A Payoffs

The following subsections describe the expected total welfare and profits of the incumbent for the situations with and without late takeover dependent on the profitability of the innovation for the incumbent. 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. Further information can be found in Fumagalli et al. (2020).

A.1 Payoffs without late Takeovers

This section provides the payoffs, if late takeovers are prohibited by the competition authority (strict and corresponding intermediate policy).

A.1.1 Innovation not profitable for the Incumbent

The welfare without late takeovers for different bidding types is defined as follows:

$$
\begin{aligned}
EW^{block} &= F(\bar{A})W^m + (1 - F(\bar{A}))(pW^d + (1 - p)W^m - K) \\
EW^{sep}_{shelve} &= F(\bar{A})W^m + (1 - F(\bar{A}))(pW^d + (1 - p)W^m - K) \\
EW^{pool}_{shelve} &= W^m \\
\Delta EW^{sep}_{shelve} &= EW^{sep}_{shelve} - EW^{block} = 0 \qquad (1) \\
\Delta EW^{pool}_{shelve} &= EW^{pool}_{shelve} - EW^{block} = -(1 - F(\bar{A}))(p(W^d - W^m) - K) \qquad (2)
\end{aligned}
$$

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 an early separating bid, due to the negligible transaction costs. Only under the following condition an early pooling bid is profitable compared to the situation without bid:

$$
\begin{aligned}
& & 0 &< \Delta\pi_{I,shelve}^{pool} \\
& & 0 &< F(\bar{A})(p(\pi_I^d - \pi_I^m)) + p(\pi_I^m - \pi_S^d - \pi_I^d) - K \\
\Rightarrow & & F(\bar{A}) &< \frac{p(\pi_I^m - \pi_I^d - \pi_S^d) + K}{p(\pi_I^m - \pi_I^d)} = \Phi'(\cdot)
\end{aligned}
$$

A.1.2 Innovation profitable for the Incumbent

If the incumbent is not expected to shelve, the welfare without late takeovers for different bidding types is defined as follows:

$$
\begin{aligned}
EW_{dev}^{sep} &= F(\bar{A})(pW^M + (1-p)W^m - K) \\
EW_{dev}^{pool} &= pW^M + (1-p)W^m - K \\
\Delta EW_{dev}^{sep} &= EW_{dev}^{sep} - EW^{block} = F(\bar{A})(p(W^M - W^m) - K) \\
\Delta EW_{dev}^{pool} &= EW_{dev}^{pool} - EW^{block} \\
&= F(\bar{A})(p(W^M - W^m) - K) - (1 - F(\bar{A}))p(W^d - W^M)
\end{aligned}
$$

Meanwhile a separating bid is always approved by the competition authority, the following condition has to be satisfied, that an early pooling bid is approved under a strict merger policy:

$$
\begin{aligned}
& & 0 &\geq \Delta EW_{dev}^{pool} \\
& & 0 &\geq F(\bar{A})(p(W^M - W^m) - K) - (1 - F(\bar{A}))p(W^d - W^M) \\
\Rightarrow & & F(\bar{A}) &\geq \frac{p(W^d - W^M)}{p(W^d - W^m) - K} = \Gamma(\cdot)
\end{aligned}
$$

Below are the payoffs for the incumbent, if the development of the innovation is profitable:

$$
\begin{aligned}
\pi_{I,dev}^{sep} &= F(\bar{A})(p\pi_I^M + (1-p)\pi_I^m - K) + (1 - F(\bar{A}))(p\pi_I^d + (1-p)\pi_I^m) \\
\pi_{I,dev}^{pool} &= p\pi_I^M + (1-p)\pi_I^m - K - (p\pi_S^d - K) \\
\Delta\pi_{I,dev}^{sep} &= \pi_{I,dev}^{sep} - \pi_I^{no} = F(\bar{A})(p(\pi_I^M - \pi_I^m) - K) > 0 \\
\Delta\pi_{I,dev}^{pool} &= \pi_{I,dev}^{pool} - \pi_I^{no} = p(\pi_I^M - \pi_S^d - \pi_I^d) + F(\bar{A})(p(\pi_I^d - \pi_I^m))
\end{aligned}
$$

An early separating bid is always profitable, but under the following condition an early pooling bid is the most profitable option for the incumbent.

$$\begin{aligned}
\Delta\pi^{sep}_{I,dev} &< \Delta\pi^{pool}_{I,dev} \\
F(\bar{A})(p(\pi_I^M - \pi_I^m) - K) &< p(\pi_I^M - \pi_S^d - \pi_I^d) + F(\bar{A})(p(\pi_I^d - \pi_I^m)) \\
\Rightarrow \qquad F(\bar{A}) &< \frac{p(\pi_I^M - \pi_I^d - \pi_S^d)}{p(\pi_I^M - \pi_I^d) - K} = \Phi(\cdot)
\end{aligned}$$

Therefore, if the probability is low enough, that the start-up is constrained, an early pooling bid is more profitable than an early separating bid, but in every case an early bid (separating or pooling) is profitable for the incumbent.

