Online Appendix to “R&D and the Incentives from Merger and Acquisition Activity”*

Index

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Online Appendix

1. High bargaining power of the small firm.

To complement the analysis of varying bargaining power of the small firm (section 2.3 in the paper) here analyze the case when the small firm enjoys high bargaining power. Figure A.1 presents the optimal investment policies for =0.9 (the small firm captures 90% of the surplus). The key difference between figures A.1 and figure 6 in the paper is that in figure A.5 the only equilibrium in region II is the one in which only the small firm invests (and the big firm does not). This equilibrium occurs because for $\eta = 0.9$ $x_{2\eta} < x_{1\eta}$. Thus, a further increase in the bargaining power of the small firm leads to an even more aggressive investment by the small firm.

Insert figure A.1 here

2. Analysis of Multiple Small Firms and 1 Large Firm

In this section, we analyze the case of increasing competition by two small firms and one large firm. Equilibrium profits and firm values are computed similarly to those in our base case.

Initially, firms decide whether or not they want to invest in R&D to develop innovation. As discussed above, the probability of obtaining access to innovation equals p=(1/n), where n is the number of firms engaged in the R&D process.

As before, we assume that the big firm has an option to acquire one small firm at a cost I_{m}. It can take over a small firm that holds a patent to innovation (if one of the small firms obtained it) or a one without it. If an acquisition is consummated, then there remain two competing firms in the industry - the big merged entity and the small firm that has not been acquired.

Figure A.2 provides the optimal R&D strategies of the three firms for the base set of parameter values and the bargaining power of the small firm =0.5. For simplicity, we focus only on pure-strategy Nash equilibria.

Insert figure A.2 here

There are seven different regions in figure A.2. In region I no firm invests in R&D. In region II only the big firm invests. In region III there are two pure-strategy Nash Equilibria: (only one small firm invests, the big firm does not) and (big firm invests, small firms do not). In region IV there are three pure-strategy Nash Equilibria: (only one small firm invests, the big firm does not), (big firm invests, small firms do not), and (two small firm invest, the big firm does not). In region V there are two pure-strategy Nash Equilibria: (only one small firm invests, the big firm does not) and (two small firm invest, the big firm does not). In region VI the only pure strategy Nash equilibrium is the one in which both small firms invest, while the big firm does not invest. In region VII all three firms invest.

By comparing figure 6 (corresponding to the same parameter values but one small firm) and figure A.2, two results emerge. First, the aggregate investment in R&D is higher when there are two small firms in the industry than when there is only one small firm (figure 6). In particular, in regions II-V in figure 6 at least one firm invests (and there exist equilibria with two firms investing in regions IV and V), in region VI two firms invest, while in region VII all three firms invest. Second, and more importantly, a small firm has a stronger motivation to engage in R&D and get a better chance of being acquired by the larger firm. A small firm that does not become a takeover target will face intensified competition with the bigger entity (formed in result of the acquisition of its rival) that also commercializes the new technology. While it faces potential competition in the R&D market with the other small firm, it has a stronger incentive to become a takeover target and to avoid becoming an outsider. On the other hand the big firm is less motivated to invest when there are two small firms, given more aggressive investment in R&D by the small firms and because it has a lower probability of success facing competition with two firms. Therefore the big firm prefers to let one of them develop innovation and consequently acquire the innovation through an acquisition. As a consequence there exists a region in which in the only pure strategy equilibrium both small firms invest, while the big firm does not (region VI) in figure A.2.

3. Analysis of Cournot competition

In this section, we change the method of competition from Bertrand differentiated products to Cournot competition in quantity. We consider a setting in which firms produce identical products and innovation reduces production costs. We show that the theoretical predictions of our model hold in this different setting. In this case the utility function of the consumer becomes:

$$U(q) = \sqrt{xa}q - \frac{1}{2}q^2$$

where q is the total quantity of the product consumed, and the cost function is

$$\pi_j = q_j p_j - \frac{q_j^2}{2K_j},$$

We assume that innovation results in cost savings and the firm that successfully innovates enjoys a cost reduction of $c > 0$ per unit of output produced:

$$\pi_j^{inn} = q_j p_j - \frac{q_j^2}{2K_j} + cq_j.$$

Case 1: One small firm, one large firm and no acquisition is possible

To find the equilibrium profits we first differentiate the utility function with respect to quantities and set the derivatives equal to prices. This produces a linear demand function of the following form:

$$p = \sqrt{x}a - q_1 - q_2.$$

We then substitute these functions into profit functions, differentiate with respect to quantities, set the derivatives equal to zero, and solve the resulting system of equations. This produces equilibrium prices, quantities, and profits. Equilibrium profit of firm j as a function of its own innovation parameter c_j and that of its competitor c_i is given below:

$$\pi_j(c_j, c_i) = \frac{K_j(1+K_j)(\sqrt{x}a(2+K_i) + 2c_j(1+K_j) - c_i K_i)^2}{(4+4K_j+4K_i+3K_jK_i)^2}.$$

The values of the two firms as functions of their R&D policies are

$$V_1(NI, NI) = \pi_1(0,0); \quad V_2(NI, NI) = \pi_2(0,0)$$

$$V_1(I,NI) = \pi_1(c,0) - RD_1; \quad V_2(I,NI) = \pi_2(c,0)$$

$$V_1(NI,I) = \pi_1(0,c); \quad V_2(NI,I) = \pi_2(0,c) - RD_2.$$

$$V_1(I,I) = 0.5(\pi_1(0,c) + \pi_1(c,0)) - RD_1; \quad V_2(NI,I) = 0.5(\pi_2(0,c) + \pi_2(c,0)) - RD_2.$$

Figure A.3 presents the equilibrium strategies of the two firms in the space (α', x).

Insert figure A.3 here

The results in figure A.3 are based on the following set of parameter values: $K_1 = 10$, $K_2 = 1$, $\gamma = 0.5$, $\alpha = 10$, $RD_1 = RD_2 = 15$, (the same set of parameters as used in the paper). In addition the cost saving parameter c is allowed to vary from 2 to 3. Figure A.3 looks very similar to figure 3 in the paper. There are three regions in figure A.3. For very low states of x, both firms optimally choose not to invest (region I). For sufficiently high values of x NPV_1 becomes positive and the big firm invests, while NPV_2 is still negative - the small firm produces less than the big one and therefore the potential cost saving resulting from innovation is less valuable to the small firm (region II). Finally, for even higher states of x the small firm chooses to join the R&D race with the big firm, as the value of the option to join becomes positive (region III).

