Digital Divide or Unequal Exchange?
How the Northern Intellectual Property Rights Regime Threatens the South

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INTRODUCTION

This conference of law librarians is convened around the theme of "New Rights — New Laws." I want to argue that, with regard to information, while there are new laws aplenty, there are in fact no new rights. Worse, we are presently witnessing a steady erosion of even the existing public rights of access to and use of information content, whether of a legal nature or not. In fact, there is mounting evidence that the idea of the public domain itself is under serious attack both as a concept and as a collection of practices. The global privatization of cultural and intellectual content in ways unimaginable only a few decades ago is actively threatening the established structures of scholarly communication, to the increasing disadvantage of the less-developed South. Intellectual property (IP) rights are being extended into new areas, as the patent system, for example, expands into biotechnology, agriculture and medicine.

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1 The attack is increasingly brutal, frontal and direct. In recent litigation in the United States about the Linux computer operating system, for instance, it has been argued that the General Public License (GPL) is invalid because it is pre-empted by copyright law. In other words, a court is being asked to rule that a rights holder cannot waive his or her IP rights even if he or she wants to. See Matthew Broersma, “SCO plans court attack on Linux GPL,” ZDNet, 15 August 2003, available at http://zdnet.com.com/2100-1104-5064337.html, [16 September 2003]. Another example might be limits imposed on inter-library loan activity by some database licenses.
while copyright, patent and trade secret protection is claimed even for computer software, mathematical algorithms, and business methods.\textsuperscript{2} IP protection is under discussion for indigenous knowledge, and not necessarily for altruistic reasons. And as the useful shelf life of such content shortens, the protection afforded to it lengthens disproportionately in a disturbing pattern that nearly always favors rights holders and their claims above even the most rudimentary forms of public good.

There are sure signs that these IP issues are entering popular political consciousness. Two or three years ago, when I was preparing a paper on copyright issues for another conference, I searched in vain for any copyright jokes. I could not find any — clearly the subject was too dry and arcane for the gag writers. Now, however, cartoons\textsuperscript{3} and satire on the topic are beginning to appear, showing yet again that accurate parody is hard to distinguish from authentic fanaticism. A CNN executive is on record as believing that if you skip television commercials you are stealing the programming (although you are permitted to go to the bathroom).\textsuperscript{4} The Onion reports that “The country formerly known as the United Republic of Tanzania has lost the use of its name to Tampa-based Tanzania Tanning Salons, the Florida Supreme Court ruled Monday.”\textsuperscript{5} The first of these examples is genuine, but the second is a spoof.

Why is this happening? Well, in short, from as early as the 1990s, the value of the export to the rest of the world of US copyright products (which include books, but are mainly entertainment commodities such as films, music and television programs) exceeded the total for clothes, chemicals, cars, computers and airplanes combined. In 1997, the value of such products was

\textsuperscript{2} The expansion is noticeable both in regard to area coverage, as mentioned, and in the total number of applications for and grants of patents. In 1999, the United States issued 169,000 patents (John HOWKINS, The creative economy: how people make money from ideas (Harmondsworth: Penguin Books, 2002), p.vii. The WIPO system permits one application for all WIPO member countries. Between 1999 and 2000, applications increased sharply, by about 25 \% (Business Day, 26 February 2001). For current WIPO statistics, go to http://www.wipo.int/ipstats/en/index.html.

\textsuperscript{3} E.g. the Roz CHAST cartoon “The Ultimate Contract” in the New Yorker (11 August 2003), p. 44.


$414 billion, according to one popular account. The core copyright industries are by no means limited to print publishing, but extend to "all industries that create copyright or related works as their primary product: advertising, computer software, design, photography, film, video, performing arts, music (publishing, recording and performing), publishing, radio and TV, and video games." This list does not even begin to cover the economic value of patents and trademarks. Commentators and analysts from Daniel Bell in the 1970s, through Manuel Castells in the 1990s, to such current popularizes as John Howkins all agree that "the creative economy will be the dominant economic form in the twenty-first century."

As librarians and information workers in a less-developed country, we cannot, however, understand the nature of the battles around intellectual property rights and their significance for our daily activities without looking at the larger picture — at the globalization of the world capitalist economy. The outcomes of these political battles will, in my view, determine the nature of the "library of the future" far more emphatically than such technical issues as the relationship between print and digital media, or the extension of Internet access to rural areas, urban slums, or places where English is not the language of daily use.

