# Knowledge spillovers and intellectual property rights ☆

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A B S T R A C T

Knowledge spillovers are widely thought to be important for innovative activity, yet theory is ambiguous about the sign of the relationship. Assuming that knowledge spillovers are more easily exploited where intellectual property rights are weakly enforced, this paper uses country–industry data to uncover the link between knowledge spillovers and innovative activity, as well as the birth and death of enterprises. IPR enforcement disproportionately increases innovation spending in R&D intensive industries, as well as both rates of entry and exit. The results are robust to accounting for financial development, labor market ridigities and a number of other institutional factors.

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## 1. Introduction

An intrinsic feature of knowledge is that it is non-rival and imperfectly excludable — see Romer (1990). Imperfect excludability is typically interpreted as a technological feature of knowledge that implies that new knowledge, once generated, may be used by agents other than the innovator — a feature commonly known as "knowledge spillovers". The term "knowledge spillovers" may also refer to the ability of an agent to produce new knowledge by building on prior knowledge, possibly including the agent's own stock of knowledge. Thus, knowledge spillovers constitute a factor of technological *opportunity* — affecting the yield of innovative effort — and also of *appropriability* — affecting the ability of agents to capture the returns of their innovative effort.[1]

Although theory suggests that knowledge spillovers across agents should be related to the quantity of innovative activity, the sign of the link between spillovers and innovation is ambiguous. On one hand, large spillovers might *encourage* innovation by providing would-be innovators with something to build upon or by allowing the rapid diffusion of new knowledge. On the other hand, large spillovers might *discourage* innovation because an innovator's competitors also benefit from the generation of new knowledge (be it through imitation or inspiration). In addition, whether new knowledge is primarily a substitute or a complement to existing knowledge is ambiguous too. Since incumbents are better positioned to have accumulated past knowledge, the impact of spillovers on *entry and exit* may also help refine the empirically relevant set of theoretical models for understanding the process of innovation.[2]

A key observation made in Romer (1990) is that the impact of spillovers on innovative behavior depends not only on the technology of knowledge generation but also on *institutions*. For example, if

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 [1] See Cohen (2011) for an extensive survey of the identification of opportunity and appropriability.

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[2] For example, in the "creative destruction" models of Aghion and Howitt (1992, 1997), the primary beneficiaries of knowledge spillovers are entering firms, whereas in Klette and Kortum (2004) knowledge spillovers benefit entrants and incumbents equally, and in Peretto (1998) they favor large incumbents.

intellectual property rights (IPRs) are not well-enforced, or if IPR disputes are costly and unpredictable, then appropriability is weaker than otherwise. Moreover, this should be particularly noticeable in industries in which the technologically determined extent of knowledge spillovers across agents is large — i.e. where opportunity is also high.[3] This suggests that exploiting variation across countries in IPR enforcement, together with variation across industries in innovation activity, may be useful for uncovering the impact of knowledge spillovers on innovation.

Consider measuring research intensity in a country where IPRs are strong, and where financial, labor and product markets are relatively frictionless. This provides a benchmark for innovative behavior when the impact of knowledge spillovers on appropriability is limited. Then, assuming appropriability encourages innovation primarily in industries with large knowledge spillovers, whether innovative activity in industries that are R&D intensive in the benchmark environment decreases disproportionately with a weakening of IPRs should indicate whether these are industries where potential spillovers are very large.[4] Furthermore, whether rates of *entry* are also disproportionately affected in R&D-intensive industries, and whether the disproportionate impact is positive or negative, should indicate the relative importance of entrants and incumbents in taking advantage of these spillovers. Finally, whether the behavior of entry and exit is disjoint indicates whether the spillover-induced replacement of incumbents by innovating entrepreneurs is an important feature of the process of innovation.

This paper implements the empirical strategy outlined above, to identify the link between institutions that limit costly IPR disputes and research intensity, as well as entry and exit. The paper exploits *country–industry variation* in rates of entry, exit and innovation indicators to understand whether knowledge spillovers discourage innovation, and whether entry or exit play an important role in this process. The paper focuses largely on innovation spending – a measure of the inputs towards innovation – following the "absorptive capacity" hypothesis in Cohen and Levinthal (1990) and Griffith et al. (2004) that spending is necessary to adopt external knowledge, so that innovative inputs and outputs are positively linked. This contrasts with the view in Spence (1984) that spillovers are costless, so that greater spillovers may encourage R&D spending yet lower innovative output. However, we also ask whether there is a disproportionate sensitivity of *industry growth* to IPRs in R&D intensive industries, underlining the validity of the absorptive capacity hypothesis.