Case 2: One small firm, one large firm, an acquisition is possible

If a merger occurs then a single entity is formed. This entity maximizes its total profit by optimally choosing q_1 and q_2. We assume that the new entity does not redeploy capital between its two divisions. The profit of the merged entity is

$$\pi_m(c) = \frac{(a\sqrt{x} + c)^2(K_1 + K_2)}{4(1 + K_1 + K_2)}$$

if the firm has access to the cost-saving technology, and

$$\pi_m(0) = \frac{a^2 x(K_1 + K_2)}{4(1 + K_1 + K_2)}$$

otherwise. As before, we assume that the large firm (the bidders) captures a fraction η of the takeover surplus. Firm values are given by the following expressions (assuming zero takeover cost I_m):

$$V_1(NI,NI) = \eta(\pi_m(0) - \pi_2(0,0) - \pi_1(0,0)) + \pi_1(0,0);$$

$$V_2(NI,NI) = (1-\eta)(\pi_m(0) - \pi_2(0,0) - \pi_1(0,0)) + \pi_2(0,0)$$

$$V_1(I,NI) = \eta(\pi_m(0) - \pi_2(c,0) - \pi_1(c,0)) + \pi_1(c,0) - RD_1;$$

$$V_2(I,NI) = (1-\eta)(\pi_m(0) - \pi_2(c,0) - \pi_1(c,0)) + \pi_2(c,0);$$

$$V_1(NI,I) = \eta(\pi_m(0) - \pi_2(0,c) - \pi_1(0,c)) + \pi_1(0,c);$$

$$V_2(NI,I) = (1-\eta)(\pi_m(0) - \pi_2(0,c) - \pi_1(0,c)) + \pi_2(0,c);$$

$$V_1(I,I) = 0.5[\eta(2\pi_m(0) - \pi_2(0,c) - \pi_1(0,c) - \pi_2(c,0) - \pi_1(c,0)) + \pi_1(0,c) + \pi_1(c,0)] - RD_1;$$

$$V_2(I,I) = 0.5[(1-\eta)(2\pi_m(0) - \pi_2(0,c) - \pi_1(0,c) - \pi_2(c,0) - \pi_1(c,0)) + \pi_2(0,c) + \pi_2(c,0)] - RD_2;$$

The analysis of this case is presented in figures A.4 ($\eta = 0$) and A.5 ($\eta = 0.5$). Qualitatively results are similar to the case with Bertrand competition (figures 4 in the paper). There are three regions in figure A.4. At low states of the demand shock x both firms prefer not to invest in R&D (Region I). In region II only the big firm invests. In region III there are two pure-strategy Nash equilibria (small firm invests, the big firm does not) and (big firm invests, small firm does not) and a mixed-strategy equilibrium in which both firm invest with certain probabilities. Both firms invest in region IV (with probability 1). Like in the Bertrand competition case, innovation by the big firm starts at a lower state of the demand shock x, because the potential benefit of innovation is greater - the big firm has an option to acquire the small one and apply innovation to both its own production capacity and the production capacity acquired through the takeover of the small firm. Also, there is a region in which there is a pure-strategy equilibrium, in which the small firm innovates while the big firm does not (region III in figure A.4)

Insert figures A.4 and A.5 here

Results in figure A.5 (corresponding to the bargaining power of the target $\eta = 0.5$) are also consistent with the Bertrand competition case. The intermediate region (region III) is much wider, while the region in which the only equilibrium involves the big firm investing shrinks (region II). Since the small firm gets a share of the acquisition benefit it is more motivated to engage in R&D, so it could sell out to the big firm at a higher price. Because of a high potential payoff in the event of successful innovation and a subsequent acquisition, the small firm is motivated to pursue an aggressive R&D strategy. Similarly, the boundary at which both firms decide to invest in R&D shifts down, as at high states of demand the big firm decides to join the R&D race in order to reduce the potential takeover surplus (which it would have to share with the small firm).

4. Analysis of the case when probability of innovating is independent of the number of firms

Here we analyze the scenario when the probability of innovating by each firm if it invests in R&D, p, is fixed and does not depend on whether the other firms also invested in their R&D programs. For the sake of simplicity we set the acquisition cost $I_m = 0$ so a takeover is always optimal (regardless of which firm innovates) due to the increased market power. We analyze this setting numerically and present the results in figures A6a and A6b. In figure A6a takeovers are not allowed so the only potential access to innovation is through the firm's own R&D investment.

Insert figure A.6 here

Furthermore, the probability of successfully innovating is $p = 0.5$ and does not depend on the actions of the other firm, so if both firms invest there is a p^2 probability that both develop and subsequently commercialize innovation. The optimal investment strategies in Figure A6a are similar to those in figure 3 in the paper, though quantitatively different, because of reduced incentives to innovate due to below 100% unconditional probability of success. There are three regions in figure A6a. In the lower region no firm invests. In the intermediate region only the big firm invests. In the upper region both firms invest.

Figure A6b presents results when takeovers are possible. There are five different regions in figure A4b. In region I no firm invests. In region II only the small firm invests. In region III there are two pure strategy Nash equilibria (small firm invests, big firm does not) and (big firm invests, small firm does not). Only the big firm invests in region IV. Both firms invest in region V.

Comparing figures A6a and A6b reveals that the major predictions of our model hold. Possibility of takeovers intensifies R&D investment, and especially by small firms. It also leads to more procyclical R&D by small firms as opposed to large ones. Indeed the small firm invests with probability 1 in regions II and V, invest with some probability in region III and does not invest in region IV.

