The Diffusion of Legal Innovation—Insights from Mathematical Modeling

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Do countries adopt legal rules due to independent, top-down processes, or do laws spread among nations in a manner that resembles the diffusion of new products and innovations in a social network? We empirically examine this question by employing an influential mathematical model based on sociological diffusion theory and frequently used for analyzing the diffusion of innovations (the Bass model). Our findings indicate that more often than not, the temporal diffusion of legal rules displays a good fit to the Bass model and suggest that this model can provide new insights in studying the diffusion of laws. Particularly, applying the Bass model to legal diffusion allows quantifying the influence that countries and states exert on each other in the adoption of specific rules, provides a metric for comparing diffusion processes across different legal branches, allows tentative prediction of the ongoing spread of specific rules, and sheds light on several debates in the areas of comparative, corporate, and international law.

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Introduction

> *"It is one of the happy incidents of the federal system that a single courageous state may, if its citizens choose, serve as a laboratory; and try novel social and economic experiments without risk to the rest of the country."*[1]

Do countries adopt legal rules as a result of independent, top-down processes which—to paraphrase Justice Louis Brandeis—pose "no risk" to other countries? Or, do legal rules spread among nations in a manner which resembles the diffusion of new products, technologies, and trends in a social network, and which is significantly susceptible to adoption by other countries?

The diffusion dynamics of legal rules among states and countries, and the role of "social influence" in this process have received limited attention in legal literature. Yet, scholarly interest in this topic is ever increasing.[2] This Article empirically explores this question by employing a prominent mathematical model known as the "Bass model."[3] Based on a renowned sociological model for innovation diffusion developed by Everett Rogers,[4] the Bass model has become an extremely influential mathematical model, frequently used to measure, analyze, and forecast the temporal diffusion of new products and technologies.[5] This Article applies the Bass model to the

1. New State Ice Co. v. Liebmann, 285 U.S. 262, 311 (1932) (Brandeis, J., dissenting) (emphasis added).

2. For a review of existing literature, see *infra* Part I.

3. *See generally* Frank M. Bass, *A New Product Growth for Model Consumer Durables*, 15 MGMT. SCI. 215 (1969). For detailed description of the model, see *infra* Parts I and II.

4. *See generally* EVERETT M. ROGERS, DIFFUSION OF INNOVATIONS (5th ed. 2003). Notably, the first edition of the book was published in 1962.

5. *See* Wallace J. Hopp, *Ten Most Influential Papers of Management Science's First Fifty Years*, 50 MGMT. SCI. 1763, 1763 (2004) (listing the Bass paper among the ten most influential papers in management science).

diffusion of laws among the world's countries and among states in the United States.

Our data provide initial yet substantial evidence that oft-times the diffusion of laws among states and countries displays an overall fitness to the Bass model. These findings imply that the adoption of legal rules is strongly influenced by "imitation"—the adoption of similar legislation by additional states. Thus, they highlight the similarities between the diffusion of legal innovations and the diffusion of products and technologies newly introduced into a social network.[6] While the role of social influence in the diffusion of legal innovations is not entirely surprising,[7] the systematic application of the Bass model allows for the generation of new, in-depth insights when studying the diffusion of laws. *First*, the Bass model's coefficients allow for the quantification of the weight of the social influence in the diffusion of specific legal rules versus the weight of other independent factors.[8] Its application therefore supplies a metric for carrying out nuanced analyses, such as comparisons between the diffusion of legal rules and the diffusion of products, or for identifying patterns of diffusion in different branches of the law. *Second*, the Bass model's forecasting power may be used to tentatively *predict* the future spread of specific rules among states and countries when such diffusion is still occurring.[9] Such tentative predictions could provide a powerful tool for policy makers contemplating the adoption of a certain legal standard. *Lastly*, employing the Bass model to quantify the diffusion of legal innovation can shed new light on several longstanding discourses in various fields of law, such as the fierce debate concerning the "competition over incorporation" hypothesis in U.S. corporate law, or the sociological approach to international law.[10] Our study does not exhaust all the possible implications of applying the Bass model to explore legal diffusion. Rather, it seeks to illustrate that this methodological tool can serve as a platform for many subsequent studies and can enhance and fine-tune our understanding of the diffusion of laws.

The Article is organized as follows: Part I begins by briefly reviewing the socio-legal literature on the diffusion of innovations and proceeds to review the scholarship specifically concerned with the diffusion of laws. Part II describes our dataset and methodology in applying the Bass model to cases of legal diffusion. Part III describes our findings and presents them in a series of figures and two accompanying tables. Part IV discusses the potential significance of these findings, concentrating on three principal implications: (1) the Bass model as a methodological tool that allows

6. The term "innovation" in this Article and in the literature discussed throughout has a broad meaning that is not confined to products that are technologically "novel." Rather, it refers to a certain subject matter that is newly introduced into a certain system. This can be a product, a trend, a technology, or an ideology. *See* ROGERS, *supra* note 4, at 12–13. In our case, the term "legal innovation" refers to legal rules that are newly introduced in a certain country or state.

7. For previous works supporting this insight, see *infra* Part I.

8. *See infra* discussion Part IV.A.

9. *See infra* discussion Part IV.B.

10. *See infra* discussion Part IV.C.

the study of legal diffusion in new ways; (2) the predictive power of the Bass model in cases of ongoing legal diffusion; and (3) informing various scholarly debates.

I. Theoretical Background and Existing Literature

Our study builds on the accumulating scientific investigation of the diffusion of innovations during the past century. To this effect, it draws on several strands of scholarship from the fields of sociology, mathematics, management science, and the study of complex networks. The following paragraphs briefly describe this literature and then proceed to review the scholarship specifically concerned with the diffusion of legal innovations.

A. Diffusion of Innovations

Sociological studies have long submitted that diffusion of innovations depends, to a large extent, on the social network in which the innovation spreads and the social influence its members exert on each other. Pioneering works in this area include, *inter alia*, Gabriel de-Tarde's century-old observations on the importance of social imitation for the success of new objects introduced in a certain society,[11] as well as famous studies that explore the successful diffusion of new agricultural products in networks of farmers[12] and of new medical drugs among medical practitioners.[13]

According to this literature, successful diffusion depends not only on the intrinsic qualities of the diffusing product and its fitness to potential adopters, but also on the particular structure of the social system into which the innovation is released and the ways members in that system influence each other.[14] Indeed, hundreds of empirical studies of different social networks confirmed that social influence deeply affects the diffusion of various types of innovations, from agricultural seeds,[15] through medical drugs,[16] to various technologies.[17]

In recent years, innovation diffusion has become a subject of interest for mathematicians and physicists investigating patterns in complex net-

11. *See generally* GABRIEL TARDE, THE LAWS OF IMITATION (1903).

12. *See* Bryce Ryan & Neil C. Gross, *The Diffusion of Hybrid Seed Corn in Two Iowa Communities*, 8 RURAL SOC. 663 (1943) (demonstrating the significance of interactions in the network of farmers for the successful diffusion of hybrid corn) https://search.proquest.com/openview/7de2b2276a089fe888071663de12b6a0/1?pq-origsite=gscholar&cbl=1817355 [https://perma.cc/FX4K-MBQH].

13. *See* JAMES S. COLEMAN ET AL., MEDICAL INNOVATION: A DIFFUSION STUDY 7–10 (1966) (studying the diffusion of tetracycline antibiotics and demonstrating the role of the social network in its success).

14. *See* ROGERS, *supra* note 4, at 23–25.

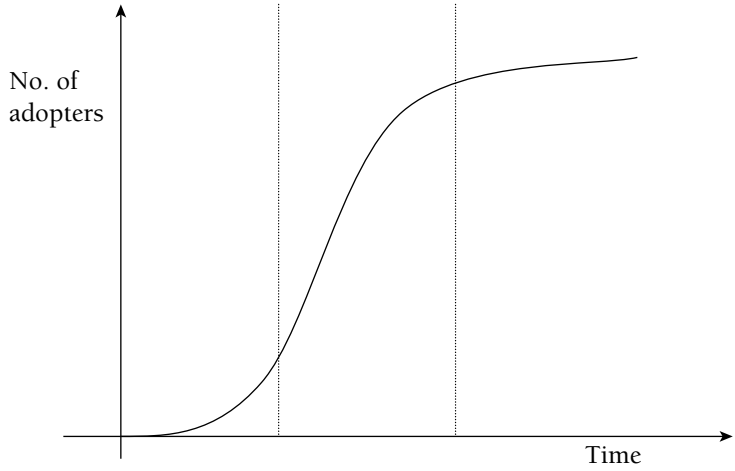
15. *See, e.g.*, Ryan & Gross, *supra* note 12, at 677 (examining the diffusion of hybrid corn).

16. *See, e.g.*, COLEMAN ET AL., *supra* note 13, at 7–10 (examining the diffusion of antibiotics).

17. *See* ROGERS, *supra* note 4, at 345 (discussing the diffusion of the facsimile). The Rogers treatise describes hundreds of additional diffusion studies carried out by Everett Rogers as well as by numerous other scientists.

works.[18] This strand of research confirms the considerable role played by the network in the decision to adopt or reject an innovation. For example, large-scale experiments demonstrated that people's decisions to adopt certain music are significantly influenced by the choices of their peers in a social network.[19] All in all, the understanding that successful diffusion is a "network phenomenon" has become widely accepted among scientists from the hard and social sciences.[20]

A leading sociological model of innovation diffusion was introduced by sociologist Everett Rogers in a treatise first published in 1962, which synthesized hundreds of diffusion studies from various fields.[21] One of the principal insights of this model is that temporal diffusion of successful innovations often follows an "S" shape, similar to the following illustration:[22]



This shape reflects the common dynamics whereby, during the first stage of diffusion, an innovation is adopted by "innovators," namely adopters that are willing to adopt it independently, regardless of whether it is

18. There are several prominent works in this field. *See, e.g.*, Albert-László Barabási, Linked–The New Science of Networks 10 (2002); Albert-László Barabási & Réka Albert, *Emergence of Scaling in Random Networks*, 286 Sci. 509, 509–10 (1999); Amac Herdagdelen & Haluk Bingol, *A Cultural Market Model*, 19 Int'l J. Mod. Physics C 271, 271–272 (2008); Duncan J. Watts & Matthew J. Salganik, *Social Influence: The Puzzling Nature of Success in Cultural Markets*, *in* The Oxford Handbook of Analytical Sociology 315 (Peter Hedström & Peter Bearman eds., 2009).

19. *See* Matthew J. Salganik et al., *Experimental Study of Inequality and Unpredictability in an Artificial Cultural Market*, 311 Sci. 854 (2006).

20. David Easley & Jon Kleinberg, Networks, Crowds and Markets 479 (2010) (describing popularity and success as "network phenomena"). *See* also Barabási, *supra* note18, at 41–54 (acknowledging the equivalences between the mathematical, physical and sociological diffusion models); Everett M. Rogers et al., *Complex Adaptive Systems and the Diffusion of Innovations*, Innovation J., Dec. 2005, at 1, 3–5 (highlighting the similarities between the "hard" and social sciences models for innovation diffusion).

21. *See generally* Rogers, *supra* note 4.

22. *Id.* at 23 ("most innovations have an S-shaped rate of adoption").

adopted by the rest of the network.[23] At this stage, the diffusion rate is relatively slow, yet the growth in the number of adopters stimulates additional people, who are more susceptible to network influence, to join in and adopt the innovation.[24] This in turn creates a positive feedback process: the more people adopt the innovation, the greater the social influence is, and the greater its chances are to attract further adopters.[25] At a certain stage, the innovation may obtain a "critical mass."[26] The increase in the number of new adopters becomes significantly sharper. When the innovation reaches that "tipping point," its further diffusion is almost self-generated, until, finally, when most of the relevant network adopts the innovation, the diffusion curve reaches saturation.[27]

B. Diffusion of Legal Innovations

One strand of the rich sociological literature on the diffusion of innovations extended the models of innovation diffusion in social networks to networks comprised of states rather than individuals.[28] For example, the pioneering work of sociologist Jack Walker examined the spread of dozens of "programs," including various laws and policy instruments among the American states, and formed an "innovation score" that measures the innovativeness of each particular state.[29] Subsequent studies in sociology and political science similarly created and tested "innovativeness indexes" while exploring the diffusion of various laws, regulatory schemes, and legal doctrines among states in the United States,[30] and among Canadian prov-

23. *Id.*

24. *Id.* at 20–30.

