Chapter 9: Competition and Entry

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1 Introduction

Is market competition good or bad for growth? The answer to this question that was provided in Chapter 4 above was unambiguous; namely that because monopoly rent is what induces firms to innovate and thereby makes the economy grow, product market competition can only be detrimental to growth. By the same token, more intense imitation discourages technological innovations and growth. Hence the importance of preserving intellectual property rights through an adequate system of (international) patent protection (see Grossman and Helpman 1991a).

On the other hand, recent empirical work (e.g., by Nickell 1996 or Blundell et al. 1995) points to a positive correlation between product market competition (as measured either by the number of competitors in the same industry or by the inverse of a market share or profitability index) and productivity growth within a firm or industry. This evidence, in turn, appears to be more consistent with the “Darwinian view” (see, for example, M. Porter 1990) that product market competition is good for growth because it forces firms to innovate in order to survive.

How can we reconcile the Darwinian view supported by Nickell et al. with the Schumpeterian paradigm developed earlier? Several tentative answers to this question will be explored in this chapter. The first section of the chapter will focus the relationship between competition among incumbent firms and innovation. There, we replace the assumption made earlier that incumbent innovators are automatically leapfrogged by their rivals, by a more gradualist (“step-by-step”) technological progress assumption. This in turn will generate an inverted-U relationship between competition and productivity growth.

The second section of the chapter will analyze the relationship between entry and innovation, showing that incumbent firms respond differently to an increased entry threat
depending on their initial distance from the technological frontier in the corresponding industry. It will also consider how entry interacts with labor market regulation, showing how the positive effects of increased entry on productivity growth are reduced by pro-worker regulations.

2 From leapfrogging to step-by-step technological progress

Based on Aghion-Harris-Vickers (1995) and Aghion et al (2001), in this section we shall replace the leapfrogging assumption of the basic Schumpeterian model (with incumbent innovators being systemically overtaken by outside researchers), with a less radical step-by-step assumption. That is, a firm that is currently $m$ steps behind the technological leader in its industry must catch up with the leader before becoming a leader itself. This step-by-step assumption can be rationalized by supposing that an innovator acquires tacit knowledge that cannot be duplicated by a rival without engaging in its own R&D to catch up. Once it has caught up we suppose that no patent protects the former leader from Bertrand competition.

This change leads to a richer analysis of the interplay between product market competition, innovation, and growth by allowing firms in an industry to be neck-to-neck. A higher degree of product market competition, by making life more difficult for neck-to-neck firms, will encourage them to innovate in order to acquire a significant lead over their rivals.

2.1 Basic environment

More formally, suppose that time is discrete and that there is a unit mass of identical consumers, each supplying a unit of labor inelastically, with a constant rate of intertemporal discount $r$ and an instantaneous utility function that depends on the amounts consumed from a continuum of sectors:

$$u_t = \int_0^1 \ln x_j dj,$$

in which each $x_j$ is the sum of two goods produced by duopolists in sector $j$:

$$x_j = x_{Aj} + x_{Bj}.$$

The logarithmic structure of this utility function implies that in equilibrium individuals spend the same amount on each basket $x_j$.\(^1\) We normalize this common amount to unity by

\(^1\)That is, the representative consumer will choose the $x_j$’s to maximize $u = \int \ln x_j dj$ subject to the budget
using current expenditure as the numeraire for the prices $p_{A_j}$ and $p_{B_j}$ at each date. Thus the representative household chooses each $x_{A_j}$ and $x_{B_j}$ to maximize $x_{A_j} + x_{B_j}$ subject to the budget constraint: $p_{A_j}x_{A_j} + p_{B_j}x_{B_j} = 1$; that is, she will devote the entire unit expenditure to the least expensive of the two goods.

### 2.2 Technology and innovation

Each firm produces using labor as the only input, according to a constant-returns production function, and takes the wage rate as given. Thus the unit costs of production $c_A$ and $c_B$ of the two firms in an industry are independent of the quantities produced. Now, let $k_i$ denote the technology level of duopoly firm $i$ in some industry $j$; that is, one unit of labor currently employed by firm $i$ generates an output flow equal to:

$$A_i = \gamma^{k_i}, \quad i = A, B,$$

where $\gamma > 1$ is a parameter that measures the size of a leading-edge innovation. Equivalently, it takes $\gamma^{-k_i}$ units of labor for firm $i$ to produce one unit of output.

