Legal innovation and learning in social media regulation: an evolutionary approach

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1. Introduction

1.1 Since the internet 2.0 revolution, the digitization of nearly all media and the continuing migration of social and economic activities to the internet is generating petabytes of data every second (OECD, 2014:9, AGCM, 2018). With the diffusion of broadband access and internet enabled devices, consumers are actively and passively divulging personal information in bulk in exchange for services. The main example are social media. In 2014, for instance, Facebook connected already 1.3 billion people around the world who generated an average of 1500 status update every second, but similar phenomena characterize other social media platforms (Stucke and Grunes, 2016 Klonick, 2018). Today, Facebook showcases more than two billion users (Stucke and Grunes 2016:18).

1.2 Some reasons for such increase are technological in nature and are related to the tremendous decrease in the cost of collecting, storing, processing and analyzing data (Stucke and Grunes, 2016:17, Bellefalmme, 2018), while others are linked to the prevailing legal institutions and general ideas about data gathering and dissemination practices.

1.3 Legal uncertainty surrounding data-driven services like Facebook and other social media has long been on the table. Along with the argument that "events on the Net occur everywhere but nowhere in particular" many people advocated that "no physical jurisdiction has a more compelling claim than any other to subject events exclusively to its laws" (Jhonson and Post, 1996, Pollicino, 2013:246, Hijman, 2016). Moreover, the "newness" of novel internet-related technology was emphasized to buttress the «internet exceptionalism» (Wu, 2010) and to sterilize most legislative intervention in any internet-mediated action (Balkin,2004, Benckler, 2006,). In this context, legislative branches of states across the western world have long been refraining from mandating full extension of legal orders over internet and social media platforms[1] (Chander, 2014, Bygrave, 2015).

1.4 The flexible 'notice and consent framework' (hereinafter: N&C) was the legal innovation

[1] To the opposite, US, EU, Canada and most of the other western Countries have legislated to provide explicit liability exemptions for the internet sector[1], ranging from copyright issues, privacy, and intermediary liability to subsidize it's growth (Chander, 2014b).

introduced to overcome these highly controversial issues, to lessen consent requirements for electronic commerce and give a legal basis to otherwise unregulated activities (Sloan and Warner, 2014). For more than a decade, the private ordering based on N&C schemes served to «progressively reduce ex-ante sector specific rules as competition in the markets develops and, ultimately, for electronic communications to be governed by competition law only» (Comparado et al, 2016:54). Courts were left alone to solve conflicts between rights arising from these innovative contracts and the prevailing order of rights and legal relationships, whose effects either manifested within their territories or harmed their citizens (Pollicino, 2013, Klonick, 2018). Platforms have collected data with little scrutiny from public authority for more than a decade, boosted by consumers' hype for social media and little consumers' interests for terms and conditions of service (Rubenstein, 2014; Bygrave, 2015). Yet, users were interests in the service and not in the applicable legal regime stemming for the N&C innovation (Ben-Shahar, 2009).

1.5 Today, users have started to learn about the implications of legal innovations in terms of protection of their rights, as they have been experimenting with the unintended consequences of Facebook's and others' data gathering practices covered by N&C. The Snowden revelations and Cambridge analitica are the most famous examples, but there are many more (O'Neil, 2016). Consumers are increasingly calling for higher protection of privacy ((Rubenstein, 2014; Bygrave, 2015; Klonick 2018). Judges2 started to enforce general legislation concerning consent requirements of terms and conditions handed down by platforms with unseen severity. Apex constitutional courts – including European Court of Justice (EUCJ) – and independent authorities underwent a deep scrutiny of the compatibility of profiling activity through data collection and fundamental rights, up to questioning the compatibility of the business model with the foundational value of human dignity and human rights (Hijmans, 2016).

1.6 The emergence of new knowledge about data gathering practices' consequences is generating patterns of legal emergence in ways akin to market phenomena of creative disruption (Savin, 2018,) . Judges have started to adopt different criteria to balance contractual and fundamental rights, that are increasingly seen as interdependent and rival (Cherednychenko, 2016). At the same time, consumers are more prone to read and contest terms and conditions, and eventually to litigate in courts to challenge platforms' practices. Platforms, on their own rights are experimenting economic harm from fines and class-actions, up to a point to (at least publicly pledging to) changing their bold use of N&C to practice aggressive data gathering. The overall legal practice is magmatic and boiling subject to rapid and unexpected change (Reins, 2019).

1.7 In this paper, we study the discovery process about the implications of legal innovations in context of uncertainty. We concentrate on the emergence and development of legal practice in social

2 In this article we consider as Judges also Independent authorities that oversee data protections practices, antitrust, and consumer protection.

media - and we make passing references to Facebook as a notorious case - to underline coevolutionary patterns that characterize the construction of legal foundation of emerging markets for innovative online services. We focus on N&C as the main legal innovation that was introduced to govern these new realities. We do so by applying a learning framework whereby boundedly rational agents make myopic choices and learn from past interactions, along with insights and tools borrowed from evolutionary game theory (Bowels, 2006; Friedman and Sinervo, 2016). A co-evolutionary process that results out of two endogenous learning patterns - Traders, and Consumers – about the strategic implications of judges' exogenous learning about the use of legal innovations.

1.8 In our framework, a large population of users and a large number of platforms interact in an environment that is co-shaped by the users learning and peer-pressure effects, by the enforcement of the prevailing legal framework and by the degree of "prudence" with which the platform decides to make use of notice and consent legal basis to deploy data gathering practices from their subscribers. The more prudent the platform, the less likely it is to be convicted for privacy and other fundamental rights violations.

1.9 The remainder of this article is as follows. In the second paragraph we introduce the theoretical framework we refer to and we introduce notice and consent as the prevailing legal innovation to govern electronic commerce. In section 3, we discuss the model's assumptions, the topological and welfare properties which are analyzed in section 4 and 5 respectively. Section 5 presents conditions for evolutionary behavioral failures to emerge and discussions. Section 6 concludes.

2. Theoretical background

2.1 Emergence of legal innovations and uncertainty

Markets are important places of knowledge generation, and in "being open to and indeed generating the incentives for endogenous change."(Metcalfe, 2003:409; boetke, 2002). Human action, entrepreurship and ingenious behaviour make up the market process "to produce patterns of growth and development in the economy as well as in its framing institutions" (Metcalfe, 2003:). In line with neo institutionalists, and Austrian economists, we understand the market as a discovery process and decentralized coordination mechanism characterized by creative disruption and radical uncertainty (Boettke, 2002, Hodgson, 2019).

Disruptive and creative change within the market extend and reverberate onto the law (Rizzo, 1999). Indeed, as neo institutionalists argue, the market process cannot properly exist without legal foundations that assign and protect property rights, ensure contract enforcement and tort liability. The legal structure helps align expectations, shape incentives, and ensure legitimacy and spontaneous compliance (Deaking et al, 2017, Porrini e Ramello, Nicita, 2009). Moreover, legal rights allow for potential *in personam* and *erga omnes* protection by public authority to guarantee performance in case of violations (Barzel, 1997; Hodgson, 2015). In the face of new circumstances generated by market

process, law is incomplete as there are - not even in principle – clear cut prior rules to apply in case of conflict over these new realities (Rizzo, 1999, Nicita, 2009, Deaking et al 2018).