25. *See id.* at 23.

26. *See* ROGERS, *supra* note 4, at 349–52 (discussing the concept of critical mass). *See also* MALCOLM GLADWELL, THE TIPPING POINT: HOW LITTLE THINGS CAN MAKE A BIG DIFFERENCE 4 (2001) (coining the term "tipping point" to describe this process).

27. *See* ROGERS, *supra* note 4, at 23.

28. James M. Lutz, *Regional Leaders in the Diffusion of Tort Innovations among the American States*, PUBLIUS, Winter 1997, at 39, 44 (indicating that studying diffusion of legal doctrines involves charting a "network among states").

29. Jack L. Walker, *The Diffusion of Innovation among the American States*, 63 AM. POL. SCI. REV. 880, 882 (1969).

30. *See, e.g.*, Gregory A. Caldeira, *The Transmission of Legal Precedent: A Study of State Supreme Courts*, 79 AM. POL. SCI. REV. 178, 179 (1985) (examining patterns of citation of court decisions between state supreme courts); Bradley C. Canon & Lawrence Baum, *Patterns of Adoption of Tort Law Innovations: An Application of Diffusion Theory to Judicial Doctrines*, 75 AM. POL. SCI. REV. 975, 975 (1981) (analyzing the diffusion of court decisions in the fields of torts among American states); Gary T. Ford, *Adoption of Consumer Policies by States: Some Empirical Perspectives*, 15 J. MARKETING. RES. 49, 54 (1978) (analyzing the adoption of consumer legislation and identifying "leaders" and "laggards" among American states); Virginia Gray, *Innovation in the States: A Diffusion Study*, 67 AM. POL. SCI. REV. 1174, 1175, 1176, 1179 (1973) (measuring the temporal diffusion of twelve legal rules among states in the United States); James M. Lutz, *The Spatial and Temporal Diffusion of Selected Licensing Laws in the United States*, 5 POL. GEOGRAPHY Q. 141, 141 (1986) (analyzing the sequence of adoptions for seven licensing policies among the American states in the 19th and 20th centuries); Robert L. Savage, *Policy Innovativeness as a Trait of American States*, 40 J. POL. 212, 218 (1978) (examining the adoption of numerous policies by American states and concluding that states' "innovativeness" degree changes across time).

inces.[31] While the influence of states on each other during the adoption process was explicitly acknowledged in several studies,[32] this literature has primarily focused on characterizing individual states as "innovators" or "laggards," and not on the temporal diffusion of legal innovations.[33]

Interestingly, social scientists preceded legal scholars in studying the dynamics of legal diffusion. Most legal scholarship concerned with the adoption of legal rules in different jurisdictions concentrates on the study of "legal transplants."[34] As a general matter, this strand of literature focuses not on diffusion dynamics, but rather on the conditions and circumstances that affect the success or failure of legal rules adopted by a new jurisdiction. Indeed, the general disregard of the sociological diffusion models by legal scholarship led William Twinning to conclude that "[l]egal and social scientific studies of diffusion have largely lost touch with each other."[35] Notably, however, the last decade has seen some significant developments in this respect. Recent studies in the field of transnational and comparative law explicitly recognize that the diffusion of legal rules is affected by networks and interactions among nations, officials, and additional players. For example, David Westbrook analogizes the diffusion of law to the adoption of fashion and acknowledges the influence of states on each other;[36] Katarina Linos emphasizes the role of imitation in the diffusion of policies among different countries;[37] and Holgar Spamann high-

31. *See, e.g.*, James M. Lutz, *Emulation and Policy Adoptions in the Canadian Provinces*, 22 CAN. J. POL. SCI. 147 (1989) (identifying regional leaders among Canadian provinces based on analysis of policy diffusion); Dale H. Poel, *The Diffusion of Legislation among the Canadian Provinces*, 9 CAN. J. POL. SCI. 605 (1976) (analyzing the adoption of various public policies by Canadian provinces).

32. *See* Walker, *supra* note 29, at 897 (observing that the likelihood of a state to adopt "an idea" is higher if other states have already adopted it). *See also* Lutz, *supra* note 28, at 44 (indicating the significance of the "network" in studying diffusion among states).

33. A prominent exception is Gray, *supra* note 30, whose work extended the analysis to the temporal diffusion process. For a discussion of Gray's work, see *infra* notes 53-54, and the accompanying texts.

34. Prominent works in this vein include, for example, ALAN WATSON, COMPARATIVE LAW: LAW, REALITY AND SOCIETY (3d ed. 2010) [hereinafter WATSON: COMPARATIVE LAW]; ALAN WATSON, LEGAL TRANSPLANTS: AN APPROACH TO COMPARATIVE LAW (1974) [hereinafter WATSON: LEGAL TRANSPLANTS]; Margit Cohn, *Legal Transplant Chronicles: The Evolution of Unreasonableness and Proportionality Review of the Administration in the United Kingdom*, 58 AM. J. COMP. L. 583 (2010); Michele William Ewald, *Comparative Jurisprudence (II): The Logic of Legal Transplants*, 43 AM. J. COMP. L. 489 (1995); Michele Graziadei, *Legal Transplants and the Frontiers of Legal Knowledge*, 10 THEORETICAL INQUIRIES L. 723 (2009); Pierre Legrand, *The Impossibility of 'Legal Transplants'*, 4 MAASTRICHT J. EUR. & COMP. L. 111 (1997) [hereinafter Legrand: Impossibility]; Pierre Legrand, *What "Legal Transplants"?*, *in* ADAPTING LEGAL CULTURES 55 (David Nelken & Johannes Feest eds., 2001) [hereinafter Legrand: "Legal Transplants"?]. For a discussion of this scholarship, see *infra* Part IV.C.1.

35. William Twinning, *Social Science and Diffusion of Law*, 32 J. L. & SOC'Y 203, 239 (2005).

36. *See* David A. Westbrook, *Theorizing the Diffusion of Law: Conceptual Difficulties, Unstable Imaginations, and the Effort to Think Gracefully Nonetheless*, 47 HARV. INT'L L.J. 489, 498-99 (2006).

37. *See generally* Katerina Linos, *When Do Policy Innovations Spread? Lessons for Advocated of Lesson-Drawing*, 119 HARV. L. REV. 1467 (2006).

lights factors such as investment ties and cooperation between organizations that affect the transnational diffusion of legal materials[38] while Margit Cohn observes that legal transplants are often the product of interactions among various players.[39]

Concomitantly, a limited yet significant body of legal scholarship examines the diffusion *dynamics* of legal rules. Roberta Romano's pioneering studies examined the diffusion of legal rules in the field of corporate law among the American states and observed that such diffusion often follows an S-shaped curve.[40] Goedris and Versteeg recently analyzed the diffusion of constitutions among countries.[41] Additional studies examined the adoption of workers' compensation legislation[42] and securities regulation[43] against political-economic theories of the development of regulation, while several recent studies adopt a social-network approach to investigate the diffusion of legal rules in the fields of contract, employment, tort, and constitutional law.[44]

Our study builds upon this growing body of scholarship but employs a mathematical modelling approach to study legal diffusion. The model we

38. *See* Holger Spamann, *Contemporary Legal Transplants– Legal Families and the Diffusion of (Corporate) Law*, 6 BYU. L. REV. 1813, 1813 (2009).

39. Cohn, *supra* note 34, at 586.

40. *See* Roberta Romano, *Law as a Product: Some Pieces of the Incorporation Puzzle*, 1 J. L. ECON. & ORG. 225 (1985) [hereinafter Romano: Product]. *See also* Roberta Romano, *The States as a Laboratory: Legal Innovation and State Competition for Corporate Charters*, 23 YALE J. REG. 209 (2006) [hereinafter Romano: Laboratory] (examining the diffusion of statutory norms in the field of corporate law among American states).

41. *See* Benedikt Goderis & Mila Versteeg, *The Diffusion of Constitutional Rights*, 39 INT. REV. L. & ECON. 1 (2014) (exploring the transnational influence in the adoption of constitutional rights by exploring spatial diffusion and various measures of proximity among adopting states).

42. *See* Price V. Fishback & Shawn Everett Kantor, *The Adoption of Workers' Compensation in the United States, 1900-1930*, 41 J. L. & ECON. 305 (1998).

43. *See* Paul G. Mahoney, *The Origins of the Blue Sky Laws: A Test of Competing Hypotheses*, 66 J. L. & ECON. 229 (2003).

44. *See* Donald J. Smythe, *Transaction Costs, Neighborhood Effects, and the Diffusion of the Uniform Sales Act*, 1906-47, 4 REV. L. & ECON. (2008) (examining the spatial diffusion of the Uniform Sales Act among American states). *See also* Robert C. Bird & Donald J. Smythe, *The Structure of American Legal Institutions and the Diffusion of Wrongful-Discharge Laws, 1978-1999*, 42 L. & SOC'Y REV. 833 (2008) (investigating the diffusion of a new standard in employment law among American states and demonstrating the influence of precedents by courts within the same federal circuit region on the diffusion process); Robert C. Bird & Donald J. Smythe, *Social Network Analysis and the Diffusion of the Strict Liability Rule for Manufacturing Defects, 1963-87*, 37 L. & SOC. INQUIRY 565 (2012) (using social network analysis to analyze the persuasiveness of legal precedents in the diffusion of the strict liability rule for manufacturing defects); Laurence A. Benner et al., *Social-Network Theory and the Diffusion of the Search-and-Seizure Exclusionary Rule Among State Courts Between Weeks and Wolf*, 27 BYU J. PUB. L. 97 (2012) (analyzing the diffusion of particular search and seizure rules among courts in various states); Kyle Graham, *The Diffusion of Doctrinal Innovations in Tort Law*, 99 MARQ. L. REV. 75 (2015) (examining the diffusion of common law doctrines in the field of torts against the sociological models of innovation diffusion, and maintaining that the diffusion rate of case law in this field is slowing down). *Cf.* Romain Boulet et al., *35 Years of Multilateral Environmental Agreements Ratifications: A Network Analysis*, 24 ARTIFICIAL INTELLIGENCE & L. 133 (2016) (employing a network approach to study the ratification of multilateral environmental agreements by various states).

employ was introduced by Frank Bass in 1969 and is commonly known as the "Bass model."[45] To a large extent the Bass model builds upon Rogers' sociological model for innovations diffusion.[46] In particular, it accepts the premise that while some adoptions of an innovation in a given social system occur independently of the decisions of others, social influence plays a significant role in numerous decisions to adopt an innovation, and its significance increases with the number of adoptions.[47] As more fully explained below, the Bass model created a benchmark for comparing the impact of these two factors in various diffusion cases.[48] It further allowed for the making of certain predictions as to the duration, rate, and magnitude of diffusion that is still ongoing, based on preliminary and partial diffusion data.[49] While the initial paper by Frank Bass focused on the diffusion of products such as air-conditioners and lawn-mowers that were considered new for the period,[50] that paper was followed by hundreds of subsequent works which applied the model to numerous products and technologies.[51] The Bass model has thus become a cornerstone in the area of innovation diffusion, widely used to describe and forecast product and technology diffusion, and Frank Bass's 1969 article was pronounced one of the ten most influential papers in the history of management science.[52]

Applying mathematical models to the study of the diffusion of legal rules is still largely unexplored in the literature. The most prominent exception (albeit in non-legal literature) is Virginia Gray's study in political science, which used the logistic mathematical model to measure the temporal diffusion of twelve legal rules among states in the United States.[53] Unlike the Bass model, the logistic model assumes that, except for the first adopter, all subsequent adoptions result *solely* from social influence/imitation of previous adopters.[54] Thus, the logistic model is a special case of the Bass model which assumes there are no independent factors affecting the diffusion process after the initial adoption. As far as legal diffusion is concerned, this assumption is problematic because oft-times, in real-world scenarios, independent factors are likely to play a role in the adoption of legal

45. *See generally* Bass, *supra* note 3.

46. *Id.* at 216 (referring to Rogers's diffusion model).

47. *Id.*

48. *See* Vijay Mahajan et al., *Diffusion of New Products: Empirical Generalizations and Managerial Uses*, 14 MARKETING SCI. G79, G81–82 (1995) (observing that the numerous applications of the Bass model provide "benchmarks" for comparison between various diffusion cases). *See also infra* discussion Part IV.A.

