Do Remedies Affect the Efficiency Defence? An Optimal Merger Control Analysis.

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Abstract

This paper examines the optimal use of remedies and efficiency defense for merger control. We focus in particular on the opportunity of simultaneously making use of both instruments to assess mergers. We develop a framework where the merger efficiency gains are endogenously obtained and not observed by the Competition Authority. The possibility of an efficiency defense can push firms to better design the merger, leading to more efficiency gains. However, the merger remedies interact with the efficiency defence: although they reduce the incentive to enhance the efficiency gains, they can be used to signal the actual level of efficiency gains. Our results address the optimality of the current framework for merger assessment which relies on both instruments, and as such provide a theoretical justification for the adoption of the efficiency defence within the 2004 reform of the ECMR.

Keywords: merger control, efficiency defence, merger remedies

JEL classification: L41, K21, D82

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1. Introduction

Merger control aims to screen concentrations, so as to clear competitive mergers and prohibit the anti-competitive ones. It is supposed to assess the merger's consequences before they even take place. As a result, the information available to the competition authority is likely to be poor. This can explain why merger control is prone to type I and II errors (see Duso et al. (2007)), and that the true challenge of the merger control is to minimize the effects of both types or errors. For this purpose, the assessment process includes nowadays the appraisal of the *merger efficiency gains* and the enforcement of *merger remedies*.

Merger remedies are structural or behavioural "commitments" on behalf of the merging parties, restoring post-merger effective competition. Accordingly, the European Merger Control Regulation (ECMR) claims that "where the undertakings modify a notified concentration [...] rendering the concentration compatible with the common market, the Commission should declare the concentration compatible with the common market". In addition, the ECMR states that "in order to determine the impact of a concentration on competition, it is appropriate to take into account of any substantial efficiencies put forward by the undertakings" and thus acknowledges that efficiency gains (EG henceforth) can possibly offset the negative impact of a merger project. Thus they are now part of the competitive balance of a merger, although this has not always been the case: the ECMR experienced a dramatic change in January 2004 with the introduction of the efficiency gains assessment.

Any change in the merger control procedure modifies the expected profit of any given merger project. Merging firms will react by designing and submitting a possibly different merger project from that considered in the beginning. Furthermore, their choice to propose remedies or to claim high efficiency gains within the so called 'efficiency defence' (ED henceforth), will have a certain signalling value, which is useful given the imperfect information context of merger control.

The objective of this paper is to examine the optimal combination of remedies and efficiency defence, taking into account the provision of ex ante incentives and the information asymmetry between merging firms and the competition authority. In that sense, we provide a normative analysis of the current merger control, by considering only its existing features, i.e. the assessment of efficiency gains and the proposal of remedies by the merging firms.

Our analysis thus aims to determine the performance of a merger control that allows both an efficiency defence and the use of remedies. For that purpose we contrast such a decision rule with its counterfactuals: a merger control that prohibits any efficiency defence, as it was the case in Europe before 2004, and one where remedies are not allowed. None of these three decision rules dominates *a priori*: it depends on the efficiency of each instrument in isolation within merger control, as well as on the impact of each instrument on the firms incentive to propose an efficient merger. Incidentally, this equally raises the question of whether it can be optimal for the CA to give up one or another of the instruments currently available within merger control, for strategic reasons. In particular, can it ever be optimal for the CA to refrain from using remedies?

To start with we consider a framework where the merger project is pro-competitive only if it entails efficiency gains. We assume that the probability of efficiency gains can be improved by an *ex ante* designing effort undertaken by the merging firms. The insiders are privately informed of the outcome of this effort while the CA observes only an imperfect signal of this outcome. We interpret an ED-based decision rule as one taking into account the expected level of efficiency gains in the merger assessment by the CA.

Even without any efficiency gains, a merger may be acceptable to the CA if the merging firms undertake remedies. These imply a private cost for firms, and will write off some benefits from efficiencies if undertaken by efficient merging firms.

The optimality of an ED-based decision rule will stem from the trade-off between the benefit expected from the ED, i.e. the provision of effort incentives (making firms exert the costly effort to obtain efficiencies) and the cost of the ED, i.e. the risk of prohibiting efficient mergers (type I errors). The outcome of this trade-off naturally depends on the quality of available information.

Merger remedies affect the above mentioned trade-off. On the one hand, everything else equal, the remedies lower the *ex ante* effort incentives for firms, because they lower the opportunity cost of submitting inefficient mergers. On the other hand, accepting a merger with remedy and allowing an ED represents for the CA the opportunity of completely eliminating type I and II errors, because when given the choice, more efficient insiders may signal accurately their actual level of efficiency gains by notifying a merger project without remedies, while inefficient ones propose remedies. This signalling behaviour is based on a higher opportunity cost to notify a merger without remedies for an inefficient merger than for an efficient one, for a high enough quality of information at least.