The central difficulty in presenting such an argument about modern day intellectual property issues is that the domain is contested between lawyers, economists, sociologists and information workers, each of whom sees the issue primarily as a technical one, and many of whom view it as pretty much cut and dried. To comprehend this contested and complex terrain as a single object of political struggle may be hard, and to persuade others to change their perspective is probably harder still. Nevertheless, it is worth the attempt, and before starting it may be valuable to sketch out a context for the argument that follows.

First of all, while the discourse of copyright in the English-speaking world has remained more or less constant throughout the nearly three centuries since the British parliament passed the Statute of Anne in 1710, the content and meaning of that discourse has shifted significantly, and continues to shift in the

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6 Howkins, loc.cit.
7 Howkins, op.cit., p. xii-xiii.
present period. Second, very little — perhaps nothing — in that discourse can or should be taken at face value. When US entertainment industry associations profess their concern for the well being of struggling writers or composers, for example, or claim losses of billions of dollars from unauthorized Internet file sharing, it is worth our while to examine the concrete basis of these claims very carefully. Third, the copyright and patent laws with which we have to deal are designed to a very large extent to protect not just the business interests of large Northern corporations, but also their actual business plans, and there is therefore convincing evidence available that they act to stifle creativity and technological innovation, not to encourage it. In any case, what is good for Northern content industries may not necessarily be good for scholarly communication and knowledge production in the less-developed world. And last of all, if nations and international organizations are genuinely concerned to encourage creativity and invention in the arts and sciences, we could do much worse than to return to first principles by examining economically more efficient ways of achieving the desired objective. This might even mean scrapping some aspects of IP protection altogether.

From this background, this paper argues that the contemporary international intellectual property regime — consisting mainly of copyright, patents, and trade marks — represents a victory for lawyers — and indeed, for legal formalism — over economists.\(^9\) The long-established balance between public access to information on the one hand, and short-term monopoly on the other, has been largely lost. We are consequently being led down a blind alley by foreign vested interests, reckless of consequences and concerned only with delivering short-term profit to their shareholders. The concept of intellectual property and its protection is being taken to its logical conclusion, the privatization in the developed North of cultural content in all its forms. This is scarcely surprising, since intellectual property legislation has always been designed at its core to confer market advantage on specific business interests.

\(^9\) This is a paraphrase of a point made nearly half a century ago by Fritz Machlup about the patent system. See his *An economic review of the patent system* (Washington DC: US GPO, 1958), available at [http://www.ipmall.fplc.edu/hosted_resources/jepson/unit1/aneconom.htm](http://www.ipmall.fplc.edu/hosted_resources/jepson/unit1/aneconom.htm) [extracts only], accessed 4 September 2003.
THE REAL NATURE OF INTELLECTUAL PROPERTY LAWS

Arguably, intellectual property laws exist first and foremost to protect the business interests of vendors of cultural content. All other consequences are secondary, and serve to mask and to mystify the real nature of this legal regime. But there are identifiable historical reasons why the IP regime appears in a particular ideological guise, presented and often accepted as helping to create a specific social benefit.

Copyright in the English-speaking world has its origins in the relatively primitive English system of control and censorship administered by the Stationer’s Company (essentially a printer’s guild) under various legislative acts from 1534 to 1709. In return for performing the role of ideological watchdogs, the printers gained monopoly rights over the works that they printed and sold. But this protectionist system, devised in the infancy of the print revolution, was inexorably overtaken by the massive social, political and economic upheavals that constituted the transition from late medieval to early modern English society.10

By the beginning of the eighteenth century, the religious and ideological struggles of the earlier years, and the influence of such progressive thinkers as the philosopher John Locke had created, within the framework of emerging parliamentary democracy, a new openness to change, and a new commitment to such modern concepts as freedom of speech and freedom of the press. It was thus no accident that the Statute of Anne not only dumped the crude mechanisms of a priori censorship, and marginalised the old guild system as represented by the Stationers, but openly declared, in the archetypal language of the Enlightenment, that the objective of copyright was “the Encouragement of Learned Men to Compose and Write useful Books.”11 In 1787, the Constitution

10 “Undoubtedly members of medieval guilds [...] believed that they had an exclusive right to practice their craft. However, no serious economist would allow the moral perceptions of guild members to alter their assessment of guild restrictions as protectionist.” Dean BAKER “Vaccine buying pools: is more protectionism the best route?” Paper prepared for the Conference “Making New Technologies Work for Human Development,” Tarrytown, NY, 31 May-2 June 2001, emphasis added. Available at http://www.cepr.net/globalization/vaccine.htm [23 September 2003].

of the United States echoed the same idea by assigning to Congress the power to “promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.”

