



Universiteit
Leiden
The Netherlands

Taking technological infrastructure seriously

Mair, C.S.

Citation

Mair, C. S. (2017, June 29). *Taking technological infrastructure seriously*. Retrieved from <https://hdl.handle.net/1887/50157>

Version: Not Applicable (or Unknown)

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/50157>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/50157> holds various files of this Leiden University dissertation.

Author: Mair, C.S.

Title: Taking technological infrastructure seriously

Issue Date: 2017-06-29



CONCLUSION



The five chapters in this volume have focussed on investigating access problems to technological infrastructure, and have attempted to demonstrate the power of the ‘infrastructural approach’ under different institutional conditions.

Chapters 1 and 2 constructed legal arguments using the institution of competition law, to explain how open access to such assets can be (and have been) imposed, as well as justified on economic and legal grounds. The main nerve of the competition law approach developed in these chapters was to show that the legal arguments for the two classes of technological infrastructure (cooperatively-set standards, chapter 1; and *de facto* standards, chapter 2) are unified by an ‘infrastructural approach’. These chapters concluded that as real and virtual networks continue to proliferate in today’s information economy, the standards which underwrite them can develop into ‘choke points’ for innovation if they are not managed in an open manner suggested by the infrastructural approach. Chapter 3 then took the economic reasoning developed in these chapters in another direction, by choosing to focus on another class of technological infrastructure, referred to as ‘pioneering inventions’ (or general purpose technologies). In particular, chapter 3 developed the argument that this class of technological infrastructure is likely to arise in cases of publicly subsidised R&D. By deploying tools from game theory, this chapter aimed to show that exclusive (IP) rights regimes can lead to sub-optimal access terms (such as ‘property traps’ and ‘risk-dominant assurance’ game equilibria¹⁰⁵¹), but that these outcomes can be controlled if the structure of the subsidy grant is modified to ‘dial up’ subsidy intensity dependent upon the openness of the results.

The final chapters (chapters 4-5) then focussed largely on private strategic responses to institutions around technological infrastructure. Chapter 4 focussed specifically on the way private strategic behaviour can subvert the purpose of Government procurement policies, leading to the necessity for strategic responses on behalf of the public sector to help maintain the openness of procured ‘open standards’. Chapter 5 switched focus to private ordering and business model innovation in innovation markets, and aimed to show that private incentives for openness do exist under certain conditions and by utilising certain business models. It also demonstrated that openness to intellectual property can, in some markets, actually be a driving force for diversity and complexity, by decentralising the control structure and permitting the bottom-up growth of new innovations.

One major unifying theme in the analysis of the chapters of this volume is that the access problems identified in relation to technological infrastructure are likely to grow rather than recede as modern economies continue to evolve away from industrial economies and towards those based on information and knowledge. Indeed, this thesis’s focus on technological infrastructure in the form of interoperability standards is ‘just one skirmish in a much larger

1051. See Part III, Section C in chapter 3.

Conclusion

war over openness and closure in technology networks.¹⁰⁵² The issues which underwrite this conflict are in many ways symptomatic of a broader change in the pattern of economic production in modern economies. As early as 1962, the Austrian-American economist, Fritz Machlup, heralded the transformation of industrial economies towards the knowledge-fuelled, innovation powerhouses he dubbed ‘information societies’. The key property of the information society compared to its industrial predecessor, was considered to be its use of information assets as primary inputs to economic production. Then, as now, a central question of information economics was: who picks up the bill today for tomorrow’s innovation, and in what currency is the bill payable?

Now that Machlup’s vision of the future has more-or-less come to pass, it is interesting to see that the legal and economic scholarship on this central question is as divided as ever. Supporters of exclusive intellectual property rights maintain that strong IP drives the investment decisions which power the dynamism of the economy: society pays the bill for tomorrow’s innovation in the currency of today’s static efficiency losses. Supporters of the commons-based production model instead argue that the non-rivalrous nature of information can be leveraged to produce net gains and no social losses, by allowing for indirect value appropriation and truly dynamic competition with low barriers to entry.