The major intuition behind our results is the same - the big firm can access innovation through the acquisition of the small firm as opposed to innovating itself, though the probability that at least one firm innovates now depends on the number of firms that innovate (it is equal to p if only one firm innovates and to $1-(1-p)^2$ if both firms innovate). In deciding whether or not to innovate itself (conditional on the small firm deciding to innovate) the big firm trades off the benefit of the high probability of innovation with the R&D cost. Given that the big firm invests in R&D less aggressively, the small firm is motivated to innovate more. We conclude that our predictions are in general robust to the setting in which the probability of innovating successfully does not depend on the number of firms that attempt to innovate and multiple firms can develop innovation.

5. Robustness of results with respect to variations in parameter values

In this section, we perform further analysis of the robustness of our results to various combinations of parameter values. In particular, we examine more closely whether conditions lemma 1c), lemma 1e), lemma 1f), and the three conditions in footnotes 16-18. Lemma 1c, lemma 1f, footnotes 16-18 are robust to different variations of parameter values. For example, all these conditions hold for $K_1 = 10; a = 10$; $0.1 \leqslant \gamma \leqslant 0.9$; $1 \leqslant K_2 \leqslant 9$; $11 \leqslant \alpha' \leqslant 30$. Condition lemma 1e is, however, more restrictive. It holds well when the ratio of the capital stocks of the two firms K_1/K_2 is relatively high. For example, it holds for the following parameter combinations: $K_1 = 10; a = 10$; $0.25 \leqslant \gamma \leqslant 0.75$; $K_2 \leqslant 1$; $11 \leqslant \alpha' \leqslant 18$, or $K_1 = 10; a = 10$; $0.05 \leqslant \gamma \leqslant 0.95$; $K_2 \leqslant 0.5$; $11 \leqslant \alpha' \leqslant 30$. We believe that the model in this paper is more relevant for large firms acquiring smaller ones and less for a merger of similar firms. When the difference in the size of the acquirer and the target is relatively large, all our results go through. However, in order to make sure our results are robust to alternative parameter values below we analyze the following combination of parameters: $K_1 = 10; a = 10$; $\gamma = 0.5$; $K_2 = 3$; $12 \leqslant \alpha' \leqslant 15$. In this case the condition in lemma 1e does not hold and

$$\frac{\pi_1(I, NI) - \pi_1(NI, I)}{2} < \pi_2(NI, I) - \pi_2(NI, NI).$$

This in turn implies that the threshold x_2 is below the threshold x_4 and gives rise to an additional equilibrium region in figure A6a below.

Insert figure A.7 here

This figure presents the equilibrium R&D strategies of the two firms when takeovers are not allowed.

It corresponds to figure 3 in the paper. The violation of lemma 1e leads to a new region - region III in which there are two pure strategy Nash equilibria (small firm invests , big firm does not) and (big firm invests, small firm does not). There is also a mixed-strategy equilibrium in this region in which each firm invests with a certain probability.

Figure A7b presents the equilibrium strategies of the two firms for the same parameter values when takeover are allowed. This figure corresponds to figure 4 in the paper. Comparing figures A7a and A7b shows that the possibility of a takeover still intensifies R&D investments and especially by the small firm. While for $x_4 < x < x_3$ in figure A7a (region IV) the small firm does not invest with probability 1, there are equilibria in which it does invest in the same region in figure A7b.

We therefore conclude that all restrictions on parameter values that we impose in our paper except for the one in lemma 1e hold for a wide range of values. Condition lemma 1e does holds for various parameter combinations as long as the ratio K_1/K_2 is relatively high (for example, when this ratio is above 10). We believe that this case (high K_1/K_2) fits well into our story as ours is a model of large firms acquiring small innovative companies and not about a merger of equals. However, even when the condition in lemma 1e is violated, our predictions in general still obtain.

6. Additional empirical results

6.1 R&D quantile regressions.

Table A1 reports estimates from R&D quantile regressions. We estimate these regressions due to concerns about non-normality of the R&D to sales ratio. The results are consistent with our base specification in table 3.

Insert table A.1 here

6.2 R&D regressions with outside liquidity measures.

For robustness here we report results from R&D regressions with outside industry M&A activity. Outside M&A activity is determined using only the deals with the target and the acquirer belonging to different industries. While the coefficients on all dependent variables except for liquidity measures are similar to those in table 3, coefficients on outside M&A activity and on the interaction terms are insignificant, in contrast to significant coefficients on inside M&A activity in table 3. These results are consistent with the intuition of our model, as it relates to competing firms in the same industry doing acquisitions to obtain access to innovation and it is not relevant for vertical or conglomerate mergers.

Insert table A.2 here

6.3 Estimating the first-stage regression in the IV model with probit.

In this section, we employ an alternative specification to estimate the probability of being a target (using MFFlow as an instrument). In the paper we estimate it using a linear probability model. Here we estimate the first stage with a probit model. The results are presented in Table A3 (for the census Herfindahl concentration measure) and A4 (HP concentration measure). They are very similar to our main results presented in tables 6 and 7 in the paper. These results need to be interpreted with caution however, given concerns that have been raised in the literature about using probit or logit to generate first-stage predicted values in applications with a dummy endogenous regressor. (See Angrist and Krueger (2001) for details).

Insert tables A.3 and A.4 here

Figure A.1. Equilibrium strategies - 2 firms, with target bargaining power Figure A.1 presents the equilibrium investment thresholds of the two firms in the case when an acquisition is possible, as functions of the innovation parameter α'. The set of input parameters is as follows: $K_1 = 10$, $K_2 = 1$, $\gamma = 0.5$, $\alpha_1 = \alpha_2 = 10, \alpha' = 15, RD_1 = RD_2 = 15$. In addition, the relative bargaining power of target shareholders $\eta = 0.9$. In region II only the small firm invests. In region III there are three Nash equilibria - two pure strategy ones (small firm invests, the big firm does not) and (big firm invests, small firm does not) and a mixed-strategy equilibrium. Both firms invest in region IV. It follows from comparing figure A.5 and figure 4 in the paper that greater bargaining power of the potential target (small firm) increases its innovation incentives.

