The inclusion of software and algorithms in the scope of patents by the U.S. Patent and Trademark Office and the proposed EC Directive on the Patentability of Computer Implemented Inventions propelled an ongoing debate on the contribution of patents to innovation and economic growth This book examines the effects of intellectual propery rights (IPRs), namely patents and copyrights, on innovation and technical change in information technologies. It provides new insights on the links between markets, technologies and legislation by applying a variety of empirical and analytical tools. The book explores how the structure of ownership of U.S. software patents and the quality of software patents have been affected by changes in legislation. The success of the Open Source movement to establish an alternative regime to IPRs is analyzed by illuminating the economic rationale beyond it and how Open Source can strategically be used by firms.

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Elad Harison Software Intellectual Property Rights

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Background

The inclusion of algorithms, business inventions and mathematical formulae in the scope of patentable subject matter and the exponential growth in the number of software patents that were approved by the USPTO after the approval of its *Guidelines* in 1996 have raised significant doubts whether patents are granted to software inventions whose novelty and contribution to the state-of-the-are of technology are sufficiently novel.

Contradicting opinions on the contribution of patents and copyrights to foster innovation in software technologies persist. Legal and economic scholars indicate that the present legislative framework, which provides inventors with long term, expansive rights over technology has distorted the balance between incentives to innovate and monopoly rights. Further, if a significant number of software patents are granted to minor improvements, as some scholar suggest (e.g. Merges, 1999), assignees are provided with wide exclusive rights over technologies in return to disclosure of relatively insignificant advances. In the short term, low-quality patents may restrict the entry of competitors to neighbouring market niches with superior technologies.

In complex technologies, such as software which integrates a large number of computational elements to achieve a required functionality, patents can potentially block development of products that use one or more essential components (Merges and Nelson, 1990). Algorithms, mathematical formulae and sub-routines are the building blocks of computer programs that accomplish particular tasks that are essential for their operation. Therefore, software products encompass high degrees of interoperability between the final product and other programs and between the elements that construct it. When invention is recognized patentable and granted exclusive rights, patent-holders can prevent competitors from entering the market with products that use similar or improved features. Consequently, when a particular element cannot be used in computer programs without infringing legal rights and cannot be substituted, the functionality of the program might be crippled or even not be attained at all.

In some cases software patents fail to provide sufficient degree of knowledge disclosure in return to monopoly rights. Then, the ability of second comers to review and to learn from prior inventions and to build new inventions upon it is fairly restricted. Similarly, if patent claims (i.e. the potential uses of the patented invention) are general and obscure, the scope of protection is wide and covers new applications that were not envisioned by inventors when the patent application was filed and those domains will be excluded from other inventors in advanced phases of the technology. Moreover, if patents lack sufficient novelty and disclosure, they become ``obvious'' to practitioners and hence their quality

encompasses lower levels of innovative added value and contribution to the public's welfare. Syrowik (1996) suggests that the examination of software patents by the USPTO suffers from those problems and as a result the balance between private and public interests has changed. Application of a different legal scheme that limit the scope of claims of software patents to particular applications and data structures can restore this balance (Schumm, 1996; Witek, 1996).

Our empirical analysis indicates that the structure of ownership of software patents is highly concentrated, as every year large numbers of patents are granted to a small group of assignees, all of them are multi-national firms that operate in the electronics and ICT sectors. However, since the establishment of the *Guidelines* by the USPTO the structure of ownership has become more fragmented, as larger amount of small patent-portfolio holders (mostly SMEs and individuals) apply for and granted patents over their software inventions.

Granting broad exclusive rights (as defined by the patent claims) for long periods to inventions whose contribution to innovation is marginal is likely to hamper entry of new developers and firms to the market and in the long run can lead to stagnation of the technological trajectories in the software industry. Nevertheless, the predictions of academic scholars and industrialists could have barely been fulfilled had the market followed a different trail in reaction to software patenting.

Our findings reveal that since the 1960s the U.S. legislation of software IPRs has lingered after the development of new software and information technologies by more than a decade. As a result, legislative changes suffered from two major sources of inefficiencies: First, policy adaptations were presented long period after the technical change had occurred, hence regulating new technologies with older legislative frameworks. Second, when IPR policies were modified due to technical developments, new technical paradigm would have already been introduced to the market, hence creating another source of inefficiencies. Consequently, the quality and the innovative value of software patents gradually deteriorated during the 1980s and the early 1990s. However, since the enactment of the *Guidelines* in 1996, the quality of software patents is increasing and recent patents are more often cited as *prior art*.