In one with an expanding market, there is and expanding framework of legal relationships that must be qualified by legal agents with the introduction of legal innovations (Pistor, 2019, Harnay and Marciano, 2009). In consequence, once the economic process of knowledge production generates new objects and services, a parallel discovery endeavor immediately begins to advance possible legal innovations to code them. In a time of legislative self-restraint3, these solutions are put into operation by private parties' and public authorities' ingenuity and experience, which use them in combination with exiting legal knowledge and rules.

Courts will definitively select and adopt which use of legal innovation is more compatible with existing order of legal rules. That solution will find public backing and will be enforced with priority over alternative uses (Engel, 2018, Graziadei, 2009, Harnay Marciano, 2009). The dominant legal solution to find sustain in courts will result out of an institutionalized social process involving "organs of the state, including judges and legislature, while it may reflect customary experiences" and it will play out as "a means of overcoming uncertainty and complexity" (Deakin et al 2017:189, Graziadei, 2019, Marciano, 2007, 2009). A process that occur in close relation but outside the market process following alternative motivational structures (Rizzo, 1999, Harnay Marciano, 2009).

Akin to the market at large, what characterize the construction of its legal foundations are ignorance and radical uncertainty (Rizzo, 1999, 2013). Judges, like economic agents, do not know how the new reality works, which interdependences exists between new activities and the prevailing social order, let alone between rights created by the legal innovation and the existing order of jural relations (Sayo and Ryan, 2016; Lessing, 1996). And yet, they must take position when they are requested to hail social conflict arising between the existing rights and those created by legal innovations, whenever they emerge to be rival. So, they must choose which side to favour, even if they do not have robust knowledge about implications of potential impacts of new legal rules on existing legal positions – including fundamental rights and public order (Pollicino, 2016; Sajo Ryan, 2016 ; Lessing, 1996).

The by-product of this healing activity is a form of assignment of property rights over novel goods and services. The process is necessarily based on poor knowledge, if not patent ignorance about the reality of concern, for judges' choices are mostly based on guesses about unknown consequences of newly emerged services (Calabresi, 1985, 2018; Sayo Ryan, 2015). In the face of ignorance and uncertainty, judges may adopt either prudent or activist stance towards alternative uses of legal innovations when asked to balance out newly emerged rights with the prevailing ones. Either they do so in a precautious way to reduce unintended conflict with incumbent legal rights, or they adopt an activist stance to prioritize new legal rights based on legal innovations.

[3] (Chander, Lessing, Pollicino Romeo, Klonick, 2018) Meaning that it provides too scattered regulation, the prevalence will be judges made law

Absent robust guidance from the legislative branch and knowledge about the new reality, judges' stance remains uncertain and unpredictable. Legal emergence may be disruptive.

2.2 Learning legal innovations and legal uncertainty

Judges' attitude towards varying uses of legal innovation does not define alone the process of construction of legal practice around new technology. Unlike rational choice analysis, economic agent do not react to judges' decisions right away because they are boundedly rational and they learn about their implication by experience and imitation. There is no immediate adaptation to information about change in the opportunity structure defined by judges' decisions, as economic agents do not know the details of the law and they follow "social mirror rules" that convey a simplified normative expectation on them (Engel et al, 2017). Economic agents need to learn about theses implications of new uses of legal innovations before acting upon them (Engel 2008). A priori nobody knows the law's implications.

The process of construction of legal foundations includes adoption patterns by economic agents, which plan their activities in contexts of strategic uncertainty. They can use legal innovations in alternative ways, and in case of disagreement, economic agents may try to see whether judges are willing to side with either one or the other party (Nicita, 2009). Whether judges sustain or not plaintiffs' requests may influence future plaintiffs' willingness to go to courts again (Engel et al, 2017).

Nobody knows how economic agents' behaviour will be affected by counterparties' uses of legal innovations to regulate reciprocal rights and duties in the new markets (Engel, 2008). Due to unknown interdependences between rights based on the legal innovation and the prevailing ones, agents may find that what they presumed to be legally robust will emerge to be incompatible with overriding and rival rights (Nicita, 2009). All agents involved must learn about the best strategic use of these legal innovations, as they are faced with uncertainty about which legal relationships will be applied to a transactions. Akin to innovative product and services, legal innovations' potential as to be discovery by use and diffusion within a group (Shur-Ofry, Fibich et al. 2016).

All groups involved must act myopically. Traders don't know either how consumers will react to legal terms they present them to govern reciprocal legal relations or which stance judges will take towards their use of legal innovation; consumers do not know either the implications of traders' legal proposals or judges' stance; and judges do not know either to what extent legal practices deployed by traders are freely consented by consumers or whether the rights and duties under these contracts will be considered compatible with existing rights. Hence, not only nobody can tell which stance towards legal innovation will prevail within the judiciary, but also consumers and traders do not know how these alternative legal solutions will play out within their strategic interactions.

Exogenous and endogenous learning are at play to define the legal foundations of expanding markets. Exogenous learning characterizes judges' discovery of legal practice emergence around the use of legal innovation and its consequences (Sayo Ryan, 2016; Lessing 1996). It is exogenous as it occurs outside the market process, and yet it may eventually affect the latter because of unexpected change in

judges' response to consumers' or traders' lawsuits. Conversely, endogenous learning characterizes traders' and consumers' legal discoveries about the actual strategic implications of the alternative use of legal innovations (Engel, 2008). As said, these exogenous and endogenous patterns are in many ways interdependent. In this article, we concentrate on the endogenous side of the with the focus on traders' and consumers' interactions in context of legal uncertanity .

2.3 The legal innovation of 'notice and consent' for social media

For almost two decades, the business model that made social media bloom have been a sort of barter between personal data and services (Belleflamme and Vergote, 2018). As economists and rule makers acknowledge, data have become the currency of the digital economy and their use has been governed by contractual frameworks based on the legal innovation of "notice and consent" (Stucke and Grunes, 2016:326). Most economic blocks adopted N&C as the "paradigm for securing free and informed consent to businesses' online data collection and use practices" (Sloan and Warner, 2014:374).

This framework "transferred the protection of privacy from the legal realm, and from an emphasis on the articulation of rights and responsibilities, to the marketplace," where consumers would now have to negotiate for what the law could otherwise provide (Rotemberg, 2001).

In this flexible framework, platforms can present consumers with a notice filled with terms and conditions of service, while consent is *consumer's action* of using the service that is presumed as acceptance of terms and conditions. The mere opportunity to read the notice makes the contract valid and binding (Ben-shahar, 2009). For social media services, the notice contains information about present as well as future collection and use of personal data.

The two main claims under which Notice and Choice shall govern these innovative services are: a) " when adequately implemented, Notice and Choice ensures that website visitors can give free and informed consent to businesses' data collection and use practices.; […] b) the combined effect of the individual consent decisions is an acceptable overall tradeoff between privacy and the benefits of information processing (Sloan and warner, 2014)".