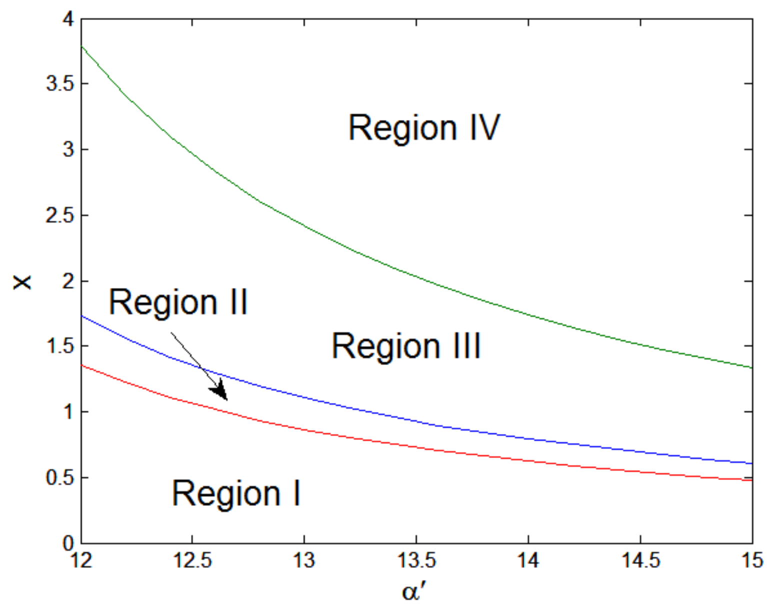

Figure A.2. Equilibrium strategies, one big firm, two small firms, an acquisition is possible This figure presents the equilibrium investment thresholds of the three firms in the case when an acquisition is possible, as functions of the innovation parameter α'. The set of input parameters is as in figure A.2. In addition, the relative bargaining power of target shareholders $\eta = 0.5$. There are seven different regions in figure A.2. In region I no firm invests in R&D. In region II only the big firm invests. In region III there are two pure-strategy Nash Equilibria: (only one small firm invests, the big firm does not) and (the big firm invests, small firms do not). In region IV there are three pure-strategy Nash Equilibria: (only one small firm invests, the big firm does not), (the big firm invests, the small firms do not), and (two small firm invest, the big firm does not). In region V there are two pure-strategy Nash Equilibria: (only one small firm invests, the big firm does not) and (two small firms invest, the big firm does not). In region VI the only pure strategy Nash equilibrium is the one in which both small firms invest, while the big firm does not invest. In region VII all three firms invest.

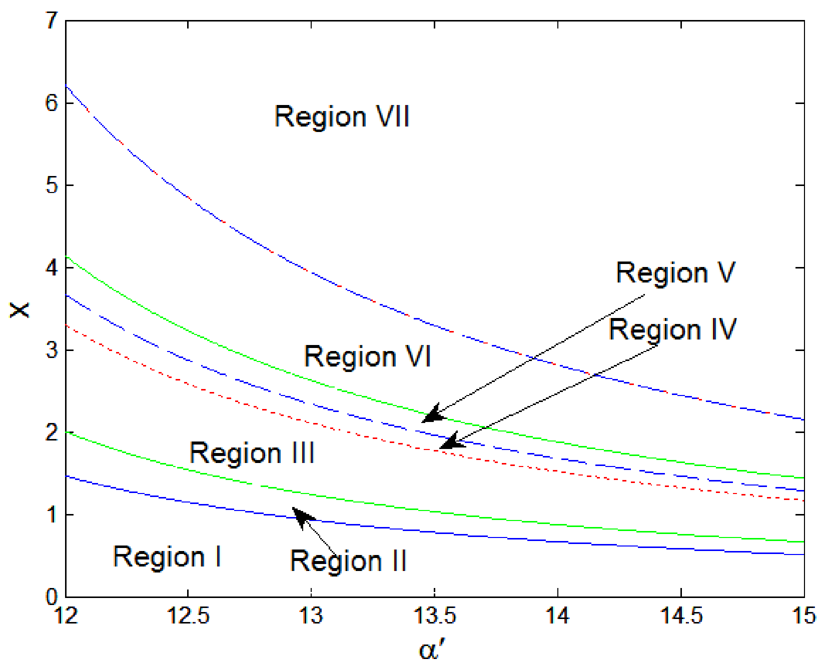

Figure A.3. Equilibrium strategies - two firms, no acquisitions possible, Cournot competition

This figure presents the equilibrium investment thresholds of the two firms in the case when an acquisition is precluded, as functions of the innovation parameter c. The set of input parameters is as follows: $K_1 = 10$, $K_2 = 1,\ \gamma = 0.5,\ \alpha_1 = \alpha_2 = 10, RD_1 = RD_2 = 15$. No firm invests in region I, only the big firm invests in region II, both firms invest in region III.

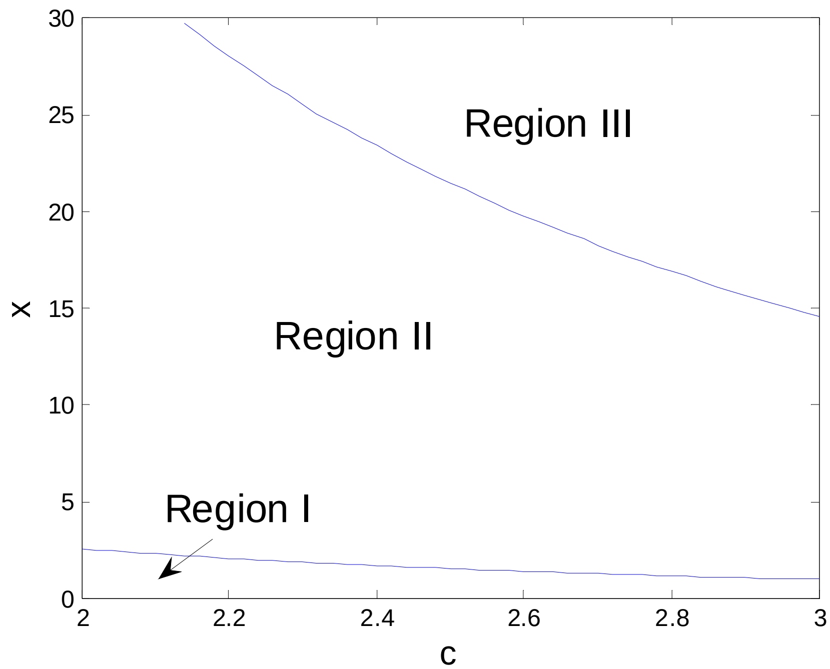

Figure A.4. Equilibrium strategies - two firms, an acquisition is possible, Cournot competition

This figure presents the equilibrium investment thresholds of the two firms in the case when an acquisition is possible, as functions of the innovation parameter c. The set of input parameters is as in figure A.3. In addition, the relative bargaining power of target is assumed to be zero ($\eta = 1$). At low states of the demand shock x both firms prefer not to invest in R&D (Region I). In region II only the big firm invests. In region III there are two pure-strategy Nash equilibria (small firm invests, the big firm does not) and (big firm invests, small firm does not) and a mixed-strategy equilibrium in which in which both firm invest certain probabilities. Both firms invest in region IV.