49. *See* Bass, *supra* note 3, at 216. *See also* Mahajan et al., *supra* note 48, at G85. *See also infra* discussion Part IV.B.

50. Bass, *supra* note 3, at 218.

51. For one meta-study describing the multiple applications of the Bass model, see Mahajan et al., *supra* note 48. *See also* Gadi Fibich & Ro'i Gibori, *Aggregate Diffusion Dynamics in Agent Based Models with A Spatial Structure*, 58 OPERATIONS RES. 1450, 1450 (2010) (describing the application of the Bass model to diverse areas such as retail service, industrial technology, agriculture, as well as educational, pharmaceutical, and consumer-durables markets).

52. *See* Hopp, *supra* note 5.

53. *See* Gray, *supra* note 30, at 1184, and the accompanying text.

54. For the assumptions of the logistics model, see *id.*, at 1176.

rules.[55] The Bass model allows for the quantification of the relative role of the independent factors and the social influence, and it is *the* canonical mathematical model for measuring innovation diffusion.[56] It therefore constitutes a more suitable platform for studying legal diffusion.

Bouchey's work in public policy used the Bass model to study the diffusion of public policies in order to support an argument based on the "punctuated equilibrium theory" of political science that "variation in the speed of [policy] innovation diffusion" results "from the disproportionate allocation of political attention."[57] This work assumed fitness of the diffusing policies to the Bass model and concentrated on the rate of diffusion in the U.S.[58] Our study introduces a more systematic methodology for applying the Bass model to legal innovation and for testing the fitness or non-fitness of the diffusion of legal rules to the Bass model. In addition, the scope of our inquiry is broader and examines legal rules from different fields of the law, including public, private, criminal, and civil law. Furthermore, we do not confine ourselves to diffusion of legal rules among U.S. states, but also apply the Bass model to diffusion among world countries. Finally, we present diverse implications of the model, including its use in the analysis of various legal questions and its potential use as a predictive tool.

II. Methods

A. Data Collection

Our dataset consists of the diffusion data of thirty-nine (39) legal rules (enacted in legislation) from various fields, including copyright, trusts, torts, corporate law, licensing laws, criminal law, labor-insurance law, and laws granting voting rights to women. With respect to each rule, we gathered information about the number of adopting states (for rules diffusing in the United States) or countries (for rules diffusing among world countries) and the year of adoption by each state or country.

The challenges of data collection and the sources of our data should be clarified at the outset. Leading legal databases such as Lexis-Nexis or Westlaw do not include legislation from most of the world's countries. Even when the legislation of a certain country or state appears in a legal database, the dates of introduction of specific amendments to a certain law are often not recorded. Therefore, in our data collection, we relied not only on the major legal databases but also on a multiplicity of sources, including comparative literature, reports prepared by countries that considered the adoption of a certain rule into their legislation, or repositories managed by various entities. *Inter alia*, we used the WIPO (World Intellectual Prop-

55. *See* Lutz, *supra* note 30, at 142.

56. *Id.* at 142–44.

57. Graeme Boushey, *Punctuated Equilibrium Theory and the Diffusion of Innovation*, 40 POL'Y STUD. J. 127, 128 (2012).

58. *See id.*

erty Organization) repository with respect to copyright legislation,[59] the IPU (Inter-Parliamentary Union) repository with respect to the introduction of women's voting rights,[60] and a repository of amendments to U.S. trust legislation managed by a trust-specialized law firm.[61] When we used online databases with concentrated data on a certain legal rule, we attempted to verify the data independently insofar as it was possible. In numerous other cases, we relied on data previously collected by other scholars contained in published articles and public research databases. Most prominently, these sources provided important information regarding the diffusion of three groups of rules among American states: (1) laws imposing various licensing requirements, which appear in an article by James Lutz[62] ("*the Licensing Law Group*"); (2) various legislative reforms to U.S. corporate law, which appear in an article by Roberta Romano[63] ("*the Corporate Law Group*"); and (3) various legislative reforms in the field of tort law, which are included in a research database created and periodically updated by Ronen Avraham[64] ("*the Tort Law Group*"). The inclusion of groups of legal rules from these three areas of law in our dataset allowed us to perform initial comparisons of diffusion patterns among the three branches, which we will turn to shortly.[65]

It is important to emphasize that in collecting our data we did *not* choose legal rules that we initially assumed were likely to fit the Bass diffusion model. Rather, in light of the challenges of data collection, *we used every data point we could reasonably obtain* and, as explained, relied heavily on data collected by several previous researchers.[66]

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59. World Intellectual Property Organization, http://www.wipo.int/portal/en/index.html [https://perma.cc/EE3D-UDUG] (last visited on Oct. 22, 2019).

60. Inter-Parliamentary Union, https://www.ipu.org/ [https://perma.cc/D3SD-PUFY] (last visited on Oct. 22, 2019).

61. Law Offices of Oshins & Associates, https://www.oshins.com/[https://perma.cc/RJ5E-PEXG] (last visited on Oct. 22, 2019).

62. *See* Lutz, *supra* note 30, at 145 (1986).

63. *See* Romano: Laboratory, *supra* note 40, at 210. Notably, the numerical diffusion data in that case were derived from the graphical diffusion figures included in that article.

64. *See* Ronen Avraham, *Dataset of Tort Law Reforms 5.1*, (available from authors). Note that version 6.1 is available here: https://law.utexas.edu/faculty/ravraham/dsltr-6.1-jan-8-2019.pdf [https://perma.cc/54WY-KZBL]. Notably, while most of the reforms in that database are legislative reforms, in certain instances the reforms were introduced by legislation in some of the states, and by case law in other states.

65. *See infra* Part IV.A. In addition to the three groups of rules described above, we obtained data on the diffusion of criminal "Add-On" Gun Laws from the following sources: David S. Abrams, *Estimating the Deterrent Effect of Incarceration Using Sentencing Enhancements*, Am. Eco. J., October 2012, at 32, 33; data on the diffusion of Workers' Compensation Laws from Fishback & Kantor, *supra* note 42, at 306–07; and data on the diffusion of "the Right to Die" from Henry R. Glick & Scott P. Hays, *Innovation and Reinvention in State Policymaking: Theory and the Evolution of Living Will Laws*, 53 J. Pol. 835, 838 (1991).

66. As we hope to expand our dataset in subsequent research, readers of this Article who might be aware of data concerning the adoption of additional legal rules, whether such rules diffused in the United States or internationally, are invited to contact the authors.

Obviously, for a variety of reasons, not all innovations obtain a critical mass, and (like additional types of innovations) new legal rules may fail to diffuse among different countries.[67] Indeed, part of the above literature explores possible differences between those innovations that successfully diffuse and those that fail to do so.[68] However, our focus in this Article is not on the distinction between successful and unsuccessful diffusions. Rather, in this study, we concentrate on legal rules whose diffusion *was successful* and examine whether it is possible to quantify the factors affecting the process and generate predictions with respect to ongoing diffusion. We leave for another day the interesting questions as to the particular conditions under which legal innovations succeed or fail to diffuse. Therefore, we included in our dataset only the legal rules whose diffusion passed the "success threshold."[69]

Most of the legal innovations that we examined are specific legislative amendments to an existing body of law, such as the adoption of a royalty-resale-right ("*droit de suite*") as part of copyright legislation, the adoption of a comparative fault principle as part of the law of torts, or the cancellation of a rule prohibiting perpetual trusts that existed under trust legislation.[70] The majority of the legal rules in our dataset diffused among American states while some of the rules we examined diffused among the world's countries.[71] The vast majority of our data (37 of 39 legal rules) is comprised of legislation adopted domestically, but we also tested, by way of comparison, the diffusion of two international treaties with respect to which we collected the dates on which various countries joined the treaty.[72] Notably, because our interest is to study "bottom-up" diffusion that results from network dynamics, we avoided domestic legal rules whose adoption resulted from mandatory obligations, such as compliance with trade agreements or with requirements imposed by international treaties.[73]

B. Quantitative Analysis: The Bass Model and Its Coefficients

We tested the general fitness of the diffusion of the legal rules comprising our dataset to the Bass model. We then performed further analyses

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67. *See* Glick & Hays, *supra* note 65, at 839–40.

68. *See* Fishback & Kantor, *supra* note 42, at 315.

69. We define a legal rule's diffusion as "successful" if it was adopted by at least 9 countries/states. In addition, we require at least 7 data-points of adoption (i.e., rules that were adopted during at least 7 different years). We also excluded rules that were "neglected" (i.e., cancelled) by more than 25% of their adopters concomitantly with the diffusion process. While our "success threshold" is admittedly somewhat arbitrary, setting a slightly higher or lower threshold would not dramatically change our results.

70. *See infra* Tables 1 and 2.

71. *See infra* Tables 1 and 2. As these tables demonstrate, our data distinguish between rules that spread among states and rules that spread internationally.

72. For further discussion of this point, see *infra* Section 4.

73. It should be clarified that, while two of the legal rules in our dataset were international conventions, we did not examine the implementation of those conventions by domestic legislation, which is essentially a "top-down" process, but rather the decisions of different countries to join the conventions—decisions that are not mandated by "top-down" requirements.

of the fitting rules using the Bass model's coefficients. Our fitting process and additional analyses warrant a brief explanation about the assumptions underlying the model and its coefficients.

As previously explained, the Bass model relies, to a large extent, on the sociological theory of innovation diffusion. According to this literature, while some adoptions of an innovation in a given social system occur *independently* of the decisions of others, other adoptions occur as a result of *peer-influence*, i.e., they are affected by the decisions of additional members in the social system to adopt the innovation.[74] The model further assumes that the social influence factor in the diffusion process is linearly proportional to the number of adopters. In other words, the increase in the number of adopters generates a linearly proportional increase in the weight of social influence in the adoption process.[75]

Based on these assumptions, the likelihood of an individual agent to adopt a certain innovation is given by the following formula:

$$\text{likelihood of adoption} = p+qn(t)/M \quad (1)$$

where ***t*** is the *time from the first introduction* of the new innovation (in our case, the new legal rule) to the market, ***n(t)*** is the number of adopters at time ***t***, ***p*** is the "*innovation coefficient*," which represents the weight of **independent** decisions in the adoption process, namely adoptions of the legal rule independently of how many other states have adopted it before, ***q*** is the "*imitation coefficient*," which represents the weight of **peer-influence** in the adoption of the new rule, and ***M*** represents the size of the potential market for the particular innovation that diffuses within the network (in our case, the number of potential adopting jurisdictions).[76]

Bass further demonstrated that in light of formula (1), the number of adopters at time *t* is given by the following formula:[77]

$$n(t) = M\frac{1-e^{-(p+q)t}}{1+\frac{q}{p}e^{-(p+q)t}} \quad (2)$$

The **q/p** ratio under the Bass model therefore reflects the magnitude of social influence in the diffusion process relative to independent factors. Specifically, a large q/p ratio corresponds to a rule that spreads predominantly due to social influence. In such cases, diffusion of innovations which complies with the Bass formula will generate an "S" shaped graph.[78] This is because at the beginning of the process $n(t) \approx 0$, and therefore the imitation component, which is proportional to $n(t)$, is very small. This reflects the fact that at the launch of a new innovation (in our case, a new legal rule), the first adopters are almost entirely innovators whose decision

74. *See supra* notes 11-17 and the accompanying text (discussing the sociological model for innovation diffusion).
75. *See* Bass, *supra* note 3, at 1826.
76. *See id.*
77. *See id.* at 1827–28.
78. Similar to the graphical illustration in *supra* Part I.A.

to adopt the innovation is mostly independent. As the process progresses, and the number of adopters increases, the imitation factor becomes more substantial, which leads to a corresponding increase in the rate of diffusion. This rate eventually slows down when the market potential nears saturation and there are fewer "agents" (in our case, states/countries) remaining to adopt.

The exact values of p, q, and M vary in each particular case of diffusion. We have therefore written an optimization program which, for any given rule in our dataset, uses as its input the empirical data—the year in which each state/country, as applicable, adopted the rule—and calculates the values of p, q and M for which the Bass formula (2) provides the best (i.e., closest) fit to the data.

C. Fitness Determination

In order to determine fitness to the Bass model, we applied the following *cumulative* requirements:

1) We used a standard measure of fit, known as "R-Squared," which is equal to the explained variance divided by the total variance of the dependent variable that was used, e.g., in the original Bass paper.[79] We apply this measure to the cumulative adoptions because the yearly adoptions are too few in light of the small number of potential adopters.

