A Model Extension

The following calculations are largely based on Fumagalli et al. (2020) and adjusted accordingly by myself for the case that assumption 4 is not satisfied.

A.1 Profitability of the Innovation

Before we address the payoffs for different situations, we show, that a development for the incumbent is never profitable, given the adjusted assumption 4 (i.e. $p(W^M - W^m) - K < 0$) and the assumption, that consumers like variety (i.e. $CS^M \geq CS^m$). To start let us assume the contrary:

$$0 \overset{!}{\leq} p(\pi_I^M - \pi_I^m) - K \tag{1}$$

$$0 > p(W^M - W^m) - K$$

$$0 > p(\pi_I^M + CS^M - \pi_I^m - CS^m) - K \tag{2}$$

Since (1) ≥ 0 and (2) < 0, we formulate the inequality as follows:

$$p(\pi_I^M - \pi_I^m) - K \overset{?}{>} p(\pi_I^M + CS^M - \pi_I^m - CS^m) - K$$

$$\Rightarrow \qquad 0 \overset{?}{>} \underbrace{p(CS^M - CS^m)}_{\geq 0}$$

This inequality is never satisfied, because consumers like variety. Therefore, in the following chapters, only the payoffs and outcomes for an unprofitable development by the incumbent are addressed (thus, after a takeover the incumbent always shelves the product).

A.2 Payoffs

The following subsections describe the expected total welfare and profits of the incumbent for the situations with and without late takeover. The welfare is then evaluated from the perspective of different merger policies in the subsequent sections for the specific assumptions about the welfare impact of the innovation. As seen in section A.1 only an unprofitable development by the incumbent has to be accounted for. Additionally, throughout this section is assumed, whenever the incumbent makes a zero profit from a takeover, it does not bid for the start-up due to negligible transaction costs.

A.2.1 Payoffs without late takeovers

Here is the welfare without late takeovers for different bidding types stated:

$$\begin{aligned}
EW^{block} &= F(\bar{A})W^m + (1 - F(\bar{A}))(pW^d + (1-p)W^m - K) \\
EW^{sep}_{shelve} &= F(\bar{A})W^m + (1 - F(\bar{A}))(pW^d + (1-p)W^m - K) \\
EW^{pool}_{shelve} &= W^m \\
\Delta EW^{sep}_{shelve} &= EW^{sep}_{shelve} - EW^{block} = 0 \qquad (3) \\
\Delta EW^{pool}_{shelve} &= EW^{pool}_{shelve} - EW^{block} = -(1 - F(\bar{A}))(p(W^d - W^m) - K) \qquad (4)
\end{aligned}$$

Below are the payoffs for the incumbent, if the development of the innovation is not profitable:

$$\begin{aligned}
\pi^{no}_I &= F(\bar{A})(\pi^m_I) + (1 - F(\bar{A}))(p\pi^d_I + (1-p)\pi^m_I) \\
\pi^{sep}_{I,shelve} &= F(\bar{A})(\pi^m_I) + (1 - F(\bar{A}))(p\pi^d_I + (1-p)\pi^m_I) \\
\pi^{pool}_{I,shelve} &= \pi^m_I - (p\pi^d_S - K) \\
\Delta\pi^{sep}_{I,shelve} &= \pi^{sep}_{I,shelve} - \pi^{no}_I = 0 \\
\Delta\pi^{pool}_{I,shelve} &= \pi^{pool}_{I,shelve} - \pi^{no}_I = F(\bar{A})(p(\pi^d_I - \pi^m_I)) + p(\pi^m_I - \pi^d_S - \pi^d_I) - K
\end{aligned}$$

The incumbent never pursuits a separating bid, due to the negligible transaction costs. Only under the following condition a pooling bid is profitable compared to the situation without bid:

$$\begin{aligned}
& 0 < \Delta\pi^{pool}_{I,shelve} \\
& 0 < F(\bar{A})(p(\pi^d_I - \pi^m_I)) + p(\pi^m_I - \pi^d_S - \pi^d_I) - K \\
\Rightarrow \qquad & F(\bar{A}) < \frac{p(\pi^m_I - \pi^d_I - \pi^d_S) + K}{p(\pi^m_I - \pi^d_I)} = \Phi'(\cdot)
\end{aligned}$$