In this abstract scheme, it is for platforms to choose how to make use of notice and consent to legally back their data collection and processing practices. In the presence of rational consumers, it is for them to choose the degree of protection they prefer and which practice give their preferences to (Sloan and Warner, 2014). Whenever "standard conditions of competition apply, each party reveals the amount of information that results from a trade-off between privacy protection and the need of information within a transaction (Posner, 1978). Under these behavioural assumptions, choices made by consumers orient practices that allow companies to operate efficiently, "both from a static (efficiency linked to the allocation of resources) and from a dynamic point of view (efficiency linked to innovations)"(AGCOM, 2018:36). Any intervention of the state to help concealment of information is inefficient, redistributive and a perverse example of government intrusion in economic and social life (Posner, 1978, Stiegler, 1980).

2.4 **Consent of b**oundedly rational **agents**

Both legal and economic literature offer compelling critiques of both claims about N&C, on theoretical and empirical grounds alike. As to legal scholarship, it is argued that the mere opportunity to read does not guarantee consent as most consumers do not read notices (Ben-shahar, 2009, Sloan and Warner, 2014, Tene and Polonetsky, 2014). And even if they did, it would take on average 244 hours per year to read privacy policies presented by all website an average consumer visits, which amounts to more that 50 per cent of the time on average a user spends on the internet. Moreover, contracts are of necessity incomplete as they must cover future and unknown uses and potential monetization of data under vague and elastic terms like "improving customer experience" (EDPS, 2014:35). In addition, lack of contextuality between consent and waiver of fundamental rights of privacy over sensitive data undermines the legitimacy of these act of private surveillance (Jolls, 2013, Rotemberg, 2001, Hijman, 2016). Some authors have straightforwardly characterized them as autistic contracts (White, 2000). Others have articulated the notion private legislation by contract (Bygrave, 2015).

As to economics, the assumptions that the consumers' 'true' privacy preferences are revealed through their online activity" is contested (Stucke and Grunes, 2016:58). Unawareness about business' personal data processing practices - who have access to their "personal information, what data is being used, how the data is being used, when the data is used, and the privacy implications of the data's debase – may lead to hypothetical bias and optimism bias (Acquisti et al, 2015). There are biases related to perception of immediacy of risk and hyperbolic of the often intangible costs of privacy losses, that prompt consumers to opt for the immediate gratification associated with consent (Acquisti and Grossklags, 2004;Strandbourg, 2016; Jolls, 2013, Turow et al, 2015). Empirical evidence support theoretical articulation of cognitive difficulties in anticipating secondary uses of personal data favoring optimism bias, status quo bias, hypothetical bias (Hermstrüwer, Y, Dickertb , 2017; Jolls 2010, Willis 2014, Schudy and Utikal,2015). In general, most biases that affects consumers' behaviour are extended to personal data gathering under notice and consent framework (Thaler and Sunstein, 2008; DellaVigna, 2009; Johnson, et al 2003).

From the above, Bar-Gill recalls a third category of market failure next to those attributed to externalities and information asymmetries. "The behavioral market failure, with its emphasis on misperception and bias, is a direct extension of the imperfect information problem (Bar-Gill, 2011)". There are two ways of addressing consumers misperceptions and biases either endogenous or exogenous (Bar-gill, 2011). In the exogenous perspective, consumers' bias is given and fixed. In consequence, platforms have incentives to exploit consumers' misconceptions- and in general of their naivete - about the actual cost of services to promote lower *perceived* prices rather than low prices right away (Eliaz and Spiegler, 2006, Garbaix and Laibson, 2006). In the endogenous perspective, consumer perceptions and misperceptions are not fixed, and they evolve over time. Consumers learn about qualities and functioning of products and sellers may invest to try to influence consumers'

perceptions(Bar-gill, 2011). Conversely, traders may invest to shape consumers' perceptions by setting up public campaigns in order to influence the institutional environment surrounding new services (Kutchar, 2016). Therefore, in the endogenous perspective competition can either play favorably to correct consumers' misperception, or to achieve the opposite result of ossifying consuemrs' misperception. Moreover, free riding issues related to collective action problem may arise, when many seller offer identical products or services and benefits of investments in consumers' education cannot be fully internalized. In these cases, persistence of consumer misperception may be the likely result as a typical tragedy of commons situation (Beales et al, 1981).

2.5 The contribution of this paper

Unlike traditional law and economics efforts, this paper applies evolutionary game theory to explore the economic effects of alternative legal rules (Harnay Marciano, 2009b). It shows how the economic consequences of legal emergence are not immediate as well as unpredictable and can result in substantially different scenarios with significant implications for the industry. Unlike standard studies of consumers' behavior, this paper extends the bounded rationality assumption also to traders in order to account for radical uncertainty surrounding legal innovations. For this, we apply a learning framework to transactions between bounded rational platforms and consumers in context of legal uncertainty. Judges' learning occurs outside the market process, but it influences it, so it is captured in terms of results only and the ensuing effects of legal emergence are captured by the parameter q. In further research, we are going to elaborate a three-population model.

It is an attempts to draw on the notion of market as a discovery process and put the emphasis on the emergence of its legal foundations. The instability dimension of markets due to learning about the law of all agents involved emerges akin to economic phenomena as a result of learning and strategic interacitons. The paper acknowledges the role of the state as one of the most important exogenous factor in the evolution of the legal foundations of markets, and yet it does so without reducing law to a positivist top down produce (Nicita, 2009). However, the paper underlines the fact that aking to market phenomena at large, disruption can be generated by legal learning and emergence. At the edge of innovation, radical uncertainty that characterize the market process extends to law.

Overall, it models an additional dimension to property rights synamics and legal incompleteness literature (Porrini and Ramello (eds.), 2009; Barzel, 1997; Libecap, 2018; Pistor, 2019). A dimension of instability of legal rights that are exposed to learning and emergence like any other humanly devises item or institution. In this context of instability the risk of investment debasement is very high and it may impose unexpected losses to those who overlook the evolutionary and conditional nature of prevailing legal practice that characterizes new technology at an early stage of its development.

The analysis draws on a subjectivist approach to law akin to Austrian economics whereby individual action and group selection play out to fill gaps of legal orders in the face of economic change. It point to suggest that a truly Austrian Law and Economics may be leaning towards (Marciano, 2009b).

3 The model

3.1 Assumptions: users

Consider a model economy populated by a mass 1 of heterogenous individuals who interact via various social media supplied by a number of providers—hereafter, "providers". As we are not interested in analyzing how the player's utility is affected by the use of the social media per se, we assume that all users derive the same utility $V > 0$ from their web-mediated interactions[4]. In addition, we also make the facilitating assumption that all individual decides to use social media when they are first introduced in the market. The scenario we have in mind is one where the initial enthusiasm for the novel socialization opportunities offered by the new kind of platforms and the initial perception of the service as free of charge push the entire population to join the online community[5]. Then, once the various social network have formed, heterogeneity in individual behavior starts to emerge, as individuals may differ in the degree of carefulness with which they use the social media as a result of learning about their actual costly nature as well as their actual unintended consequences .

More precisely, we assume that platform users are of two types: attentive, denoted by A, and non-attentive, denoted by NA, respectively occurring in the population with frequencies $0 \leq x \leq 1$ and $(1 - x)$. A-players pay attention to the service they consume and seek information about the provider's behavior by reading and understanding notices, at a private cost $C(x) > 0$. To model the idea that gathering knowledge generates a positive externality for the rest of the attentive group, we assume that $C'(x) < 0$. In words, when the share of A-players in the users' population increases, so does the volume of available information on the provider's behavior. Straightforwardly, this reduces information costs. To keep things simple, we assume that $C(x)$ takes the particular form $C(x) = C_L x + C_H(1 - x)$, with $0 < C_L < C_H$. In addition, we assume there are intrinsic psychological benefits from attentiveness, as seeking information on

[4] We do not consider network effects attached to using a single platfomr. In that case, we may reframe the game as involving a single platfrom to decide which strategy adopt.

