Published as:
Aghion, Philippe, Peter Howitt, and Susanne Prantl. 2013. "Revisiting the Relationship Between Competition, Patenting, and Innovation." In *Advances in Economics and Econometrics* (Tenth World Congress, Volume 1, Economic Theory), edited by Daron Acemoglu, Manuel Arellano, and Eddie Dekel, chapter 15, 451-455. Cambridge, Massachusetts: Cambridge University Press.

Revisiting the Relationship Between Competition, Patenting, and Innovation

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1 Introduction

Boldrin and Levine (2008a) argue that patent protection is detrimental to product market competition and thereby to innovation. In addition to the analysis in their book, they built a growth model in which innovation and growth can occur under perfect competition (Boldrin and Levine, 2008b). It is a sound idea that reducing product market competition can be detrimental to innovation and this is not accounted for by the endogenous growth models of Romer (1990) and Aghion and Howitt (1992). In these models, competition is detrimental to innovation and growth for exactly the same reason that renders intellectual property rights (IPRs) in the form of patent rights good for innovation: namely, because competition reduces post-innovation rents whereas patent protection increases these rents.

In these comments, we argue that the view of patent protection and product market competition as opposite forces is not robust to considering more elaborated models of product market competition and innovation. In particular, in a step-by-step innovation model, we show that not only can competition enhance innovation, as in Boldrin and Levine (2008b), but also (and perhaps more important), competition and IPRs can become complementary forces. Why? Because a firm's incentive to innovate depends on the gap between the post-innovation rent and the pre-innovation rent, i.e., the net innovation rent. Typically, product market competition lowers the pre-innovation rent, and it may also lower the post-innovation rent, although the net innovation rent may increase with competition, and all the more so with stronger patent rights protecting the post-innovation rent. In contrast, in the models of Romer (1990) or Aghion and Howitt (1992) in which innovations are made by outsiders who create new varieties or leap-frog incumbent firms, the pre-innovation rent is always equal to zero. Thus, all that product market competition does in these models is to reduce the post-innovation rent, which is equal to the net innovation rent.

In the empirical literature, a finding of Qian (2007) provides a first hint towards complementarity between product market competition and patent protection in enhancing innovation and growth. In her cross-country analysis, she finds that the introduction of national pharmaceutical patent protection complements a country's economic freedom in stimulating its pharmaceutical innovation activities. She measures economic freedom with the Fraser Institute composite index which comprises, among various other factors, components of country-level freedom to compete and trade. Her panel data set covers 92 OECD countries between 1978 and 2002. In Aghion, Howitt and Prantl (2012), we provide an in-depth investigation of whether product market competition and patent protection can complement each other in inducing innovation. Our empirical analysis focuses on identifying heterogeneity in innovation responses to competition-increasing product market reforms, depending on the strength of patent rights. We use panel data disaggregated to the country-industry-year level for various industries in manufacturing, as well as in services, in OECD countries since the 1980s. Overall, our empirical findings support the view that product market competition and patent protection can complement each other in inducing innovation.

2 Complementarity between Competition and Patent Protection

In this section, we show that complementarity between product market competition and patent protection can arise in a step-by-step innovation model.[1]

2.1 Basic Model

We consider an economy populated by a continuum of individuals who all live for one period. Time is discrete and in each period t a final good Y is produced under perfect competition using a continuum of intermediate inputs, according to the technology:

$$Y_t = \int_0^1 A_{it}^{1-\alpha} \, x_{it}^{\alpha} \, di$$

where x_{it} denotes the quantity of the intermediate input produced in sector i at date t; A_{it} is the productivity parameter associated with the latest version of intermediate product i; and $\alpha \in (0,1)$. The final good, which we take as the numéraire, in turn is used for consumption, as an input to innovation, and also as an input to the production of intermediate products with a one-to-one technology.

In each intermediate sector i, only one firm, a monopolist, is actively producing in each period. Intermediate firms live for one period, and property rights over their technological capabilities are transmitted within dynasties. Each intermediate producer chooses how much to produce to maximize profits, taking into account that the price at which the intermediate good can

[1]The model that we present here builds on Acemoglu et al. (2006) and Aghion et al. (2001).

be sold to the final good sector equals the marginal productivity of that good in final good production.