A.2 Payoffs with late Takeovers

This section provides the payoffs, if late takeovers are authorized by the competition authority (laissez-faire and corresponding intermediate policy). Therefore, the incumbent can acquire an entrant through a late pooling bid after a successful product development.

A.2.1 Innovation not profitable for the Incumbent

If the incumbent is expected to shelve, the total welfare with late takeovers for different types of bidding are defined as follows:

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

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

$$\begin{aligned}
\pi_I^{no,T} &= F(\bar{A}^T)(\pi_I^m) + (1 - F(\bar{A}^T))(p(\pi_I^M - \pi_S^d) + (1-p)\pi_I^m) \\
\pi^{sep,T}_{I,shelve} &= F(\bar{A}^T)(\pi_I^m) + (1 - F(\bar{A}^T))(p(\pi_I^M - \pi_S^d) + (1-p)\pi_I^m) \\
\pi^{pool,T}_{I,shelve} &= \pi_I^m - (p\pi_S^d - K) \\
\Delta\pi^{sep,T}_{I,shelve} &= \pi^{sep,T}_{I,shelve} - \pi_I^{no,T} = 0 \\
\Delta\pi^{pool,T}_{I,shelve} &= \pi^{pool,T}_{I,shelve} - \pi_I^{no,T} = p(\pi_I^m - \pi_I^M) + K - F(\bar{A}^T)(p(\pi_S^d + \pi_I^m - \pi_I^M))
\end{aligned}$$

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

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

A.2.2 Innovation profitable for the Incumbent

If the incumbent is not expected to shelve, the total welfare with late takeovers for different types of bidding are defined as follows:

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

Below are the payoffs for the incumbent, if the development of the innovation is profitable:

$$\begin{aligned}
\pi^{sep,T}_{I,dev} &= F(\bar{A}^T)(p\pi^M_I + (1-p)\pi^m_I - K) \\
&\quad + (1 - F(\bar{A}^T))(p(\pi^M_I - \pi^d_S) + (1-p)\pi^m_I) \\
\pi^{pool,T}_{I,dev} &= p\pi^M_I + (1-p)\pi^m_I - K - (p\pi^d_S - K) \\
\Delta\pi^{sep,T}_{I,dev} &= \pi^{sep,T}_{I,dev} - \pi^{no,T}_I = F(\bar{A}^T)(p(\pi^M_I - \pi^m_I) - K) > 0 \\
\Delta\pi^{pool,T}_{I,dev} &= \pi^{pool,T}_{I,dev} - \pi^{no,T}_I = F(\bar{A}^T)(p(\underbrace{\pi^M_I - \pi^m_I - \pi^d_S}_{<0 \rightarrow A2})) < 0
\end{aligned}$$

If late takeovers are possible and the innovation is profitable, the incumbent always makes an early separating bid, since it can acquire a start-up after a successful development with a late pooling bid.

A.3 Tolerated Harm by the Competition Authority

Based on the total welfare derived in section A.1 and A.2, the competition authority established thresholds for the tolerated harm to total welfare. For a strict merger policy the competition authority tolerates the harm from takeover following a pooling bid with subsequent development.

$$H^0 = max\{(1 - F(\bar{A}))(p(W^d - W^M)) - F(\bar{A})(p(W^d - W^m) - K), 0\}$$

If only early takeovers are allowed, the intermediate policy accepts a bigger amount of harm to tolerated welfare. Additionally, a takeover after a pooling bid with expected shelving afterwards is tolerated.

$$H^1 = (1 - F(\bar{A}))(p(W^d - W^m) - K)$$

If late takeovers are authorized, with an intermediate policy the competition authority approves takeovers harming total welfare to the extent of an early takeover through a pooling bid with subsequent shelving of the innovation. Therefore, the tolerated level of harm is between $\bar{H} \in (W^d - W^M, H^2]$, because the market monopolization through a late takeover causes harm in size of $W^d - W^M$. But if the probability is high enough, that the start-up is constrained, this policy is not feasible, since the harm of late market monopolization is bigger than H^2. This scenario occurs if condition 5 in Fumagalli et al. (2020) is satisfied.

$$H^2 = (1 - F(\bar{A}^T))(p(W^M - W^m) - K)$$

Under a laissez-faire policy the competition authority accepts any amount of harm to total welfare.

B Model Extension

As suggested by Fumagalli et al. (2020) in section 8.3, this extension relaxes the assumption of an efficient innovation regarding total welfare. The following calculations are largely based on Fumagalli et al. (2020) and adjusted accordingly by myself for the case that assumption A4 is not satisfied. The necessary payoffs for the calculations are listed in section A.