[5] For evolutionary models comparing face-to-face and online interactions as different modes of socialization see Antoci et al. (2012) and Antoci and Sabatini (2018).

the provider's behavior increases awareness and cognition. Moreover, attentiveness can reduce hidden add-on costs present in shrouded contractual terms and services (Garbaiz an Laibson, 2006). We measure this subjective gain by the $B > 0$ parameter.

In the economy, both privacy rights and contracts governing their transfers are incomplete within online transactions and the provider cannot foresee how platform users will react to the possibility of privacy violations (AGCOM, 2018, Sloan and Warner, 2014, Ben-shahar, 2009). If attentive individuals perceive the provider's data gathering activities as unlawful, they may indeed litigate in courts. The consumers' litigation costs are given by $L(x) > 0$, where we assume $L'(x) < 0$ to allow for the possibility of class actions[6]. As before, we further assume that $L(x)$ takes the tractable form $L(x) = L_A x + L_{NA}(1 - x)$, with $0 < L_A < L_{NA}$. Since it is unclear how existing privacy laws applies to web-mediated interactions, the outcome of judicial decisions is uncertain for both parties. The introduction of radical innovations such as social media services, in fact, makes it impossible for the rule makers to anticipate the future implications of the newborn technologies.

3.2 Assumptions: providers

At the beginning of the game, any provider designs a contract and decides how prudently to gather consumers' data. The degree of prudence includes how much data to collect, how recklessly selling them to third parties as well as how transparently to inform her clients on her data-driven activities. We index the service prudence with the real variable $0 \leq y \leq 1$ and further denote by NP and P the pure strategies of playing $y = 1$ and $y = 0$. If $y = 1$, the provider designs a full-disclosing and detailed contract (P); if $y = 0$, the provider uses a notice and consent as legal basis for its bold practices about data-driven activities (NP). Our key assumption is that playing P reduces profitability, as providers may monetize less data as consumers may use additional information provided via notices to bargain in order to limit the use of their personal information or reduce information to share. Assumptions of this sort are quite standard in models of consumer awareness. In Sanxi et al. (2014), for instance, a profit-maximizing firm who produces a good with potentially adverse effects on consumers' well-being selects an optimal disclosing strategy after observing the initial rate of awareness in the buyers' population. Similarly, Thadden and Zhao (2012) find that when the share of aware individuals in the buyer's population is initially large, sellers will find optimal to offer a full-disclosing contract. Conversely, when unawareness is wide-spread, they will propose an

incomplete contract and keep their buyers unaware. This provides the platform with an incentive not to come clear on her data-gathering activities due to the fact that most of consumers will not change their strategy.

Given the above, we assume that the payoffs from playing the pure strategies NP and P are given, respectively, by $R^H > 0$ and by $R^L > 0$, with $0 < R^L < R^H$ by assumption. This entails that if no individual sues the provider for privacy violations, playing P is always dominated by playing NP. However, when litigious consumers are allowed into the picture, choosing the A strategy exposes the provider to the risk of being sentenced to compensate for privacy violations. To keep things simple, we assume that attentive consumers always litigate when offered an NP-service, as they perceive that in some instances the degree of aggressiveness of the NP-service may give rise to fundamental rights and other legal violations on the part of the provider. Hence, when the provider offers an-NP service to an A-player, her payoff is given by $R^H - (K + qE)$, where $K > 0$ measure the provider's litigation costs and $qE \geq 0$ has the same interpretation as above.

To sum up, the one-shot game works as follows. At each instant of time $t \in [0, +\infty]$ the provider offers a service of type $j, j = P, NP$ to a large number of individuals of type $i, i = A, NA$ who are randomly drawn from the consumer's population. Heterogeneity in consumers' behaviour is represented by the shares of individuals who initially choose the A and NA strategies, while heterogeneity in the provider's behaviour is captured by the fact that she may initially randomize between the pure strategies P and NP and offer a service of type $0 \leq y_0 \leq 1$. This amount to assuming that she may be neither entirely transparent nor entirely ambiguous on her data gathering policies. As usual in evolutionary game theory, players are boundedly rational, make initial decisions in a myopic way and adjust their strategy by best-responding to payoff difference in the past[7].

The reason for assuming bounded rationality is as follows. Since online privacy rights are incomplete, both agents are unable to foresee how the judge will evaluate the provider's data-gathering activities. Differently from the literature on consumer awareness where adverse product effects are known ex-ante by the seller, our provider does not know if her data-driven activities actually violates the existing body of privacy law. However, she knows that by offering

[7] Observe that our understanding of the provider partially departs from the standard approach in evolutionary game theory. Here, we do not have a large population of providers which choose alternative organisational forms and then randomly interact with a population of consumers. Instead, we have a single and large provider who simultaneously interact with many different individuals who are randomly picked from the consumers' population. Hence, the fraction $0 \leq y \leq 1$ and $(1 - y)$ do not represent shares of agents who pick a given strategy within a population, but rather, a degree of transparency which is myopically selected by the provider within the interval $(0, 1)$.

an NP-contract she exposes herself to the risk of being sued for privacy violation. From the provider's viewpoint hence, if she believes that both judges and individuals will advocate that privacy laws apply differently to web-mediated interactions, she will choose to play NP; conversely, she will choose to play P. In addition, the existence of network effects such as those captured by the assumptions $C'(x) < 0$ and $L'(x) < 0$ imposes a further limitation on the users' foreseeing capability. By ignoring their fellow-players' behavior, in fact, they are unable to estimate the magnitude of both $C(x)$ and $L(x)$ and thus cannot assess the costs of attentiveness.

Judges: Q

Economic innovation generates legal uncertainty as the existing regulatory framework may be outpaced by the path of technological innovation and no one can anticipate which form of legal innovation will come out on top to fill the gap. In these cases, judges are asked to either sustain traders' use of legal innovations or to impose more prudent solutions more compatible with the pre-existing system of rights. In our model, this is captured by the fact that the court may reject providers' not prudent practice of data gathering, deny legal base for their processing and compel the provider to pay litigious users a damage compensation $E > 0$. We assume that this may happen with an exogenously given probability $0 \leq q \leq 1$. In this framework, judicial decisions act as a validation tool for the A-players' beliefs: when the latter are offered an NP-service in fact, they perceive the possibility of privacy violations, and thus litigate in courts. However, since privacy rights in online transactions are incomplete and unstable, they do not know if their perceptions are well-founded, as judicial decisions may either validate or discredit their beliefs about the applicable property rights structures in the field of privacy.

3.3 Payoffs

Given the above assumptions, the users' payoff matrix is given by (1), where users are row players and the provider is the column player. As anticipated, the utility differential between strategies P and NP depends on three elements: upon the intrinsic benefit $B > 0$ from paying attention to the service one consumes; upon the magnitude of the information and litigation costs $C(x) = C_L x + C_H(1 - x)$ and $L(x) = L_L x + L_H(1 - x)$; and upon the expected gain from winning the lawsuit, which is given by $qE \geq 0$.