One fascinating aspect of this debate that is often overlooked is that the question about the relationship between exclusive (or open) rights and innovation is fundamentally *empirical*, rather than theoretical. Despite being of an empirical form, the question seems to be intractable according to empirical methods. As Machlup observed in 1958, in a report on the US patent system:¹⁰⁵³

If we did not have a patent system, it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting one. But since we have had a patent system... it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it.

Given the fact that we are immersed in a world where information is propertised it is difficult to see if the rapid pace of technological innovation is in fact driven by it, or if it occurs in spite of it. Since the causal connection is uncertain, one cannot suggest to abolish intellectual

1052. Contreras ‘A Tale of Two Layers’ 881

1053. Fritz Machlup, *An Economic Review of the Patent System*, Study No.15 of Committee on Judiciary, Subcommittee on Patents, Trademarks, and Copyrights, 85th Cong., 2d Sess. (Comm. Print 1958).

property; but neither can one argue that it is indispensable nor that the benefits outweigh the costs.¹⁰⁵⁴

By focussing on one very special category of propertised information- what this thesis calls 'technological infrastructure'- the chapters in this volume have attempted to illuminate the complexities and trade-offs associated with the exclusions and access rights in today's version of Machlup's information society. This thesis has attempted to cash out the idea of technological infrastructure in two main ways, which run like two nerves through the chapters of this volume. First, that despite the neologism, the concept of technological infrastructure is a deep and old component of legal systems, finding expression in the boundary between protectable and non-protectable information resources, and in the interaction between competition law and intellectual property in a number of major EU and US cases. As the complexity of technologies increases, so do their interdependencies and requirements for common standards, whether these emerge from the market (*de facto*), are cooperatively-set, or involve pioneering inventions. The drive for continued innovation and the reliance on exclusive rights means that the clash between exclusivity and access, and the concomitant trade-off between private and social interests is sharpening, leading to increased pressure on legal systems to adjudicate disputes and set rules within which private interests can better track social ones. The second nerve that runs through the chapters in this thesis is that the innovation system is a system with many moving parts. All five chapters in this volume focus on the interaction of intellectual property rights with a second institution, which either operates to soften its hard edges or reorganises the strategic landscape of private interactions. In order to capture the richness of some of these private interactions, many of the chapters in this volume either use game-theoretical tools explicitly (chapters 1 and 3) or implicitly (chapter 4). Chapters 2 and 5, which do not structure arguments around private interactive models, nevertheless take the concept of incentives seriously, and deploy economic arguments that companies self-organise in the shadow of legal rules.

The upshot of all the above chapters is that when technological infrastructure is open the structure of innovation radically changes form: from one where essential information inputs are controlled under property rules via a top-down approach, to one where they are liberated under liability rules to operate via a bottom-up approach. The decentralisation of control and decision-making represented by the second approach dove-tails into Tim Wu's argument for polyarchal innovation structures¹⁰⁵⁵, where control over key resources is dispersed rather than concentrated, leading to multiple nodes of innovative activity (as discussed in chapter 5). Perhaps paradoxically, the key orientation of this approach is not pro-Government intervention at all, rather it is *pro-market*: it challenges economic theory which argues that

1054. *ibid*

1055. Wu, 'Intellectual Property'.

Conclusion

owners of technological infrastructure who exist in many ways outside of the disciplining effect of markets can make efficient decisions with regard to their resources. If the success of open source software and the study of socio-cultural production systems in general, have taught us anything, it is that we do not stand on the shoulders of giants but on the shoulders of countless individual agents who each make a contribution (no matter how minor) to the sum total of available knowledge.¹⁰⁵⁶

According to the work of Sam Bowles on the historical emergence of property rights, the transformation of modern society's productive tools from *things* to *information assets*, brings with it a host of trade-offs which erodes the economic arguments for property rights. The logic Bowles applies is derived from his study of the *reverse* transition: from forager economies to agrarian economies, where property rights first developed. The nub of Bowles' argument is that enforcement costs, and the social costs of that enforcement, over assets of a 'weightless' information-based economy will likely outweigh the benefits.