This paper uses data from Eurostat, which provides internationally comparable industry data covering the universe of legal firms in 28 European countries, including both manufacturing and non-manufacturing industries.[5] Country–industry data provide a natural environment in which to search for evidence of a link between IPRs and innovative entry. Samaniego (2010) finds that country and industry dummies account for almost half the variation in European rates of entry and exit — whereas time dummies account for about 1%. The use of European data implies that the countries considered do not significantly differ in their access to natural or human resources, given low barriers to trade and immigration.

The main results are as follows. First, comparing across countries, enterprises in weak-IPR countries tend to disproportionately report difficulty raising funds, difficulty finding partners for innovation or the dominance of an established incumbent as obstacles to innovation. This suggests that IPR enforcement not only encourages innovation, but that it shifts the balance towards entrepreneurs and away from incumbents. Then, we find that effective IPR enforcement indeed tends to encourage innovation spending in R&D intensive industries. In addition, the same is true of both rates of entry and exit. The results are robust to conditioning on a variety of institutional factors, including other forms of property rights or contract enforcement, entry costs and financial development. As discussed below, IPR enforcement tends to be measured using patent protection measures, and contribution of the paper is to use several institutional indicators, including several different indicators of IPRs.

The results speak in favor of models of economic growth where knowledge spillovers across firms encourage innovation, and where entry and exit are important for innovation. For example, in R&D-based models of growth that are close to growth accounting frameworks such as Romer (1990), Jones (1995) and Krusell (1998), growth is driven by knowledge spillovers across firms, but there are no industry dynamics to delimit the scope of spillovers. Our results suggest it is important to distinguish between the impact of spillovers on entrants and incumbents. In the basic creative destruction model of Aghion and Howitt (1992), as well as more recent versions such as Howitt (1999), knowledge spillovers increase the rate of innovation, and this favors entry (and leads to exit) because incumbents face the obsolescence of their current IP. The key is that, in these models, innovation is a substitute for prior expertise, so that "business stealing" is an important incentive for innovating that favors entrants.

Several more recent papers extended such models to allow for incumbent innovation, as well as entry and exit.[6] In the quality ladder model of Klette and Kortum (2004) knowledge spillovers occur because a successful innovator raises permanently the productivity of the next innovator, whoever it is, and as such spillovers affect entrants and incumbents similarly. Peretto (1998) argues that the tendency should be towards incumbent-dominated R&D and, while our findings appear to contradict this conclusion, the model is useful for interpreting those findings. Peretto (1998) assumes a weak-IPR environment where there is a tendency to develop large innovative incumbents because size is a way to internalize knowledge spillovers when appropriability is weak, and this is consistent with the finding that in countries with weak IPRs innovative entry appears suppressed, as well as the surveys that report the presence of a dominant incumbent as an obstacle to innovation in such countries. The implication is that in an environment with strong IPRs innovative entrepreneurship should be boosted, as found in this paper.

Acemoglu and Cao (2010) and Akcigit and Kerr (2010) also develop models in which both entrants and incumbents may innovate and, while they do not study the impact of IPRs in their models, the models suggest reasons why the entrant-bias of IPR-protected innovation carries over into an environment with incumbent innovators. In both models, entrants are more likely to introduce innovations that are fundamentally different from what is on the market, whereas incumbents are more likely to improve existing product lines — an activity that would depend more on in-house knowledge and (hence) less on the IPR regime.

The results stand in contrast to the view of Teece (1986) and Gans et al. (2002), whereby a strong IPR regime may discourage entry in innovative sectors because it allows innovators to profit by selling their idea to an incumbent who may have developed complementary assets (e.g. distribution networks) rather than having to enter to

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[3] Suppose that knowledge in each industry naturally spreads and can be built upon at a certain rate. The hypothesis is that IPRs limit this spread, which will make most difference where that spread would have been large. In order to build on knowledge one must possess it, and if one possesses it one could also use it for imitation, absent IPRs.

[4] In theory the impact of IPR-induced appropriability is also ambiguous. We assume a positive impact of appropriability to be able to provide concrete interpretations of the results. Assuming appropriability *discourages* innovation primarily in industries with large knowledge spillovers, some of the conclusions would be overturned, as discussed later. However, the idea that appropriability discourages innovation contradicts other evidence, to be supplied later.

[5] Most studies of entry and exit focus on manufacturing; exceptions include Brandt (2004) and Samaniego (2010), who use earlier Eurostat entry and exit data but do not look at R&D nor at IPR enforcement.

[6] Thompson (2001) has entering and incumbent innovators, but abstracts from exit as it renders the model intractable.