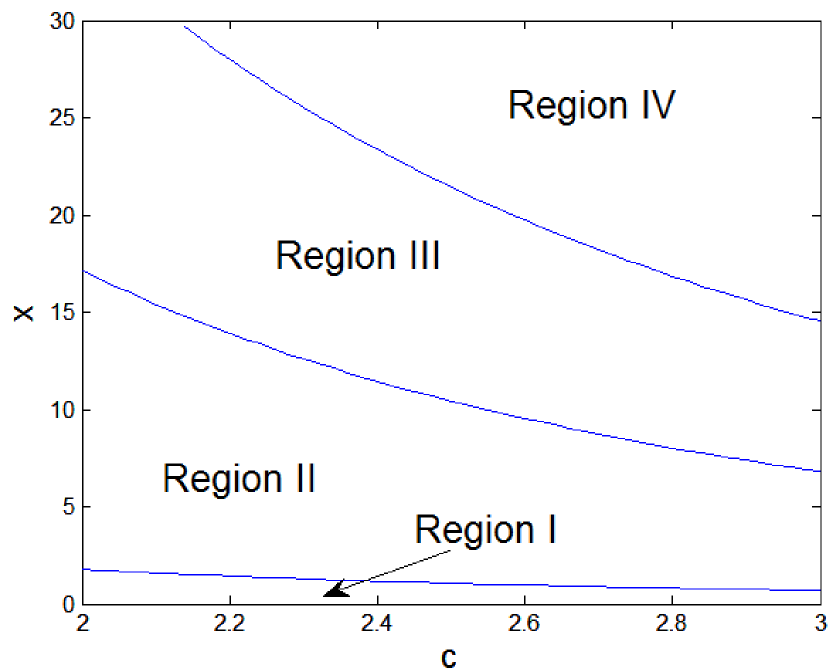

Figure A.5. Equilibrium strategies - two firms, an acquisition is possible, Cournot competition, positive bargaining power of the target

This figure presents the equilibrium investment thresholds of the two firms in the case when an acquisition is possible, as functions of the innovation parameter c. The set of input parameters is as in figure A.3. In addition, the relative bargaining power of target is assumed to be 0.5 ($\eta = 0.5$). At low states of the demand shock x both firms prefer not to invest in R&D (Region I). In region II only the big firm invests. In region III there are two pure-strategy Nash equilibria (small firm invests, the big firm does not) and (big firm invests, small firm does not) and a mixed-strategy equilibrium in which in which both firms invest with certain probabilities. Both firms invest in region IV.

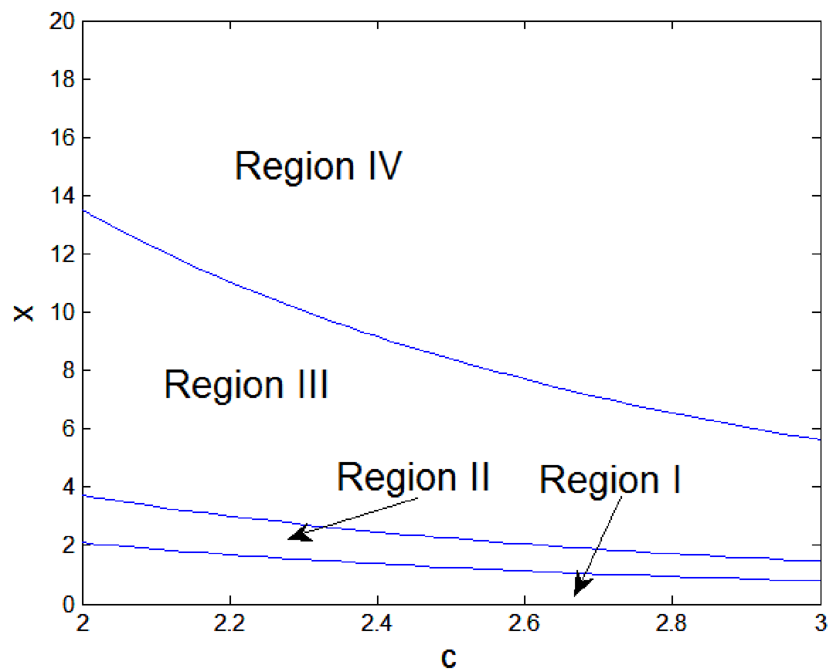

Figure A6a. Equilibrium strategies - 2 firms, no takeover, independent probability of innovation This figure presents the equilibrium investment thresholds of the two firms in the case of no takeovers, as functions of the innovation parameter α. The set of input parameters is as in figure 3. In addition, the probability of each firm innovating $p = 0.5$ and independent of the other firms innovation. In the lower region no firm invests. In the intermediate region only the big firm invests. In the upper region both firms invest