	P	NP
A	$V + B - C(x)$	$V + B - C(x) + qE - L(x)$
NA	V	V

(1)

Turning to the provider, her payoff matrix is given by:

	A	NA
P	R^L	R^L
NP	$R^H - (K + qE)$	R^H

(2)

Where the provider is the row player and consumers are column players. As anticipated, $R^H > 0$ and $R^L > 0$ are the profits from playing strategies NP and P respectively; $K > 0$ measures the provider's litigation costs and $qE \geq 0$ has the same interpretation as above. From matrix (2), it easy to check that playing P against NA is always dominate by playing NP against NA. Intuitively, when individuals do not pay attention to the service they consume, it is more rewarding for the provider to offer an incomplete contract that keeps her clients unaware. Conversely, playing NP against A dominates playing P against A if the probability of losing the lawsuit from the provider's viewpoint is small enough. Formally, this occurs if:

$$q < \frac{R - K}{E} \tag{3}$$

Where we have defined $R^H - R^L \equiv R > 0$. With condition (3), we have completed the static specification of the economy at any moment in time. The next step is to describe how the system may evolve under alternative parametrizations.

4 Dynamics

4.1 Replicator equations and strategy adoption

We model the diffusion of the A strategy in the consumers' populations via the standard replicator-dynamics derived by Taylor and Jonker (1978). The replicator-dynamics is a learning-by-imitation model which postulates that players are boundedly rational, they learn

from each other, and they tend to adopt the strategy that performs better than the other. In this framework, relatively successful behaviors are replicated, while unsuccessful behaviors are abandoned. As concern providers, we assume that they adjust their strategy in a similar way, initially making myopic choices and subsequently reviewing the latter by best responding to payoff-differences in the past. Hence, the system's dynamics are given by:

$$\begin{cases} \dot{x} = x(1-x)\left(\Pi^{A} - \Pi^{NA}\right) \\ \dot{y} = y(1-y)\left(\Pi^{P} - \Pi^{NP}\right) \end{cases} \tag{4}$$

Where $\dot{x}$ and $\dot{y}$ are the time derivatives of x and y respectively. As usual, the growth rate of a given strategy is proportional to the difference between the expected payoff of that strategy and the expected payoff of its alternative, as players are assumed to imitate (abandon) (un)successful behaviours by best-responding to payoff differences in the past.

Recalling that the real variable $0 \leq y \leq 1$ represents the degree of transparency with which the platform provides her service, we calculate the expected payoffs to the A and NA strategies from matrix (1), which are given, respectively, by:

$$\Pi^{A} = V + B - C(x) + \left(qE - L(x)\right)(1-y)$$

$$\Pi^{NA} = V$$

The payoff differences thus writes:

$$\Pi^{A} - \Pi^{NA} = B - C(x) - \left(qE - L(x)\right)(1-y)$$

From which it is easy to derive the nullcline along which $\Pi^{A} - \Pi^{NA} = 0$, whose equation writes:

$$y = \frac{B - C(x) + L(x) - qE}{L(x) - qE} \tag{5}$$

Recalling that the real variables $0 \leq x \leq 1$ and $(1-x)$ represents the shares of A and NA players in the users' population, we similarly calculate the expected payoffs to the P and NP strategies from matrix (2), which are given, respectively, by:

$$\Pi^{P} = R^{L}$$

$$\Pi^{NP} = R^H - (K + qE)x$$

The payoff differences thus writes:

$$\Pi^P - \Pi^{NP} = -R + (K + qE)x$$

From which it is easy to derive the nullcline along which $\Pi^T - \Pi^{NT} = 0$, whose equation writes:

$$x = \frac{R}{K + qE} \tag{6}$$

4.2 Basic topological properties

Dynamics (4) is defined in the unit square $Q = [0,1]^2$. As usual with replicator dynamics, all edges of the square are invariant[8] and the four vertices $(0,0)$, $(0,1)$, $(1,0)$ and $(1,1)$ where both populations are homogenous—they are both composed of one type only—are always stationary states. In addition, dynamics (4) may admit three other stationary points, the first and second of which correspond to the intersections, when existing, of the nullcline defined by (5) and the edges of Q where $y = 0$ and $y = 1$, which we call, respectively, $Q_{y=0}$ and $Q_{y=1}$. In the first of these critical points—indicated as $(\hat{x}, 0) = \left(\frac{C_H + L_H - B - qE}{C + L}, 0\right)$—the provider plays strategy *NP*, while consumers randomize between strategy *A* and *NA*. In the second of these critical points—indicated as $(\tilde{x}, 1) = \left(\frac{C_H - B}{C}, 1\right)$—the provider plays strategy *P*, while consumers randomize between strategy *A* and *NA*. Imposing $0 < \hat{x} < 1$ and $0 < \tilde{x} < 1$, we see that $(\hat{x}, 0)$ may only exist if:

$$\begin{cases} q > \dfrac{C_L + L_L - B}{E} & (7) \\[2ex] q < \dfrac{C_H + L_H - B}{E} & (8) \end{cases}$$

while $(\tilde{x}, 1)$ may only exist if:

[8] Meaning that all trajectories starting from an initial pair $(x_0, y_0) = (1, \hat{y})$, $(x_0, y_0) = (0, \hat{y})$, $(x_0, y_0) = (\hat{x}, 0)$ and $(x_0, y_0) = (\hat{x}, 1)$ will lie on the side with $x = 1, x = 0, y = 0$ and $y = 1$ respectively, where $0 \leq \hat{x} \leq 1$ and $0 \leq \hat{y} \leq 1$.

$$\begin{cases} B > C_L & (9) \\ B < C_H & (10) \end{cases}$$

The last stationary state admitted for by dynamics (4)—indicated as $(\bar{x}, \bar{y}) = \left(\frac{R}{C_L+qE}, \frac{B-C(\bar{x})+L(\bar{x})-qE}{L(\bar{x})-qE}\right)$—is located in the interior of Q and corresponds to the intersection, when existing, of the nullclines defined by (5) and (6). Since the graphs of eq. (5) and (6) define a hyperbola and a line respectively, the stationary point in the interior of Q —when existing— is unique. In such state, both types of players coexist and the provider chooses an intermediate level of transparency, that is, she randomizes between P and NP. Observe that $\dot{x} = 0$ holds along line (6) and along the edges of Q where $x = 0$ and $x = 1$—which we call, respectively, $Q_{x=0}$ and $Q_{x=1}$—while $\dot{y}$ holds along line (5) and along the edges $Q_{y=0}$ and $Q_{y=1}$. Imposing $0 < \bar{x} < 1$ and $0 < \bar{y} < 1$ we see that $(\bar{x}, \bar{y})$ may exist under two alternative parametrizations, the first of which is given by:

$$q > \frac{R-K}{E} \text{ and } q < \frac{C_H + L_H - B - (C+L)x}{E} \text{ and } B > C_H - Cx \tag{11}$$

While the second of which is given by:

$$q > \frac{R-K}{E} \text{ and } q > \frac{C_H + L_H - B - (C+L)x}{E} \text{ and } B < C_H - Cx \tag{12}$$