2) In addition, we did not include M (the actual number of adopters) as part of our real-data input. Instead, we allowed the model to predict the value of M in each particular case and then compared it to the actual "market"—namely the number of countries or states that adopted the rule. We expected M to be in the range of 200 (or less) when a legal rule fully diffused among world countries, and in the range of 50 (or less) when it fully diffused among American states. It should be clarified that "successful diffusion" does not necessarily imply full diffusion among 50 states or 200 countries.[80] If a certain rule diffused among 28 states and then reached saturation, the "market" for that particular rule would be 28, and we would expect the value of M generated by the Bass model to be in that range. Thus, if the value of M generated by the Bass model for a certain legal rule deviated by more than 35% from the actual number of adopters of that rule, we considered the rule as non-fitting.

3) Finally, when the value of q generated by applying the model turned out to be negative, the rule was considered non-fitting.

Altogether, legal rules whose diffusion was deemed fitting to the Bass model had to fulfill all three conditions: 1) $r^2 > 0.9$; 2) *M (Bass) = actual number of adopters* ±35%; and 3) $q > 0$.

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79. *See* Bass, *supra* note 3, at 1827.

80. *See supra* note 69 and the accompanying text (discussing of the "success threshold").

III. Findings and Discussion

A. Fitness to the Bass Model

In 74% of the cases we examined, i.e., 29 out of 39 legal rules comprising our dataset, the diffusion of the legal rule displayed a good fit to the Bass model.

The diffusion graphs of Bass-compliant legal rules appear in the following figures. Each graph carries a serial number which corresponds to the number allocated to each particular rule, as detailed in **Table 1** in the Appendix.

In each figure below, the x-axis represents the time since the first adoption, while the y-axis represents the number of adopting countries/states. "Year 0" in the graphs is the year in which the first adoption of the rule by a country/state occurred. The actual year of first adoption in each case (*e.g.*, 1920, 1893, 1983, etc.) is specified below the graph. The small circles are the actual adoption data, namely the accumulating number of adopters since "Year 0." The solid line represents the Bass formula (2) that provides the best (i.e., closest) fit to the actual data, whereby the values of p, q, and M were determined by the optimization program we have written.

Fig. 1: **Fitting of the Bass Model to the Diffusion of Legal Rules–Distinct Rules** (copyright-*droit de suite*; women voting rights, trusts-perpetuities; copyright: fair use, criminal: add-on gun law; workers compensation law).

The numbering on the graphs corresponds to the numbering of the rules as appears in Table 1.

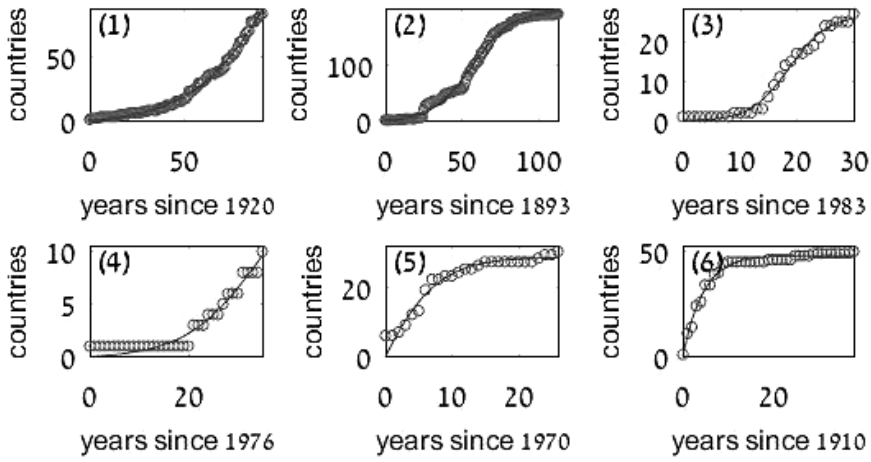
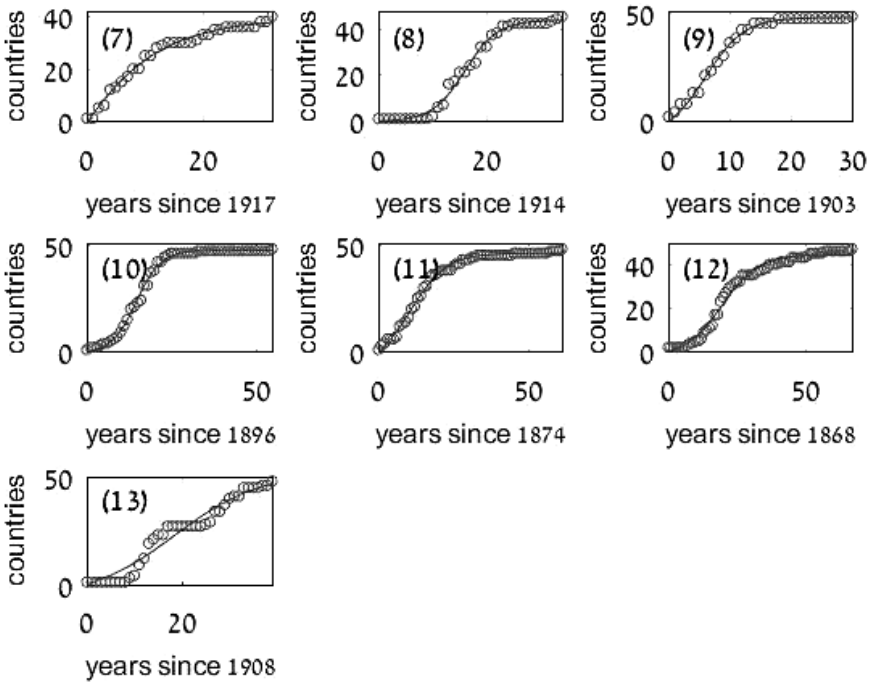
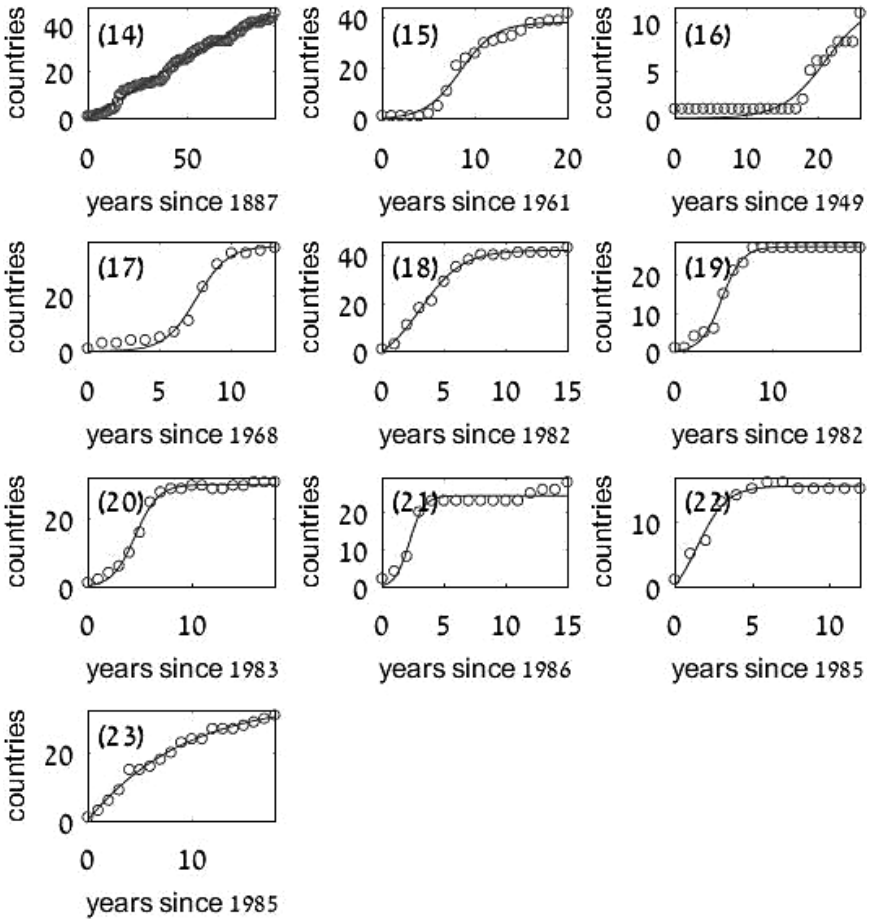


Fig. 2: **Licensing Law Group**[81]



81. As elaborated in Table 1.

Fig. 3: **Corporate Law Group**[82]



82. As elaborated in Table 1.

Fig. 4: **Tort Law Group**[83]

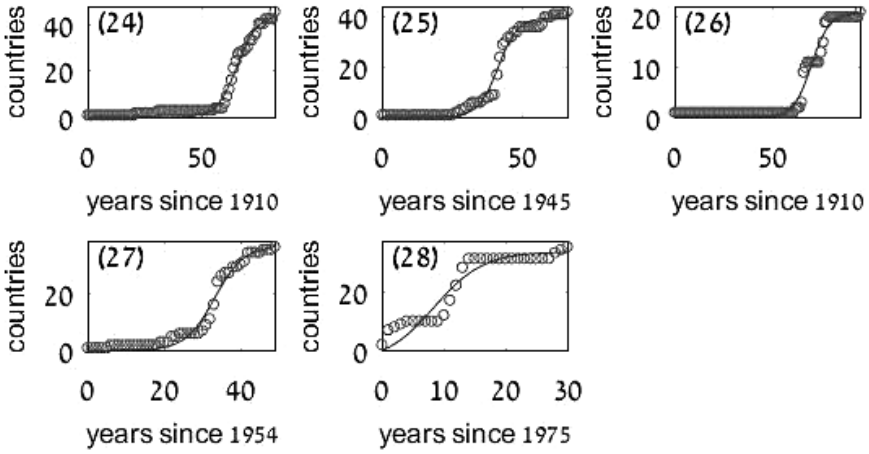


Fig. 5: **International Conventions**[84]

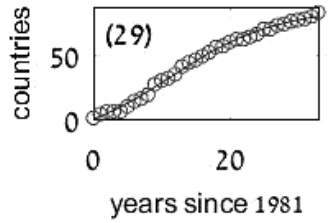


Table 1 in the Appendix provides the details of the rules displayed in Figures 1–5; the relevant market (namely the U.S. or international); the values of p, q, and M generated by the Bass model; the actual number of adopters; the q/p ratio; as well as the R-squared value for each legal rule.

These findings indicate that the general fitness to the Bass model subsists in various circumstances: legal innovations that diffuse among world countries as well as among American states; legal innovations in diverse fields of law, including, *inter alia*, torts, corporate, copyright, criminal law, trusts, and licensing laws; legal innovations in the form of enactment of new laws, amendments to existing laws, as well as cancellation of limitations under existing legislation.

Therefore, subject to various methodological constraints that are discussed below,[85] our initial findings provide substantial empirical evidence that oft-times, though not always, the diffusion of laws among countries and states follows the Bass model. This diffusion process is largely similar to the manner in which refrigerators, air conditioners, and lawnmowers diffuse during the period following their initial introduction into the mar-

83. As elaborated in Table 1.
84. As elaborated in Table 1.
85. *See infra* Part III.

ket.[86] Generally, the fitness to the Bass model implies that such diffusion is not only a product of independent considerations, but is strongly influenced by "imitation," namely the adoption of similar legislation by additional states. It thus provides further empirical support to existing literature that highlighted the role of social influence in legal diffusion. Beyond this general insight, our initial findings call for a more nuanced analysis of the particular coefficients comprising the Bass model that allows for the assessment of the weight of the network, or "imitation," in the diffusion process. We now turn to this exploration.

B. Social Influence v. Independent Factors in Legal Diffusion

When first presenting his model, Frank Bass observed that when the diffusion of a new product is successful, the weight of imitation (q) will typically be larger than the weight of independent decisions (p).[87] This observation was validated in numerous subsequent studies that examined the diffusion of various products.[88] We find that the diffusion of legal innovation is no exception. Among the legal rules that diffused in accordance with the Bass model, in the vast majority of instances (25 out of 29 cases), the value of q ("imitation" factor) was substantially larger than p ("independent" factor).[89]

The q/p ratios in the Bass-compliant diffusions were, as a general matter, higher than q/p ratios in the diffusion of tangible products and technologies.[90] These values highlight the substantial—at times even major—weight of peer-adoption in the decisions of countries to adopt certain legal rules.