B.1 Profitability of the Innovation

Given the adjusted assumption A4 (i.e. $p(W^M - W^m) - K < 0$) and the assumption, that consumers like variety (i.e. $CS^M \geq CS^m$), a development for the incumbent is never profitable. To show this assumption, the contrary is assumed:

$$
\begin{aligned}
& 0 \overset{!}{\leq} p(\pi_I^M - \pi_I^m) - K && (5) \\
& 0 > p(W^M - W^m) - K && \\
\Rightarrow \quad & 0 > p(\pi_I^M + CS^M - \pi_I^m - CS^m) - K && (6)
\end{aligned}
$$

Since (5) ≥ 0 and (6) < 0, we formulate the inequality as follows:

$$
\begin{aligned}
p(\pi_I^M - \pi_I^m) - K & \overset{?}{>} p(\pi_I^M + CS^M - \pi_I^m - CS^m) - K \\
\Rightarrow \quad 0 & \ngtr p(\underbrace{CS^M - CS^m}_{\geq 0})
\end{aligned}
$$

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

B.2 Pro-competitive Effect

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

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

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:

$$
\begin{aligned}
\Delta EW_{shelve}^{sep} &= (1) = 0 \\
\Delta EW_{shelve}^{pool} &= (2) < 0
\end{aligned}
$$

The competition authority would allow a takeover after an early 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:

$$\Delta EW^{sep}_{shelve} + H^1 = (1) + H^1 > 0$$
$$\Delta EW^{pool}_{shelve} + H^1 = (2) + H^1 = 0$$

The competition authority does not block any early takeovers, but 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 ($H^2 = 0$), but authorizes all late takeovers. The following changes in total welfare are realized with a separating or pooling bid:

$$\Delta EW^{sep}_{shelve} + H^2 = (3) + H^2 = 0$$
$$\Delta EW^{pool}_{shelve} + H^2 = (4) + H^2 > 0$$

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 early takeover occurs, since it is not profitable for the incumbent. An unconstrained start-up is acquired through a late pooling bid if the development of the innovation 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.

B.2.1 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 strict policy, since only takeovers causing harm to welfare are additionally 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 is compared to a laissez-faire merger policy. At first the policies are compared if $F(\bar{A}^T) < \phi^T(\cdot)$:

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

If $F(\bar{A}^T) < \phi^T(\cdot)$ a laissez-faire is not preferred by the AA. The next comparison is for $F(\bar{A}^T) \geq \phi^T(\cdot)$:

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

Due to the modified 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, because it enables all possible situations, where the start-up has the opportunity to develop the innovation and avoids every situation, where the incumbent can forgo competition through a killer acquisition or develop the innovation on its own.

B.3 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:

$$\Delta EW^{sep}_{shelve} = (1) = 0$$
$$\Delta EW^{pool}_{shelve} = (2) > 0$$

The competition authority is willing to approve every takeover, if the incumbent shelves the product following the takeover. But only an early pooling bid is profitable for the incumbent for a specific scope. Therefore, the solution of the game results in:

- $F(\bar{A}) < \phi'(\cdot)$: The incumbent makes an early pooling bid, which is approved. After the takeover the incumbent shelves the development.
- $F(\bar{A}) \geq \phi'(\cdot)$: No takeover occurs, since an early 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 by the competition authority.

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 B.2).

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

B.3.1 Optimal Merger Policy

There are no differences between a strict and laissez-faire merger policy with their respective intermediate policies. As in section B.2.1, 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.

Table 9: Comparisons of expected Welfare

	$F(\bar{A}) < \Phi'(\cdot)$	$F(\bar{A}) \geq \Phi'(\cdot)$
$F(\bar{A}^T) < \Phi^T(\cdot)$	$EW^{pool}_{shelve}, EW^{pool,T}_{shelve}$	$EW^{block}, EW^{pool,T}_{shelve}$
$F(\bar{A}^T) \geq \Phi^T(\cdot)$	$EW^{pool}_{shelve}, EW^{block,T}$	$EW^{block}, EW^{block,T}$

Note: The superscript T denotes the expected welfare for the laissez-faire policy.

This comparison constitutes four cases, which are illustrated in table 9: The first case is if $F(\bar{A}) < \Phi'(\cdot)$ and $F(\bar{A}^T) < \Phi^T(\cdot)$:

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

Both merger policies imply the same expected welfare, therefore in this case the competition authority prefers a laissez-faire policy, because it is more lenient with late takeovers. The second case is if $F(\bar{A}) < \Phi'(\cdot)$ and $F(\bar{A}^T) \geq \Phi^T(\cdot)$:

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

Due to the modified assumption (A4), this inequality is not satisfied. Therefore, 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 the modified assumption (A4), the eventual introduction of the innovation into the market reduces welfare. Therefore, the competition authority prefers a laissez-faire policy, which approves killer acquisitions. 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 in Fumagalli et al. (2020) (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 (note, that the incumbent is always expected to shelve):

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

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