For expositional simplicity, we assume that knowledge spillovers between the two firms in any intermediate industry are such that neither firm can get more than one technological level ahead of the other. That is, if a firm already one step ahead innovates, the lagging firm will automatically learn to copy the leader’s previous technology and thereby remain only one step behind. Thus, at any point in time, there will be two kinds of intermediate sectors in the economy: (i) level or neck-and-neck sectors where both firms are at technological par with one another, and (ii) unlevel sectors, where one firm (the leader) lies one step ahead of its competitor (the laggard or follower) in the same industry.\(^2\)

By spending the R&D cost $\psi(n) = n^2/2$ in units of expenditure, a leader (or frontier) firm moves one technological step ahead, with probability $n$. We call $n$ the “innovation rate” constraint $\int p_j x_j d_j = E$. The first-order condition for this is:

$$\frac{\partial u}{\partial x_j} = \frac{1}{x_j} = \lambda p_j \text{ for all } j$$

where $\lambda$ is a Lagrange multiplier. Together with the budget constraint this first-order condition implies

$$p_j x_j = 1/\lambda = E \text{ for all } j.$$  

\(^2\)Aghion et al (2001) analyze the more general case where there is no limit to how far ahead the leader can get. However, unlike in this chapter, that paper provides no closed form solution for the equilibrium R&D levels and the steady-state industry structure.
or “R&D intensity” of the firm. We assume that a follower firm can move one step ahead with probability $h$, even if it spends nothing on R&D, by copying the leader’s technology. Thus $n^2/2$ is the R&D cost of a follower firm moving ahead with probability $n + h$. Let $n_0$ denote the R&D intensity of each firm in a neck-and-neck industry; and let $n_{-1}$ denote the R&D intensity of a follower firm in an unlevel industry; if $n_1$ denotes the R&D intensity of the leader in an unlevel industry, note that $n_1 = 0$, since our assumption of automatic catch-up means that a leader cannot gain any further advantage by innovating.

### 2.3 Equilibrium profits and competition in level and unlevel sectors

We can now determine the equilibrium profits of firms in each type of sector, and link them with product market competition. Consider first an unlevel sector where the leader’s unit cost is $c$. She is constrained to setting a price $p_1 \leq \gamma c$ because $\gamma c$ is the rival’s unit cost, so at any higher price the rival could profitably undercut her price and steal all her business. Thus the leader’s profit will be:

$$\pi_1 = p_1 x_1 - c x_1$$

Since the leader is able to capture the whole market her revenue will be the total consumer expenditure on that sector, which we have normalized to unity:

$$p_1 x_1 = 1$$

She will therefore choose the maximal feasible price: $p_1 = \gamma c$, because at any lower price her revenue $p_1 x_1$ would be the same but her cost: $c x_1 = c / p_1$ would be higher. So her profit will be:

$$\pi_1 = 1 - c x_1 = 1 - c / p_1 = 1 - \gamma^{-1}$$

The laggard in the unlevel sector will be priced out of the market and hence will earn a zero profit:

$$\pi_{-1} = 0$$

Consider now a level sector. If the two firms engaged in open price competition with no collusion, the equilibrium price would fall to the unit cost $c$ of each firm, resulting in zero profit. At the other extreme, if the two firms colluded so effectively as to maximize their joint profits and shared the proceeds, then they would together act like the leader in an unlevel sector, each setting $p = \gamma c$ (we assume that any third firm could compete using
the previous best technology, just like the laggard in an unlevel sector), and each earning a profit equal to \( \pi_1/2 \).

So in a level sector both firms have an incentive to collude. Accordingly we model the degree of product market competition inversely by the degree to which the two firms in a neck-and-neck industry are able to collude. (They do not collude when the industry is unlevel because the leader has no interest in sharing her profit.) Specifically, we assume that the profit of a neck-and-neck firm is:

\[
\pi_0 = (1 - \Delta) \pi_1, \quad 1/2 \leq \Delta \leq 1,
\]

and we parameterize product market competition by \( \Delta \), that is, one minus the fraction of a leader’s profits that the level firm can attain through collusion. Note that \( \Delta \) is also the incremental profit of an innovator in a neck-and-neck industry, normalized by the leader’s profit.