This is the rhetoric which remains alive and well in much copyright discourse through the nineteenth and twentieth centuries and right up to the present day. But it is a rhetoric that we should do well to examine meticulously, especially as it is deployed in our more cynical post-modern times.

The fundamental premise is that copyright protection performs a useful social function by encouraging the creators of works to write, assemble or compose literary and scientific works. It does this first by allowing them the so-called “moral rights” to publicly assert their authorship, and to protect the textual integrity of their creations; and second by providing a statutory framework in which such works can be put to economic use. The profit motive, in this view, is what drives most creative activity: writers write and singers sing to make money. Representatives of the modern US entertainment industries strongly and openly endorse this stance — Jack Valenti of the MIAA, for instance, is on record as claiming that “copyright protects not just the financial interest of people who create artistic or intellectual property, but the very existence of creative work.”

Two questions naturally arise. First, is it true that the primary motivation for creative work amongst writers and artists is financial gain? Second, even conceding that some financial motivation may exist, is the present IP regime the best way of protecting the creator’s interests? It is important to emphasize that we are talking here, not of the Sony Corporation, or Warner Brothers, or Elsevier Publishers, but of the majority of authors, photographers, and composers.

Nearly forty years ago, the late Robert Hurst dismissed the idea that authors are motivated to write “in the expectation of monopoly profits,” pointing to a wide range of other intentions, such as “the propagation of partisan ideas;

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12 Constitution of the United States of America, Article I, Sect. 8.
13 The British Act of 1842 begins expansively by recognizing the expediency of affording “greater Encouragement to the Production of Literary Works of lasting Benefit to the World,” (PHILLIPS et al., op. cit., p. 17).
notions of altruism [...]; desire for recognition; and enhancement of one’s reputation.” 15 Obviously there are many more possibilities.

Creators are different from vendors, then? Unhappily, the positions often taken by big content corporations confuse this issue by conflating the interests of the several distinct groups under the single umbrella of “rights holders.” It is clear that the interest in IP protection of publishers, professional writers such as best-selling novelists, and scholars or researchers is quite different. It is also clear that the vendors of content are the ones who act from financial motives. In fact, some historians of copyright have argued that until quite recently copyright had nothing at all to do with authors’ rights: “the publishers [...] created this right for themselves as a necessary protection for their business [...] the interest protected was still essentially, in its practical effect, the publisher’s exclusive right to copy.” 16 Robert Hurt agreed: “The role of the publisher in the realm of intellectual property is substantially different [...] and] is almost exclusively entrepreneurial.” 17

So authors — unlike publishers — are not necessarily in it just for the money. Does copyright protection then have other advantages for them, does it stimulate their creativity in other ways? The answer is probably no; there is a surprisingly venerable tradition of serious criticism by economists of intellectual property protection as a stimulus to innovation. 18 Earlier in this paper I quoted the Austrian economist Fritz Machlup, who wrote in a report to the US Congress in 1958 that the patent system, even in those relatively far-off days, represented a victory for the lawyers over the economists. Machlup was and is not alone among economists in believing that the copyright and patent systems, while possessing some virtue, are in fact “a form of protectionism [...an] interference with a free market.” 19 In his paper he refers to the fact that many German economists, as far back as the nineteenth century, had been critical of the effectiveness of the patent system. Similarly, in a posthumous article published in the prestigious American Economic Review in 1966, Robert Hurt was able to show that, even without the benefit of copyright protection, British authors and

