



# A general equilibrium analysis of software development: Implications of copyright protection and contract enforcement

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## Abstract

We develop a general equilibrium model to study the implications of a legal environment on the organization of software production. We show that contract enforcement determines the organizational mode (i.e., in-house versus outsourcing) of customized software development while copyright protection affects both packaged software as well as customized software development. We obtain some testable results: when copyright protection is weak, only customized software will be developed; when copyright protection is strong, both customized software and packaged software will be developed; environment changes in one software market affect the equilibrium in the other software market.

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## 1. Introduction

We are now living in the new economy in which information technology is playing a more and more important role. For example, in the United States, computer software is vital to both the domestic economy and external trade. In 1998, the software industry became the second largest industry group in manufacturing.<sup>1</sup> In 1997, packaged software (PS) alone contributed a surplus of \$13 billion to the U.S. trade balance, without which the U.S. trade deficit (excluding U.S. military and government transactions) would have been 36% higher (BSA, 1999b, p. 16). However, software development is very uneven across countries. In 1994, the U.S. controlled about 75% of the global software market. Europe had 20% of the market, and Japan had 4.3% (Fortune, 1994).

Unlike most products and services, though, software is protected by copyright laws against piracy. Software piracy is a serious problem all over the world, but it varies tremendously from country to country. According to a report by the Business Software Alliance (BSA, 1999a), in 1998, 38% of the business software applications in the world were pirated, and, by countries, the software piracy rate ranged from 25% (in the U.S.) to 97% (in Vietnam). It is not a coincidence that the U.S. has the lowest software piracy rate and at the same time has the largest market share of software in the world. The BSA concludes that “[p]rotecting the intellectual property rights that are the basis of packaged software distribution is conducive to greater international trade and increased industry investment in the economies that provide such protections” (BSA, 1998, p. 24).

In this paper, we develop a model to analyze software development formally with a focus on the influence of the legal environment, namely contract enforcement and copyright protection policies. Software products are commonly classified into two groups: PS which is designed for general purposes, like word processing, and *customized software* (CS, in short), which is designed for special use, like an accounting program for a particular company.<sup>2</sup> We show that the degree of contract enforcement affects the organizational *mode* of the CS development, i.e., whether the software is developed in-house (vertical integration) or obtained by outsourcing (contracting). We define a *type-B contract* (B stands for breach) as a contract that will be breached by one contracting party, and a *type-H contract* (H stands for honor) as a contract that will be always honored by all contracting parties. We show that as contract enforcement becomes stronger, the optimal mode of organization switches from vertical integration to type-B contract, then to vertical integration, and finally to type-H contract. For PS, since piracy reduces legitimate consumption, copyright protection is essential to ensure investment in software development. As a result, when copyright protection is weak, only CS will be developed. When

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<sup>1</sup>The software industry tied with the electronic components and accessories industry for second place, after the motor vehicles and equipment industry, according to a report by the Business Software Alliance (BSA, 1999b, p. 6).

<sup>2</sup>Examples of PS include operating systems, word processing programs and spreadsheets. Examples of CS include some specific software designed for banks and some professional training programs. See Torrisi (1998) for more about this classification.

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