In short, we provide an insight into what should be the best merger policy. We show that for very good information available on the efficiency gains, the best policy consists in applying an efficiency defence without allowing remedies, i.e. it could be efficient for the CA to commit not to consider remedies[1]. Instead, if the quality of information on the efficiency gains is lower, the combination of remedies and efficiency defence is more appropriate for maximizing expected welfare. For very poor information it could be even optimal for the CA to give up the assessment of efficiency gains and only consider the submission of remedies.

The novelty of our study is twofold. First, our paper contributes to the literature on endogenous merger characteristics induced by the very design of merger control. This was pointed out by Neven et al. (1993) in a non-formalized discussion, and by Besanko and Spulber (1993) in a model without remedies studying from this point of view the role of the CA's objective. Concerning the merger remedies, they have a weak deterrent effect on merger submissions according to the empirical analysis of Seldeslachts et al. (2009), but may be used by the CA to implement its preferred market structure. This is a deterrent, hold-up effect on possibly efficient mergers, highlighted by Vasconcelos (2010) in a perfect information exogenous efficiency gains model. Banal-Estanol et al. (2008) deals simultaneously with both endogenous EG and the ED, but does not consider remedies. The paper examines the impact of investment decisions and firms' internal organization on the merger's EG, and goes on to show that the ED may trigger both types of error if the CA takes for granted the EG. Our main contribution to this literature is thus to examine the impact of both the ED and remedies on the merger's endogenous EG, as well as to conclude on the opportunity of removal of one of these two merger control instruments.

Secondly, our paper takes into account the information asymmetry on efficiency gains, although we neither aim to provide a revelation mechanism to extract the private information, nor deal with the evidence production costs associated with the ED on behalf of firms. The latter point was dealt with by Lagerlöf and Heidhues (2005) to justify the opportunity of an ED in a model without remedies. Instead we focus on the benefit of information acquisition by the CA, and stress that the use by firms of merger control instruments has a signaling value[2].

The remainder of the paper is organized as follows. Next we describe the model built to explore the interaction between the ED and the remedies. Then we discuss the implications for merger control, and conclude before presenting all technical proofs in a final section.

[1] This result is reminiscent of the strategic benefit to commit not to use an instrument potentially efficient *ex post* - see Schelling (1960).

[2] Our paper can also be related to Yosha (1995), where the choice between bilateral and multilateral financing signals to competitors the firms' cost performance. Still, the cost parameter in Yosha's model is exogenous, wheres here the merger EG are endogenous.

2. A simple model of merger control with efficiency defence

Consider the following simple model of merger control, between the CA and some merging firms, the insiders, which propose to merge on an oligopoly market.

The merger is likely to create specific cost reductions or efficiency gains (EG) denoted by e and which can be either low ($\underline{e}$) or high ($\overline{e}$). By EG we understand merger-specific cost savings obtained through the integration of specific hard-to-trade resources (i.e. "synergies" in the terminology of Farrell and Shapiro (1990)). Hence the EG summarize the positive effect of an essential complementarity between the merger partners (their technological or administrative capabilities of firms, as Röller et al. (2001) argue) that will allow them to lower *ex post* their common cost[3]. The proportion of mergers of type $\overline{e}$ is equal to q which depends on an endogenous *ex ante* effort exerted by the merging firms. This effort could concern the design of the merger project[4], or identifying the best merger partner, or even the resources needed by the acquirer to buy the target[5]. In brief, we consider a composition-based effect, according to which merger proposals are shaped differently *ex ante* so as to enable *ex post* (more) synergies.

We consider the following assumptions:

A1 The probability q (where $q \leq \overline{q} < 1$) requires a cost $F(q)$ with $F'(q) > 0$, $F''(q) > 0$ and $\underset{q \to \overline{q}}{Lim} F(q) = +\infty$.

A2 $\Pi(\overline{e}) > \Pi(\underline{e}) > 0$ where $\Pi(e)$ denotes the merger profit increase.

Thus the merger is profitable and the profit increases with the EG. The joint profit increase through merger incorporates the outcome of any *ex post* effort to achieve EG.

A3 $W(\overline{e}) > 0 > W(\underline{e})$, where $W(e)$ denotes the change in consumer surplus (CS).

The two possible merger types have opposite CS effects.

[3] A growing literature (see for instance Banal-Estanol and Seldeslachts (2010)) studies the post-merger effort required to materialize the EG. We do not introduce explictly this effort, or rather we assume its outcome to be included in the post-merger profit change.

[4] The Financial Times ("Clean teams banish acquisition uncertainty", August 8, 2006) reports that an increasingly favoured approach to integrating two disparate companies is "to use a 'clean team' [...]. Clean teams collect and analyze data from both parties, which it then uses to plan how the merger will work - and crucially, where the synergies and cost savings will occur. Such a team starts it work well in advance of the completed deal, setting out a strategy for realizing the claimed synergies".