From (11) and (12), we immediately see that $(\bar{x}, \bar{y})$ may only exist if the probability of losing the lawsuit is high from the provider's viewpoint—condition (3) is not satisfied. To further analyze the system's topological properties, we first calculate the Jacobian matrix, which is given by:

$$J = \begin{bmatrix} (1-2x)\left(\Pi^A - \Pi^{NA}\right) + x(1-x)[L('x)(1-y) - C'(x)] & x(1-x)\left(qE - L(x)\right) \\ y(1-y)(K+qE) & (1-2y)\left(\Pi^{NT} - \Pi^T\right) \end{bmatrix}$$

As it is well-known, the behavior of the system near an equilibrium point is related to the eigenvalues of the Jacobian matrix at that point. By evaluating J at each stationary point, we derive the topological properties of dynamics (4), which are summarised in the following

Proposition:

Proposition 1—*The stationary points* $(0,1)$, $(\hat{x},0)$, $(\tilde{x},1)$ *and* $(\bar{x},\bar{y})$, *when existing, are either saddles or sources. In particular,* $(\hat{x},0)$ *and* $(\tilde{x},1)$ *are both saddles if the nullcline defined by* (5) *has a positive slope and both sources if the nullcline defined by* (5) *has a negative slope. In addition, the stationary point* $(\bar{x},\bar{y})$ *exists if and only if no point is globally attractive. in particular, it is a saddle when condition* (11) *is satisfied and a source when condition* (12) *is satisfied. In the former case,* $(0,0)$ *and* $(1,1)$ *simultaneously attract; in the latter case, all four corners are saddle points. Finally:*

(i) *The* $(1,0)$ *equilibrium is attractive if conditions* (3) *and* (7) *are simultaneously satisfied;*

(ii) *The* $(0,0)$ *equilibrium is attractive if condition* (8) *is satisfied;*

(iii) *The* $(1,1)$ *equilibrium is attractive if condition* (9) *is satisfied but condition* (3) *is not.*

Proof: see the Appendix.

4 Taxonomy of dynamic regimes

4.1 Definitions

From Proposition 1, we immediately see that dynamics (4) admits three monostable regimes, featuring a single equilibrium which globally attracts. In these cases, the system will eventually gravitate towards the global attractor regardless of initial conditions. To refer to the potentially attractive equilibria in an intuitive way, we call (1,0) the "Conflict" equilibrium, (0,0) the "Opportunity" equilibrium and (1,1) the "Vigilance" equilibrium. In addition, by comparing conditions (7) and (8) and recalling that $C + L > 0$ by construction, we further say that platform users have a low probability of winning the lawsuit when $q < (C_L + L_L - B)/E$; that this probability is intermediate when $(C_L + L_L - B)/E < q < (C_H + L_H - B)/E$ and that it is high when $q > (C_H + L_H - B)/E$. Similarly, we say that the provider has a high probability of losing the lawsuit when $q > (R - K)/E$ and that this probability is low when $q < (R - K)/E$. As these critical thresholds depend on the parameters' values, it may be the case that the users and the providers have diverging payoffs given a certain level of q. For instance, the provider may have positive payoffs even when q is high. Finally from (9) and (10), we say that the

intrinsic benefits from attentiveness are low when $B < C_L$; that are intermediate when $C_L < B < C_H$ and that are high when $B > C_H$.

4.2 Monostable regime

In the first monostable regime admitted for by dynamics (4), the Conflict equilibrium globally attracts—see figure 1a. At this state, all consumers play strategy A and the provider plays strategy NP. From Proposition 1, we see that this scenario requires[9]:

$$\frac{C_H + L_H - B}{E} < q < \frac{R - K}{E}$$

In words, the expected benefit from winning the lawsuit more than compensate the users' information and litigation costs (the user's probability of winning the lawsuit is high), while the expected cost of losing the lawsuit does not outweighs the extra-gain of offering an-NT rather than a T service for the provider (the provider's probability of losing the lawsuit is low). Hence, litigating is welfare-enhancing for the individual consumer and it is not welfare-depressing enough to push the provider to review her strategy.

In the second monostable regime admitted for by dynamics (4), the Opportunity equilibrium globally attracts—see figure 1b. At this state, all consumers play strategy NA and the provider plays strategy NP. From Proposition 1, we see that this regime may occur under two alternative parametrizations. In the first we have that:

$$q < \frac{C_L + L_L - B}{E} \text{ and } q < \frac{R - K}{E}$$

In words, the expected benefit from winning the lawsuit less than compensate the users' information and litigation costs (the user's probability of winning the lawsuit is low), while, as before, the expected cost of losing the lawsuit does not outweighs the extra-gain of offering an-NP rather than a P service for the provider (the provider's probability of losing the lawsuit is low). Hence, litigating is welfare-depressing for the individual consumer, who thus stick to the NA strategy, and it is not welfare-depressing enough to push the provider to review her strategy.

[9] From point (i) of Proposition 1, we see that a sufficient condition for $(1, 0)$ to attract is that (7) is satisfied. However, when conditions (7) and (8) are simultaneously satisfied, $(0, 0)$ and $(1, 0)$ simultaneously attract—see below for the discussion of bistable regimes. Hence, a necessary condition for $(1, 0)$ to globally attract is that condition (8) is not satisfied.

In the other parametrization, we have that:

$$\frac{C_L + L_L - B}{E} < q < \frac{C_H + L_H - B}{E} \text{ and } q > \frac{R - K}{E} \text{ and } B < C_L$$

In words, the user's probability of winning the lawsuit is intermediate, while the provider's probability of losing the lawsuit is high. In addition, the benefits from attentiveness are low, so that playing A against NT is always dominated by playing NA against NT.

In the third and last monostable regime admitted for by dynamics (4), the Vigilance equilibrium globally attracts—see figure 1c. At this state, all consumers play strategy A and the provider plays strategy T. From Proposition 1, we see that this scenario requires:

$$q > \frac{C_H + L_H - B}{E} \text{ and } q > \frac{R - K}{E} \text{ and } B > C_L$$

In words, the expected benefit from winning the lawsuit more than compensate the users' information and litigation costs (the user's probability of winning the lawsuit is high), while the expected cost of losing the lawsuit outweighs the extra-gain of offering an-NP rather than a P service for the provider (the provider's probability of losing the lawsuit is high). In addition, the benefits from attentiveness are high, so that playing A against NP dominates playing NA against NP. IN this context, we may observe that property rights in the social media are higly specified and all agents involved have aligned expectations about the way judges will enforce them.

4.3 Bistable and cyclical regimes

Besides the three monostable scenarios we have just described, dynamics (4) admits three other regimes, two of which may be referred to as bistable and the third as cyclical or oscillatory. As usual with replicator dynamics, bistable regimes are strongly path-dependent and the system may gravitate towards a Pareto-inferior equilibrium because of adverse initial conditions or poor equilibrium selection—see Carrera (2018) and Antoci et al. (2018).