Notably, the values of p in some of the legal rules we examined are particularly small. Therefore, the q/p ratios in those cases are extremely high (see, prominently, several items in the tort law group—Figure 4). A possible explanation for such instances is a long ripening period prior to the first adoption: in other words, the principle which was eventually encoded in those particular legal rules was plausibly known in the relevant network for a long period, which may have amounted to two or three decades, before its first adoption by a state legislature. Possibly, this state of affairs resulted from the existence of academic articles, court cases, public debates, etc., which preceded the formal adoption. Another explanation

86. Air conditioners, lawnmowers, and refrigerators are some of the paradigmatic examples used by Frank Bass to demonstrate the validity of his model. *See* Bass, *supra* note 3, at 1828.

87. *See id.* at 1826.

88. *See* Mahajan et al., *supra* note 48, at G82 (presenting generalization studies of p and q values based on hundreds of real-world applications of the Bass model, whose data indicate that the value of q is generally larger than p).

89. For a complete list of the p and q values of the rules whose diffusion fit the Bass model, see *infra* Table 1. The four exceptions are the rules numbered 5 ("add-on" gun in criminal law), 6 (workers' compensation), 7 (licensing realtors), and 23 (plurality voting in corporate law) in Table 1.

90. For generalizations concerning average p and q values in diffusion studies of tangible products, see Mahajan et al., *supra* note 48, at G82.

might be that other unknown events caused a certain deviation from the Bass model during *the initial stages* of diffusion. In those cases, after the first adoption, the continued diffusion of the legal rule was influenced almost solely by peer-adoption. We denoted these values by $p < 0.0001$ to clarify that there is no practical difference between, e.g., $p = 0.0001$ and $p = 0.000001$.

Indeed, in some instances the interest of countries to imitate their peers in adopting legal innovations is apparent. For example, with respect to certain reforms in the law of trusts, countries might have a clear interest in replicating other countries and shedding restrictions imposed upon trusts and trustees in order to attract wealth into their jurisdictions.[91] Likewise, American states may be quick to imitate reforms in the area of corporate law introduced by other states, typically Delaware, as part of their competition over incorporation.[92] In such instances, the high q/p ratio is to be expected.

Interestingly, however, our findings indicate that q/p ratios of diffusing legal innovations are high—in comparison to other products and technologies—even when the interest in imitating peer-adopters is less apparent, such as in the case of certain reforms to copyright law.[93] In other words, our findings provide an initial yet substantial, indication that social/network influence plays a significant role in the decision of countries to adopt legislative instruments, whether or not there are clear and immediate utilitarian benefits to such imitation.

Finally, because our dataset included three distinct groups of rules from three legal fields (licensing, corporate law, and tort law), we examined the values of q (social influence) within each group.[94] As a general matter, the intra-group q values were in a similar range. Thus, in the Licensing Law Group, q generally ranged between 0.1 and 0.3.[95] In the Corporate Law Group, q was generally higher and ranged between 0.3 and 1.4, which may indicate the significance of imitation in this field.[96] In the Tort Law Group, q ranged between 0.22 and 0.28. Subject to the constraints of our limited dataset, these findings provide a preliminary and tentative indica-

91. *See generally* Adam S. Hofri-Wingradow, *The Stripping of the Trust: A Study in Legal Evolution* 65 U. TORONTO L.J. 1 (2015) (listing states' competition over wealth and investment as a major reason for the diffusion of law reforms in the field of trusts).

92. *See* Romano: Laboratory, *supra* note 40, at 210–11 (maintaining that states' competition over incorporation explains the diffusion pattern and relative uniformity of corporate laws among American states); Romano: Product, *supra* note 40, at 226. For further discussion of this point, see *infra* Part IV-C-3.

93. *See* the rules concerning the introduction of a royalty resale right (*droit de-suite*), and the introduction of an open-ended "fair-use" exception—numbered 1 and 4 in Table 1, *infra*.

94. *See infra* Table 1. Notably, we refer here to "q" rather than "q/p" values, because, as previously noted, due to the limited size of agents (countries or states) in our network, the values of p are more sensitive to "noise" and may be significantly affected by small changes during the initial stages of adoption. We therefore focus on the q values, which are more robust and less affected by such influences.

95. The one exception is the rule numbered 7 (licensing realtors). *See infra* Table 1.

96. Two exceptions are the rules numbered 14 (staggered board) and 23 (plurality vote). *See infra* Table 1. For further discussion of this point, see *infra* Part IV-C-1.

tion that different branches of the law display intra-group diffusion patterns in a manner akin to different groups of products.[97] This insight, of course, requires further investigation.

C. The Bass Model's Limitations

Before proceeding to explore various implications of these findings, a few clarifications are in order. Like any attempt to capture real-life dynamics in a mathematical formula, the Bass model is not free of limitations and constraints. Most prominently, the model assumes that all "agents"—in our case, all states and countries—in the relevant network exert equal influence on all other agents. For the sake of illustration, under the Bass model the impact of the adoption of a certain legal rule on the prospects of its further adoption by peer countries is identical, whether the rule is adopted by the United States or by Israel. Likewise, the model assumes that the adoption of a rule by the state of California exerts similar influence on peer states as the adoption of the same rule by Alaska. The model, in other words, does not reflect variations in the extent of influence agents in a network exert on each other.

Nonetheless, in real-life scenarios, special properties of the relations among countries may well influence the diffusion process. Thus, states belonging to a certain "sub-group" may have increased influence over other members of that group.[98] For example, research demonstrates that factors such as former colonizing relations and shared "legal origin" increase the willingness of countries to follow other countries in adopting corporate laws, and in adopting constitutional rights.[99] In other cases, a country may possess a special stature in a certain legal domain, which increases its influence on its peers in that specific area. The state of Delaware, for example, plays a leading role in the field of corporate law in the United States, and its legislation in this area is likely to have a unique impact on other states.[100] In yet other cases, spatial proximity between states may increase their influence on each other.[101] Similarly, states belonging to a

97. For a somewhat similar observation under the framework of the logistic model, see Gray, *supra* note 30, at 1179.

98. *See, e.g.*, Benner et al., *supra* note 44 (empirically examining the diffusion of "the exclusionary rule" precedent among courts in various states and suggesting that precedents by other state supreme courts in the same federal circuit regions affect the adoption of the rule by a certain state's court).

99. *See* Goderis & Versteeg, *supra* note 41, at 17 (demonstrating an effect in the adoption of constitutional rights); Spamann, *supra* note 38, at 1818 (demonstrating the similar effect of "legal families" and former colonization in the field of corporate law).

100. *See, e.g.*, Romano: Product, *supra* note 40 (examining explanations for Delaware's prominence and influence in the field of corporate law).

101. *See, e.g.*, Fishback & Cantor, *supra* note 42; (exploring geographical effects in the diffusion process); Goderis & Versteeg, *supra* note 41, at 14 (exploring the effect of geographical proximity on the adoption of constitutional rights); Linos, *supra* note 37, at 1477 (discussing the effect of spatial proximity in innovation diffusion); Smythe, *supra* note 44 (demonstrating the significance of "neighborhood effects" in the diffusion of the diffusion of the Uniform Sales Act among American states). *But cf.* Bruce G. Carruthers et al., *Bringing "Honest Capital" to Poor Borrowers: The Passage of the Uniform Small Loan Law 1907–1930*, 42 J. INTERDISC. HIST. 393, 411 (2012) (finding no strong spatial influ-

certain Federal Circuit under the U.S. legal system may be more willing to follow other states in that same Circuit in adopting legal rules and court precedents.[102] These and similar factors are not embedded in the original Bass model and are therefore not reflected in our application of the model to legal diffusion.

Indeed, numerous subsequent scholarly works built upon Bass and introduced more nuanced mathematical models that attempt to incorporate additional factors affecting the diffusion process. For example, scholars have extended the model to take into account temporal variations in the extent of social influence.[103] Other researchers explored the structure of the social network and its impact on the diffusion process,[104] while others adapted the Bass model to consider heterogeneity among the different agents in the network.[105] Possibly, in certain instances, the application of such models to specific legal rules may produce a better, more accurate fit. Such an investigation is beyond the scope of this study and will hopefully be the subject of future research. Yet, importantly, our findings illustrate that in many instances, the diffusion of legal innovations displays a good fit to the original, simplest version of the Bass model, even before any additional calibration. Possibly, these findings suggest that the various factors identified in the literature as affecting the adoption of specific legal rules may be ultimately compartmentalized into the fairly-simple, two-coefficient Bass model.

Against these clarifications, we turn to take a closer look at the cases in our dataset whose diffusion did *not* fit the Bass model.

D. Non-Fitting Cases

Just like products and technologies do not *always* diffuse in accordance with the Bass model, one cannot expect that the diffusion of legal rules will fit the model in each and every case. Indeed, as indicated above, not all the legal rules included in our dataset presented a good fit to the

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ence of neighboring states in the passage of the Uniform Small Loan Law among states in the United States). For a general mathematical diffusion model that takes into account geographical proximity between adopters, see Tal Garber et al., *From Density to Destiny: Using Spatial Dimension of Sales Data for Early Prediction of New Product Success*, 23 MARKETING SCI. 419, 420 (2004).

102. *See* Bird & Smythe (2008), *supra* note 44, at 833) demonstrating the effect of precedents by other courts within the same federal circuit region on the judicial adoption of wrongful-discharge laws); Bird & Smythe (2012), *supra* note 44, at 97–98 (analyzing the diffusion of the "search and seizure exclusionary rule" among state courts, and demonstrating the influence of precedents by other state supreme courts in the same federal circuit on the adoption of the rule).

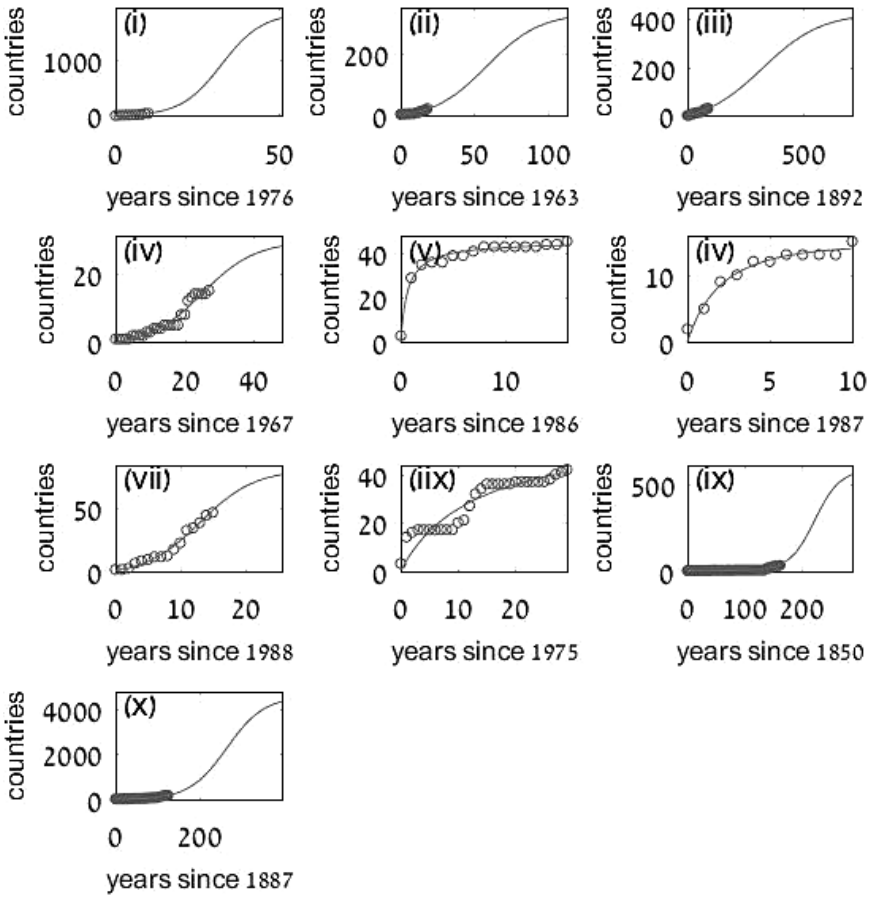
103. *See* Christopher J. Easingwood et al., *A Nonuniform Influence Innovation Diffusion Model of New Product Acceptance*, 2 MARKETING SCI. 273, 273, 276 (1983).

