting the mobility of personnel towards rival firms and it was also studied the indispensable role these arrangements have in preventing the loss of knowledge. The purpose was to analyze how and whether this factor could contribute to increase the perceived value of high-risk R&D projects over low-risk ones.

As a result, these agreements encourage companies to go for bolder and riskier R&D initiatives, thereby increasing the likelihood that their corporate inventions will fall at the extremes of the value distribution curve (either as breakthrough innovations or failures) and cover new technological domains.

The study assessed a dataset that includes all granted patents whose applications were filed in the United States by a public company from 1981 to 2001. The patents' information comes from the National Bureau of Economic Research (NBER)'s latest update, which is a patent database that provides citations of all U.S. patents granted from 1976 to 2006 (Hall, Jaffe, Trajtenberg, 2001).

Additionally, in order to unveil the companies and subsidiaries owners of the patents, the identification numbers of the NBER dataset were connected to the Compustat's GVKEY[5] identification numbers, through the concordance file provided by Bessen (2009).

It is a known fact that ownership can undergo changes due to mergers, acquisitions, or spin-offs, and when this happens organizations are likely to also transfer its patents to the new owner. These alterations were meticulously tracked using data on mergers and acquisitions of publicly traded companies as reported in the SDC database[6].

[5] The Global Company Key or GVKEY is a unique six-digit number key assigned to each company (issue, currency, index) in the Capital IQ Compustat database.

[6] A collection of financial databases that provides worldwide information on Merger & Acquisition transactions, Corporate Restructurings, Global Public Finance, and Global New Issues

Exactly 1.143.531 observations were collected, each patent was linked to the respective state and year in which it was applied for. But the most useful result found within this dataset lies in the indication of success or failure related to each license.
It is challenging to extrapolate such insights in order to categorize a patent. This is particularly true when it comes to breakthrough innovations.
Determining the circumstances under which an innovation can be deemed as a breakthrough is exceedingly tricky, yet it is vital to figure it out to facilitate further analysis.
In this occurrence, the label of breakthrough innovation was assigned based on the volume of forward citations received by a patent since its application year.
This value was measured through a combination of patents' characteristics since the citations' number can be the result of various indicators regarding technological and economic value, such as consumer surplus generated (Trajtenberg, 1990), expert assessments of patent worth (Albert et al., 1991), patent renewal rates (Harhoff et al., 1999), contribution to an organization's market value (Hall, Jaffe, and Trajtenberg, 2005), and inventors' evaluations of economic value (Gambardella et al., 2008). Consistent with prior research (Fleming and Singh 2010; Phene et al., 2005), a dichotomous variable has been chosen as the method of evaluation for this variable, it has been utilized the value of '1' if the patent falls within the top 5 percent in terms of forward citations received among all patents filed in the same year (based on the application date) and within the same technological class (i.e., four-digit International Patent Classification (IPC) classes). Otherwise, to the breakthrough variable is assigned a value of '0'.

Regarding the assessment of failures instead, it was measured according to whether the invention received no forward citations, aligned with Fleming and Singh (2010).
Therefore, also in this case it was used a dummy variable that takes the value of '1' if a patent received no citations and '0' otherwise.
Furthermore, considering a five-year window as "organizational forgetting" time frame as suggested by preceding research (Argote, Beckman, and Epple, 1990), if a company's invention was different from the types of inventions that have previously applied for patents in the past five years, it was coded as "1." If it was similar to previous inventions, it was coded as "0." (Gilsing et al., 2008). The patent class referred to the first four digits of the IPC system.
In addition to these binary variables, the dataset gathered other information for each patent.

The subsequent dataset taken as a reference relates to the second main theme of this analysis, namely, the judicial independence. The dataset in question correlates each state with the respective judicial independence. The variable of judicial independence is binary and is associated with the approach of judicial elections applied in the state in question. The logic behind this derives from the existing literature; indeed, it is the latter that suggests how partisan elections tend to elect candidates who are the least

independent from the influence of incumbents, conversely, the most independent state judges are those selected through the nomination system. Accordingly ; 1 was given if it is independent (nomination system) and 0 if it is not (partisan election).

The collected dataset comes from a scientific study on specific changes in the institutional environment, focusing on reforms that modify the way in which U.S. state judges are selected. The study proved how a switch from a method of election to another decreases the ability of incumbent firms to establish judicial connections, i.e., an increase in judicial independence can promote entrepreneurship (Conti and Valentini, 2018).

The study has uncovered interesting results that correlate the firms' entry rate with the mechanism of U.S. judges elections for every states, thus their degree of judicial independence. Well connected companies have the ability to completely avoid fulfilling onerous dispositions implicitly contained in regulations or contracts and even in laws. Moreover, they are able to exert a credible influence on potential new competitors, putting them in a position of threat.

As a result, there was evidence that when elections switched from partisan ballot to other methods, incumbements had more difficulties in building relationships with judges precisely because the latter were elected through nomination system and not through partisan sponsorships behind which generally the very same companies are hidden. Data relating to changes in judicial selection procedures were collected from the website www.judicialselection.com, which provides information on possible reforms of the judicial system in the United States. In particular, longitudinal variations in judicial independence among US states were considered.

The analysis focused on the reforms that have taken place in the United States in recent decades. In fact, lately five states moved from a partisan election-based judge selection system to nonpartisan elections, or from nonpartisan elections to nomination, i.e. towards greater judicial independence.

To conclude the data search section, once these two dasets were acquired, they were merged into one file, the ultimate document where the analyses for this research will be conducted.

5. DISCUSSION OF THE RESULTS

This section presents the results obtained from the econometric analysis.

To assess the effect that judicial independence has on the ability to develop both extremely successful patents such as breakthrough innovations and failure R&D projects, the investigation was conducted at two levels of analysis: at the patent and at the state level.

In the first case, I assess the probability that a given patent is a breakthrough or failure, conditional on patent characteristics and assignee characteristics. In the second case, I measure the total number of failures and successes that were produced in a given year by all the firms located in that state.
For both analyses, I used a difference-in-differences (DID) statistical technique, a method used in data analysis to assess the causal effect of an intervention on a given group of units compared with a control group.
The DID is typically used to estimate the effect of a specific intervention or treatment (such as the passage of a law, the enactment of a policy, or the implementation of a large-scale program)[7] by comparing changes in outcomes over time between a cohort that has undergone the intervention (the intervention group) and a group that has not undergone any change (the control group).