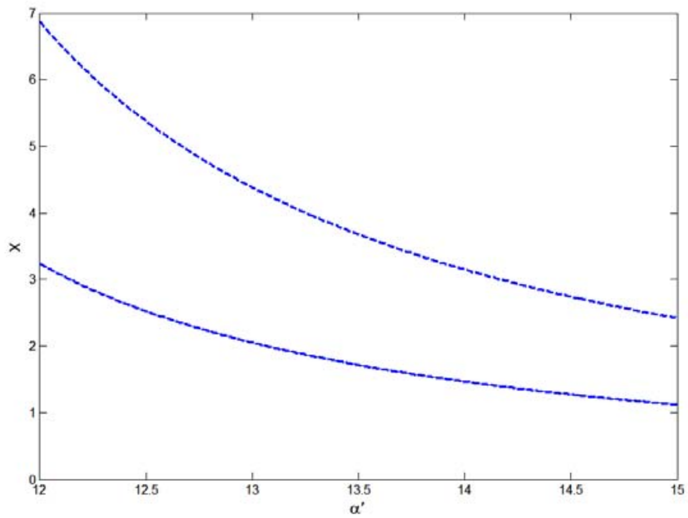

Figure A6b. Equilibrium strategies - 2 firms, takeover, independent probability of innovation
This figure presents the equilibrium investment thresholds of the two firms in the case when takeovers are possible, as functions of the innovation parameter α. The set of input parameters is as in figure 3. In addition, the probability of each firm innovating $p = 0.5$ and independent of the other firms innovation and the relative bargaining power of target shareholders $\eta = 0.5$. There are five different regions in figure A6b. In region I no firm invests. In region II only the small firm invests. In region III there are two pure strategy Nash equilibria (small firm invests , big firm does not) and (big firm invests, small firm does not). Only the big firm invests in region IV. Both firms invest in region V.

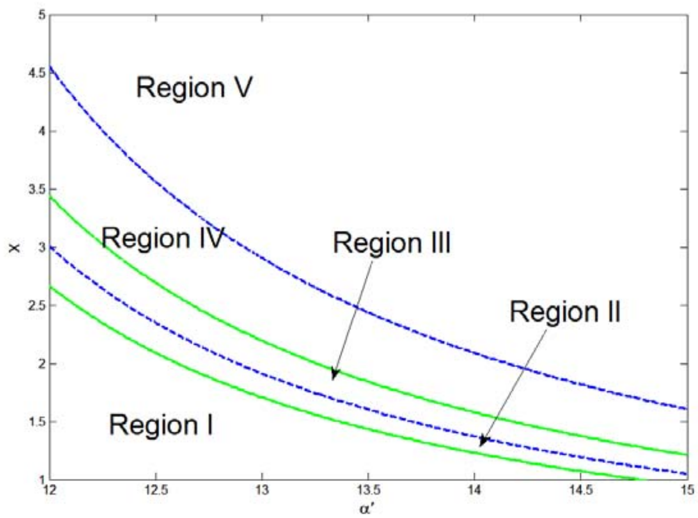

Figure A7a. Equilibrium strategies - two firms, no acquisition possible This figure presents the equilibrium investment thresholds of the two firms in the case when an acquisition is precluded, as functions of the innovation parameter α'. The set of input parameters is as follows: $K_1 = 10$, $K_2 = 3$, $\gamma = 0.5$, $\alpha_1 = \alpha_2 = 10, \alpha' = 15, RD_1 = RD_2 = 15$. No firm invests in region I, only the big firm invests in regions II and IV, both firms invest in region V. In region III there are two pure strategy Nash equilibria (small firm invests , big firm does not) and (big firm invests, small firm does not). Regions I and II are separated by x_1, regions II and III are separated by x_2, regions III and IV are separated by x_3, regions IV and V are separated by x_3.

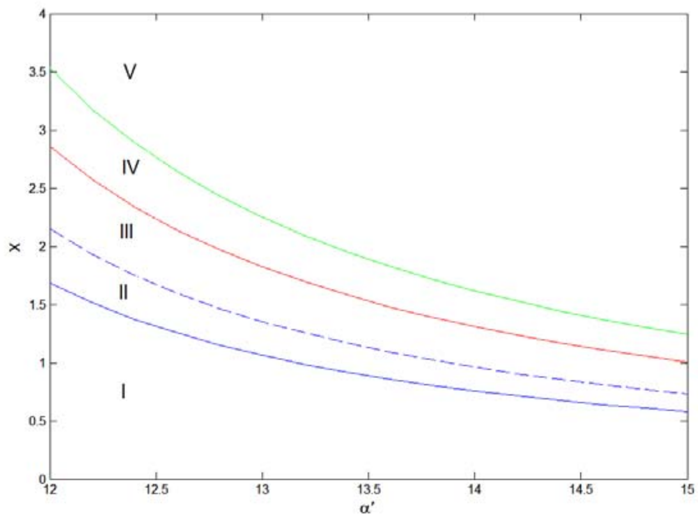

Figure A7b. Equilibrium strategies - two firms, an acquisition is possible This figure presents the equilibrium investment thresholds of the two firms in the case when an acquisition is possible, as functions of the innovation parameter α'. The set of input parameters is as in figure A7a. In addition, the relative bargaining power of target is assumed to be zero ($\eta = 0$). At low states of the demand shock x both firms prefer not to invest in R&D (Region I). In region II only the big firm invests. In region III there are two pure strategy Nash equilibria (small firm invests , big firm does not) and (big firm invests, small firm does not) Both firms invest in region IV.

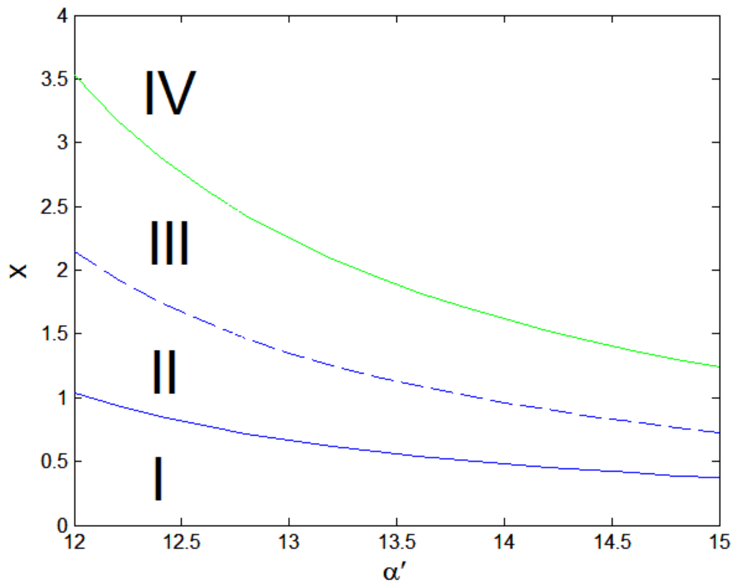

Table A1: R&D quantile regressions with inside industry M&A Activity.