In the first of these regimes, which we call "Impasse", the Opportunity and the Conflict equilibria simultaneously attract—see figure 2. The associated parametrization is given by:

$$q < \frac{R - K}{E} \text{ and } \frac{C_L + L_L - B}{E} < q < \frac{C_H + L_H - B}{E} \tag{13}$$

When the users' probability of winning the lawsuit is intermediate, the network externalities characterising both information and litigation costs play a major role in affecting the system's dynamics. As a matter of fact, when the share of A-strategists is high (resp., low) in the users' population, both information and litigation costs are low (resp., high) and joining the A-group yields positive payoffs (resp. negative payoffs) to the individual user. Formally, this is given by the fact that $C_L + L_L < qE + B < C_H + L_H$. Hence, attentiveness is characterised by mass behavior in this regime and chiefly evolves according the initial share of A-players in the users' population. Mass behavior effects of this sort are not novel in behavioral sciences—see for instance Schelling (1978). As concerns the provider, given that $R > qE + K$, the extra-gains from offering an NP-service are higher than the expected costs of losing the lawsuit, so that playing P is always dominated by playing NP.

In the other bistable regime, which we call "Institutional Change", the Opportunity and the Vigilance equilibria simultaneously attract—see figure 3. The associate parametrization is given by:

$$q > \frac{R - K}{E} \text{ and } q < \frac{C_H + L_H - B}{E} \text{ and } B > C_L \tag{14}$$

As in the previous scenario, $qE + B - (C_H + L_H) < 0$ also in this regime, so that the net gains from being attentive and suing an NP-provider are negative when the share of A-players is low. However, since the provider's probability of losing the lawsuit is high. Hence, when attentiveness is wide-spread and many litigate for privacy violations, the provider has an incentive to switch to the P strategy. Finally, since the intrinsic benefits from attentiveness are high, playing A against NP dominates playing NA against P.

The third and last dynamic configuration, which we call "Nomadic", admitted for by dynamics (4) is the cyclical or oscillatory regime displayed in figure 5, which occurs when the following condition is satisfied:

$$q > \frac{R - K}{E} \text{ and } q > \frac{C_H + L_H - B}{E} \text{ and } B < C_L \tag{15}$$

Differently from all the other regimes investigated so far, it displays a perpetually oscillating behavior rather than convergence to a stable state. The reason for this cyclicality is as follows. Consider an exogenously given pairs of behavioral types in the neighborhood of the Vigilance equilibrium, e.g., $(x_0, y_0) \approx (1, 1)$. Since the benefits from attentiveness are low in this

regime, attentive consumers have an incentive to switch to the NA-strategy when approaching the Vigilance state. As the rate of NA-players increases in the users' population, the system starts gravitating towards the Opportunity equilibrium, as the provider increases the non-transparency of her service by taking advantage of the fact that NA-players avoid litigating for privacy violations. However, since the user's probability of winning the lawsuit is high, users start switching to the A strategy when offered an NP-service, and the system gravitates towards the Conflict equilibrium. This, in turn, gives the provider an incentive to increase her service's transparency, since her probability of losing the lawsuit is high. In doing so, however, she gives users an incentive to stop being attentive because of the low benefits from attentiveness and the cycle starts all over again.

5. Welfare *(Preliminary)*

In this section, we connotate further the potentially attractive equilibria by studying their welfare properties to possibly come up with some policy suggestions. Using matrixes (2) and (3), we compute the users' and the provider's expected payoffs at the Conflict, Opportunity and Vigilance equilibria. Then, we compare the Pareto-efficiency of these critical states in the two bistable regimes associated to conditions (13) and (14). Hence, the following Proposition holds:

Proposition 2—*At all states, NP is the provider's dominant strategy (in the sense of Pareto), regardless of the outcome of judicial decision. Conversely, playing NA against NP is Pareto-dominated by playing A against NP if the probability of winning the lawsuit is either high or intermediate, that is, if condition* (7) *is satisfied. Similarly, playing A against P is Pareto-dominated by playing NA against P if the following is satisfied:*

$$q > \frac{L_L}{E} \tag{16}$$

Finally, playing A against P is more efficient (in the sense of Pareto) than playing NA against NP if the benefits from attentiveness are either high or intermediate, that is, if condition (9) *is satisfied Hence, the following remarks hold:*

(i) *In the Impasse regime, users' payoffs are always higher in the Conflict than in the Opportunity equilibrium, while the provider payoffs are always higher in the Opportunity than in the Conflict equilibrium.*

(ii) *In the Institutional Change regime, users' payoffs are always higher in the Opportunity than in the Vigilance equilibrium, while the provider payoffs are always higher in the Opportunity than in the Vigilance equilibrium.*

The key insight from Proposition 2 is that, both in the Impasse and in the Institutional Change regime, the "litigious equilibrium" is Pareto-efficient for platform users, while it is welfare-depressing for the provider. From conditions (13) and (14), we see that in both of these regimes, the users' probability of winning the lawsuit is either intermediate or low. At first sight, this may sound counterintuitive. However, when network externalities are allowed into the picture—$C'(x) < 0$ and $L'(x) < 0$—litigiousness may spread across the user's population because of a bandwagon dynamics which reinforces with the growth of A-players. In this case, the provider may be either forced to review her strategy and snowball towards a Pareto-inferior situation—as in the Institutional Change regime—or may stick to her course of action and enjoy lower payoffs—as in the Impasse regime. The key difference between these two situations is that, in the former, the provider has a negative payoffs from offering an NP service and litigate, so she switches to the P strategy and avoid litigation costs—$R < qE + K$. In latter, these payoffs are positive, so she sticks to her strategy and bear with judiciary costs, although, of course, $R^H > R - (qE + K)$.

Hence, our model predicts that discrepancies between the pace of technological and regulatory innovation may create incentives for litigiousness to spread, with negative ex-post implications for profitability. This, in turn, suggests that misplaced legal incentives may ex-ante stimulate sellers to offer an innovative product without disclosing the potentially adverse effects of the newborn technology or, if the seller herself is unaware of these effects, to choose myopic strategies which may reveal counterproductive in the long run. When it is unclear how an existing body of law applies to a newborn technology, sellers may be induced the temptation to "try their luck" and choose a course of action which provides with high profits in the short-run but which have negative, though uncertain, long-term returns. In order to discourage moral hazards of this sort, a full ex-ante framework of legitimate uses of data and platforms' management, as to limit the "N&C" in favour of more product regulation models whereby regulations delimit the set of contractual clauses to be included

More generally, our model also allows for the possibility that inattentiveness in the users' behavior may diffuse despite A-players have a high probability of winning the lawsuit. This may happen when information costs are very high, and/or when the intrinsic benefits from attentiveness are low. Consider a situation where $qE - L(x) > 0$ but $qE - L(x) + B - C(x) <$

0. In this case, judges may validate the belief whereby the provider is violating the privacy of platform users, but attentiveness do not spread because $B - C(x) < 0$. In terms of policy, this suggest that incentive should be designed to encourage consumer attentiveness, such as rules that force sellers to make easily available the information on her behavior

6. Conclusions *(Preliminary)*

In this article we developed an evolutionary game of *legal practice* at the edge of innovation in context of radical uncertainty, We start from the acknowledgement that markets are legally founded and their legal foundations are a necessary pre condition for their functioning. We emphasized law's incompleteness vis-à-vis innovative services and goods, and we analyse the process of legal emergence that springs together with any innovation adopted in the market. Hence, in one with each economic innovation, there comes up at least one complementary legal innovation to define legal relationships concerning the new object or service. The process involves state and private parties and is co-produced by their interdependent learning processes about the strategic implications of alternative uses of a legal innovation.