We next analyze how the equilibrium research intensities \( n_0 \) and \( n_{-1} \) of neck-and-neck and backward firms respectively, and consequently the aggregate innovation rate, vary with our measure of competition \( \Delta \).

2.4 The Schumpeterian and “escape competition” effects

In each level sector, each firm chooses its innovation intensity \( n_0 \) so as to maximize its expected profit level. Suppose for simplicity that the firm looks only one period ahead. Suppose also that only one of the two neck-and-neck firms has the opportunity to innovate. Then the potential innovator’s expected profit not including R&D cost will be \( \pi_1 \) with probability \( n_0 \) and \( \pi_0 \) with probability \( 1 - n_0 \). So \( n_0 \) will be chosen so as to maximize the expected profit net of R&D cost:

\[
n_0 \pi_1 + (1 - n_0) \pi_0 - n_0^2/2
\]

resulting in:

\[
n_0 = \pi_1 - \pi_0
\]

or, in terms of our measure of competition \( \Delta \):

\[
n_0 = \Delta \pi_1 \quad (1)
\]
In each unlevel sector, the laggard chooses its innovation intensity \( n_{-1} \) so as to maximize its expected profit net of R&D cost:

\[
(n_{-1} + h) \pi_0 - n_{-1}^2/2
\]

resulting in:

\[
n_{-1} = \pi_0 = (1 - \Delta) \pi_1
\]

(2)

So we see the effect of competition on innovation depends on the situation. In unlevel sectors, equation (2) reveals the standard Schumpeterian effect that results from reducing the rents that can be captured by a follower who succeeds in catching-up with its rival by innovating. In such sectors an increase in competition, as measured by \( \Delta \), will discourage innovation.

But in level sectors, equation (1) indicates a positive effect of competition on innovation. This is because of what we call an “escape-competition” effect; that is, more competition induces neck-and-neck firms to innovate in order to escape from a situation in which competition constrains profits.

On average, an increase in product market competition will thus have an ambiguous effect on growth. It induces faster productivity growth in currently neck-an-neck sectors and slower growth in currently unlevel sectors. The overall effect on growth will thus depend on the (steady-state) fraction of level versus unlevel sectors. But this steady-state fraction is itself endogenous, since it depends upon equilibrium R&D intensities in both types of sectors. We proceed to show under which condition this overall effect is an inverted U, and at the same time derive additional predictions for further empirical testing.

2.5 Composition effect and the inverted-U

In a steady state, the fraction of sectors \( \mu_1 \) that are unlevel is constant, as is the fraction \( \mu_0 = 1 - \mu_1 \) of sectors that are level. The fraction of unlevel sectors that become leveled each period will be \( n_{-1} + h \), so the sectors moving from unlevel to level represent the fraction \( (n_{-1} + h) \mu_1 \) of all sectors. Likewise, the fraction of all sectors moving in the opposite direction is \( n_0 \mu_0 \), since one of the two firms innovates with probability \( n_0 \). In steady state, the fraction of firms moving in one direction must equal the fraction moving in the other direction:

\[
(n_{-1} + h)\mu_1 = n_0 (1 - \mu_1),
\]
which can be solved for the steady state fraction of unlevel sectors:

\[ \mu_1 = \frac{n_0}{n_{-1} + h + n_0}. \]  

(3)

This implies that the aggregate flow of innovations in all sectors is

\[ I = \frac{2(n_{-1} + h)n_0}{n_{-1} + h + n_0}. \]

Substituting in this equation for the R&D intensities \( n_0 \) and \( n_{-1} \) using (1) and (2) yields:

\[ I = \frac{2((1 - \Delta)\pi_1 + h)\Delta\pi_1}{\pi_1 + h} \]