[5] Although our modelling framework does not perfectly fit with the case of an acquirer buying a target, the model could be modified to do so while preserving the main intuitions.

A4 $\overline{q}W(\overline{e}) + (1-\overline{q})W(\underline{e}) < 0$.

We assume here that the CA needs further information on e than the mere distribution in order to infer that the expected CS is positive[6].

The anticompetitive outcome of the inefficient merger can however be corrected if the insiders equally propose an effective remedy in the shape of commitments, typically asset divestitures in the case of horizontal mergers.

A5 $W^R(\overline{e}) \geq W^R(\underline{e}) \geq 0$ where we denote by $W^R(\overline{e})$ and $W^R(\underline{e})$ the change in CS when remedies apply.

The remedy is effective[7], i.e. it will improve CS when applied to an inefficient merger, and will not write off the merger's social gain when applied to the more efficient merged entity as compared with the low efficiency type.

A6 $\Pi(e) \geq \Pi^R(e) > 0, \forall e$ where $\Pi^R(e)$ is the joint merger profit increase when remedies apply.

The remedies prevent the market-power effect of the merger, and as such they involve a private cost for the insiders even though the merger remains profitable.

A7 $\frac{\Pi(\overline{e})}{\Pi^R(\overline{e})} > \frac{\Pi(\underline{e})}{\Pi^R(\underline{e})}$

The remedies are costlier for the more efficient merger entity. This could be the result of an *ex post* effort to enhance the efficiency gains: without the costly remedies the efficient merged entity has higher incentives to exert this effort than the inefficient one.

A simple oligopoly model is consistent with the assumptions A2 to A7. Take a three-firm symmetric Cournot market where each individual firm holds k assets before merger such that the individual constant marginal cost writes $c(k)$. Following a bilateral merger, the insiders' marginal cost becomes $c^M(2k, e)$ with $c^M(2k, \overline{e}) < c^M(2k, \underline{e}) = c(2k)$. For the linear inverse demand $P = a - Q$, it is straightforward to check that the bilateral merger is both profitable and price-increasing for $c(2k) \in \left[\frac{5c(k)-a}{4}, \frac{a+c(k)}{2}\right]$. In turn, cost reductions (efficiency gains) e allow a lower post-merger price for $c^M(2k; \overline{e}) \in \left[0, \frac{5c(k)-a}{4}\right]$, while also improving merger profitability. By the same token, there exist asset divestitures Δ leading to marginal costs of $c^M(2k - \Delta; e)$ and $c(k + \Delta)$ respectively, which, by increasing the symmetry of the asset distribution on the market, lower the

[6] This assumption is not crucial but simplifies the exposition of results.

[7] Unerstandably, we consider here a very simple representation of remedies, since implicitly the only remedy available is also effective in terms of CS. We discuss the impact of imperfect remedies in the last section.

post-merger price, while still allowing the merger to be profitable. There exists an asset divestiture Δ such that the merger does not affect price while still being profitable[8]. Finally, the condition $\frac{\Pi(\overline{e})}{\Pi^R(\overline{e})} > \frac{\Pi(\underline{e})}{\Pi^R(\underline{e})}$ holds as soon as the asset complementarity enabling the synergies e for the insiders is completely removed by the application of a uniquely feasible and non-divisible remedy, such that $c^M(2k-\Delta; e) = c(2k-\Delta)$ and therefore leading to $\Pi^R(\overline{e}) = \Pi^R(\underline{e})$. This can be the case whenever the synergies stem from particular hubs or time slots shared as is the case for an airline merger, or alternatively from intellectual property rights, which if divested lead to the complete loss of synergies.

The level of efficiency gains is known only by the insiders, but the CA can gather information on these cost reductions. The outcome of its investigation is a noisy signal on the actual level of efficiency gains:

A8 For an actual level e, the CA observes a signal s uniformly distributed on the interval $\left[e - \frac{\overline{e}-\underline{e}}{2\beta}, e + \frac{\overline{e}-\underline{e}}{2\beta}\right]$ where $\beta \in]0,1]$ without loss of generality.

We consider the following three intervals: $L = \left[\underline{e} - \frac{\overline{e}-\underline{e}}{2\beta}, \overline{e} - \frac{\overline{e}-\underline{e}}{2\beta}\right]$, $M = \left[\overline{e} - \frac{\overline{e}-\underline{e}}{2\beta}, \underline{e} + \frac{\overline{e}-\underline{e}}{2\beta}\right]$ and $H = \left[\underline{e} + \frac{\overline{e}-\underline{e}}{2\beta}, \overline{e} + \frac{\overline{e}-\underline{e}}{2\beta}\right]$. Then for a signal $s \in L$, the CA infers $e = \underline{e}$, whereas for a signal $s \in H$, the CA infers $e = \overline{e}$. A signal in M could *a priori* come from the two types of firms, thus the probability for each type to send a signal s is equal to $P(M/e) = 1-\beta$. Therefore the parameter β represents the quality of the signal on the efficiency gains.