Profit maximization by an intermediate producer i yields the expected equilibrium profit

$$\pi_{it} = q\pi A_{it} \tag{1}$$

where

$$\pi = \left(\frac{1-\alpha}{\alpha}\right)\alpha^{\frac{2}{1-\alpha}}$$

and q is the probability that innovation profits are not expropriated, measuring the strength of patent protection.

2.2 Technology and Entry

Before deciding on production in period t, each incumbent intermediate firm can invest in innovation to increase its productivity, and each innovation increases the firm's productivity by the factor γ. By investing

$$c_t = cz^2 A_{t-1}/2$$

where A_{t-1} denotes the firm's productivity at the beginning of period t and $c < 1$, an incumbent intermediate firm can increase its productivity with probability z in period t.

Intermediate incumbents are subject to potential entry by new firms. We let p denote the probability that an entrant shows up in sector i and we assume p to be exogenous. An increase in p corresponds to increased product market competition. New entrants in period t are supposed to operate with productivity A_{t-1} in that period.

Entry is deterred in sector i with probability one if the incumbent in that sector innovates. If the incumbent does not innovate, and therefore the incumbent and the entrant have the same productivity A_{t-1}, entry is deterred with probability βq, where β indicates the marginal effect of patent protection on entry. Thus, in line with Boldrin and Levine (2008a), we allow for a negative effect of patent protection on entry. In the case where entry occurs, we suppose that the incumbent's profit falls to zero due to Bertrand competition.

2.3 Equilibrium Innovation

If an incumbent firm successfully innovates, then its profit will be $\pi\gamma A_{t-1}$ with probability q. If it fails to innovate, then its profit will be πA_{t-1} with probability $q[1-p(1-\beta q)]$. This is the probability that the firm is not expropriated times the probability that entry does not occur or is not successful.

Therefore, an incumbent firm's expected profit, including the cost of innovation, is:

$$zq\pi\gamma A_{t-1} + (1-z)\, q[1-p(1-\beta q)]\pi A_{t-1} - cz^2 A_{t-1}/2.$$

An incumbent firm will choose the probability z to maximize its expected profit, with the corresponding first-order condition implying:

$$z = \frac{\pi q}{c}[\gamma - 1 + p(1-\beta q)]. \tag{2}$$

Differentiating with respect to p, as well as to p and q, we obtain:

$$\frac{\partial z}{\partial p} = \pi q(1-\beta q)/c > 0; \frac{\partial^2 z}{\partial p \partial q} = \frac{\pi}{c}(1-2\beta q).$$

Thus, *product market competition* as measured by p has a positive effect on innovation incentives: this is an ëscape competitionör ëscape entryëffect (see, for example, Aghion et al., 2005, and Aghion et al. 2009). In addition, *patent protection* as measured by q affects the magnitude of this effect in two counteracting ways: (1) for given effective entry threat $p(1-\beta q)$, it increases the gain from escaping competition through innovation; and (2) it reduces the effective entry threat and therefore the incumbent firms' incentives to innovate in order to escape competition. The former effect dominates if q is small, and for all values of q if β is small. Then, the model predicts that product market competition has a more positive effect on innovation incentives when patent protection is stronger.

3 Conclusion

In these comments, we argue that opposing patenting in general because of the positive effects of product market competition on innovation is a fallacy.

A related fallacy is the view that industrial policy, i.e., state support to selected sectors, is always detrimental to product market competition and therefore to innovation and growth. However, Aghion et al. (2012) derive from theory that the effects of industry policies that induce several firms to focus on the same sector are more growth-enhancing when ex post within-sector competition is more intense, and when competition is better preserved or increased by the policy. Their empirical analysis is based on panel data of state-owned and non-state-owned enterprises in China during the time period 1998 through 2007.

Overall, this discussion suggests that the relationship between product market competition and innovation is more subtle than often depicted. This, in turn, opens up a large set of potentially interesting questions to be explored in future research.

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