The first consideration to be debated concerns the observations made patent by patent. Table 1 shows the effect of judicial independence in both successful and unsuccessful patents using a logistic regression. The control variables inserted are *Research and Development Expense, Assets on Total, Team Size of Inventors, Science intensity Ratio* which indicates the volume of scientific or research and development (R&D) activity in relation to the total economic activity of a sector and *Number of patent claims* a significant indicator since it determines the scope of the commercial value of the patent and the magnitude of its scientific importance for future exploration, development and improvements (Carpenter, Narin and Wolf, 1981)

These components measure possible time-variant factors affecting the years and state in analysis.

[7] Columbia University Mailman School of Public Health

Table 1. Impact of Judicial Independence on successful and failed patents

	Breakthrough	*Failure*
Judicial Independence	0.89212**	0.7741832***
	(0.041)	(0.052)
Research and Development Expense	0.9999407**	0.9999881
	(0.000)	(0.000)
Assets on Total	0.9999997	1
	(2.87e-07)	(2.58e-07)
Team Size of Inventors	1.099141***	0.9738546***
	(0.010)	(0.004)
Science intensity Ratio	1.266687**	2.789454***
	(0.086)	(0.266)
Number of patent claims	1.017404***	0.9661844***
	(0.001)	(0.002)
State FEs	Yes	Yes
Year FEs	Yes	Yes
Observations	351,519	351,585
Log-likelihood	-83111.618	-108830.58

Notes: ∗p < 0.1; ∗∗p < 0.05; ∗∗∗p < 0.01.

In this analysis, the effect of judicial independence was tested at the patent level. This has enabled to observe individually whether patents from judicially independent states had experienced the benefit of judicial independence as a reason for extreme outcomes, i.e., both extremely successful patents and largely unsuccessful patents during the years collected.

These findings show that judicial independence have a positive effect on successful patents, and it is also statistically significant. The effects remain positive also for what concerns failures with a slight decrease in the intensity but stronger in a statistically significance manner.

The interpretation I give to this result is that when judges are not elected through partisan elections in which they are funded by large corporations, the possibility of experimentation in the area of research and development increases. With the purpose to fully understand these results, it is helpful to comment on them by both looking for foundations with other works and by giving possible interpretations of the findings.

Independently elected judges seem to encourage innovation within firms, furthermore it is of interest to note the fact that breakthroughs and failures are also positively correlated with R&D expenditures. This outcome finds its significance in what has already been mentioned in the literature regarding how expensive research and development processes are often the kind of experiment that led to breakthrough innovations. Since breakthrough result from never-before-adopted combinations of knowledge, tools, and processes, companies must redesign entire development designs, and cannot rely on something already implemented. It leads to necessary expenses for those “big, risky projects” (Cooper, 2005). The topic is interesting for the purposes of my research since an independent and reliable judicial system makes a country or region attractive for investment in research and development. Companies are more likely to invest in an environment where their rights are protected, and where they can trust a judicial system which ensures that the law is applied in an impartial and predictable manner. This can lead to an influx of capital and expertise into the research and development sector, stimulating economic growth and technological innovation.

The fact that the independence of judges has a positive value for both extreme outcomes demonstrate how the JI affects an entire research process and not just specific outcomes, the finding is consistent with what has been widely asserted by many authors, namely that the pursuit of breakthrough innovations can only come from lengthy processes that also lead to numerous failures (Campbell, 1960).

This detail is important since it makes it clear that even a wide-ranging factor such as judicial independence can enter inside development processes, allowing for greater variance of outcomes. It demonstrates a strong degree of openness toward scientific experimentation from the institutions which is reflected on both tails of the results. Contrary, judges elected in a partisan way and so considered not independent, would not create this sort of environment since being reliant on specific businesses. They may tend to establish a path dependency and be a target of influences from such enterprises, this would be totally unfavorable to research

and development activity, especially for the ones whose seeks results and technologies capable of mastering the status quo.

By analyzing the results more macroscopically, it is also possible to draw conclusions to a broader level, seizing information about what kind of climate JI creates at the institutional level.

Table 1 shows how JI provide technical-institutional support for change, since the lack of that is one of the main causes of the "institutional inertia" (Fuchs and Shapira, 2005), it is possible to assert with certainty that JI removes this phenomenon, known to create an unfavorable climate for innovations, and encourages innovations. The independence of the legal institution not only creates a freer system but also lays the foundations for a more protected and secure social condition.

It happens because JI allows citizens and businesses to develop a higher level of trust in the judicial system. The latter feel protected regarding their legal actions and rights by professionals who are independent from political considerations or external pressures. In addition, the presence of independent judges also encourages innovation as it promotes legal stability. Decisions made by impartial judges are in fact more consistent and predictable over time, thereby providing a solid basis for law and legal interpretation. In such a way, companies can carefully evaluate proposals or interpret any court decisions in advance in case they have decided to undertake riskier research experiments.

I now proceed to perform the analysis at the state level. Since the dependent variable, i.e., successful patents and failed patents produced in a given state/year, are a count variable, a fixed effects (FE) Poisson regression was used for all analyses. The formula is therefore:

$$E[Yst] \exp (\varphi s + \tau t + \beta_{JI} JIst + \beta_{xrd} Xrd_{st-1} + \beta_{At} At_{st-1} + \beta_{Noi} NoI_{st-1} + \beta_{Sci\_r} Sci\_r_{st-1} + \beta_{Nr\_claims} Nr\_claims_{st-1}),$$

where JI is a dummy that captures changes in state judicial selection method in the direction of higher independence.

While φs and τt are vectors of state and year fixed effects.

Thereby, it is possible to verify whether the effects on individual patents, once grouped under the same state of origin, maintain a positive influence on the variance, or if the effect is attenuated through aggregation.

As Table 2 suggests, in this case, the effect of judges' independence is still positive and statistically significant. Contrary to the previous analysis, in this case the influence seems stronger in failures than in successful patents.