A9 The CA either observes the existence of effective and available remedies (signal $r = R$) or nothing (signal $r = \varnothing$). The probability of signal R is equal to 1 if firms propose remedies and γ otherwise.

The firms' strategy consists in proposing a merger with remedies (action R) or a merger with an efficiency defence (action ED). The strategy chosen maximizes the expected profit[9].

The CA's strategy is constrained by the decision rule. A decision rule specifies under which terms the ED and the remedies apply. Similarly to Lagerlöf and Heidhues (2005), we consider the

[8] Absent any efficiency gains, there exist $c(2k-\Delta) > c(2k)$ and $c(k+\Delta) < c(k)$ such that the price does not increse, i.e. $\frac{a+c^M(2k-\Delta)+c(k+\Delta)}{3} \leq \frac{a+3c(k)}{4}$, while still allowing the merger to be profitable: $\left(\frac{a-2c^M(2k-\Delta)+c(k+\Delta)}{3}\right)^2 \geq 2\left(\frac{a-c(k)}{4}\right)^2$.

[9] We use the same notation R for the signal, the firms' action, as well as for the type of merger accepted in order to alleviate the notation.

three following decision rules as merger control institutions or regimes, that are ultimately chosen by the legislator, the CA being simply the executor:

- a "remedy" decision rule (R rule), meaning "assess the merger ignoring any possible efficiency gains but considering the submitted remedies". Here the signal received is always R and the probability to clear the merger with remedies is denoted by $d^R(R)$.

- a "strict ED" decision rule (SED rule): "assess the merger taking into account the expected level of efficiency gains and ignoring any remedies". Here the CA does not consider remedies so that the signal received is only s. The probability to clear the merger without remedies is denoted by $d^{ED}(s)$.

- a "flexible ED" decision rule (FED rule): "assess the merger taking into account both the expected level of efficiency gains and submitted remedies". If the firms propose a merger with ED, the signal observed by the CA sr is two-dimensional with $r = R, \varnothing$ and $s \in L$, M or H. If the firms propose remedies, the signal is R. We denote by $d^j(\cdot)$ $(j = R, ED)$ the probability to clear a merger with j.

In the three cases we denote $b(sr, \cdot)$ the updated belief on $\overline{e}$ according to both the signal received and the firms' action.

The CA clears a merger if the expected change in CS is positive. If two mergers, one with remedies and another one without, lead to a positive expected welfare, then the CA clears the merger initially proposed[10] . By assumption, whenever a merger is rejected, under any decision rule, the status-quo is maintained.

Note that three decision rules considered are not arbitrarily chosen. Indeed, the ultimate purpose of our analysis is to examine the performance of the current setting generally used by CAs to assess mergers, i.e. the FED rule, which takes into account both efficiency gains information and the submission of remedies by the insiders. For that purpose, we will compare its effectiveness with that of the two possible theoretical alternatives: assess mergers when remedy submission is forbidden but an ED is available (the SED decision rule), or asses mergers when the efficiency gains are disregarded but remedies can be submitted (the R decision rule).

[10] According to the Commission notice on remedies acceptable under Council Regulation (EC) No 139/2004 and under Commission Regulation (EC) No 802/2004, the Commission is not in a position to impose unilaterally any conditions to an authorisation decision, but only on the basis of the parties' commitments. In other words, it will clear a merger proposal as soon as it acceptable, without considering alternative configurations.

The timing of the game is the following:

At the first stage, the firms choose the probability q and privately observe the efficiency outcome.

At the second stage, insiders of type e submit either a merger proposal with remedies with probability $m(e)$ or without remedies with probability $1 - m(e)$.

At the third stage, the CA either clears the merger or prohibits it.

We determine the Perfect Bayesian Equilibrium (PBE) of this game.

3. Merger control with remedies and efficiency defence: do remedies complement the efficiency defence?

So as to eventually compare the three decision rules considered, we begin by analyzing the outcome of the two of them that represent truncated versions of the current framework for merger assessment, the SED and the R rules. The following proposition presents the equilibria under these decision rules.

Proposition 1. *Under the SED rule, there exists a unique PBE where:*

- *The firms choose* $m(\underline{e}) = m(\overline{e}) = 0$
- *The CA applies* $d^{ED}(s) = 1$ *for* $s \in H$ *and* $d^{ED}(s) = 0$ *otherwise.*

Under the R rule, there exists a unique PBE where:

- *The firms choose* $m(\underline{e}) = m(\overline{e}) = 1$
- *The CA applies* $d^{R}(R) = 1$.