16 PHILLIPS et al., op. cit., p. 12.
17 HURT and SCHUCHMAN, op. cit., p. 426.
18 However, the modern reformist writings on IP of lawyers and non-economists such as e.g. Lawrence Lessig, Pamela Samuelson, Jessica Litman, James Boyle, or Siva Vaidhyanathan make little use of the inefficiency argument.
19 Dean Baker (Center for Economic and Policy Research, Washington DC), e-mail to Colin Darch, 8 January 2003.
their publishers were able to turn a profit in the United States book market for solid and conventional economic reasons.\textsuperscript{20} This critical tradition continues to the present day. In a recent and widely reported paper published by the Federal Reserve Bank of Minneapolis, Michele Boldrin and David K. Levine argue that the copyright and patent systems reinforce monopoly control, keep prices high and smother future innovation.\textsuperscript{21} As Dean Baker, also an economist, has pointed out, “Calling patents intellectual property “rights” does not change their logical status as a form of protectionism.”\textsuperscript{22}

Why, then, has it proved so difficult to get these arguments heard and to either limit or at least control the ongoing expansion of intellectual property rights into new aspects of daily life? What, indeed, are the real chances of reforming the IP system so that it does not continue to stifle creativity, and ideally serves to both protect creators and encourage inventiveness? Twenty years ago, the authors of a report to the Australian government on patent reform summarized the difficulties well: “an historical awareness of the political economy of [...] reform suggests that this task is not easy at the domestic policy level. This is basically because those who perceive they would lose by such reform are concentrated, powerful and active defenders of their interests. In contrast, those who would gain by [...] reform are diffuse and hardly aware of their interest in the matter.”\textsuperscript{23} The recent dismissal, in January 2003, by the US Supreme Court of a challenge to the constitutionality of copyright term extensions seems to confirm the correctness of this insight.\textsuperscript{24}

If this was true in the early 1980s, it is even truer today. As we have seen, the entertainment industries of the United States appear to be doing

\textsuperscript{20} HURT and SCHUCHMAN, op.cit., p. 421-432.


\textsuperscript{22} BAKER, “Vaccine buying pools.”

\textsuperscript{23} T. MANDEVILLE et al., Economic effects of the Australian patent system (1982), summary and quotations available at http://swpat.sffit.org/archive/quotes/index.en.html#mandeville82 [16 September 2003]. The argument applies just as well to copyright reform as it does to patent reform.

\textsuperscript{24} Eldred v. Ashcroft. There is extensive Web documentation on this case. See, e.g. Harvard Law School coverage, with documents, at http://cyber.law.harvard.edu/openlaw/eldredvashcroft/ [24 September 2003].
extremely well, and it is logical that they should wish to secure their own profitability. But they have also succeeded in harnessing the US government and its foreign policy in the service of an expanding and aggressive assertion of the corporate “right” to patent or copyright any idea that might be commercially exploited, up to and including plants, animals and other life forms. The US has consistently sought to strengthen the global agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), which was introduced at the end of the Uruguay Round of GATT in 1994. The truth is, all IP rights are trade-related, and so all forms of content are under threat. Indeed, “the US government has made the rigorous enforcement of intellectual property rights a top priority of its foreign policy” as it attempts to use such international organizations as the WTO and WIPO to impose harmonization of local IP rules to US standards.25 It is able to pursue this agenda because in the era of globalization, international capital is pretty much “free to pursue profit wherever it wishes and on whatever terms it can impose.”26

But how well are the Northern, and especially the US content industries actually doing? In the long term, the confident predictions are that they will be the dominant components of the global economy of the immediate future, as we have seen. But there have also been many wild claims of losses, mostly attributed to insufficiently ferocious administration of IP legislation — certainly not to any problems with their ability to adapt to new environments or technology. It is undoubtedly true that the music recording industry has been experiencing a downturn, with a fall in 2002 of 7.2 percent in global sales of recordings. From this, analysts have extrapolated hypothetical “lost sales” worth US$4.7 billion by 2008, attributed to Internet file-sharing and other forms of “piracy.”27 The problem is, as Stan Liebowitz has convincingly shown, that it is impossible to quantify the exact relationship between unauthorized copying and hypothetical purchasing behavior by the copier, either in the case of file-sharing or cheap Chinese or Mexican “pirate” versions of CDs or videos. It is quite possible that the music recording industry would be in a slump in any case.28