In this instance, the time-variant factors considered were different from the previous analysis. They were *R&D on assets*, *Employees* that indicates the average size in terms of work force at the state level in order to

monitor the size of enterprises during the time frames analyzed, *Patent is a Biotech* that indicates the share of patents which are biotech while *Patent is an ICT* capture the share of patents which are in the field of information and communications technology.

Table 2. Impact of Judicial Independence on successful and failed patents; errors are clustered by state.

	Breakthroughs	*Failures*
Judicial Independence	0.3209928** (0.139)	0.5372382*** (0.169)
R&D on assets	-0.1486242 (0.499)	-1.258071** (0.578)
Employees	0.0041016 *** (0.000)	0.0031542*** (0.000)
Patent is a Biotech	-0.6407443 (0.489)	1.655746 *** (0.360)
Patent is an ICT	0.6459941*** (00.186)	0.3937564** (0.178)
Year FEs	Yes	Yes
Observations	1,169	1,204
Log-likelihood	-3435.3203	-3819.3728

Notes: ∗p < 0.1; ∗∗p < 0.05; ∗∗∗p < 0.01.

The state-level analysis reports interesting results.

The extent to which the results remained consistent with each other by always showing a positive contribution of JI, even though the analyses were conducted on two different levels of analysis demonstrates not only robustness of the methodologies but also the significance that the JI element has in the landscape of institutions with regard to their influence on innovations.

The findings presented are corroborating with the hypothesis that in a judicially independent climate breakthrough innovations should flourish. It is especially significant as it allows us to place the topic of the judges' elections methodologies, and consequently their evaluation as independent or not, within the numerous factors previously investigated by the literature aimed to understand the relationship with corporate R&D activities. Most importantly, it also reveals an important response to the main question this thesis sought to answer, namely, how the institutional landscape could somehow facilitate or hinder the development of breakthrough innovations.

6. CONCLUSIONS

In this paper I have attempted to offer insight off the relationship between elements concerning institutions and the world of enterprise research and development. Although the results have a wide room for deepening, I believe that I have at least contributed to the research by providing interesting observations aimed to stimulate the pursuit of further research in this area, in order to arrive with a clearer future view of institution' role in such a topical and important issue.

6.1 Contributions

This article first investigated a specific area by demonstrating that the concept of judicial independence can provide a framework for the promotion of socio-economic development by defining the relationship between the actors involved in the innovation environment. This required bringing the analysis of the election methods of judges into relationship with the achievements of companies' R&D projects under a corresponding independent or not legislature. The work thus found in patents deposited under an independent judicial system guidance a greater variance in results. Both breakthrough and failure innovations are positively correlated with legal independence. The paper then considered judicial independence as an asset to ensure a higher level of renewal, this statement serves as the signature element of the paper as it allows to be inherited as a takeaway for creating a social economic and institutional system more inclined to innovation.

6.2 Limitations

Despite the robustness of the results, of course, the work has limitations that can be overcome by future literature; for example, the sample taken into analysis covered only the United States, therefore, it is desirable for future research to test what is set forth in this paper in other nations; the second limitation is that a legal system such as the U.S. one is not replicated in all economies, therefore, a difficulty may arise when identifying legal independence in the countries taken into analysis. However, the results obtained have clarified, at least in part, what kind of position must be taken by a branch of institutions in order to stimulate research, consequently the goal set by the work has been achieved. It would be relevant, nevertheless, to pursue the analysis of other components of the system external to enterprises in order to obtain an increasingly clearer picture of what factors can be combined to create optimal conditions to promote quality

research and development. Facilitating research by ensuring optimal synergy of all structures, not just the legal apparatus, is the goal that institutions must set themselves in order to contribute to economic growth, scientific progress and social welfare, and this work has at least partly contributed to the pursuit of this purpose.

BIBLIOGRAPHY AND SITOGRAPHY

Ahuja, G., Lampert, C.M., 2001. Entrepreneurship in the large corporation: a longitudinal study of how established firms create breakthrough inventions. Strategic Management Journal 22, 521–543.

Albert, M. B., F. Narin, D. Avery, P. McAllister. 1991. Direct validation of citation counts as indicators of industrially important patents. Res. Policy 20 251–259.

Amin, A., Thrift, N., 1994. Globalization, Institutions, and Regional Development in Europe. Oxford University Press.

Arbour B, M. McKenzie, 2010, National Criminal Justice Reference Service, Journal: judicature.

Arts, Veugelers, 2015, Technology familiarity, recombinant novelty, and breakthrough invention, Industrial and Corporate Change, Volume 24, Issue 6, December, Pages 1215–124.

Argote L, Beckman S, Epple D. 1990. The persistence and transfer of learning in industrial settings. Management Science.

Berkson, Larry, updated by Rachel Caufield. 2004 [1980]. "Judicial Selection in the United States: A Special Report." Originally appeared in *Judicature* 64(4): 176-93.

Bessen J. 2009. Matching patent data to Compustat firms. Working paper, National Bureau of Economic Research, Cambridge, MA.

Campbell, D. 1960. Blind variation and selective retention in creative thought as in other knowledge processes. Psych. Rev. 67 380–400.

Cerf, (2016), Making Innovation Happen: 2016 IRI Medal Address: Breakthrough innovation requires the right environment and flexibility and resilience in technical design. IRI Medal Address,Research-Technology Management, 59:6, 25-29.

Chandy, Rajesh, and Gerard Tellis 1998, "Organizing for Radical Product Innovation: The Overlooked Role of Willingness to Cannibalize," Journal of Marketing Research, 34 (November), (3), 256-70.

Choi B, Ravichandran T., and O'Connor G. 2013 The Effect of Human Capital Management Practices on Breakthrough Innovation (BI) in Large Firms. Academy of Management Annual Meeting Proceedings, November 2013.

Clayton M. Christensen 2020, interviewed by Karen Dillon, "Disruption 2020: An Interview With Clayton M. Christensen". MIT Sloan review, January 31.

Cohen W. and Klepper S. 1996.. Firm Size and the Nature of Innovation within Industries: The Case of Process and product R&D. The Review of Economics and Statistics, May 1996, Vol. 78, No. 2 (May 1996), pp. 232-243 Published by: The MIT Press.

Conti R, 2014. "Do non-competition agreements lead firms to pursue risky r&d projects?", Strategic Management Journal.