The Open Source movement challenges the traditional IPR regimes by providing alternative incentive mechanisms for software developers that are based on reputation rather than on exclusive rights. Open Source development is based on disclosure of the source code. Programmers remove their ownership rights from their contributions to enable further development of applications. Open Source projects attract growing numbers of developers and many firms adopt it as their favourite mode of development, although their creative outputs are disclosed at a zero price tag. The thesis presents the dynamics of Open Source communities and elaborates whether policy-makers should integrate the Open Source mode of development as a substitute or complementary approach to IPRs.

Outline

Chapter 2, *Intellectual Property Rights and Innovation: Introducing Economic Rationale into Legal Regimes*, reviews the economic role of IPRs and their impact on the market. The chapter presents various legal-economic theories by which the structure of the legal regime and the public and private benefits that it provides can be analyzed.

Chapter 3, *The Role and Performance of IPRs as Knowledge-Propelling Regimes*, proposes a conceptual framework for analyzing the role and functionality of IPRs. The frame-of-analysis is based on insights from the evolutionary economics literature discussing the effects of technical knowledge and disclosure on innovation and technological change.

Chapter 4, *Revealing Obscure Sources: The Paradoxical Evolution of Software Appropriation Regimes*, discusses how software IPRs evolved *vis-à-vis* the development of information technologies. We elaborate the role of patents and copyrights in protecting software and whether software IPRs have formed an over- or under-protective regime. We also discuss the success of the Open Source movement to establish an alternative regime that is based on removal of IP claims from the source code and the dynamics of developers' communities.

Chapter 5, *On Substitution of Intellectual Property and Free Disclosure*, aims at revealing the economic rationale underlying Open Source development and how this mode can strategically be used by firms. By constructing an analytical model of the market, we identify the optimal share of source code that should be disclosed and developed as Open Source to maximize profits and how it is affected by the pricing decisions of firms.

Chapter 6, *Designed for Innovation: The Structure of IPR Regimes and the Evolution of Information Technologies*, constructs a dynamic model of the software market that explores links between different structures of the patent regime affect market dynamics and technical change over time. The chapter provides insights on the relations between patent duration and novelty criterion and the degree of competition and the performance of technologies.

Chapter 7, *Owning Technology: The Structure of Intellectual Property Ownership in Software Technologies*, studies the structure of ownership of U.S. software patents and how it was affected by changes in IPR policy. Further, the chapter evaluates how the quality and the innovative value of software patents have been influenced by structural changes in the legal regime and reveals links between software patenting and the emergence of Open Source projects.

Chapter 8, *IPRs in a Knowledge-Based Economy: A New Frame-of-Analysis*, discusses the economic nature of software and computational processes. We compare between the schemes of IPRs that were established for protecting computer programs and those that protect their physical equivalents (i.e. *computational machines*). Then, we propose a new conceptual framework for legal and economic analyses of software products and

technologies. The importance of the U.S. experience is emphasized in the light of the proposal of the *Directive on the Patentability Computer-Implemented Inventions* (COM (2002) 92 Final) that aims at expanding the scope of the legal regime of software IPRs in the E.U. beyond the prior legislation from 1992.

Finally, Chapter 9 provides conclusions and policy implications.

Curriculum Vitae

Elad Harison was born in Haifa, Israel, on May 13th 1971.
In 1993 he obtained his B.Sc. from the Faculty of Industrial Engineering and Management at the Technion - Israel Research Institute. During the following six years he was working as a logistic engineer and as an information systems analyst at the Israeli Navy Computing Center, where he specialized in Enterprise Resource Planning systems. From 1997 to 1999 he completed his Master in Engineering at the Faculty of Industrial Engineering and Management at the Technion.

In 1999 he joined the Ph.D. programme at the Maastricht Economic Research Institute on Innovation and Technology (MERIT), University of Maastricht. In 2001 he was awarded a National Doctoral Research Fellowship (OiO) funded by the Netherlands Organization for Scientific Research (NWO). The final stages of his research were funded by a fellowship from the Dutch Ministry of Economic Affairs.

Elad completed two research projects on Intellectual Property Rights in a Knowledge-Based Economy for the Dutch Advisory Council for Science and Technology Policy (AWT) with Robin Cowan. He participated in the European Commission's Expert Group on Intellectual Property Rights Aspects of Internet Collaborations. Between December 2003 and May 2004 he visited the Copenhagen Business School as Marie Curie doctoral fellow. Currently, he participates in MERIT's study on the Effects of Patenting Computer-Implemented Inventions for the EC. He is also a member of the EC's Network-of-Excellence on European Policy for Property (EPIP). During his Ph.D. research, he presented his work on numerous occasions to conferences and to policy makers.

Since January 2005 Elad is working as Assistant Professor in Business and Information and Communications Technologies at the Department of Economics, University of Groningen.

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