A.2.2 Payoffs with late takeovers

Whenever late takeovers are allowed, the incumbent can acquire an entrant after a successful product development through a pooling bid. The total welfare with late takeovers for different types of bidding are defined as follows:

$$
\begin{aligned}
EW^{block,T} &= F(\bar{A}^T)W^m + (1 - F(\bar{A}^T))(pW^M + (1-p)W^m - K) \\
EW^{sep,T}_{shelve} &= F(\bar{A}^T)W^m + (1 - F(\bar{A}^T))(pW^M + (1-p)W^m - K) \\
EW^{pool,T}_{shelve} &= W^m \\
\Delta EW^{sep,T}_{shelve} &= EW^{sep,T}_{shelve} - EW^{block,T} = 0 \qquad (5) \\
\Delta EW^{pool,T}_{shelve} &= EW^{pool,T}_{shelve} - EW^{block,T} \\
&= -(1 - F(\bar{A}))(p(W^M - W^m) - K) \qquad (6)
\end{aligned}
$$

Below are the profits of the incumbent, if the development of the innovation is not profitable:

$$
\begin{aligned}
\pi^{no,T}_I &= F(\bar{A}^T)(\pi^m_I) + (1 - F(\bar{A}^T))(p(\pi^M_I - \pi^d_S) + (1-p)\pi^m_I) \\
\pi^{sep,T}_{I,shelve} &= F(\bar{A}^T)(\pi^m_I) + (1 - F(\bar{A}^T))(p(\pi^M_I - \pi^d_S) + (1-p)\pi^m_I) \\
\pi^{pool,T}_{I,shelve} &= \pi^m_I - (p\pi^d_S - K) \\
\Delta\pi^{sep,T}_{I,shelve} &= \pi^{sep,T}_{I,shelve} - \pi^{no,T}_I = 0 \\
\Delta\pi^{pool,T}_{I,shelve} &= \pi^{pool,T}_{I,shelve} - \pi^{no,T}_I = p(\pi^m_I - \pi^M_I) + K - F(\bar{A}^T)(p(\pi^d_S + \pi^m_I - \pi^M_I))
\end{aligned}
$$

The incumbent never pursuits a separating bid, due to the negligible transaction costs. Only under the following condition a pooling bid is profitable compared to the situation without bid:

$$
\begin{aligned}
& 0 < \Delta\pi^{pool,T}_{I,shelve} \\
& 0 < p(\pi^m_I - \pi^M_I) + K - F(\bar{A}^T)(p(\pi^d_S + \pi^m_I - \pi^M_I)) \\
\Rightarrow \qquad & F(\bar{A}^T) < \frac{p(\pi^m_I - \pi^M_I) + K}{p(\pi^d_S + \pi^m_I - \pi^M_I)} = \Phi^T(\cdot)
\end{aligned}
$$

A.3 Pro-competitive effect

In this part of the extension is assumed, that the innovation is only welfare beneficial, if the entrant develops the product.

$$
p(W^M - W^m) - K < 0 < p(W^d - W^m) - K \qquad \text{(A4)}
$$

Strict merger policy The competition authority only allows a takeover at $t = 1$ if the takeover does not harm total welfare ($H^0 = 0$). The following changes in total welfare are realized with a separating or pooling bid:

$$\Delta EW^{sep}_{shelve} = (3) = 0$$
$$\Delta EW^{pool}_{shelve} = (4) < 0$$

The competition authority would allow a takeover after a separating bid, if the incumbent is expected to shelve. But the incumbent expects to gain no additional profit from a separating bid, therefore in no situation a takeover occurs.

Intermediate policy (more lenient at t=1, strict at t=2) The competition authority allows additional takeovers damaging welfare in the size of takeover after a pooling bid with a subsequent shelving of the product ($H^1 = (1 - F(\bar{A}))(p(W^d - W^m) - K)$). The following changes in total welfare are realized with a separating or pooling bid:

$$\Delta EW^{sep}_{shelve} + H^1 = (3) + H^1 > 0$$
$$\Delta EW^{pool}_{shelve} + H^1 = (4) + H^1 = 0$$

The competition authority does not block any takeovers, since the incumbent does always shelve following the takeover.