Conti R., G. Valentini 2018 Super Partes? Assessing the Effect of Judicial Independence on Entry. Management Science 64(8):3517-3535.

Conti, R., Gambardella A., & Mariani, M., 2014. Learning to Be Edison: Inventors, Organizations, and Breakthrough Inventions. *Organization Science*, *25*(3), 833–849.

Cooper, D.F., Grey, S., Raymond, G. and Walker, P. 2005 Project Risk Management Guidelines: Managing Risk in Large Projects and Complex Procurements. John Wiley & Sons, Ltd., England, 384.

Corriher, B, 2012, Big Business Taking Over State Supreme Courts, American progress.

Coulson A and Ferrario C., 2007, 'Institutional Thickness': Local Governance and Economic Development in Birmingham, England. International Journal of Urban and Regional Research.

Dahlin, K., M. Taylor, M. Fichman. 2004. Today's Edisons or week- end hobbyists: Technical merit and success of inventions by independent inventors. Res. Policy 33(8) 1167–1183.

Farrell, M. P. 2001. Collaborative circles: Friendship dynamics & creative work. Chicago, IL: University of Chicago Press.

Fleming L, Singh J. 2010. Lone inventors as sources of breakthroughs: myth or reality? Management Science.

Fleming, L. 2007. Breakthroughs and the “long tail” of innovation. Sloan Management Rev. 49(1) 69–74.

Flor, M. L., Cooper, S. Y., and Oltra, M. J. 2018. External knowledge search, absorptive capacity and radical innovation in high-technology firms. *Eur. Manag. J.* 36, 183–194. doi: 10.1016/j.emj.2017.08.003

Fuchs G. and Shapira P., 2005, Rethinking regional innovation and change: path dependency or regional breakthrough, Economics of science, technology and Innovation, Volume 30, Springer.

Gambardella A, Harhoff D, Verspagen B. 2008. The value of European patents. European Management Review.

Gilsing VA, Nooteboom B, Vanhaverbeke WPM, Duijsters GM, vanden Oord A. 2008. Network embeddedness and the exploration of novel technolo- gies: technological distance, betweenness centrality, and density. Research Policy

Hackman J., Vidmar N, 1970, Effects of Size and Task Type on Group Performance and Member Reactions. American sociological Association.

Hall BH, Jaffe AB, Trajtenberg M. 2001. The NBER patent citations data file: lessons, insights and methodological tools. Working paper 8498, National Bureau of Economic Research, Cambridge, MA

Hall, B., A. Jaffe, M. Trajtenberg. 2005. Market value and patent citations. RAND J. Econom. 1 16–38.

Harhoff, D., F. Narin, F. Scherer, K. Vopel. 1999. Citation frequency and the value of patented inventions. Rev. Econom. Statist. 81(3) 511–515.

Huges, 2004. American genesis, Chicago University press.

J. Sample, L. Jones & R. Weiss, the new politics of judicial elections 2006, at 18 (Jesse rutledge ed., 2006)

John Steinbeck, 1965. East of Eden. Bantam book with Viking Press, Inc. um 1965

Kamuriwo, D. S., Baden-Fuller, C., and Zhang, J. 2017. Knowledge development approaches and breakthrough innovations in technology-based new firms. *J. Prod. Innov. Manage.* 34, 492–508.

Kang M, Shepherd JM 2011,The partisan price of justice: An empirical analysis of campaign contributions and judicial decisions. New York Univ. Law Rev. 86:69–130.

King, G. 1989. Variance specification in event count models: From restrictive assumptions to a generalized estimator. American Journal of Political Science, Vol. 33, No. 3, August 1989.

Kirchhoff B. 1991. Entrepreneurship's contribution to economics. *Entrepreneurship Theory and Practice* 16(2): 93–112.

Kogut , Zander, 1992 Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology, Organization Science Volume 3Issue 301 August 1992pp 383–39.

Larry C. Berkson & Rachel Caufield, 2004. Judicial Selection in the United States: A Special report American Judicature Society.

Latane B, Williams K, Harkins S. 1979 Many hands make light the work: The causes and consequences of social loafing. Journal of personality and social psychology.; 37(6):822.

LeRoy MH 2010 Do partisan elections of judges produce unequal results? When courts review employment arbitrations. Iowa Law Rev. 95:1569–1620.

Mao A, Mason W., Suri S., Watts D., 2015. An Experimental Study of Team Size and Performance on a Complex Task. PLOS Journal.

March, J. G. 1991. Exploration and Exploitation in Organizational Learning. Organization Science, 2(1), 71–87.

Mónica Edwards-Schachter 2018. "The nature and variety of innovation", International Journal of Innovation Studies, Volume 2, Issue 2, 2018.

Nelson, R., S. Winter. 1982. An Evolutionary Theory of Economic, The Belknap Press Of Harvard University Press Cambridge, Massachusetts And London, England.

Paulus P., Coskun H., (2017). Group Creativity: Innovation through Collaboration. OUP Oxford.

Phene A, Fladmoe-Lindquist and Marsh L, “Breakthrough Innovations in the US Biotechnology Industry: The Effects of Technological Space and Geographic Origin,” Strategic Management Journal, Vol. 27, No. 4, 2006, pp. 369-388.

Rajesh K., Chandy and Gerard J. Tellis 2000. The Incumbent's Curse? Incumbency, Size, and Radical Product Innovation. Journal of Marketing, Jul. 2000, Vol. 64, No. 3 (Jul. 2000), pp. 1-17 Published by: Sage Publications, Inc. on behalf of American Marketing Association

Rakic K., 2021. Breakthrough and Disruptive Innovation: A Theoretical Reflection. Journal of Technology Management & Innovation, 15(4), 93–104.

Reinganum, Jennifer F 1983, "Uncertain Innovation and the Persistence of Monopoly," The American Economic Review, 73 (September).

Roy Rothwell, 1989. Small Firms, Innovation and Industrial Change, Vol. 1, No. 1 (1989), pp. 51-64 Published by: Springer.

Schumpeter JA. 1975. *Capitalism, Socialism and Democracy*. Harper & Row: New York. (Originally published in 1942 by Harper and Brothers.).

Shepherd JM 2009 money, politics, and impartial justice. Duke Law J. 58:623–685.