Therefore the effect of competition on innovation is measured by the derivative:

\[ \frac{dI}{d\Delta} = \frac{2\pi_1}{\pi_1 + h} [(1 - 2\Delta)\pi_1 + h] \]

which is positive when there is the least amount of competition (at \( \Delta = 1/2 \)), and diminishes as competition increases (since \( \frac{d^2I}{d\Delta^2} < 0 \)). Whether or not the effect eventually turns negative depends on the size of the help factor \( h \). Specifically, the effect will be negative when there is the greatest amount of competition (at \( \Delta = 1 \)) if and only if \( h < \pi_1 \). In summary, we have:

**Proposition 1** If \( h < \pi_1 \), then aggregate innovation \( I \) follows an inverted-U pattern: it increases with competition \( \Delta \) for small enough values of \( \Delta \) and decreases for large enough \( \Delta \). When \( h \geq \pi_1 \), then innovation always increases with competition but at a decreasing rate.

The inverted-U shape can be explained as follows by a “composition effect” whereby a change in competition changes the steady-state fraction of sectors that are in the level state, where the escape-competition effect dominates, versus the unlevel state, where the Schumpeterian effect dominates. At one extreme, when there is not much product market competition, there is not much incentive for neck-and-neck firms to innovate, and therefore the overall innovation rate will be highest when the sector is unlevel. Thus the industry will be quick to leave the unlevel state (which it does as soon as the laggard innovates) and slow to leave the level state (which will not happen until one of the neck-and-neck firms innovates). As a result, the industry will spend most of the time in the level state, where the escape-competition effect dominates (\( n_0 \) is increasing in \( \Delta \)). In other words, if the degree of

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3 \( I \) is the sum of the two flows: \( (n_{-1} + h)\mu_1 + n_0(1 - \mu_1) \). But since the two flows are equal, \( I = 2(n_{-1} + h)\mu_1 \). Substituting for \( \mu_1 \) using (3) yields \( I = \frac{2(n_{-1} + h)n_0}{n_{-1} + h + n_0} \).
competition is very low to begin with, an increase in competition should result in a faster average innovation rate.

At the other extreme, when competition is initially very high, there is little incentive for the laggard in an unlevel state to innovate. Thus the industry will be slow to leave the unlevel state. Meanwhile, the large incremental profit $\pi_1 - \pi_0$ gives firms in the level state a relatively large incentive to innovate, so that the industry will be relatively quick to leave the level state. As a result, the industry will spend most of the time in the unlevel state where the Schumpeterian effect is the dominant effect. In other words, if the degree of competition is very high to begin with, an increase in competition should result in a slower average innovation rate.

2.6 Empirical evidence

Aghion-Bloom-Blundell-Griffith-Howitt(2005) test these predictions using a firm-level panel data set of UK firms listed on the London Stock Exchange between 1970 and 1994. Competition measures are computed using firm-level accounting data, and innovation output, measured by citation-weighted patenting, is derived using the NBER patents database\textsuperscript{4}.

Competition is measured by is the Lerner Index, or price cost margin, following Nickell [1996], itself defined by operating profits net of depreciation, provisions and an estimated financial cost of capital\textsuperscript{5} divided by sales,

$$l_i = \frac{\text{operating profit} - \text{financial cost}}{\text{sales}},$$

averaged across firms within the industry.

ABBGH then use these measures to estimate the equation

$$E[p_{jt}|c_{jt}, x_{jt}] = e^{g(c_{jt})+x_{jt}\beta},$$

where $p_{jt}$ is the patenting measure, $c_{jt}$ is the competition measure for industry $j$ at date $t$, and $x_{jt}$ represent a complete set of time and industry dummy variables.

Figure 1A below summarizes the findings.

\textsuperscript{4}See Hall, Jaffe and Trajtenberg [2000]. The NBER database contains the patents taken out in the US patent office, which is where innovations are effectively patented internationally, dated by the time of application.

\textsuperscript{5}The cost of capital is assumed to be 0.085 for all firms and time periods and the capital stock is measured using the perpetual inventory method. The inverted-U shape is robust to excluding this financial cost from the Lerner measure, principally because it is relatively small and constant over time.
FIGURE 1A BELOW

The figure shows that if we restrict the set of industries to those above the median degree of neck-and-neckness, the upward sloping part of the inverted-U relationship between competition and innovation is steeper than we consider the whole sample of industries.