- $F(\bar{A}) < \phi'(\cdot)$: The incumbent makes a pooling bid, which is approved. After the takeover the incumbent shelves the development.
- $F(\bar{A}) \geq \phi'(\cdot)$: No takeover occurs, because a separating bid is not profitable for the incumbent.

Intermediate policy (stricter at t=1, lenient at t=2) The competition authority does not tolerate early takeovers, which harm total welfare, but allows all late takeovers ($H^2 = 0$). The following changes in total welfare are realized with a separating or pooling bid:

$$\Delta EW^{sep}_{shelve} + H^2 = (5) + H^2 = 0$$
$$\Delta EW^{pool}_{shelve} + H^2 = (6) + H^2 > 0$$

The competition authority allows all early takeovers, which are followed by shelving the product. If the entrant is successful in developing the product, the incumbent buys the entrant through a late pooling bid.

- $F(\bar{A}^T) < \phi^T(\cdot)$: The incumbent makes a pooling bid, which is approved. After the takeover the incumbent shelves the development.
- $F(\bar{A}^T) \geq \phi^T(\cdot)$: No takeover occurs at $t = 1$, since it is not profitable for the incumbent. An unconstrained start-up is acquired at $t = 2$ if the development of the innovation by the start-up is successful.

Laissez-faire policy There are no modifications compared to an intermediate strategy, because all early takeovers are already tolerated by the competition authority.

A.3.1 Optimal Merger Policy

A strict merger policy always dominates an intermediate merger policy, which is more lenient with early takeovers, because total welfare is either equal or lower compared to an enforced strict policy, since some takeovers causing harm to welfare are allowed with an intermediate strategy. The laissez-faire strategy and the corresponding intermediate strategy are no different, therefore is assumed, that the competition authority prefers a strategy with less interventions. Therefore, the strict merger policy has to be compared to a laissez-faire merger policy. At first the policies are compared if $F(\bar{A}^T) < \phi^T(\cdot)$:

$$\begin{aligned} EW^{pool,T}_{shelve} &\overset{!}{\geq} EW^{block} \\ W^m &\overset{!}{\geq} W^m + \underbrace{(1 - F(\bar{A}))(p(W^d - W^m) - K)}_{>0} \end{aligned}$$

If $F(\bar{A}^T) < \phi^T(\cdot)$ a laissez-faire is never preferred by the AA. The next comparison is for $F(\bar{A}^T) \geq \phi^T(\cdot)$:

$$\begin{aligned} EW^{block,T} &\overset{!}{\geq} EW^{block} \\ \Rightarrow \qquad \underbrace{(1 - F(\bar{A}^T))(p(W^M - W^m) - K)}_{<0} &\overset{!}{\geq} \underbrace{(1 - F(\bar{A}))(p(W^d - W^m) - K)}_{>0} \end{aligned}$$

Due to assumption (A4) a laissez-faire strategy is not optimal if $F(\bar{A}^T) \geq \phi^T(\cdot)$. Thus, there is no scope in the distribution of the start-up assets, where a laissez-faire merger policy is optimal. Meanwhile, a strict merger policy is always optimal, since it enables all possible situations, where the start-up has the opportunity to develop the innovation and avoid every situation, where the incumbent can forgo competition through a killer acquisition.

A.4 Innovation wastes resources

In this part of the extension is assumed, that the innovation is never welfare beneficial, neither developed by the entrant nor by the incumbent, thus the developed innovation is always a waste of resources.

$$p(W^M - W^m) - K < p(W^d - W^m) - K < 0 \tag{A4}$$

Strict merger policy The competition authority does not allow any takeovers, which harm welfare ($H^0 = 0$). The following changes in total welfare are realized with bidding types:

$$\Delta EW^{sep}_{shelve} = (3) = 0$$
$$\Delta EW^{pool}_{shelve} = (4) > 0$$

The competition authority is willing to approve every takeover, if the incumbent shelves the product following the takeover. Only a pooling bid is profitable for the incumbent for a specific scope of start-up assets. Therefore, the solution of the game results in:

- $F(\bar{A}) < \phi'(\cdot)$: The incumbent makes a pooling bid, which is approved. After the takeover the incumbent shelves the development.
- $F(\bar{A}) \geq \phi'(\cdot)$: No takeover occurs, since a bid is not profitable for the incumbent.