Shinsuke Kamoto, 2016. “Managerial innovation incentives, management buyouts, and shareholders’ intolerance of failure” Faculty of Economics, Kagawa University, 2-1 Saiwaicho, Takamatsu, Kagawa 760-8523, Japan.

Simonton, D. K. 1999. Origins of Genius: Darwinian Perspectives on Creativity. Oxford University Press, New York.

Singh and Fleming 2010, Lone Inventors as Sources of Breakthroughs: Myth or Reality? Management Science 56(1), pp. 41–56, © INFORMS.

Staber, U., 1997, An ecological perspective on entrepreneurship in industrial districts. Entrepreneur- ship and Regional Development; 9:45-64.

Tirole, Jean 1988, The Theory of Industrial Organization. Cambridge, MA: MIT Press.

Trajtenberg, M. 1990. A Penny for Your Quotes: Patent Citations and the Value of Innovations. *The RAND Journal of Economics*, *21*(1), 172–187.

Utterback, J.M. 1994-1996. “Mastering the dynamics of innovation Boston”. MA: Harvard University Business School Press.

Van Knippenberg, D., & Schippers, M. C. 2007. Work group diversity. Annual Review of Psychology, 58, 515–541.

Vinton G. Cerf 2016 Making Innovation Happen: 2016 IRI Medal Address, Research-Technology Management, 59:6, 25-29.

Zoltan and Audretsch, 1987. Innovation, Market Structure, and Firm Size. The Review of Economics and Statistics. Nov. 1987, Vol. 69, No. 4 (Nov. 1987), The MIT Press.

Zoltan J. Acs and David B. Audretsch. 1988 Innovation in Large and Small Firms: An Empirical Analysis. The American Economic Review, Sep. 1988, Vol. 78, No. 4 (Sep. 1988), pp. 678- 690. American Economic Association.

SITOGRAPHY

https://www.wipo.int/global_innovation_index/en/2022/#:~:text=Switzerland%20is%20the%20most%20innovative,according%20to%20the%20GII%202022.
https://italia-informa.com/airbnb-profitti-2022.aspx, https://www.milanofinanza.it/news/airbnb-in-utile-per-la-prima-volta-nel-2022-tornano-di-moda-i-viaggi-a-lungo-raggio-202302151100515819
https://moderncourts.org/programs-advocacy/judicial-selection/methods-of-judicial-selection/

SUMMARY

What do Airbnb, penicillin and the Tik Tok recommendation algorithm have in common? Well, all the above mentioned belong to the so called "breakthrough innovations." This is certainly not a new term; indeed, this expression has been already used before the 2000s in the scientific literature, during the era of emerging ICT technologies, in order to define radical innovation; this word is used as a synonym of radical or discontinuous innovation. The main characteristic of this kind of innovation is that “it describes a process by which a product or service initially takes root in simple applications at the lower end of a market, since it is generally less expensive and more accessible, and then relentlessly moves into the high-end market, eventually replacing established competitors.” this is the definition given by the developer of the "disruptive innovation" theory Clayton Magleby Christensen at the MIT Sloan management review.

The three aforementioned innovations have indeed retraced the stages that Christensen stated, Airbnb earlier when it was founded in 2008, was only focusing on low-value customers. But in the present, thanks to its innovative approach to tourism accommodation, during the third quarter of 2022 had managed to register its most profitable period ever despite widespread inflation, now the platform is the nightmare of the hotel industry, which hadn't been disrupted for decades, only to be utterly caught off guard by Airbnb.

Penicillin itself, accidentally discovered in 1928 by Fleming, was not widely distributed until after World War II, when antibiotics became the solution to many previously fatal illnesses. The circumstances of the war effort of the 1940s certainly provided a boost to the commercialization of the product, with the transition from laboratory to mass production in an incredibly brief time frame and with productivity improvements of two orders of magnitude. By jumping forward more than 50 years, we find ourselves in China, in 2016, where Tik Tok was born. The app follows the standard pattern of Clayton Christensen's "Innovator's Dilemma": it supplies an affordable (in the present case free) service to an underserved segment of the market (teens and young adults). Yet this simple approach, in combination with favorable circumstances for its rapid bursting expansion in the last few years, has made TikTok a competitive player against the big tech giants, such as Facebook and Google.

Such examples are just a few breakthrough innovations that have arisen over the years. The core feature of these types of innovations is the fact that firms that develops them mature a unique and valuable economic advantage.

The breakthroughs forge new paths and, above all, reshape the technological landscape. These factors are not only beneficial for the company that succeeds in commercializing such innovation but also, and hence the real importance of this topic arises, towards the surrounding competitive landscape.

Indeed, they are defined as the basis for future technologies (Ahuja and Lampert, 2001), and the theory that they generate both private and public wealth is confirmed by investigations that identify in breakthrough innovation (BI) generation of streams of Schumpeterian rents for their inventors (Harhoff et al., 1999).

Breakthrough Innovations in fact allows competing companies to pursue research and development with a renewed avenue to explore, this only boosts innovation globally by continually driving technology to new limits to overcome. (Phene, Fladmoe-Lindquist and Marsh, 2006).

Since they are thus considered the core of entrepreneurial activity and wealth creation (Kirchhoff, 1991; Schumpeter, 1975), the amount of attention that is paid to such innovations by scholars is quite agreeable; understanding the characteristics that lead to the discovery of such innovations is a topic of primary interest for all strategy theorists. (Ahuja and Lampert, 2001).

While it is true that for some scholars, innovation is indeed created in environments that promote freedom and serendipity (Cerf, 2006), the school of thought on which this work seeks to place itself is the one that consider the process of disruptive innovation more as a planned activity than a fortuitous event (Rakic, 2020), and which deals with the debate on technological research and development by investigating elements that can foster innovation or not.

To date, the literature has produced interesting results investigating specific factors; indeed, there are frequent scientific studies that have analyzed the effect of combining formerly uncombined but familiar technology components (Arts & Veugelers, 2014), and have found that the creation of new combinations not only increases average utility, but also leads to a significantly higher probability of breakthroughs, while reducing the probability of failure. Analysis that finds familiarity with the findings of Fleming (2001), who claims that the origin of technological novelty and uncertainty lies within new configurations of formerly combined components.