Table A1 reports estimates from *R&D* quantile regressions. The dependent variable is *R&D* expense scaled by sales in the previous year. Column 1 reports results from the median quantile and column 2 reports results from the 75th percentile. Standard errors are clustered by industry-year.

VARIABLES	(1) rdsales p(50)	(2) rdsales p(75)
Vexpand	0.015***	0.047***
	(0.002)	(0.004)
Log(net assets)	-0.002***	-0.006***
	(0.001)	(0.001)
Vexpand*Log(net assets)	-0.002***	-0.005***
	(0.000)	(0.001)
Inside industry M&A Activity	1.079***	2.791***
	(0.022)	(0.046)
Ins M&A * Log(net assets)	-0.087***	-0.253***
	(0.004)	(0.009)
Compete	0.004***	0.010***
	(0.001)	(0.001)
Compete*Log(net assets)	-0.000***	-0.001***
	(0.000)	(0.000)
InstOwn	0.000***	0.001***
	(0.000)	(0.000)
Firm-level UV, PV	0.011***	0.024***
	(0.000)	(0.001)
Industry-level UV, PV	-0.005***	-0.020***
	(0.001)	(0.002)
C&I spread	0.002*	0.005*
	(0.001)	(0.003)
Log(Cash /NA)	0.001***	0.002***
	(0.000)	(0.000)
Leverage	-0.052***	-0.064***
	(0.001)	(0.003)
NWC	-0.010***	-0.034***
	(0.000)	(0.000)
Tangibility	0.002***	0.007***
	(0.000)	(0.000)
P/E	-0.000***	-0.000***
	(0.000)	(0.000)
Divd dummy	-0.023***	-0.060***
	(0.001)	(0.002)
Constant	0.046***	0.123***
	(0.004)	(0.009)
Observations	45,530	45,530
Adj. R-squared	0.0207	0.119

Table A2: R&D regressions with Outside Industry M&A Activity

Table A2 reports estimates from *R&D* regressions. The dependent variable is *R&D* expense scaled by sales in the previous year. *Vdshock* is a de-trended demand shock variable constructed from the input-output matrix. *Vexpand* is a discretized version of *Vdshock* . *Log(net assets)* is the log of the asset value. *Outside Industry M&A Activity* is the asset liquidity measure based on outside industry acquirers. *Compete* is a measure of industry competitiveness equaling one minus the Herfindahl index. *C&I spread* is the commercial and industrial loan spread. *Firm-level UV, PV* is the firm-level unexplained valuation computed from the Pastor and Veronesi (PV) model. *Industry-level UV, PV* is the industry-level unexplained valuation variable. Control variables are tangible assets, cash, and net working capital scaled by sales, price-to-earnings ratio, dividend payment dummy, and institutional ownership. Standard errors are clustered by industry-year.

PANEL A

Independent Variable	*Dependent variable - R&D expenditures scaled by sales*						
Vexpand	0.350***	0.327***	0.656***	0.575***	0.543***	0.526***	0.499***
	(0.100)	(0.096)	(0.135)	(0.123)	(0.126)	(0.130)	(0.126)
Log(net assets)		-0.117***	-0.056***	-0.048***	-0.037***	-0.051***	-0.142***
		(0.017)	(0.011)	(0.009)	(0.008)	(0.011)	(0.023)
Age		-0.249***	-0.249***	-0.241***	-0.237***	-0.168***	-0.204***
		(0.042)	(0.042)	(0.040)	(0.040)	(0.035)	(0.038)
Vexpand*Log(net assets)			-0.075***	-0.065***	-0.057***	-0.057***	-0.057***
			(0.019)	(0.018)	(0.016)	(0.016)	(0.015)
Outside industry M&A Activity				-0.005	-0.152	-0.402	-0.504
				(0.413)	(0.407)	(0.466)	(0.468)
Out M&A * Log(net assets)				-0.136**	-0.090	-0.058	-0.016
				(0.055)	(0.056)	(0.061)	(0.053)
Compete						0.029***	0.139***
						(0.006)	(0.024)
Compete*Log(net assets)							-0.019***
							(0.003)
Firm-level UV, PV					0.142***	0.143***	0.144***
					(0.016)	(0.017)	(0.017)
Industry-level UV, PV					-0.112	-0.105	-0.163
					(0.112)	(0.106)	(0.116)
C&I spread							0.432*
							(0.253)
Observations	84,471	84,459	84,459	81,047	56,934	51,001	49,233
R-squared	0.017	0.033	0.034	0.035	0.032	0.050	0.045
Adj. R-squared	0.0165	0.0326	0.0333	0.0342	0.0314	0.0495	0.0445
Control variables	No	No	No	No	No	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	No

PANEL B

Independent Variable	*Dependent variable - R&D expenditures scaled by sales*						
Vdshock	0.561	0.247	1.078*	1.134**	0.790	0.809	0.907
	(0.435)	(0.440)	(0.594)	(0.524)	(0.549)	(0.568)	(0.565)
Log(net assets)		-0.118***	-0.109***	-0.090***	-0.077***	-0.089***	-0.184***
		(0.017)	(0.018)	(0.013)	(0.012)	(0.017)	(0.031)
Age		-0.252***	-0.256***	-0.250***	-0.249***	-0.172***	-0.209***
		(0.044)	(0.044)	(0.042)	(0.043)	(0.035)	(0.039)
Vdshock*Log(net assets)			-0.195**	-0.224***	-0.157**	-0.161**	-0.156**
			(0.099)	(0.083)	(0.079)	(0.079)	(0.075)
Outside industry M&A Activity				0.003	-0.140	-0.392	-0.482
				(0.422)	(0.413)	(0.477)	(0.473)
Out M&A * Log(net assets)				-0.139**	-0.094*	-0.063	-0.019
				(0.056)	(0.056)	(0.061)	(0.053)
Compete						0.033***	0.146***
						(0.007)	(0.025)
Compete*Log(net assets)							-0.019***
							(0.003)
Firm-level UV, PV					0.143***	0.144***	0.145***
					(0.016)	(0.017)	(0.017)
Industry-level UV, PV					-0.080	-0.073	-0.098
					(0.113)	(0.108)	(0.115)
C&I spread							0.435*
							(0.255)
Observations	84,471	84,459	84,459	81,047	56,934	51,001	49,233
R-squared	0.014	0.031	0.031	0.032	0.029	0.047	0.042
Adj. R-squared	0.0142	0.0305	0.0306	0.0314	0.0284	0.0468	0.0420
Control variables	No	No	No	No	No	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	No