104. *See* Fibich & Gibori, *supra* note 51, at 1450.

105. For prominent works in this vein, see, e.g., Floortje Alkemade & Carolina Castaldi, *Strategies for the Diffusion of Innovations on Social Networks*, 25 COMPUTATIONAL ECON. 3 (2005); Gadi Fibich et al., *Averaging Principle for Second-Order Approximation of Heterogeneous Models with Homogeneous Models*, 109 PNAS 19545, 19546, 19548 (2012); Rajiv K. Sinha & Murali Chandrashekaran, *A Split Hazard Model for Analyzing the Diffusion of Innovations*, 29 J. MARKETING RES. 117 (1992).

model. Out of the 39 rules we examined, the diffusion of 10 rules was not Bass-compliant. The diffusion graphs of all the non-fitting rules appear in Figure 6.

Fig. 6: **Non-Fitting Rules**



Each graph in Figure 6 carries a serial number which corresponds to the numbers in Table 2 in the Appendix. Table 2 includes a complete list of all the non-fitting rules we examined, the relevant market in which they diffused (U.S./international), and the basis for their non-fitness ("non-fitness criterion").

In some of these instances, the lack of fitness to Bass is visibly apparent: the circles representing the actual diffusion data do not form an S-shape and do not fit the graph generated by the Bass formula. For example, the tort rule entitled "collateral source law" (rule iix in Table 2) generated both a negative q and a low R-squared value. In numerous other cases, the lack of fitness to Bass stems from an unreasonable "M" value generated by the model. Such is the case, for example, with respect to the

diffusion of the Berne Convention among the world countries (rule x in Table 2). At first sight, the actual diffusion data of the Convention seems to fit the consecutive line generated by the Bass model. However, the "M" value generated by the Bass model is unreasonable: as apparent from graph x in Figure 6, according to the model, the diffusion of the Convention is only in its preliminary stages, while in fact, it already diffused among most of the world countries. Moreover, the model predicts that the Berne Convention will continue its spread until it is adopted by 4,550 countries, a number that is completely not feasible given the actual number of world countries.[106] A possible explanation for the non-fitness in this case may be that the adoption of international conventions is often accompanied by intense preparatory work, or organized campaigns, which constitute a coordinated attempt to ensure that countries will join the Convention shortly after its adoption.[107] These dynamics are not entirely equivalent to the "bottom-up" dynamics assumed by the Bass model. Therefore, one might expect that as a general matter, the rate in which countries join a new international convention is less likely to be Bass-compliant.[108]

However, we cannot always point toward an immediately apparent explanation for non-compliance with the Bass model. In certain cases, the model may have failed to capture the actual diffusion dynamics which occurred "on the ground," due to its inherent limitations, as described in the previous section. It is also possible that certain real-world developments accelerated or otherwise affected the adoption of a certain rule in a manner that caused deviation from the model.[109] Illuminating these fac-

106. Notably, the WTO Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), which came into force in 1995, requires countries that are parties to the Agreement to comply with the copyright protection standards set out in the Berne Convention. Agreement on Trade-Related Aspects of Intellectual Property Rights art. 1(c), § 3, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299 (1994). Because this may be viewed as a "top-down" intervention which distorts the bottom-up diffusion process, we also examined the Convention's diffusion during the period which preceded TRIPS, i.e., until 1994. Under that option, the diffusion pattern also did not fit the Bass model.

107. *See generally* Uta Oberdorster, *Why Ratify? - Lessons from Treaty Ratification Campaigns*, 61 VAND. L. REV. 681 (2008) (describing these campaigns and arguing that "certain features of treaty ratification campaigns" impact treaties' "success in achieving broad ratification"). With respect to the adoption of the Berne Convention, see SAMUEL RICKETSON & JANE GINSBURG, INTERNATIONAL COPYRIGHT AND NEIGHBOURING RIGHTS: THE BERNE CONVENTION AND BEYOND (2d ed. 2005), PART I-2 (describing the diplomatic conferences and preparations that preceded the adoption of the Convention).

108. Thus, we concentrate our current study on diffusion of domestic legal rules. Notably, however, the second convention we analyzed, the Vienna Convention, displayed a very good fit to the model (rule 29 in Table 1). Therefore, the diffusion dynamics of international conventions and their quantitative analysis certainly deserve further exploration in future research. *Cf.* Boulet et al., *supra* note 44, at 133, 138, 145 (using a quantitative approach to study the ratification of multilateral environmental agreements and to analyze the state of the global environmental order).

109. *Cf.* Spamann, *supra* note 38, at 1874 (noting that legal adoption could be a consequence of independent reaction to external conditions rather than a result of diffusion dynamics).

tors requires a thorough, case-by-case investigation, which exceeds the scope of this study.

Despite the limitations of the Bass model itself, and although certain legal innovations do not diffuse in accordance with the model, the majority of rules we examined displayed a good fit to the model. In other words, oft-times, the Bass model's underlying assumptions seem to capture the essence of the dynamics according to which legal rules diffuse among countries and states. The next Section discusses possible implications of our findings.

IV. Implications

A. A Nuanced Tool for Studying and Comparing Legal Diffusion

Generally, the overall fitness of the diffusion of legal rules to the Bass model indicates that the model can provide a nuanced and sophisticated methodological tool for studying the diffusion of legal innovation and for comparing different cases of legal diffusion. This tool can enrich and fine-tune our understanding of how laws diffuse in various respects.

First, our study demonstrates that oft-times legal rules diffuse in accordance with the dynamics of Bass model, thus reinforcing previous research that highlighted the weight of peer-influence in the diffusion of legal innovations.[110] *Moreover*, our findings indicate that Bass-compliant diffusion dynamics are not confined to legal rules spreading among American states, but also occur among rules diffusing in the international network.[111] This latter finding adds to existing sociological and legal studies, which have so far concentrated mainly on diffusion dynamics among American states or Canadian provinces.[112]

Indeed, we are well aware that, due to methodological constraints, one cannot draw overreaching generalizations from our findings. The size of our dataset is limited, and the rules included therein do not cover all branches of law. Nor do they randomly represent the entire universe of legal rules. As indicated earlier, the model itself has internal limitations and does not capture all diffusion cases. However, even if we cannot draw overreaching conclusions as to the exact scope of legal rules whose diffusion fits the Bass model, or their particular properties, the overall fitness of legal innovation diffusion to the Bass model indicates that the model can serve as a useful platform for studying legal diffusion.

We do not attempt to provide a full and detailed explanation for the significant weight of peer-influence in the adoption of legal rules. Various

110. *See supra* Part I.B.

111. *See infra* Table 1. One should note, however, that the significant increase in the number of countries in the world during the last two centuries very likely injected some noise into the quantification of the diffusion process of the rules that diffused internationally (as opposed to rules that diffused among the states of the United States).

112. *See supra* Part I.B. For a prominent exception, see Goderis & Versteeg, *supra* note 41, at 1 (studying the spatial diffusion of constitutions among world countries by using a different methodology).

theoretical accounts from different disciplines seem relevant to the case at hand. Economists highlight network effects and the increased utility in adopting certain products—in our case: certain legal rules—that are adopted by many,[113] and further maintain that following the choices of others is a method for overcoming uncertainty and information gaps.[114] In our case, given the variety of potential legal arrangements and the limited resources of policy makers, adopting a legal rule that was already adopted by numerous other jurisdictions may seem like a "safe" and reasonable choice. Research in the fields of complexity and social networks identifies universal patterns that are common to various types of interdependent networks, including the international network and the social system.[115] This line of research further maintains that universal diffusion (or "contagion") dynamics are tightly related to the interactions among the individual "agents" comprising the network.[116] Indeed, scholars who investigated the diffusion of legal innovations emphasized the role of interactions among regulators and policy makers who are often embedded in professional networks that facilitate the exchange of ideas and information about legal and regulatory regimes.[117]

Beyond these general insights, employing the Bass model provides a *unified benchmark* that enables *quantification and comparison of* diffusion processes based on the model's coefficients, namely q, p, and q/p ratio. Such a metric allows for the more accurate evaluation of the role of the independent and social-influence factors with respect to each specific legal rule that diffuses according to Bass dynamics, illuminates parallels and differences between the diffusion of laws and the diffusion of additional types of innovations, and enables comparison of diffusion patterns among various area of the law.[118] For example, our initial findings that groups of similar rules exhibit similar q values imply that different characteristics of branches of law may affect the diffusion process in a manner analogous to

113. *See, e.g.*, Michael L. Katz & Carl Shapiro, *Network Externalities, Competition, and Compatibility*, 75 AM. ECON. REV. 424, 424 (1985) (introducing the concept of network externalities).

114. For an elaboration of this argument, see ROBERT H. FRANK & PHILIP J. COOK, THE WINNER-TAKE-ALL SOCIETY: WHY THE FEW AT THE TOP GET SO MUCH MORE THAN THE REST OF US 38 (1995) (discussing the concept of a limited "mental shelf" that increases the tendency to join the choices of others).

115. *See, e.g.*, ZEEV MAOZ, NETWORKS OF NATIONS: THE EVOLUTION, STRUCTURE, AND IMPACT OF INTERNATIONAL NETWORKS 1816-2001 at 6 (2011) (applying social network analysis methods to international relations among states); Zeev Maoz et al., *International Relations: A Network Approach*, *in* NEW DIRECTIONS FOR INTERNATIONAL RELATIONS 38-40, 44 (Alex Mintz & Bruce Russett eds., 2005). *Cf.* Jason Beckfield, *The Social Structure of the World Polity*, 115 AM. J. SOC. 1018, 1018 (2010) (using network analysis of the network of intergovernmental organizations to analyze the structure of the world polity).

116. *See* BARABÁSI, *supra* note 18, at 33-34; MELANIE MITCHELL, COMPLEXITY-A GUIDED TOUR 10 (2009) (stressing the importance and influence of interactions between agents comprising a system for generating collective behavior).

117. *See* Walker, *supra* note 29, at 894-95. *See also* Linos, *supra* note 37, at 1481.

118. *Cf.* Mahajan et al., *supra* note 48, at G81-82 (discussing the contribution of the Bass model in providing a benchmark for comparison between cases of product diffusion).

different groups of products. The Bass model can therefore provide a useful tool for subsequent meta-studies of legal diffusion.

B. Predictive Value

In the field of management science, the Bass model is frequently employed to forecast the spread of particular products and technologies, based on initial diffusion data.[119] Our findings imply that the forecasting power of the Bass model could be applied to diffusing legal innovations: when the diffusion of a particular legal rule seems to follow the Bass model, some tentative predictions as to its progress may be possible, even when the process is still ongoing.

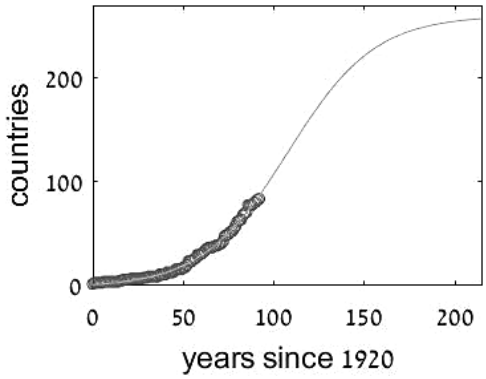
The following two cases are illustrative. Our first example concerns the case of *droit de suite*, a legal rule that provides a resale-royalty-right to artists as part of copyright law.[120] Our data indicate that since 1920 *droit de suite* has diffused among 83 countries, with a diffusion pattern that closely fits the Bass model.[121] Applying the model to the existing diffusion data of *droit de suite* generates an "M" value of 260, which roughly fits the number of world countries, and allows us to predict, tentatively, that *droit de suite* will continue to spread among most world countries. Notably, the application of the model also gives us an approximate time-estimate for the progress of the diffusion. In this particular case, the forecast is that diffusion of *droit de suite* will reach saturation within approximately 70 years, as described in Figure 7.

119. For a discussion of the model's forecasting power, see Bass, *supra* note 3, at 226. *See also* Mahajan et al., *supra* note 48, at G85 (describing applications of the Bass model for predicting ongoing diffusion).