The literature also finds studies regarding whether firms should use sources of external knowledge or not in order to foster BI (Phene 2006, Kamuriwo, Baden-Fuller, Zhang 2017), and the adoption of open innovation and absorptive capacity as tools that can improve the innovation performance were also assessed (Flor, Cooper, Oltra-Maestre, 2018). Moreover, the literature has also collected studies regarding the characteristics of innovation teams or the individual inventor (Singh & Fleming, 2010), analyzing more or less positive correlations depending on background, and whether inventors' past stock of inventions affects the rate at which they produce technological breakthroughs (Conti, Gambardella, Mariani, 2014).

These features although important in the research and development landscape, all concern aspects over which companies have direct control. Consequently, it would be interesting to investigate features that fall outside the competence of companies such as institutions, which play an important role in society since they set a guide for the behavior of entities and people. Furthermore, they are supported by laws, regulations, or rules that define their role and responsibilities.

The investigation will then look at the institutional landscape and how this may affect these processes in the U.S. scenario.
The analysis focuses on a particular branch of institutions: jurisdiction. In detail, the work investigates the correlation between judicial independence (JI) and innovation within companies. Although they are two apparently distant topics, it has been demonstrated how the independence of judges has a determining effect on aspects related to the world of business and economics (Conti, Valentini, 2010). The presence of not super partes judges is an issue that has concerned many fields, and it needs to be addressed also from a research and development perspective.
The law surrounding patents is very complex and leaves room for interpretations of various kinds. In this scenario, judges have the task of firmly maintaining the legal principles that guide research and development and patenting issues. Moreover, the subject of patents is an area where lawsuits and trials are often used to solve conflicts over permissions for experiments, validity of patents, and especially patents' ownership. It is therefore evident how judges, through their decisions, can really delineate the limits of corporate research and development. Their decisions in fact create standards of criteria for patentability, granting, and evaluation of licenses. This power influences the research and development strategy of companies. It is precisely for this reason that the analysis investigates the relationship between judges' independence and corporate's research and development outcomes. Through the difference-in-differences statistical regression model, the research shed light on the type of correlation and the intensity of it with extreme outcomes, i.e., those that most often allow to arrive at innovations of particular relevance. The results shown agrees with the first hypothesis stated, confirming that breakthrough innovations and failures outcomes are encouraged by independent judges.

With regards to the literature to date, the investigation has focused mainly on five aspects.
The first element to analyze is the individual dimension of inventors, and how this has been treated in the literature, Nobel-prize winning author John Steinbeck (1952) championed the creative abilities of the individual in his writing: "Our species is the only creative species, and it has only one creative instrument, the individual mind and spirit of a man. Nothing was ever created by two men. Once the miracle of creation has taken place, the group can build and extend it, but the group never invents anything. The preciousness lies in the lonely mind of a man."
However, there is ongoing debate among scholars about whether lone inventors are more likely to generate breakthroughs than those who work in groups. Proponents of the lone inventor argue that individual creativity is unencumbered by the politics and bureaucracy of group decision-making. (Diehl and Stroebe 1987, Mullen et al. 1991, Dougherty 1992, Runco 1999, Paulus and Brown 2003). The lone inventors are more likely to strike for the breakthroughs or improvements in nascent systems rather than for the incremental improvements in well-established technological ones. One of the main considerations

that support the thesis of this strand of literature is that breakthrough innovations are extremely limited in an organization since the loner inventors' radical ideas upset the existing status quo, and their inventions did not fulfill the needs or solve the problems of existing organizations. Large organizations often rejected their inventive proposals as technically crude and economically risky (Huges, 2004). Dahlin et al. (2004) show that independent inventors have produced the patents with the greatest impact in the population, emphasizing their ability to create breakthrough inventions.
On the other hand, the statement has also highlighted how lone inventors are also more likely to patent inventions that have little impact. The explanation for this apparently contradicting result is that pursuing radical innovation involves a great deal of uncertainty, and this uncertainty is clearly more characteristics of independent inventors (those who do not work for an organization) which are over-represented in the tails of creative distributions (Dahlin 2004). As a matter of fact, the variance of creative outcome distributions has been widely discussed in literature, since this could outline the features that support breakthrough innovations. Fleming (2007) uses mean variance decomposition models (King, 1989) to show a lower average and greater dispersion of creative outcomes by individuals who work alone; this supports the thesis about lone inventors because when there is more variability, there are more outliers or unusual results, which can lead to breakthroughs. This idea is similar to the argument made by March (1991) saying that the methods and strategies that lead to average performance may be different from those that lead to breakthroughs.

Following the discussion, the study highlighted the most interesting results achieved by the authors regarding the second fundamental element: collaboration.
Scholars who support collaboration argue that working in teams can lead to more diverse perspectives and increased resources, which can facilitate breakthroughs.
Collaborative teams have the advantage of being able to draw on the collective knowledge and experience of their members, which can lead to a more thorough evaluation of ideas and potentially identify hidden issues or shortcomings that an individual may not have considered. The diversity of perspectives can also lead to more innovative and creative solutions, as team members bring different skills, backgrounds, and approaches to problem-solving, this can save time and resources by preventing the pursuit of ideas that may not be viable in the long run.
Singh and Fleming (2010) have studied how and if the collaboration can influence the breakthrough results.
The authors compared the relative success of lone inventors versus teams, by the number of citations received by patents. The evidence suggests that collaboration is beneficial at both extremes of the distribution of outcomes. In other words, working with others increases the likelihood of achieving breakthroughs while also decreasing the likelihood of experiencing particularly poor outcomes.

The research emphasizes the importance of considering both the positive and negative outcomes of innovation when evaluating the impact of collaboration. It suggests that an analysis of working alone versus collaborating is not sufficient because it fails to account for the fact that breakthroughs can come at the expense of increasing the likelihood of poor outcomes. Therefore, it is necessary to consider the full range of outcomes when evaluating the impact of collaboration on innovation.