Under the R rule the CA will always accept the merger, since by assumption the remedies applied are effective in preserving the expected CS in case of an inefficient merger. Without the possibility of remedies, the CA will optimally accept a merger only if it receives a "good" signal, i.e. $s \in H$. Otherwise, the lower expected CS leads to merger prohibition[11]. Thus, under the SED decision rule, the CA may prohibit CS enhancing projects because it commits to disregarding remedies and thereby makes type I errors (false prohibitions).

The next step in our analysis requires to examine the FED rule. We start by identifying the optimal strategies for the CA under this decision rule:

[11] Here, the assumption A4 matters and simplifies our results since otherwise there would exist an equilibrium where the CA would clear the merger with a positive probability in case of signal $s \in M$. Nevertheless, the comparison between the three decision rules would be roughly unchanged.

Lemma 1. *Under the FED rule, and for any strategy of the insiders, the CA will always apply* $d^{ED}(sr) = 1$ *and* $d^R(sr) = 0$ *for* s *in* H *and for any* r*, but* $d^{ED}(s\varnothing) = 0$ *and* $d^R(sR) = 1$ *for* s *in* L*.*

Moreover for s *in* M *either* $d^{ED}(s\varnothing) = d^{ED}(sR) > 0$ *and* $d^R(sR) = 0$*, or* $d^{ED}(s\varnothing) = 0 = d^{ED}(sR)$ *and* $d^R(sR) = 1$*.*

In other words, since a signal in H can only come from the efficient insiders, the merger is cleared without remedies, whereas since a signal in L comes only from the inefficient insiders, the merger is prohibited whenever the CA is unaware of the remedies. If the signal is in M, the type is *a priori* unknown so the CA decision depends on the updated beliefs. For such a signal, two cases are possible: either the updated beliefs are sufficient to lead the CA to clear a merger without remedies ($d^{ED}(s\varnothing) = d^{ED}(sR) > 0$ and $d^R(sR) = 0$), or they require the CA to clear the merger only if remedies are submitted ($d^{ED}(s\varnothing) = 0 = d^{ED}(sR)$ and $d^R(sR) = 1$). In brief, when $s \in M$ updated beliefs are relevant only for $d^{ED}(s\varnothing)$.

We turn now to the insiders' strategy under the FED rule:

Lemma 2. *Under the FED rule, given the CA's strategies* $d^{ED}(s\varnothing) = d$*, there exist two thresholds* $d_{\overline{e}}(\beta)$ *and* $d_{\underline{e}}(\beta, \gamma)$ *such that the optimal strategy of the merging firms is the following:*

(i) for $d < d_{\overline{e}}(\beta)$*, the firms choose* $m(\underline{e}) = m(\overline{e}) = 1$

(ii) for $d_{\overline{e}}(\beta) < d < d_{\underline{e}}(\beta, \gamma)$*, the efficient insiders choose* $m(\overline{e}) = 0$ *while the inefficient ones choose* $m(\underline{e}) = 1$

(iii) for $d > d_{\underline{e}}(\beta, \gamma)$*, the firms choose* $m(\underline{e}) = m(\overline{e}) = 0$*.*

In addition, $d_{\underline{e}}(\beta, \gamma) = 1$ *iff* $\beta \geq \frac{\Pi(\underline{e}) - \Pi^R(\underline{e})}{\Pi(\underline{e}) - \gamma \Pi^R(\underline{e})} = \underline{\beta}(\gamma)$ *and* $d_{\overline{e}}(\beta) = 0$ *iff* $\beta > \frac{\Pi^R(\overline{e})}{\Pi(\overline{e})} = \overline{\beta}$*.*

We find that applying the flexible ED gives the insiders the opportunity to self-select by means of the merger notification they make. This outcome of possible self-selection depends on the quality β of the signal s, the capacity γ of the CA to observe the effective remedies, as well as on the probability d for the CA to clear the merger if it receives a signal in M without observing the effective remedies.

More precisely, for a very low probability d to clear a merger without remedies when $s \in M$, both types of insiders do not run the risk of rejection under the ED, but propose instead remedies so as to ensure merger approval. In turn, for a very high such a probability, neither type of insiders submit remedies and both choose instead the ED. Finally, for intermediate levels of this probability there is self-selection: the efficient insiders run the risk of the ED whereas the inefficient ones submit remedies.

Moreover, if the probability for the CA to receive a signal $s \in M$ is very low, then the probability of detecting an inefficient merger is very high, thus the inefficient insiders always prefer to propose remedies whereas the efficient ones propose none. In this case and for any probability d, there is self-selection. On the contrary, for a very high probability to receive $s \in M$, the opportunity cost for the inefficient firms to propose a merger with remedy is high, because there are less chances to see the merger banned with the ED and thus the inefficient insiders always submit their merger without remedy.