120. For a general discussion of *droit de suite,* see SAM RICKETSON, THE BERNE CONVENTION FOR THE PROTECTION OF LITERARY AND ARTISTIC WORKS: 1886–1986 at 410 (1987). Importantly, unlike many intellectual property rights whose incorporation into national legislation is required under the provisions of international treaties and agreements, the Berne Convention for the Protection of Literary and Artistic Works leaves the adoption of *droit de suite* to the discretion of its Member States, so that its diffusion does not result from "top-down" constraints imposed by the Convention. *See* Berne Convention for the Protection of Literary and Artistic Works art. 14ter (2), Sept. 9, 1886, 828 U.N.T.S. 221. Notably, the European Union instructs the Member States to adopt a *droit de suite* as part of their domestic legislation. Directive 2001/84, of the European Parliament and of the Council of 27 September 2001 on the Resale Right for the Benefit of the Author of an Original Work of Art, 2001 O.J. (L 272). However, our data indicate that most EU Members adopted *droit de suite* prior to the passage of the Directive, and therefore this "top-down" intervention did not significantly affect the diffusion dynamics.

121. *See supra* Figure 1, graph 1; item 1 in Table 1.

Fig. 7: **Droit de Suite— Forecast:**



Our second, more tentative example concerns the diffusion of a "fair-use" provision as part of copyright legislation among world countries. While many jurisdictions provide that certain uses of copyrighted works are permitted even in the absence of the copyright owner's consent, the vast majority of countries limit these permitted uses to a "closed list" of circumstances.[122] The prominent exception is the United States, which adopted an open-ended "fair-use" exception, not limited to specified circumstances, as part of its 1976 Copyright Act.[123] In recent years, several additional jurisdictions decided to amend their copyright legislation and shifted to an "open list" regime, similar to "fair-use."[124] While the number of adopters is small,[125] the adoption pattern seems to fit the Bass dynamics. Therefore, application of the Bass model allows us to forecast—very tentatively— that "fair-use" will continue to modestly spread and will reach saturation after adoption by approximately 19 countries within approximately 30 years (see Figure 8):

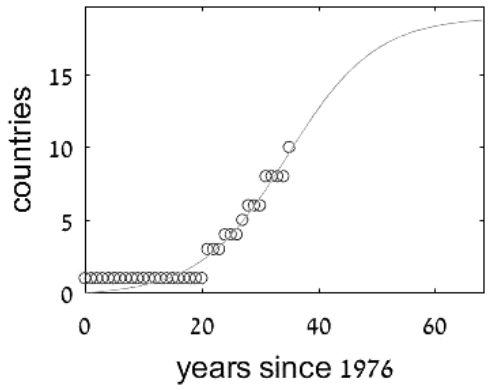
122. *See generally* INTERNATIONAL COPYRIGHT LAW AND PRACTICE (Paul Edward Geller & Melville Nimmer eds., 2002) (reviewing, *inter alia*, the exceptions to copyright infringement in numerous jurisdictions); JONATHAN BAND & JONATHAN GERAFI, THE FAIR USE/FAIR DEALING HANDBOOK (2015), http://infojustice.org/wp-content/uploads/2015/03/fair-use-handbook-march-2015.pdf [https://perma.cc/NK4D-BYWB].

123. *See* Eric J. Schwartz & David Nimmer, *USA*, *in* INTERNATIONAL COPYRIGHT LAW AND PRACTICE, *supra* note 122, at § 8 [2] [a] (reviewing the U.S. "fair-use" provision).

124. *See* BAND & GERAFI, *supra* note 122, at 1 (reviewing the shift to an "open list" exception in various countries); Peter K. Yu, *Fair Use and Its Global Paradigm Evolution*, 2019 U. ILL. L. REV. 111, 115, 128 (reviewing the shift of various countries from a "closed" to "open" fair-use paradigm).

125. *See* Yu, *supra* note 124, at 137.

Fig. 8: **Fair Use— Forecast**



Notably, the Bass model's general prediction concerning the continued diffusion of the "fair-use" regime is consistent with scholarly evaluations and with the fact that several jurisdictions are now contemplating the adoption of a similar provision.[126] However, we emphasize that, due to the very limited data we have at this stage, the predictive power of this latter case is extremely provisional, and more data is required in order to validate it.[127] More generally, as is true with respect to any forecast, predictions are rarely completely accurate, and their accuracy tends to increase with the amount of data available. Yet, as the foregoing examples demonstrate, certain predictions under the Bass model may be carried out even when a legal rule has not yet reached a critical mass and even when a relatively small amount of data is available.

This insight carries significant policy ramifications. As previously noted, in many circumstances, countries may have a clear and rational interest for adopting rules that conform to those of other countries. Therefore, the application of the Bass model may allow policy makers contemplating the adoption of a certain legal rule to predict, tentatively, to which extent that rule will indeed become a standard among other countries. In such circumstances, the signals provided by the quantitative analysis can indicate to policy makers whether to "jump on the bandwagon," wait for further adoptions, or perhaps initiate competing legislation.

126. *See id.* at 128 (noting that Australia, Hong Kong, and Ireland are considering the introduction of a fair use exception). *See also* Sean Flynn et al., *Inside Views: South Africa's Proposed Copyright Fair Use Right Should Be A Model For The World*, IP WATCH (July 24, 2018), http://www.ip-watch.org/2018/07/24/south-africas-proposed-copyright-fair-use-right-model-world/ [https://perma.cc/R3DF-2WTH] (describing a proposed transition into a "fair-use" regime under a suggested amendment to the Copyright Act of South Africa).

127. For example, the diffusion dynamics and the related prediction can change significantly if the European Union decides to adopt an open-ended "fair-use" exception. In case of such top-down intervention, all Member States of the EU will be obliged to introduce the exception into their domestic legislation within a relatively short timeframe.

C. Informing Legal Discourse

Finally, our findings and, more broadly, the methodological tool introduced in this study can shed light on several ongoing debates and discussions in legal scholarship. The following paragraphs briefly sketch such possible influences in the areas of corporate law, comparative law, and international law. We are well aware that this is merely a "back of the envelope" discussion of complex issues. Yet, our purpose here is neither to present a complete exploration, nor to solve the complicated dilemmas that have been occupying researchers in these areas. Rather, our aim is to demonstrate manners in which legal discourse can benefit from an increased understanding of the dynamics of legal diffusion.

1. Competition-Over-Incorporation: Not All S-Shapes Are Alike

The quantitative parameters generated by the Bass model may carry implications for a longstanding debate about state competition in U.S. corporate law. The question whether states compete over incorporation is a subject of fierce controversy among U.S. scholars.[128] While one scholarly view maintains that states compete by adopting laws that offer optimal shareholder protection so that federalism in corporate law yields a "race to the top,"[129] others argue that such competition yields a "race to the bottom" because states offer rules that cater to the interest of corporate managers at the expense of corporate shareholders.[130] Both sides of this debate, however, adopt the paradigm that states compete over incorporation. Yet, Marcel Kahan and Ehud Kamar vigorously challenged this conventional paradigm. They maintain that state competition over incorporation is an "unfounded myth" that should not be employed in the study of corporate law.[131]

One argument raised by both proponents and opponents of the competition-over-incorporation-paradigm concerns the diffusion pattern of legal rules in the field of corporate law. In her influential studies, Roberta

128. For a review of this debate, see, e.g., Stephen J. Choi & Andrew T. Guzman, *Choice and Federal Intervention in Corporate Law*, 87 VA. L. REV. 961, 961–65 (2001) (describing it as one of the "fiercest debates within the corporate law literature").

129. *See, e.g.*, FRANK H. EASTERBROOK & DANIEL R. FISCHEL, THE ECONOMIC STRUCTURE OF CORPORATE LAW 212–27 (1991) (describing the economic rational of the "race to the top" view). *See* ROBERTA ROMANO, THE GENIUS OF AMERICAN CORPORATE LAW 2, 3, 9 (1993) (discussing corporations' incentives for choosing corporate law that maximizes shareholders' investment).

130. *See, e.g.*, Lucian Arye Bebchuk, *Federalism and the Corporation: The Desirable Limits on State Competition in Corporate Law*, 105 HARV. L. REV. 1435, 1444 (1992); Lucian Arye Bebchuk & Allen Ferrell, *Federalism and Corporate Law: The Race to Protect Managers from Takeovers*, 99 COLUM. L. REV. 1168, 1171, 1173 (1999) (arguing that states actually compete to provide corporate rules that are attractive to managers and harm shareholders). *See also* William L. Cary, *Federalism and Corporate Law: Reflections upon Delaware*, 83 YALE L. J. 663, 665–705 (1974) (arguing that states' competition over incorporation results in a "race to the bottom").

131. Marcel Kahan & Ehud Kamar, *The Myth of State Competition in Corporate Law*, 55 STAN. L. REV. 679, 684 (2002) ("the very notion that states compete for incorporations is a myth").

Romano regards the S-shaped diffusion curve found in several corporate-law rules as an indication for the subsistence of competition among states in this area.[132] Conversely, Kahan and Kamar observe that a similar diffusion pattern exists in additional areas of the law and therefore maintain that its prevalence in corporate law does not indicate state competition.[133]

The quantitative analysis generated by the Bass model may shed new light on this discussion. Indeed, our findings show that fitness to the Bass model is not confined to rules spreading in the field of corporate law. However, they also provide preliminary evidence that "*not all S-shapes are alike*": different areas of law may possess typical—yet different—q values, which implies that the magnitude of the peer-influence in the diffusion process may vary across different legal branches. Specifically, our preliminary results indicate that the Corporate Law Group generally had a higher range of q values than those in the Licensing Law Group and the Tort Law Group.[134] This finding, if reinforced by future research, may attest to the particular weight of imitation in adopting rules in the field of corporate law, which may, in turn, support the competition-over-incorporation hypothesis, and vice-versa. Indeed, our current dataset is too limited to draw any definitive conclusion on this question. Yet, our purpose here is not to settle the competition-over-incorporation debate, but merely to demonstrate how employing the Bass methodology allows for more nuanced analyses than those performed so far and can possibly illuminate this important discussion.

2. *Legal Transplants and Legal Unification*

Our study may also shed some light on broader ongoing debates in comparative law. As indicated earlier, the field has long been concerned with the application of legal arrangements originating in one jurisdiction by another jurisdiction, a phenomenon famously labeled "legal transplantation."[135] For a long time, the rich literature on the topic was divided along two camps. While one camp regarded legal transplants as "overwhelmingly common" and inevitable,[136] an opposing strand maintained

132. *See* Romano: Product, *supra* note 40, at 226–33. *See also* Romano: Laboratory, *supra* note 40, at 209, 211 (maintaining that states' competition over incorporation explains the diffusion pattern and relative uniformity of corporate laws across American states).

133. Kahan & Kamar, *supra* note 131, at 715–16 (disputing that the S-shaped pattern indicates the presence of competition, and noting the prevalence of this diffusion pattern in areas where states do not compete).

134. *See supra* Part III-B. *See also infra* Table 1.

135. *See supra* Part I.B.

136. *See* WATSON: LEGAL TRANSPLANTS, *supra* note 34, at 21 (maintaining that the transfer of legal rules between societies is "overwhelmingly common" and important, while coining the term "legal transplant"); WATSON: COMPARATIVE LAW, *supra* note 34, at 5 (emphasizing the prevalence of "borrowing" legal rules from external jurisdictions); Ewald, *supra* note 34, at 489–90 (discussing the importance of Watson's theory of legal transplants).

that such transplants are in fact "impossible."[137] More recent scholarship indicates that the divide between the two extreme positions may have reached a point of saturation and proposes more nuanced analyses of the topic, concentrating on the conditions that lead to successful legal transplantation.[138] Such recent scholarship also acknowledges that "legal transplantation" is not detached from processes of interaction, imitation, and diffusion dynamics.[139]

Our findings provide empirical support for this contemporary approach by demonstrating that the diffusion of legal arrangements is oftentimes subject to strong imitation dynamics and by quantifying the substantial role played by the network in this process. They also highlight that, on the metaphorical level, diffusion of legal innovations among states may be more akin to an organic, "bottom-up" process, than to an external "transplantation." More importantly, when the diffusion of a legal rule follows the Bass model, at a certain point its continuing spread among additional countries is, to some extent, unavoidable, similar to the continued diffusion of tangible products that reach their critical mass.[140] Our analysis therefore lends certain support to the growing scholarly understanding that "legal transplants"—or, perhaps, "legal diffusions"—are somewhat inevitable.