The third element examined is the size and the composition of the research team in this case the results are very clear.
Empirical evidence suggests that small groups may be more effective than large groups when it comes to innovation and performance.
Small groups are well-suited to achieving breakthrough innovation because they tend to have higher levels of cohesion and communication, which can foster creativity and collaboration.
Additionally, small groups can be more agile and adaptable, allowing them to respond quickly to changing circumstances and to make decisions more efficiently. While larger groups may have advantages in terms of access to resources and diverse perspectives, the benefits of small groups may outweigh these advantages in certain situations. To achieve breakthrough innovation, organizations should focus on building strong, cohesive teams and fostering a culture of collaboration and risk-taking. While there is no one-size-fits-all solution, the evidence suggests that smaller teams may be a promising approach for achieving these goals.

Widening the analysis to more macro factors, in this section, we will delve into the correlation between the dimension of the company and breakthrough innovation. Regarding this factor has been found evidence that small and large firms face the same R&D project productivity schedules and have the same costs of performing R&D. The only way they differ is in terms of incentives that are the consequence of limited appropriability and growth due to innovation. Notwithstanding that large firms have a greater incentive to pursue all types of innovation, this incentive is relatively greater for types of innovation that depend more heavily on existing output for their exploitation.
Incumbent firms are not prone to develop breakthrough projects because their profit would benefit more from the sale of the established product than from a new technology (Reinganum, 1983).
The explanation about why incumbents may be reluctant to introduce radical innovations has been articulated by Chandy and Gerard (2000). The theory they suggest is that technologies evolve along a series of successive S-curves that drive different new product introductions (Chandy and Tellis, 1998). This type of curve arises since there is a gradual growth of the consumer benefits when the technology is

first introduced, an increasing consumer benefits as it is developed, and finally the consumer benefits decline as the technology matures.

As the last key factor in the research and development system, the paper analyzed the environment. Creating an innovative environment requires certain attributes that foster a culture of experimentation and exploration. Among these attributes is the freedom to fail (Cerf, 2016), as many scientific experiments don't yield the desired results. Especially the ones that aims to discover breakthrough innovations.
Embracing failure and learning from it is a crucial step towards achieving breakthrough innovation. Additionally, an environment that encourages interaction and gives individuals the freedom to explore can also foster innovation. Breakthrough innovation depend upon unquestionably complex processes that requires the right environment to flourish. However, despite the comprehensive analysis of the various elements that contribute to breakthrough innovation in businesses, remains the fact that policymakers and stakeholders must stand vigilant in promoting innovation and avoiding institutional inertia to ensure that the innovation system continues to thrive.
There remains a lack of evidence on how institutions can facilitate or hinder this process. Therefore, the aim of this dissertation is to examine the impact of judicial independence on breakthrough innovation, as a means of understanding how institutions can foster innovation.

To better understand the purpose of this analysis, a description of the institution’s context must be made. Since the line of argument specifically regard the judicial system, the chapter will expound on today's setup of the U.S.A. in this respect and how it might affect breakthrough innovations according to two assumptions.
The judicial system in the United States is made up of two main components: the federal court system and the state court systems. The federal court system is made up of district courts, circuit courts of appeal, and the Supreme Court while the state court systems have trial courts and appellate courts. The federal court system handles cases that involve federal law or the U.S. Constitution, while each state court handle cases that involve state law or state Constitutions. Since federal courts can only hear cases authorized by the United States Constitution or federal statutes, they have a much-narrowed jurisdiction, in truth most of the litigation brought to the U.S. courts takes place in state courts.
The election of state judges differs from one state to another. Even if today the combination of schemes used to select judges is nearly boundless, the literature is unanimous in recognizing two main methodologies.
The most frequently used classification distinguishes between states that appoint their own judges and states that elect them (Berkson and Caufield, 2004).

The appointive system is where a chief executive, like a governor, has the power to select a candidate for a judicial position. However, this authority is monitored and bounded by certain actions, such as the requirement of confirmation by a legislative body.
Nevertheless, appointment systems generally seem to lean on adjustments of formerly known as "merit-based selection." [8]
Merit selection generally requires a nominating commission in charge of assessing candidates for the open position, identifying as “well-qualified” a prescribed number of applicants, and ultimately submits that list of candidates to the chief executive.

The nominating commission could be:
-nonpartisan (or bipartisan or multi-partisan).
-broadly based, including members from diverse backgrounds.
-composed of members appointed by a variety of sources (for example, the governor, each house of the legislature, the state administrative body of the courts, bar associations, law school deans, public interest, and citizen groups, etc.).

The electoral system, on the other hand, is conducted differently. There are three ballot forms largely correspond to three election systems:
Partisan elections: Judges are elected by the people, the candidates and their relative label designating political party affiliation are listed on the ballot and candidates typically are nominated in partisan primary elections.
Nonpartisan elections: Judges are elected by the people, and candidates' partisan affiliations are not listed on the general election ballot, and the nominations are made from nonpartisan primary election.
Retention election: Judges run in yes-no elections without opposition, with a simple majority of positive votes usually required for retention.
The modality that in the literature and in the public opinion has raised most doubts is definitely the election system.
Indeed, it has been shown that those who spent more on campaigns prevailed in most state supreme court races, in 1997 and 1998. The situation even increased between 2001 and 2002 where the top fundraisers actually won 80 percent of the elections (Kang and Shepard, 2011).
The sponsors of all these expensive campaign activities are the parties with whom judges run for office, but the parties only act as administrators of the economic resources needed to promote the judges’ campaign, indeed parties mostly serve as able brokers who intensify the connection between campaign contributors and judicial candidates.

[8] The found for modern courts, statewide judicial interest organization in New York.

For clarity campaign contributors are largely business groups. Only in 2006 business groups contributed more than $15 million directly to the candidates, accounting for 44 percent of the total and double the contribution of the second interest group which are attorneys (Sample, Jones and Weiss, 2006).
All of this process undermines the vision of the impartial judge, the newly central role of money in judicial elections may allow wealthy interest groups to influence both the judges who are elected and the way these judges vote after they are elected. Firstly, by donating significant campaign funds to endorse preferred candidates and secondly because judges have an incentive to benefit wealthy interest groups in their deliberations to secure stronger electoral endorsement in forthcoming elections.
There is empirical evidence that justify growing concerns about the influence of campaign contributions in judicial elections. It has been found that elected judges who have previously received campaign contributions from business groups, are more likely to vote for corporate interests in all types of cases (Kang and Shepard, 2011).
This leads to think that when an innovation is developed by other firms and not by the one which have supported the campaign, it might find resistance from the judges, for example in litigation concerning the possibility of experimenting with new technologies, property rights to patents, intellectual works, and especially forms of liability that may arise from the introduction of technological innovations related to the company's business. This would lead to a restriction of the innovative activity, granted "exclusively" to the incumbent firms that are allowed to experiment.
While independent judges would be more open about innovation since they have no firms to foster or protect. For this reason, the first hypothesis is that in presence of judges named by nonpartisan election, is expected an increase in innovative activity, more specifically of breakthrough innovations since this are the ones that would cause greater worriment within large companies, and the ones that will find more resistance from non-independent judges.