Note also that a high probability γ for the CA to be aware of the available effective remedies hinders the self-selection effect (formally $d_{\underline{e}}(\beta, \gamma)$ increases with γ). Indeed, being able to identify the effective remedies increases for the CA the probability to clear the inefficient merger even if the ED is attempted, and thus reduces the opportunity cost of inefficient insiders to propose a merger without remedies.

At this point, it is worth mentioning that here we model a situation where besides its corrective role, the merger remedy may possibly convey information on the level of efficiency gains from the merger. This is possible however because the CA's decision rule allows this type of behaviour. As a matter of fact, by making their choice when being given the opportunity to propose or not remedy, merger partners may signal the type of their merger. Note that the level of information quality for the ED required by the CA, reminiscent of a "standard of proof" on the EG, is endogenous here, since it depends on the decision rule applying.

The next proposition presents the consequences of this signaling behaviour in terms of equilibrium outcome under the FED rule.

Proposition 2. *Under the FED rule:*

(i) for $\beta > \underline{\beta}(\gamma)$ there exists a separating equilibrium with:

- the efficient insiders submit an ED ($m(\overline{e}) = 0$) and the inefficient ones propose remedies ($m(\underline{e}) = 1$)

- the CA applies $d^{ED}(sr) = 1$, $d^{R}(sr) = 0$ for $s \in H$ and for any r, $d^{R}(sR) = 1$ and $d^{ED}(s\varnothing) = 0$ for $s \in L$, $d^{ED}(s\varnothing) = 1$ and $d^{R}(sR) = 0$ for $s \in M$

(ii) for $\beta < \underline{\beta}(\gamma)$ there exists a semi-separating equilibrium:

- the efficient insiders always choose the ED ($m(\overline{e}) = 0$) while the inefficient ones attempt the

ED with probability $m(\underline{e}) \in]0,1[$.

- the CA applies $d^{ED}(sr) = 1$, $d^{R}(sr) = 0$ *for* $s \in H$ *and for any* r, $d^{R}(sR) = 1$ *and* $d^{ED}(s\varnothing) = 0$ *for* $s \in L$, $d^{ED}(s\varnothing) = d_{\underline{e}}(\beta, \gamma) \in]0,1[$ *and* $d^{R}(sR) = 0$ *for* $s \in M$

(iii) for $\beta < \overline{\beta}$ *there exists a pooling equilibrium where:*

- both types of insiders choose to submit remedies ($m(e) = 0$)

- the CA applies $d^{ED}(sr) = 1$ *and* $d^{R}(sR) = 0$, *for* $s \in H$ *and for any* r, $d^{R}(sR) = 1$ *for* $s \in M$ *or* $s \in L$, $d^{ED}(s\varnothing) = 0$ *for* $s \in L$ *or* $s \in M$.

This equilibrium does not satisfy the Cho and Kreps criterion whenever $\beta > \underline{\beta}(\gamma)$.

In other words, if the information quality β is high enough, a separating equilibrium exists under the FED rule. In turn, for medium and low levels of information quality β, there is a semi-separating one where the inefficient type randomizes between proposing or not remedies. Note at this point that the probability of acceptance for a merger without remedies with a signal in M, i.e. $d_{\underline{e}}(\beta, \gamma)$, increases with the information quality β, since a higher β reduces the incentives for the inefficient merger type to argue high EG, and thus allows the CA to raise the probability of acceptance even without a signal in H. This probability $d_{\underline{e}}(\beta, \gamma)$ decreases with the probability γ for the CA to observe the effective remedies. This is explained by a higher incentive for the inefficient type to propose a merger without remedy, and thus a higher probability for the merger to be inefficient if a signal in M is observed. Finally, for low quality of information a pooling equilibrium also exists, where both types of insiders propose remedies.

These equilibria result from the optimal behaviour of the merging firms described in Lemma 2. Indeed, if the information quality on the EG is high, then the self-selection of insiders induces the CA to optimally clear a merger that attempts the ED. For lower levels of information quality, the incentives for the inefficient merger to choose the ED if the probability of such clearance is high makes the CA reduce the probability of acceptance to the level where the inefficient insiders are indifferent between proposing or not remedies. Hence the semi-separating equilibrium. The pooling equilibrium also exists for lower information quality, because if the CA sets a low probability of approval, it is optimal for the insiders to propose remedies whatever the level of EG, and there exist beliefs for the CA to support such a low probability of acceptance.

It is worth noting that an increase in the CA's capacity to observe the effective remedies (a higher γ) can lead, for a given level of β, to a change from the separating to the semi-separating equilibrium. This is due to the lower opportunity cost for the inefficient insiders to attempt an ED.

We can now compare the three different rules in terms of expected CS, which basically depends on the probability for the merger to be efficient and on the rate of type I errors. Therefore we need to examine first the impact of each decision rule on the effort incentives.