3 Entry

Until now, competition policy in Europe has emphasized competition among incumbent firms, while paying insufficient attention to entry. Entry, as well as exit and turnover of firms, are more important in the United States than Europe. For example, 50% of new pharmaceutical products are introduced by firms that are less than 10 years old in the United States, versus only 10% in Europe. Similarly, 12 percent of the largest US firms by market capitalization at the end of the 1990s had been founded less than twenty years before, against only 4 per cent in Europe, and the difference between US and Europe turnover rates is much bigger if one considers the top 500 firms.

That the higher entry costs and lower degree of turnover in Europe compared to the US are an important part of the explanation for the relatively disappointing European growth performance over the past decade has been shown in empirical work by Nicoletti and Scarpetta (2003). In this section we extend the Schumpeterian paradigm to analyze the effects of entry on innovation and growth. We then provide evidence that is consistent with the predictions of that paradigm and questions the other two models of endogenous growth (AK and product variety).

Even more than competition among incumbents, Schumpeterian theory implies that entry, exit and turnover all have a positive effect on innovation and productivity growth, not only in the economy as a whole but also within incumbent firms. The idea here is that increased entry, and increased threat of entry, enhance innovation and productivity growth, not just because these are the direct result of quality-improving innovations from new entrants, but also because the threat of being driven out by a potential entrant gives incumbent firms an incentive to innovate in order to escape entry, through an effect that works much like the escape-competition effect described above. This “escape-entry” effect is especially strong for firms close to the work technology frontier. For firms further behind the frontier, the dominant effect of entry threat is a “discouragement” effect that works much like the Schumpeterian appropriability effect described above.
3.1 The environment

Here we use again our workhorse multi-sector model in discrete time. All agents live for one period. In each period $t$ a final good (henceforth the numéraire) is produced in each state by a competitive sector using a continuum one 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 to be the numéraire, is used in turn for consumption, as an input to R&D, and also as an input to the production of intermediate products.

In each intermediate sector $i$ only one firm (a monopolist) is active in each period. Thus the variable $i$ refers both, to an intermediate sector (industry), and to the intermediate firm which is active in that sector. As any other agent in the economy, intermediate producers live for one period only and property rights over intermediate firms are transmitted within dynasties. Intermediate firms choose how much to produce in order to maximize profits, taking into account that the price at which they sell their intermediate good to the final sector is equal to the marginal productivity of that good. As in the one-sector analysis of chapter 4, the equilibrium profit for each intermediate firm takes the form:

$$\pi_t(i) = \delta A_{it},$$

where

$$\delta = \left(1 - \frac{\alpha}{\alpha}\right)^{\frac{\alpha}{1-\alpha}}.$$

3.2 Technology and entry

Let $\bar{A}_t$ denote the new frontier productivity at date $t$ and assume that

$$\bar{A}_t = (1 + g)\bar{A}_{t-1}$$

with $1 + g = \gamma > 1$. We shall again emphasize the distinction already made in the previous section, between sectors in which the incumbent producer is "neck-and-neck" with the frontier and those in which the incumbent firm is far below the frontier:
At date $t$ an intermediate firm can either be close to frontier, with productivity level $A_{it-1} = \bar{A}_{t-1}$ (type-1 sector $i$) or far below the frontier, with productivity level $A_{it-1} = \bar{A}_{t-2}$ (type-2 sector $i$).

Before they produce and generate profits, firms can innovate to increase their productivity. Each innovation increases the firm’s productivity by the factor $\gamma$. For innovation to be successful with probability $z$ a type-$j$ intermediate firm with $j \in \{1, 2\}$ at date $t$ must invest

$$c_{it} = cz^2 A_{it-j}/2.$$ 

Intermediate firms are subject to an entry threat from foreign producers. Let $p$ denote the probability that an entrant shows up. Liberalization corresponds to an increase in $p$. Foreign entrants at date $t$ are assumed to operate with the end-of-period frontier productivity, $\bar{A}_t$.