The second hypothesis is that instead, since the judges are encouraged to favor incumbent companies, this type of attitude can lead to an increase in breakthrough innovations. This might happen since even when companies may have undertaken too risky innovations and have to pay the consequences, the judges could still protect them in court. As a result, with judge having their backs, large companies can feel free to experiment without having to mind the consequences. It leads to expect an increase in risky innovations and breakthroughs in states with judges elected through partisan elections.

The data used for the research consist of two datasets.
The first dataset comes from a scholarly work concerning the influence of non-compete agreements on the nature of research and development (R&D) activities undertaken by firms (Conti, 2013).

Specifically, non-compete agreements were investigated through their ability to limit the mobility of personnel to rival firms, and the indispensable role these agreements play in preventing knowledge loss was also studied.
The subsequent dataset taken as a reference relates to the second main theme of this analysis, namely, the judicial independence. The dataset in question correlates each state with the respective judicial independence. The variable of judicial independence is binary and is associated with the approach of judicial elections applied in the state in question. The logic behind this derives from the existing literature; indeed, it is the latter that suggests how partisan elections tend to elect candidates who are the least independent from the influence of incumbents, conversely, the most independent state judges are those selected through the nomination system. Accordingly; 1 was given if it is independent (nomination system) and 0 if it is not (partisan election). once these two dasets were acquired, they were merged into one file, the ultimate document where the analyses for this research will be conducted.
The collected dataset comes from a scientific study on specific changes in the institutional environment, focusing on reforms that modify the way in which U.S. state judges are selected. The study proved how a switch from a method of election to another decreases the ability of incumbent firms to establish judicial connections, i.e., an increase in judicial independence can promote entrepreneurship (Conti and Valentini, 2018).

To assess the effect that judicial independence has on the ability to develop both extremely successful patents such as breakthrough innovations and failure R&D projects, the investigation was conducted at two levels of analysis: at the patent and at the state level. For both analyses, I used a difference-in-differences (DID) statistical technique, a method used in data analysis to assess the causal effect of an intervention on a given group of units compared with a control group.

In the first analysis, the effect of judicial independence was tested at the patent level. This has enabled to observe individually whether patents from judicially independent states had experienced the benefit of judicial independence as a reason for extreme outcomes, i.e., both extremely successful patents and largely unsuccessful patents during the years collected. The findings show that judicial independence have a positive effect on successful patents, and it is also statistically significant. The effects remain positive also for what concerns failures with a slight decrease in the intensity but stronger in a statistically significance manner.
The second analyses, the ones where the effect of judicial independence was tested by clustering patents state by state, shows that the effect of judges' independence is still positive and statistically significant. Contrary to the previous analysis, in this case the influence seems stronger in failures than in successful patents.

The findings presented are corroborating with the hypothesis that in a judicially independent climate breakthrough innovations should flourish. It is especially significant as it allows us to place the topic of the judges' elections methodologies, and consequently their evaluation as independent or not, within the numerous factors previously investigated by the literature aimed to understand the relationship with corporate R&D activities. Most importantly, it also reveals an important response to the main question this thesis sought to answer, namely, how the institutional landscape could somehow facilitate or hinder the development of breakthrough innovations.

Judicial Independence provide technical-institutional support for change, since the lack of that is one of the main causes of the "institutional inertia" (Fuchs and Shapira, 2005), it is possible to assert with certainty that JI removes this phenomenon, known to create an unfavorable climate for innovations, and encourages innovations. The independence of the legal institution not only creates a freer system but also lays the foundations for a more protected and secure social condition.

It happens because JI allows citizens and businesses to develop a higher level of trust in the judicial system. The latter feel protected regarding their legal actions and rights by professionals who are independent from political considerations or external pressures. In addition, the presence of independent judges also encourages innovation as it promotes legal stability. Decisions made by impartial judges are in fact more consistent and predictable over time, thereby providing a solid basis for law and legal interpretation. In such a way, companies can carefully evaluate proposals or interpret any court decisions in advance in case they have decided to undertake riskier research experiments.

This article first investigated a specific area by demonstrating that the concept of judicial independence can provide a framework for the promotion of socio-economic development by defining the relationship between the actors involved in the innovation environment. This required bringing the analysis of the election methods of judges into relationship with the achievements of companies' R&D projects under a corresponding independent or not legislature. The work thus found in patents deposited under an independent judicial system guidance a greater variance in results. Both breakthrough and failure innovations are positively correlated with legal independence. The paper then considered judicial independence as an asset to ensure a higher level of renewal, this statement serves as the signature element of the paper as it allows to be inherited as a takeaway for creating a social economic and institutional system more inclined to innovation.

Despite the robustness of the results, of course, the work has limitations that can be overcome by future literature; for example, the sample taken into analysis covered only the United States, therefore, it is desirable for future research to test what is set forth in this paper in other nations; the second limitation is that a legal system such as the U.S. one is not replicated in all economies, therefore, a difficulty may arise when identifying legal independence in the countries taken into analysis. However, the results obtained have clarified, at least in part, what kind of position must be taken by a branch of institutions in order to stimulate research, consequently the goal set by the work has been achieved. It would be

relevant, nevertheless, to pursue the analysis of other components of the system external to enterprises in order to obtain an increasingly clearer picture of what factors can be combined to create optimal conditions to promote quality research and development. Facilitating research by ensuring optimal synergy of all structures, not just the legal apparatus, is the goal that institutions must set themselves in order to contribute to economic growth, scientific progress and social welfare, and this work has at least partly contributed to the pursuit of this objective.