Lemma 3. *(i) The effort exerted is higher under the FED than under the SED for low values of* β *and the opposite holds for low values of* β*.*

(ii) The effort exerted under the R rule is always lower than the effort exerted under the FED rule.

This lemma states that for low levels of quality of information on the EG (low β), the FED gives more incentives to exert effort than the SED.

The effort incentives rely on two key elements: the importance of type I errors, which lower them, and the opportunity cost not to exert effort, which increases them. Both decision rules that take into account efficiency gains (the SED and the FED) affect both elements.

The SED leads to a high such opportunity cost, since the profit in case of merger prohibition is lower than with conditional approval. Yet, the SED leads to type I errors in the decision making, and the magnitude of these errors depends on the quality of available information.

In turn, the FED avoids any type of errors whenever β is high enough ($\beta > \underline{\beta}(\gamma)$), since inefficient insiders are induced to propose remedies over this range of information quality. Moreover, even for lower levels of β, if the semi-separating equilibrium prevails, the importance of type I errors is reduced as compared with the SED since the CA clears mergers with positive probability even for a signal in M. Nevertheless, the opportunity cost of exerting no effort is lower, since remedies guarantee approval in case of low efficiency gains.

To sum up, as long as the magnitude of type I errors remains high under the SED, the FED gives more incentives to exert effort.

Thus, simultaneously allowing for both the ED and remedies (within the FED) can dramatically improve the decision process: for an intermediate level of information quality on EG (intermediate values of β), the self-selection potentially leads to an increase in the effort exerted, but also avoids any type of errors. Nevertheless, for other levels of information quality, either the self-selection does not occur, or the possibility of remedy reduces the *ex ante* effort incentives. In that case, the decision to allow or not simultaneously both the remedy and the ED within the FED decision rule implies a trade-off between reducing errors in the decision process and increasing the probability of efficient mergers.

Finally, we can add that the CA's capacity to tell the effective remedies (γ) has a negative impact on the incentive to exert effort under the FED. This is due to the negative impact of a higher γ on the probability $d_{\underline{e}}(\beta,\gamma)$ of merger approval when $s \in M$.

The choice of the optimal decision rule stems from the above-mentioned trade-off between providing incentives and reducing decision errors:

Proposition 3. *The decision rule that maximizes the expected CS depends on the quality of information β as follows:*

(i) there exists β^{***} such that for $1 \geq \beta \geq \beta^{***}$ the SED maximizes the expected CS;

(ii) there exists β^{**} such that for $\beta^{***} \geq \beta > \beta^{**}$, the FED maximizes the expected CS;

(iii) there exists β^{*} such that for $\beta^{*} \geq \beta > 0$, the R rule maximizes the expected CS.

In this proposition, we show that the optimal decision rule depends on the quality of information on EG measured by the probability β to observe either a signal in L or in H. A low information quality induces the CA to use the R rule. A higher quality should induce to add the ED to the remedy (hence the FED), and eventually, for high enough information quality, the SED becomes the optimal rule.

Identifying the optimal decision rule amounts to the following trade-off: the FED likely leads the insiders to reveal information on their EG, but the SED possibly gives higher incentives to exert effort, while the R rule avoids any type of errors. Basically the trade-off balances the low level of errors against the high expected level of EG.

To provide the intuition, let us first detail this trade-off whenever the quality of information is high enough to lead the inefficient insiders to actually signal their low efficiency gains by proposing remedies.

Lemma 3 showed that the FED can sometimes maximize the incentives to exert effort. In such a case there is actually no trade-off and the FED dominates. Instead, for higher information quality on EG (higher β), the level of effort exerted will be higher under the SED. Hence the trade-off between higher expected EG and type I errors. The key parameter here is the CS level in case the EG are high. Indeed, the higher $W(\overline{e})$, the higher the benefit to provide high incentives and thereby to adopt the SED rule. Moreover, the higher the quality of information on EG, the lower the number of errors under the SED. As a result, if the quality of information is high enough (for β beyond β^{***}, where $\beta^{***} < 1$ iff $W(\overline{e})$ is high enough), giving up remedies and applying the SED encourages more efficient mergers. It is efficient to give up remedies even though they improve *ex post* the outcome of merger control. The underlying rationale is well known, namely the benefit for a player to commit *ex ante* to undertaking *ex post* a possibly inefficient strategy. Here, it can be efficient for the CA to commit not to use remedies *ex post* in order to constrain firms to propose *ex ante* more efficient mergers.

Second, for lower levels of information quality on EG, two possibilities arise. If the semi-separating equilibrium prevails under the FED rule, then this decision rule ensures a higher effort than the SED as well as a lower level of type I errors. Nevertheless, the FED rule does not avoid completely type I errors as the R rule does. Hence a trade-off between the inefficiency of type I errors and a higher effort. Again, the result depends on the level of the information quality on EG since a decrease in the quality of information reduces the expected CS under the FED rule and leads the CA to prefer the R rule (for β lower than β^*). Instead, if the pooling equilibrium prevails, the FED rule leads to the same expected CS as the R rule, and thus the comparison simply amounts to balancing the R rule against the SED rule.