If the foreign firm manages to enter and competes with a local firm which has a lower productivity, it takes over the market and becomes the new incumbent firm in the sector. If it competes with a local firm which has the same productivity, however, Bertrand competition drives the profits of both the local and the foreign firm to zero. Now, suppose that potential entrants observe the post-innovation technology of the incumbent firm before deciding whether or not to enter. Then the foreign firm will find it profitable to enter only if the local firm has a post-innovation productivity level lower than the frontier. However, the foreign firm will never enter in period $t$ if the local firm has achieved the frontier productivity level $\bar{A}_t$. Therefore, the probability of actual entry in any intermediate sector $i$, is equal to zero the local firm $i$ was initially close to the frontier and has successfully innovated, and it is equal to $p$ otherwise.

### 3.3 Equilibrium innovation investments

Using (4), together with the above innovation technology, we can analyze the innovation decisions respectively by intermediate firms that close and far below the frontier. Consider first firms that are initially far below the frontier at date $t$. If they choose to innovate with probability $z$ then their profit, not including the cost of innovation, will be $\delta A_{t-1}$ with probability $(1 - p) z$, which is the probability that they innovate and no entry occurs; and it will be $\delta A_{t-2}$ with probability $(1 - p) (1 - z)$, the probability of no innovation and no entry. If entry occurs they earn no profit. Therefore their expected profit, including the cost of innovation, will be:

$$(1 - p) z \delta A_{t-1} + (1 - p) (1 - z) \delta A_{t-2} - cz^2 A_{t-2}/2.$$
They will choose the probability $z$ that maximizes this expression; the first-order condition of this maximization problem yields the probability:

$$z_2 = (1 - p) (\gamma - 1) (\delta/c).$$

(5)

Next consider firms that are initially close to the frontier. Their expected profit will be $\delta \bar{A}_t$ if they innovate (with probability $z$), and $\delta \bar{A}_{t-1}$ if they fail to innovate and no entry occurs (with probability $(1 - p)(1 - z)$), so they will choose their probability of innovation so as to maximize:

$$z \delta \bar{A}_t + (1 - p)(1 - z) \delta \bar{A}_{t-1} - cz^2 \bar{A}_{t-1}/2,$$

so that:

$$z_1 = (\gamma - 1 + p) (\delta/c).$$

(6)

We interpret an increase in the threat of product entry, $p$, as a liberalization reform. Straightforward differentiation of equilibrium innovation intensities with respect to $p$, yields:

$$\frac{\partial z_1}{\partial p} = \frac{\gamma - 1}{c} > 0; \quad \frac{\partial z_2}{\partial p} = -\frac{\delta (\gamma - 1)}{c} < 0.$$

In other words, increasing the threat of product entry (e.g., through trade liberalization) encourages innovation in advanced firms and discourages it in backward firms. The intuition for these comparative statics is immediate. The higher the threat of entry, the more instrumental innovations will be in helping incumbent firms already close to the technological frontier to retain the local market. However, firms that are already far behind the frontier have no chance to win over a potential entrant. Thus, in that case, a higher threat of entry will only lower the expected net gain from innovation, thereby reducing ex ante incentives to invest in innovation.

### 3.4 The effect of labor market regulations

Next, consider the effects of changes in labor market regulations. A pro-employer change in regulation will raise the profit parameter $\delta$, so the qualitative effect on investments will be given by the derivatives:

$$\frac{\partial z_1}{\partial \delta} = (\gamma - 1 + p)/c > 0; \quad \frac{\partial z_2}{\partial \delta} = (1 - p) g/c > 0.$$

Hence, pro-employer labor market regulations encourage innovation in all firms.
On the other hand, if we look at the cross-partial derivatives with respect to reform \((p)\) and labor regulation \((\delta)\), we get:

\[
\frac{\partial^2 z_1}{\partial \delta \partial p} = \frac{1}{c} > 0; \quad \frac{\partial^2 z_2}{\partial \delta \partial p} = -\frac{g}{c} < 0.
\]

Thus, in particular, a more pro-employer labor regulation, i.e., a higher \(\delta\), increases the positive impact of entry on innovation investments in type-1 industries.