Table A3: R&D with instrumented target from mutual fund flows and probit first-stage regressions

Table A3 reports estimates from *R&D* regressions using instrumental variable approach and *Mfflow* as an instrument for the target indicator variable and all the control variables from the target prediction regression. The dependent variable is *R&D* expense scaled by sales in the previous year. *Log(net assets)* is the log of the asset value. *Age* is time in 100s years since the founding year, incorporation year (if founding is missing), or the first year the firm appears in CRSP tapes (if both founding and incorporation years are missing). *Compete* is a measure of industry competitiveness equaling one minus the Herfindahl index. *C&I spread* is the commercial and industrial loan spread. *Firm level UV, RKRV* is the firm-level unexplained valuation computed from the Rhodes-Kropf, Robinson, and Viswanathan (RKRV) model. *Industry-level UV, RKRV* is the industry-level unexplained valuation variable. *C&I spread* is the commercial and industrial loan spread. Control variables include tangible assets, cash, and net working capital scaled by sales, price-to-earnings ratio, dividend payment dummy, and institutional ownership.

Independent Variable	*Dependent variable - R&D expenditures scaled by sales*		
Target dummy	1.095***	1.242***	1.178***
	(0.443)	(0.498)	(0.459)
Vexpand	0.745***	0.604***	0.627***
	(0.095)	(0.100)	(0.097)
Log(net assets)	-0.334***	-0.336***	-0.315***
	(0.065)	(0.080)	(0.071)
Age	-0.280***	-0.311***	-0.300***
	(0.097)	(0.106)	(0.099)
Vexpand*Log(net assets)	-0.103***	-0.085***	-0.087***
	(0.017)	(0.017)	(0.017)
Compete	0.076*	0.030	0.035
	(0.045)	(0.052)	(0.046)
Compete*Log(net assets)	-0.010*	-0.004	-0.004
	(0.006)	(0.006)	(0.006)
Firm-level UV, RKRV		0.260***	
		(0.064)	
Industry-level UV, RKRV		-0.217***	
		(0.066)	
Firm-level UV, PV			0.227***
			(0.054)
Industry-level UV, PV			-0.236***
			(0.060)
C&I spread	0.976***	1.016***	0.970***
	(0.209)	(0.253)	(0.234)
Observations	46,470	44,510	44,410
Control variables	Yes	Yes	Yes

Table A4: R&D with instrumented target from mutual fund flows and HP concentration measures, probit first-stage regressions

Table A4 reports estimates from *R&D* regressions using instrumental variable approach and *Mfflow* as an instrument for the target indicator variable. The dependent variable is *R&D* expense scaled by sales in the previous year. *Log(net assets)* is the log of the asset value. *Age* is time in 100s years since the founding year, incorporation year (if founding is missing), or the first year the firm appears in CRSP tapes (if both founding and incorporation years are missing). *HP fixed comp. measure* is 1- Hoberg-Phillips Herfindahl based on fixed industry definitions. *HP variable comp. measure* is 1-Hoberg-Phillips Herfindahl based on variable industry definitions. *C&I spread* is the commercial and industrial loan spread. *Firm-level UV, RKRV (PV)* is the firm-level unexplained valuation computed from the Rhodes-Kropf, Robinson, and Viswanathan (RKRV) model. (Pastor and Veronesi model). *Industry-level UV, RKRV (PV)* is the industry-level unexplained valuation variable. *C&I spread* is the commercial and industrial loan spread. Control variables include tangible assets, cash, and net working capital scaled by sales, price-to-earnings ratio, dividend payment dummy, and institutional ownership.

Independent Variable	*Dependent variable - R&D expenditures scaled by sales*					
Target dummy	0.610**	1.765**	1.637**	0.557**	1.708**	1.583**
	(0.265)	(0.077)	(0.685)	(0.257)	(0.762)	(0.672)
Vexpand	0.881***	0.593***	0.621***	0.853***	0.583***	0.609***
	(0.085)	(0.144)	(0.135)	(0.083)	(0.139)	(0.130)
Log(net assets)	0.225***	-0.046	0.124	0.018	-0.346*	-0.301*
	(0.057)	(0.158)	(0.135)	(0.066)	(0.208)	(0.180)
Age	-0.154***	-0.377***	-0.362***	-0.171***	-0.396***	-0.379***
	(0.058)	(0.149)	(0.136)	(0.057)	(0.149)	(0.136)
Vexpand*Log(net assets)	-0.112***	-0.090***	-0.092***	-0.108***	-0.087***	-0.089***
	(0.013)	(0.036)	(0.021)	(0.013)	(0.021)	(0.020)
HP variable comp. measure	3.466***	3.164***	3.188***			
	(0.322)	(0.572)	(0.546)			
HP variable*Log(net assets)	-0.456***	-0.459***	-0.461***			
	(0.058)	(0.105)	(0.100)			
HP fixed comp. measure				1.547***	0.953***	0.998***
				(0.072)	(0.311)	(0.285)
HP fixed*Log(net assets)				-0.220***	-0.166***	-0.171***
				(0.026)	(0.041)	(0.038)
Firm-level UV, RKRV		0.334***			0.331***	
		(0.100)			(0.099)	
Industry-level UV, RKRV		-0.185**			-0.186**	
		(0.118)			(0.073)	
Firm-level UV, PV			0.290***			0.288***
			(0.082)			(0.081)
Industry-level UV, PV			-0.146			-0.178***
			(0.107)			(0.058)
C&I spread	0.731**	1.158***	1.096***	0.682***	1.112***	1.053***
	(0.100)	(0.320)	(0.288)	(0.097)	(0.314)	(0.282)
Observations	46,401	39,619	39,536	46,420	39,647	39,564
Control variables	Yes	Yes	Yes	Yes	Yes	Yes