Intermediate policy (more lenient at t=1, strict at t=2) There are no modifications compared to a strict strategy, because all early takeovers are already tolerated.

Intermediate policy (stricter at t=1, lenient at t=2) There are no modifications compared to the same intermediate policy, where the innovation is only beneficial in the hands of the start-up, since the incumbent acquires any entrant with a successful product development, a duopoly will never arise (see section A.3).

Laissez-faire policy There are no modifications compared to the corresponding intermediate strategy, which is stricter with early takeovers, because all takeovers are tolerated.

A.4.1 Optimal Merger Policy

There are no differences between a strict and laissez-faire merger policy with their respective intermediate policies. As in section A.3.1, we assume the competition authority prefers policies with less interventions. Therefore, the comparison of the optimal merger policy is limited to an intermediate policy, which is more lenient with early takeovers than a strict policy and a laissez-faire policy. This comparison constitutes four cases: The first case is if $F(\bar{A}) < \Phi'(\cdot)$ and $F(\bar{A}^T) < \Phi^T(\cdot)$:

$$\begin{aligned} EW^{pool}_{shelve} &\leq EW^{pool,T}_{shelve} \\ W^m &\leq W^m \end{aligned}$$

Therefore in this case the competition authority prefers a laissez-faire policy, because it is less invasive. The second case is if $F(\bar{A}) < \Phi'(\cdot)$ and $F(\bar{A}^T) \geq \Phi^T(\cdot)$:

$$\begin{aligned} EW^{pool}_{shelve} &\overset{!}{\leq} EW^{block,T} \\ W^m &\overset{!}{\leq} W^m + \underbrace{(1 - F(\bar{A}^T))(p(W^M - W^m) - K)}_{<0} \end{aligned}$$

Due to assumption (A4) the competition authority prefers an intermediate policy. The third case occurs if $F(\bar{A}) \geq \Phi'(\cdot)$ and $F(\bar{A}^T) < \Phi^T(\cdot)$:

$$\begin{aligned} EW^{block} &\leq EW^{pool,T}_{shelve} \\ W^m + \underbrace{(1 - F(\bar{A}))(p(W^d - W^m) - K)}_{<0} &\leq W^m \end{aligned}$$

Due to assumption (A4) the competition authority prefers a laissez-faire policy. The fourth and last case is if $F(\bar{A}) \geq \Phi'(\cdot)$ and $F(\bar{A}^T) \geq \Phi^T(\cdot)$:

$$\begin{aligned} EW^{block} &\leq EW^{block,T} \\ W^m + (1 - F(\bar{A}))(p(W^d - W^m) - K) &\leq W^m + (1 - F(\bar{A}^T))(p(W^M - W^m) - K) \\ \Rightarrow \qquad \frac{1 - F(\bar{A})}{1 - F(\bar{A}^T)} &\geq \frac{p(W^M - W^m) - K}{p(W^d - W^m) - K} \end{aligned}$$

This term resembles to condition 6 (note the changed equality sign). Thus the competition authority prefers a laissez-faire policy if condition 6 is not satisfied. Therefore, a laissez-faire merger policy is optimal if one of the following conditions is satisfied:

- Financial imperfections are not severe, i.e. $F(\bar{A}^T) < \Phi^T(\cdot)$
- Financial imperfections are always severe and condition 6 is not satisfied

Otherwise, an intermediate merger policy, which is more lenient at $t = 1$ than a strict policy, is optimal. In general, the competition authority prefers a policy, which avoids as many developments as possible, e.g. by allowing killer acquisitions if the start-up is not financially constrained.