Again, this is an empirical not a theoretical claim. But it may have some support. Between 2007 and the present, we have witnessed a number of startling pushes towards open access in the high technology sector, which have led to an interesting reconsideration of the merits of exclusive rights over information assets. In no particular order, we have witnessed both Court decisions and private ordering decisions which have led to: open access licensing over operating system interoperability information¹⁰⁵⁷; the application of liability rules over cooperatively-set standards and patents in general¹⁰⁵⁸; a flurry of cross-license agreements over smartphone-related standards-essential patents¹⁰⁵⁹; patent non-aggression pacts and pledges by dominant software companies such as Twitter and Google; Tesla's opening up of its essential electric car patent portfolio. The list, does in fact, go on. But the point should be clear: exclusive rights over information in high technology has less cache than it used to.

Although it might be tempting to argue that the commons-production arguments have been right all along: that innovation is not a zero-sum game, and that the commons is a 'comedy'¹⁰⁶⁰ rather than a tragedy, the facts are more complicated. The key question: who pays, and in what currency? must still be asked, and the answer is surprising.

Future work in this area will have to take stock of the new form of information production incentivisation which is taking over the traditional product-for-a-fee model: product-for-

1056. Sterelny, *The Evolved Apprentice*.

1057. See chapter 2

1058. See chapter 3

1059. e.g the HTC-Apple 10 year cross license, see <http://www.imore.com/applehtc-cross-licensing-deal-details-revealed-scads-redactions> accessed October 2016

1060. Carol Rose, 'The Comedy of the Commons: Commerce, Custom, and Inherently Public Property' (1986) 53(3) U Chicago L Rev 711.

data. Innovation in consumer-facing high technology products is currently being driven by data, based on the informal information-science principle that *more data* beats *better algorithms* every time.¹⁰⁶¹ Of course, data drives advertising revenues as everyone knows, and the more technology companies know about their customers, the greater is their value on the multi-sided markets of advertising, app development, and consumers. However, more data also drives product innovation: search engines better calibrate their suggestions, maps sharpen their proposed trajectories, and dating apps accelerate lonely-hearts in the quest for their other half. Interestingly, most of the software that qualify as beneficiaries of more data also qualify as quasi technological infrastructure, since their successes in the market drive their status as *de facto* standards for the services they offer. Unfortunately, the analysis of this new form of currency is outside the scope of this thesis. However, future work could well focus on the extent to which this new model of ‘payment’ is supplanting and eroding the old models of direct value appropriation, while also raising a host of new issues, traversing the domains of innovation, economic relationships, and personal privacy. These new models may also place increasing pressure on the openness of standards: as data becomes more valuable, the standards which encode them may face increasing pressure to become proprietary and under the private control of data processors. For these new problems, as for the problems addressed in this thesis, solutions to these new legal and economic challenges will likely only be forthcoming, once lawyers, economists and policymakers begin by taking technological infrastructure seriously as infrastructure, and take stock of the fact that the real hubs of productive activity in the modern economy are privately owned resources with a growing public character.¹⁰⁶²

1061. Pedro Domingos, ‘A Few Useful Things to Know about Machine Learning’ (2012) <<http://homes.cs.washington.edu/~pedrod/papers/cacm12.pdf>> accessed on 3 October 2016, 6 (‘more data beats a cleverer algorithm’).

1062. See generally Contreras ‘Market Reliance’ (where he discusses the public character of the various commitments made to ensure public licenses, such as patent pledges. The public character of these pledges is a necessary way of managing the essentially public character of the underlying assets that they regulate).