### 3.5 Main theoretical predictions

Let us conclude this section by summarizing our main findings:

1. **Liberalization (as measured by an increase in the threat of entry) encourages innovation in industries that are close to the frontier and discourages innovation in industries that are far from it.** Productivity, output, and profits, should thus be raised by more in industries and firms that are initially more advanced.

2. **Pro-worker labor market regulations discourage innovation and growth in all industries, and the negative effect increases with liberalization.**

### 3.6 Evidence on the growth effects of entry

The results of this simple extension of Schumpeterian growth theory have been corroborated by a variety of empirical findings. First, ABGHP (2005) investigate the effects of entry threat on TFP growth of UK manufacturing establishments, using panel data with over 32,000 annual observations of firms in 166 different 4-digit industries over the 1980-93 period. They estimate the equation:

\[
Y_{ijt} = \alpha + \beta E_{jt} + \eta_i + \tau_t + \varepsilon_{ijt}
\]

where \(Y_{ijt}\) is TFP growth in firm \(i\), industry \(j\), year \(t\), \(\eta\) and \(\tau\) are fixed establishment and year effects, and \(E_{jt}\) is the industry entry rate, measured by the change in the share of UK industry employment in foreign-owned plants. (For the UK foreign entrants are typically US entrants, close to the technology frontier, as in the theory, whereas domestic entrants are typically smaller, less efficient, and less likely to survive.) Column (1) of Table 1 below shows that OLS estimation produces a significant positive estimate of \(\beta\), indicating that entry-threat, as proxied by \(E_{jt}\), tends to increase the average productivity growth of incumbents. Column (2) shows that this estimate is largely unaffected by controlling for the
establishment’s sample average productivity growth. Columns (3) and (4) are IV estimates of the equations in the first two columns respectively, where the instruments for entry are cross-industry and time series variation in UK product market regulation triggered by the introduction of the EU Single Market Program and US R&D intensity in the industry. The IV estimates show an even stronger positive effect of entry threat on incumbent productivity growth.

\textit{TABLE 1 HERE}

This entry effect is economically as well as statistically significant. For example, according to column 3, a one-standard-deviation increase in the entry variable would raise the average incumbent’s TFP growth rate by 1.3 percentage points.

In order to verify that this effect of entry on incumbent productivity growth is a result of increased incumbent innovation rather than technology spillover from, or copying of, the superior technologies brought in by the entrants, ABGHP (2004) estimate equation (7) using a patent count rather than productivity growth as the dependent variable. Specifically, using a panel involving over 1000 annual observations of 176 UK firms in 60 different 3-digit industries over the 1987-93 period, they defined $Y_{ijt}$ as the log of the number of patents successfully applied for by firm $i$ in the United States, and $E_{jt}$ as the employment weighted share of new foreign-owned firms in the industry. An OLS regression using not just firm and year dummies but also controls for the firm’s pre-sample patent stock and a dummy for that stock being positive, produces a highly significantly positive estimate of $\beta$. The sign and significance of the estimate is robust to the inclusion of controls for import penetration, competition, and distance to the frontier $D_{jt}$, where the latter is measured by the labor-productivity in the corresponding US industry relative to the UK industry. Its significance is enhanced by instrumenting for entry as in the above growth regression.

ABGHP (2005) provide direct evidence that the escape competition is stronger for industries that are closer to the frontier. Specifically, when the interaction term $E_{jt} \cdot D_{jt}$ is added to the equation, its coefficient is highly significantly negative in all estimations. A one-standard deviation increase in the entry variable above its sample mean would reduce the estimated number of patents by 10.8% in an industry far from the frontier (at the 90th percentile of $D_{jt}$) and would increase the estimated number by 42.6% in an industry near the frontier (at the 10th percentile). Figure 1B below shows a similar picture when total factor
productivity growth replaces patent count as the left hand side variable. TFP growth in incumbent firms that closer to the technological frontier, reacts positively to an increase in (lagged) foreign entry whereas the opposite holds for firms that are far from frontier. Thus it seems that the positive effect of entry threat on incumbent productivity growth in Europe is indeed much larger now than it was immediately after WWII, and that the relative neglect of entry implications of competition policy is having an increasingly detrimental effect on European productivity growth.