We analysed this process of emergence of legal practice in the context of social media, whereby Notice and Consent was introduced as the main legal innovation to govern legal relationships around users' personal data. We explored how platforms' and users' learn about actual implications of early uses of legal innovations in context of uncertain judges' willingness to sustain them, in order to identify possible legal practice equilibria.

We elaborated a model where the interactions between Platforms and Users on a social media are regulated by alternative uses of N&C. No group can know ex ante which equilibrium will emerge as the evolution depends on other's learning and strategies. Despite economic and legal uncertainty, consumers, platforms had to confront with the new reality and make their strategic decisions in a myopic way. At the same time judges had to solve conflict and to complete the legal system with little if no knowledge about interdependence between new rights based on alternative uses of N&C and prior rights.

The main results of the model are that there are six main possible equilibria with relevant policy implications. Three of them are monostable and mainly depend on judges' willingness to either sustain platforms' uses of N&C or impose fines to compensate users for unlawful data processing. We called them the "Opportunity", the "Conflict" and the "Vigilance" equilibria. Conversely, there are two bistable equilibria that we called "Impasse" and "Institutional change" whereby there are two simultaneously attractive equilibria: "Conflict" and "Opportunity"; "Opportunity and Vigilance", respectively. In these cases, the possibility for users to get compensation is intermediate and the final outcome will depend on information and litigation costs. They exhibit strong path dependence as the starting conditions become decisive to determine which equilibrium will emerge. A last "Nomadic" equilibrium may emerge

where by platforms and users oscillate from one strategy to the other in cyclical way in the neighbourhood of Vigilance equilibrium without ever reach and stable status.

The general argument of this paper, that find confirmation in the model, is that at the edge of technological innovations radical legal uncertainty. It can generate emergence and creative disruption with signification economic results. Ex ante, nobody can tell which legal solution will prevail and to invest accordingly. Moreover, the presence of a delay between the emergence of judges' decision about the use of legal innovation and users' and platforms' reactions, may retard the manifestation of co-evolutionary equilibria. This may exacerbate investment debasement and frustration of economic expectations.

Legal innovations like N&C that decentralize the delineation of rights and duties may exacerbate the instability of legal rules and aggravate legal uncertainty. These regulatory frameworks depend on unstable preferences of the boundedly rational agents involved as well as on their knowledge and information. In consequence, ignorance, cognitive biases and learning make the resulting rules unstable and subject to unexpected and pivotal revision. The main policy recommendation is to introduce a full ex-ante framework of legitimate uses of data and platforms' management, as to significantly limit the "N&C" in favour of more product regulation models whereby regulations delimit the set of contractual clauses to be included

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Appendix: proof of Proposition 1

As it is well-known, a stationary point is attractive if both the eigenvalues of the Jacobian matrix computed at a critical state have negative real parts. In addition, when either of the partial derivative $\mathrm{d}\dot{x}/\mathrm{d}y$ and/or $\mathrm{d}\dot{y}/\mathrm{d}x$ is $= 0$—which happens whenever $x = 0$ or $x = 1$ and/or $y = 0$ or $y = 1$—both eigenvalues exactly correspond to the partial derivatives $\mathrm{d}\dot{x}/\mathrm{d}x$ and $\mathrm{d}\dot{y}/\mathrm{d}y$. With these facts in mind, the topological properties of the four vertices $(0, 0)$, $(0, 1)$, $(1, 0)$ and $(1, 1)$ and of the two equilibria $(\hat{x}, 0)$ and $(\tilde{x}, 1)$ on the edges of Q with $y = 0$ and $y = 1$—whose $\mathrm{d}\dot{x}/\mathrm{d}y$ and/or $\mathrm{d}\dot{y}/\mathrm{d}x$ are always $= 0$—are immediately verifiable by consulting table 1, which was obtained by evaluating J at each stationary point and by imposing $1 < \hat{x} < 0$, $1 < \tilde{x} < 0$, $1 < \bar{x} < 0$ and $1 < \bar{y} < 0$.

Equilibrium	$\frac{d\dot{x}}{dx} < 0$	$\frac{d\dot{y}}{dy} < 0$	**Existence**
$(0, 0)$	$q < \frac{C_H + L_H - B}{E}$	Always	Always
$(\hat{x}, 0) = \left(\frac{C_H + L_H - B - qE}{C + L}, 0\right)$	Never	$\hat{x} < \bar{x}$	$\frac{C_L + L_L - B}{E} < q < \frac{C_H + L_H - B}{E}$
$(1, 0)$	$q > \frac{C_L + L_L - B}{E}$	$q < \frac{R - K}{E}$	Always
$(1, 1)$	$B > C_L$	$q > \frac{R - K}{E}$	Always
$(\tilde{x}, 1) = \left(\frac{C_H - B}{C}, 1\right)$	Never	$\tilde{x} > \bar{x}$	$C_L < B < C_H$
$(0, 1)$	$B < C_H$	Never	Always

To further prove the topological properties of the $(\bar{x}, \bar{y})$ equilibrium, we study the sign of its trace and determinant. From J, it is straightforward to check that sign $\mathrm{Tr}\, J_{(\bar{x},\bar{y})} = \mathrm{sign}\ C + L(1 - \bar{y})$. As the latter is a strictly positive quantity, $(\bar{x}, \bar{y})$ is either a saddle or a source. In addition, $\mathrm{Det}\, J_{(\bar{x},\bar{y})} < 0$ if

$$q < \frac{L_H - Lx}{E} \tag{16}$$

Comparing (16) with the existence conditions of the $(\bar{x}, \bar{y})$ equilibrium (11) and (12), we see that $\frac{C_H + L_H - B - (C+L)x}{E} < \frac{L_H - Lx}{E}$ if $B > C_H - Cx$, so that $(\bar{x}, \bar{y})$ is a saddle when condition (11) is satisfied and a source when condition (12) is satisfied. Further, by comparing conditions (11)

with the existence condition of the bistable regime that we call "Institutional Change"—condition (13)—we see that $\frac{C_H+L_H-B-(C+L)x}{E} < \frac{C_H+L_H-B}{E}$ always, so when $q < \frac{C_H+L_H-B-(C+L)x}{E}$, $q < \frac{C_H+L_H-B}{E}$ always. Similarly, $C_H - Cx > C_L$ always, so when $B > C_H - Cx$, $B > C_L$ always. Hence, when $(\bar{x}, \bar{y})$ exists under condition (11), $(1, 1)$ and $(0, 0)$ simultaneously attract and are separated by $(\bar{x}, \bar{y})$, which is a saddle point. Similarly, by comparing (12) with the existence condition of the cyclical regime—condition and (14)—we see that $\frac{C_H+L_H-B}{E} > \frac{C_H+L_H-B-(C+L)x}{E}$ always, so when $q > \frac{C_H+L_H-B}{E}, q > \frac{C_H+L_H-B-(C+L)x}{E}$ always. Similarly, $C_L < C_H - Cx$ always, so when $B < C_L,\ B < C_H - Cx$ always. Hence, when all four corners are saddle, condition (12) is always satisfied, so that $(\bar{x}, \bar{y})$ exists and it is a source. Q. E. D.