25 Kristin DAWKINS, “Intellectual property rights and the privatization of life,” Foreign Policy in Focus vol.4, no.4 (January 1999), available at
26 LEYS, op.cit., p. vi.
Meanwhile, there have been signs of some short-term skepticism, for purely business reasons, about the viability of the kind of huge content conglomerate that has emerged over the last few years. The shares of companies such as AOL Time Warner or Vivendi Universal have shown themselves to be less than stable, while their ability to consistently produce the kind of moneyspinning blockbuster—whether movie, book, or hit record—that they need to maintain profitability, has also turned out to be precarious.29 The amounts of money at stake are so huge, the rate of technology change so rapid, and the business plans of the corporations involved so fragile that it is scarcely surprising that they will adopt almost any tactic to ensure their own continued profitability. As we will see, these tactics have a direct and negative impact on information use in the academies of less developed nations, for specific political and historical reasons.

**DEPENDENCY THEORY AND UNEQUAL EXCHANGE: WHAT'S WRONG WITH THE CONCEPT OF THE "DIGITAL DIVIDE"**

In the kind of environment sketched out above, one in which a handful of multinational media and content corporations are aggressively pushing for a highly restrictive global IP regime that is already having negative consequences for developing nations, does it make sense to talk of a digital divide between the information rich and the information poor? The expression is problematic in several ways. Not the least of these is the implication that better networks and more workstations might help to solve this (imprecisely identified) problem. After all, if the difficulty is fundamentally one of the supply of goods, one could point to the fact that there are more railways or more shopping malls in the United States or in Europe, but nobody refers to a "rail divide" or a "shopping divide." The expression originates from a series of US government reports dating from July 1995, examining computer use in poor rural and urban America.30 Commentators on the spread of Internet facilities in less developed countries have rapidly and perhaps too uncritically appropriated it.

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29 There are six content/distribution giants, and one hybrid. For a more detailed analysis of their troubles, see "Tangled webs," *The Economist*, vol. 363, no. 8274, 25 May 2002.

30 For the texts of these reports go to the Website "Americans in the Information Age: falling through the Net," at http://www.ntia.doc.gov/ntiahome/digitaldivide/ [24 September 2003].
The expression is in fact singularly unhelpful in understanding the concrete nature of the difficulties faced by less developed countries in meeting their own information needs and serves objectively to disguise the real functions of present day information delivery systems. The concept also suffers from an implicit voluntarism — that is to say, it implies that structural problems of information production, control and access in countries such as South Africa can be reduced to a question of connectivity. Of course, the discourse of globalization is not marked by clear and unambiguous terminology, or by agreement on meaning among those contesting the significance of particular expressions. Nonetheless, we can choose to reject popular but ideologically mystifying expressions, such as this one, in favor of less alliterative but more precise terminology borrowed, for example, from now largely abandoned development theory. I believe that a much more helpful analytical category for understanding information inequalities and the way in which current IP trends are likely to reinforce them, comes from the terminology of development theory. It is the concept of unequal exchange.

"Development theory" emerged in the late 1950s, as the African colonies of Britain and France began to achieve independence, and at the height of the Cold War. For various reasons, as a body of work, it was initially strongly oriented towards practical solutions to the question of how to “develop” the former colonies. Ironically, scholars were, at least initially, shy of theory, since in the area of development this would have meant to risk being branded as Marxists. As Colin Leys summarizes the situation: "The goal of development was growth; the agent of development was the state and the means of development were [...] macroeconomic policy instruments."31 Over time, and within this framework it became clear that classical economic theory was unable to provide adequate answers, and in the 1970s a left critique began to be mounted of modernization theory by such writers as André Gunder Frank, Samir Amin, Geoffrey Kay, Giovanni Arrighi, Bill Warren, and Arghiri Emmanuel.32 However, we are now living in an era marked by a major ideological shift away from the then dominant idea of a more-or-less regulated international system of inter-related national economies, to a system that has successfully liberated capital to pursue profit wherever it can and by whatever means it chooses. The theoretical basis of the new international system, which most of us know as "globalization," is neo-liberalism, in which the market, a euphemism for capital,
is the only regulatory mechanism allowed in the game.\textsuperscript{33} The effective disappearance of regulation from the international financial system has meant that many of the assumptions of development theory no longer hold, and the theory and its various offshoots are now seen as largely irrelevant.