**FIGURE 1B HERE**

### 3.7 Evidence on the effects of (de)regulating entry

Evidence that the effect of regulatory policy depends on a country’s circumstances is provided by Aghion, Burgess, Redding and Zilibotti (2005b) [ABRZ], who study the effects of delicensing entry in India over the period from 1980-97, during which there were two major waves of delicensing whose timing varied across states in industries. Using an annual panel with roughly 24,000 observations on 85 industries, 16 states and 18 years, they show that although delicensing had no discernible effect on overall entry it did increase the dispersion of output levels across establishments in the delicensed state-industries. Thus it seems that the effects of regulatory liberalization depend upon specific industry characteristics. ABRZ focused on one specific characteristic, namely the restrictiveness of labor market regulation. They estimated an equation of the form:

\[
\ln (y_{ist}) = \alpha + \beta \cdot delicense_{ist} + \gamma \cdot Lreg_{ist} + \delta \cdot delicense_{sit} \cdot Lreg_{ist} + \eta_{is} + \tau_t + \varepsilon_{ijt}
\]  

where \(y_{ist}\) is real output, \(delicense\) is a dummy that switches when the state-industry is delicensed, and \(Lreg_{ist}\) is a measure of the degree of pro-worker regulation. Although the coefficient \(\beta\) was statistically insignificant, the interaction coefficient \(\delta\) was highly significantly negative, indicating that one of the characteristics of an industry that makes it grow faster as a result of deregulation is the absence of restrictive labor-market regulation. This suggests a complementarity between different kinds of regulatory policy that needs to be taken into account when designing pro-growth policies. Relaxation of entry barriers may not succeed in promoting growth if not accompanied by other changes that are favorable to business development.
That the overall effect \( \beta \) of delicensing should be negligible is consistent with the theoretical model of ABGHP (2005) sketched above, which says that the marginal effect of entry threat on average incumbent productivity growth will be positive only if the threat already exceeds some threshold level \( p \). Indeed, combined with the finding of ABGHP (2004, 2005) to the effect that the effect on overall incumbent productivity growth in the UK is positive, the result is a confirmation of this theoretical framework, since presumably entry is more open in the UK than in India, and hence the theory predicts a more significant positive effect in the UK than in India.

Generally speaking, the message of ABRZ is again that the reaction to the threat of entry posed by liberalization is different for “advanced” and “backward” state-industries in the same sector. Removing barriers to entry incentivises competitive advanced state-industries to invest in new production and management practices but may have the opposite effect on “backward” state-industries that have little chance of competing in the new environment.

### 4 Conclusion

What have we learned from our analysis in this chapter? First, we have seen that empirical evidence supports the prediction of an inverted-U relationship between competition and innovation. Second, the evidence also supports the prediction that entry and delicensing have a more positive effect on growth in sectors or countries that are closer to the technological frontier, but have a less positive effect on sectors or countries that lie far below the frontier. These findings in turn question what the other models of endogenous growth have to say on how growth is affected by competition and entry policy. AK theory is simply silent on this topic, as up to now it has been developed exclusively using the theory of perfect competition. The product variety model is silent on the differential effects of entry, because in that theory all firms are the same distance from the frontier, and it delivers the counterfactual prediction that increased product market competition, which in that model corresponds to a higher degree of substitutability between intermediate inputs, should always reduce productivity growth by reducing the monopoly rents that reward R&D.

The findings in this chapter have important policy implications. In particular, they go directly against the belief that national or European “champions” are best placed to innovate at the frontier, or that these should be put in charge of selecting new research projects for public funding. Instead, our analysis suggests that although disregarding entry was no big
deal during the thirty years immediately after WWII when Europe was still far behind the US and catching up with it, nevertheless now that Europe has come close to the world technology frontier this relative neglect of entry considerations is having an increasingly depressing effect on European growth.

More generally, the above analysis of the growth effects of competition and entry, is an example of a phenomenon we shall explore in more detail in the following chapters, namely that policies which promote rapid economic growth when the economy is far from the world technology frontier may work in the opposite direction once the country has approached close to the frontier.