In addition, and relatedly, our study sheds some light on the scholarly discussion of unification or harmonization of laws across countries and states.[141] This discourse addresses a range of questions, from whether such unification is a desirable end to debates concerning the preferable manner for achieving harmonization in various contexts.[142] Our study

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137. *See* Legrand: Impossibility, *supra* note 34, at 114 (arguing that "because of what they effectively are, rules cannot travel. Accordingly, legal transplants are impossible."). *See also* Legrand: "Legal Transplants"?, *supra* note 34, at 57 (presenting a similar argument).

138. *See, e.g.*, Cohn, *supra* note 34, at 584–90 (reviewing the classical divide on legal transplantation as well as more nuanced analyses of the issue).

139. *See, e.g.*, Lionel Bently, *The "Extraordinary Multiplicity" of Intellectual Property Laws in the British Colonies in the Nineteenth Century*, 20 THEORETICAL INQUIRIES L. 161, 189–92 (describing the role of interactions in conferences of colonial representatives in the application of Imperial intellectual property laws in the British Colonies); Cohn, *supra* note 34, at 585 (referring to the role of interactions in among various players in the production of "legal transplants"); Graziadei, *supra* note 34, at 733–34 (exploring legal transplants through the lens of social theory that emphasizes social action as interpreted and applied by individuals); Linos, *supra* note 37, at 1467; Westbrook, *supra* note 36, at 494, 498–99 (acknowledging the interactions among states as a factor affecting the diffusion of law).

140. *See supra* Part I.A; *supra* notes 22–26 and the accompanying texts.

141. For some prominent (but non-exhaustive) literature discussing legal unification, see R. H. Graveson, *The International Unification of Law*, 16 AM. J. COMP. L. 4, 4 (1968); Konstantinos D. Kerameus, *Procedural Harmonization in Europe*, 43 AM. J. COMP. L. 401, 401 (1995); Brian R. Opeskin, *The Architecture of Public Health Law Reform: Harmonisation of Law in a Federal System*, 22 MELB. U. L. REV. 337, 337 (1998); Rodolfo Sacco, *Diversity and Uniformity in the Law*, 49 AM. J. COMP. L. 171 (2001).

142. *See, e.g.*, Opeskin, *supra* note 141, at 338 (discussing the need "to find an appropriate mix between unity and diversity in federal systems," and describing the shift from complete unification to "harmonization"); Sacco, *supra* note 141, at 176–77 (describing

indicates that harmonization is not necessarily a top-down process that can be completely orchestrated by policy makers. Rather, some degree of legal harmonization may likely occur due to grassroot processes, as described above. It further indicates that some areas of the law may be more prone to such "self-organized" unification processes and that, at a certain stage, tentative evaluation of the prospects for unification may be attained by using the Bass model. The dynamics we describe here further imply that processes of harmonization may not always result in the adoption of the "best quality" legal rule, but possibly, in the adoption of an early legal rule that was first to diffuse in the system.[143] These insights further imply that the influence of policymakers on processes of harmonization may be more nuanced and should take network dynamics into account.

Our research does not imply, however, that legal rules diffusing among countries are always successful, or that legal rules are necessarily implemented in an identical manner across various jurisdictions.[144] Our focus in this study is on the mere adoption of a legal innovation and not on its exact implementation by the adopting state. Our findings regarding the similarities between legal diffusion and product diffusion allow us to hypothesize that states adopting legal innovations may well differ in their "use"—that is, in their implementation, interpretation, and enforcement—of the adopted rules, just like individual adopters vary in their use of similar technologies and products. This point, however, requires a more nuanced "micro" research, which exceeds the scope of this Article.

3. *The Sociological Approach to International Law*

Finally, our study can also inform contemporary discourse in international law. An emerging legal strand in this area calls for employing a sociological approach to the study of international law by applying sociological theoretical tools, including the analyses of social interactions.[145] This approach maintains that sociological factors likely affect international relations, and therefore sociological theories can inform legal discourse in this area.[146] Our study lends support to these premises. It indicates that diffu-

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the debate in Europe between the advocates of uniformity and those supporting diversity).

143. *Cf.* Kerameus, *supra* note 141, at 401–02 (describing the ideal notion of unification as a synthesis of legal rules, "guided by an effort to design the best possible solution," but acknowledging that this ideal is often unattainable).

144. For a review of these discussions in comparative law literature, see, e.g., Cohn, *supra* note 34, at 584–89.

145. *See* MOSHE HIRSCH, INVITATION TO THE SOCIOLOGY OF INTERNATIONAL LAW 1–2 (2019); Moshe Hirsch, *The Sociology of International Economic Law: Sociological Analysis of the Regulation of Regional Agreements in the World Trading System*, 19 EUROPEAN J.I.L. 277, 277–79 (2008) (maintaining that international trade should also be conceived as a specific type of social interaction, while using sociological tools to analyze Regional Trade Agreements); Moshe Hirsch, *The Sociology of International Law: Invitation to Study International Rules in Their Social Context*, 55 TORONTO L. J. 891, 891–92 (2005) (discussing the interrelationships between international law and other social factors and calling for the incorporation of sociological theoretical tools into mainstream international law scholarship).

146. *See* HIRSCH, *supra* note 145, at 1–2.

sion dynamics in the social network are essentially similar to diffusion dynamics in the network of states or countries. It further indicates that these diffusion dynamics are not confined to regional systems but occur in the international system as well.[147] Interestingly, these insights are consistent with recent studies in the field of complex networks theory, which examine global connections between states through the lens of complex networks and identify patterns that are common to the international network and the social system.[148] This Article's insights therefore reinforce the relevance of sociological theories—at least those pertaining to social networks—to the study of the international system.

On a related, more general note, our study reinforces the perception of law as one of the fields susceptible to complexity analysis[149] and highlights the relevance of complexity and network studies for addressing questions in various legal domains.

Conclusion

This Article began with a famous quote by Justice Brandeis that depicts the adoption of a legal innovation by a state as an independent act, which poses "no risk" to its peers. The application of the Bass model to evaluate cases of legal diffusion demonstrates that this perception is very much illusory. Rather, it confirms that legal rules spread among countries in a manner akin to the spread of products and technologies in a social network and is susceptible to social influence. The quantitative analysis of legal diffusion allows us to evaluate that the role of such social, or network, influence in the diffusion of legal rules may be no smaller, and indeed may be even greater than the diffusion of tangible products.

More importantly, the applicability of the Bass model to numerous cases of legal diffusion in diverse fields provides us with a sophisticated methodological tool to study the diffusion of laws. This tool allows us to quantify and compare different cases of legal diffusion, to make tentative predictions regarding the spread of legal rules where the diffusion process is still ongoing, to identify diffusion patterns in different areas of the law, and to perform new and nuanced analyses of various legal questions. This study merely constitutes a single step in this direction, and its findings are limited in many respects. Yet, the methodological tool introduced herein, and its various implications, can form a platform for exploring myriad

147. *See supra* Part III.A.

148. For literature applying social network analysis to international relations among states and intragovernmental organizations, see MAOZ, *supra* note 115, at 6; Beckfield, *supra* note 116, at 1018; Maoz et al., *supra* note 115, at 35–40.

149. For literature employing complexity and insights from diffusion of innovation theory to analyze legal questions, see, e.g., Michal Shur-Ofry, *Popularity as a Factor in Copyright Law*, 59 U. TORONTO L. J. 525 (2009) (employing insights from the field of complex networks to analyze the diffusion of cultural icons and technological standards in the social network, and to critically examine the protection afforded to these subject matters under copyright law); Michal Shur-Ofry, *IP and the Lens of Complexity,* 54 IDEA 55 (2013) (demonstrating that complexity can shed light on various doctrinal and theoretical questions in the field of intellectual property law).

research questions and provide us with increased and deeper understanding of the diffusion of legal innovation.

On a more general note, our Article demonstrates the value of using mathematical models to inform legal theory and analysis and is yet another example of the broad potential of interdisciplinary work bridging law and STEM.[150] Hopefully, more work in this vein will follow.

150. On the potential of work combining law and STEM (Science, Technology, Engineering, Mathematics), see, e.g., Christopher S. Yoo, *Bridges II: The Law-STEM Alliance & Next Generation Innovation*, 112 NW. U. L. REV. ONLINE 173 (2017-2018) (highlighting this potential and discussing ways to foster mote collaboration between the law and the STEM fields).

Appendix – Table 1—Fitting Rules

Color Code: Distinct Rules; Licensing; Corporate; Torts; International Conventions

	Legal Rule	q	p	q/p	R^2	M (Bass)	US/International; No. of Adopters
1	Copyright-Royalty Resale Right	0.04	0.00046	90	1	260	International; 83 (diffusion ongoing)
2	Women's Voting Rights	0.076	0.00098	78	0.99	196	International; 190
3	Trusts: Cancellation of Restrictions on Perpetuities	0.29	0.0012	252	0.99	27	US; 27
4	Copyright – Fair Use (open ended exception)	0.13	0.0013	100	0.95	19	International; 10 (diffusion ongoing)
5	Criminal: Add-On Gun Laws	0.09	0.13	0.7	0.96	28	US; 30
6	Workers' Compensation	0.022	0.21	0.1	0.98	48	US; 50
7	Licensing Realtors	0.027	0.082	0.3	0.99	39	US; 40
8	Licensing Beauticians	0.33	0.0016	200	0.99	43	US; 45
9	Licensing Nurses	0.28	0.04	7	0.99	48	US; 48
10	Licensing Accountants	0.27	0.005	56	1	47	US; 48
11	Licensing Pharmacists:	0.14	0.025	5.5	0.99	46	US; 48
12	Licensing Dentists	0.14	0.008	29.5	0.99	44	US; 47
13	Licensing Engineers	0.097	0.013	7.6	0.96	53	US; 48
14	Corporate: Staggered Board	0.017	0.008	2	0.99	58	US; 45
15	Corporate: Indemnification Expansion	0.52	0.006	86	0.98	38	US; 42
16	Corporate: Majority Action without Meeting	0.32	0.0003	988	0.92	12	US; 11
17	Corporate: First Generation Takeover Statute	0.9	0.0001	940	0.98	37	US; 37
18	Corporate: Second Generation Takeover Statute	0.51	0.08	6.3	0.99	42	US; 43
19	Corporate: Control Share Acquisition	0.92	0.01	90	0.99	27	US; 27
20	Corporate: Other Constituency	0.88	0.014	62	0.99	30	US; 31

21	Corporate: Poison Pill	1.7	0.036	47	0.96	24	US; 28
22	Corporate: Five Year Moratorium	0.84	0.19	4.4	0.97	15	US; 15
23	Corporate: Plurality Voting	0.001	0.11	0.09	0.99	35	US; 31
24	Torts: Comparative Fault	0.23	<0.0001	NA	0.98	44	US; 45
25	Torts: Joint and Several Liability	0.28	<0.0001	NA	0.99	40	US; 42
26	Torts: Contingency Fee	0.22	<0.0001	NA	0.97	21	US; 21
27	Torts: Punitive Damages - Evidence	0.26	<0.0001	NA	0.98	36	US; 36
28	Torts: Periodic Payments	0.22	0.027	8.3	0.91	33	US; 35
29	Vienna Convention on Contracts for Sale of Goods	0.11	0.024	4	1	86	International; 76

Table 2—Non Fitting Rules

Color Code: Distinct Rules; Licensing; Corporate; Torts; International Conventions

	Legal Rule	Non-Fitness Criterion	R^2	US/International; No. of Adopters
i	Right to Die	M (Bass) = 1848	0.91	US; 39
ii	Corporate: Merger Vote Exemption	M (Bass) = 330 $R^2 < 0.9$	0.8	US; 22
iii	Corporate: Cumulative Voting Not Required	M (Bass) = 426	0.96	US; 30
iv	Corporate: Appraisal Rights Exemption	M (Bass) = 441	0.95	US; 15
v	Corporate: Limited Liability	$q < 0$ ($q=-1.5$)	0.98	US; 45
vi	Corporate: Three Year Moratorium	$q < 0$ ($q=-0.27$)	0.95	US; 15
vii	Corporate: Electronic Proxy Voting	M (Bass) = 80	0.98	US; 46
iix	Torts: Collateral Source	$q < 0$ ($q=-0.076$) $R^2 < 0.9$	0.84	US; 42
ix	Torts: Caps on Punitive Damage	M (Bass) = 585	0.91	US; 32
x	Berne Convention for the Protection of Literary and Artistic Works	M (Bass) = 4550	0.96	International; 166