Typically, neo-classical economists were always (and remain) impatient of dependency theory as developed by the writers mentioned, terming their writings "vague, not presented with mathematical clarity, and couched in tiresome rhetoric [...] most importantly, [...] they are largely tautological."\textsuperscript{34} Some of the so-called "dependency school" economists of the 1950s and 1960s, such as Furtado, Baran and Frank, had been deeply pessimistic about the idea that trade was a stimulus to development in underdeveloped countries. However, the most exhaustive attack on the idea that trade did anything other than extract surplus from the south was made by the Italian scholar Arghiri Emmanuel whose concept of "unequal exchange" was first fully developed in 1969, and has retained a certain degree of credibility.\textsuperscript{35} In very broad terms, Emmanuel argued that the global and international movement of capital results in a tendency towards the establishment of a generalized rate of profit. However, wage labor is not subject to any parallel tendency towards a global wage rate, since workers are effectively separated into national units by restrictions on migration, differentiated national trade union regimes, the often national character of working class politics, and so on. The outcome, according to this theory, is that rich nations benefit proportionately much more from international trade than do poor nations, contrary to the neo-classical conventional wisdom.

Intuitively, it is possible to see how unequal exchange applies to the trade in IP. South Africa and most other countries outside the developed North


produce and publish much less “knowledge” — cultural content — than they consume. The threat to the free flow of scholarly communication, that appropriation of this content by large corporate rights holders constitutes, is obvious. To give one example, our system of rewarding research privileges publication by our scholars and scientists in prestigious foreign journals, many of which our libraries cannot afford to buy, and may not permitted to access through other means. The relative social costs of research in South Africa and similar countries are high, and there is an imbalance in the “trade” in information built into the system. The more difficult and expensive it becomes, because of what is effectively the privatization of the scientific record under IP agreements, to access necessary information, the less likely it is that we will continue to produce quality research of our own. And so the cycle will continue. This system is not a “digital divide” in which it is possible in some way to play catch-up. It is a self-perpetuating system of unequal exchange underpinned by the increasingly restrictive trade rules of the intellectual property regime.

**CONCLUSION: LAWYERS, ECONOMISTS AND LIBRARIANS**

For those of us not trained in law or in economics, the whole intellectual property debate is a minefield — or perhaps a better metaphor would be a series of adjacent minefields. It is extremely easy to trip over some technical misunderstanding of what appears to be a statement in plain English, only to discover that the words used carry some special meaning within the particular discourse of the discipline. In addition, lawyers and economists do not communicate easily with each other, so there exist relatively few examples of what one might term holistic or comprehensive treatments of the issues and questions involved in the operation of the changing IP system in real societies.

I have argued in this paper that, despite the risk of ending up with egg on one’s face, it is vitally important for those of us who are concerned with the way scholarly communication will function in the immediate future to confront these complex issues, and to resist glib mystification of the underlying structural problems. This means logically that the big social questions cannot simply be left to the lawyers and to the economists. As information workers, for example, it would arguably be dangerous for us to be seduced by arguments in favor of the philosophy of “legal formalism”; a set of positions that represent the law as
essentially an autonomous and internally coherent thought system.\textsuperscript{36} In the intellectual property debates it is clear that the law and its impact on society must be considered together.

The — as it turns out — fragile structures of traditional scholarly communication have become entangled in the struggles for continued profit of the US entertainment and media corporations, who seek above all to protect their antiquarian business practices. Third World universities are bobbing along in the wake of these multi-billion dollar business deals like corks behind an ocean liner. The complete abandonment of the copyright and patent systems is extremely unlikely in the short term, but it is highly desirable that we should seek alternative models for the delivery of scholarly communication.\textsuperscript{37} If we do not, the rules will continue to be drawn up for us by the US entertainment industries, with disastrous consequences for science.

\textsuperscript{36}Although this slippery term is itself used in varying and contested senses, I take it here reductively to represent a fundamental reluctance to recognize that since the law is an instrument of social policy, legal decisions should be considered in a social context rather than mainly assessed for their internal consistency. See D. KENNEDY, "Legal formalism," in: \textit{International Encyclopaedia of the Social and Behavioral Sciences} (Amsterdam: Elsevier, 2001), p. 8634-8638 for an introductory discussion of this topic.

\textsuperscript{37}For example, open source software, or the Open Archive Initiative for delivering preprints of scientific articles.