Note finally that our model provides a possible interpretation for the introduction in 2004 of the ED procedure within the ECMR. The improvement in the ability of the Commission to assess EG represents an increase in the quality of information available. According to our model, this may have led merging firms to self-select according to the "procedure" chosen. As a result, the combination of remedies with the ED (our FED) is now optimal against the R rule on its own. In addition, a further increase in the information quality may lead in the future to EC to occasionally refrain from taking into account the remedy submission by merging firms so as to provide even higher incentives to look for EG.

4. Discussion

In this section we explore four different aspects of our model.

Investment in information acquisition

Our model allows to discuss the *benefit* of the CA investment in two types of expertise: the assessment of EG (parameter β) and the identification of effective and available remedies (parameter γ). A higher quality of the signal β on EG increases the expected welfare. Proposition 3 shows that starting from a very low β, a higher β induces the CA to switch from the R rule to the FED rule, where the effort is higher and where the firms self-select according to the type of merger proposed.

An even higher β could lead the CA to disregard the remedies and adopt instead the SED, thus providing the highest incentive for the submission of an efficient merger. Hence a trade-off between the cost of a better signal and the benefit in terms of improved expected CS.

The benefit of a better signal on effective remedies is much more ambiguous. A high level of β induces self-selection and thus removes any benefit to invest in the signal γ. Even worse, a higher γ has a welfare cost by increasing the threshold $\underline{\beta}(\gamma)$ above which the firms self-select under the FED rule. For a $\beta < \underline{\beta}(\gamma)$, where the semi-separating equilibrium prevails under the FED rule, an increase in γ has an ambiguous impact on the expected CS, equal to $\beta \cdot q^{FED}(\beta, \gamma) \cdot W(\overline{e}) + (1 - q^{FED}(\beta, \gamma)) \cdot W^R(\underline{e}) \cdot [(1 - m(\underline{e})) + \beta\gamma]$. On the one hand, a higher γ induces the merging firms to reduce the effort exerted, $q^{FED}(\beta, \gamma)$, because an increase in γ reduces the probability for the efficient merger to be cleared without remedies. On the other hand, a higher γ allows the CA to increase the probability to clear an inefficient merger with remedies.

According to our model, it seems more valuable to improve the detection of EG rather than the expertise to find out the right remedies. This is true as long as the CA is able to assess the effectiveness of remedies whenever they are proposed by the merging firms.

Imperfect remedies

We can introduce the imperfection of remedies in a simple way by assuming that there exist two equally probable types of inefficient merged firms, $\underline{e}$ and $\underline{e}^R$, that differ only regarding the effectiveness of remedies[12]: remedies can only fix the type $\underline{e}^R$ merger. The CA observes a noisy signal on the actual inefficient type so that with probability α the CA is able to infer the true inefficient type and thus the effectiveness of remedies whereas with probability $1-\alpha$ the signal can come from both inefficient types (but never from the efficient type $\overline{e}$). The parameter α captures the imperfection of remedies. Moreover, the CA must be sure the remedies are effective in order to clear the merger: $\frac{1}{2}W^R(\underline{e}^R) + \frac{1}{2}W^R(\underline{e}) < 0$. The expected profit for an inefficient type that proposes remedies is now equal to $\alpha\frac{1}{2}\Pi^R(\underline{e})$. For simplicity we assume that in case of ED, the CA never observes the efficient remedies. In brief, imperfect remedies in our model amount to studying the outcome of a decrease in both $\Pi^R(\underline{e})$ and $W^R(\underline{e})$. Hence the following proposition.

Corollary 1. *For high enough $W(\overline{e})$, imperfect remedies improve the outcome of the FED rule with respect to both the SED and the R rule, and the opposite holds for low values of $W(\overline{e})$.*

[12] The profit increase is the same for $\underline{e}^R$ and for $\underline{e}$ and the CS without remedies is also the same for these two types.

Imperfect remedies increase the error rate of the CA's merger decision whenever remedies are available but nevertheless increase the incentive to exert effort. Thus, the net impact is ambiguous on the trade-off of between the SED rule, unaffected, and the FED rule for which the higher effort increases the expected welfare but for which the decreasing efficiency in case of remedies reduces the expected welfare. The net effect depends on $W(\overline{e})$ that drives the magnitude of the positive effect due to a higher effort. The choice between Remedy and FED is also affected. If remedies are proposed, imperfect remedies reduce less the expected welfare under the FED rule than under the R rule because remedies are less often proposed under the FED rule. Yet, the increasing effort could improve less the FED rule then the R rule since the efficient merger is cleared with a lower probability under the FED rule. Again, the impact of the higher effort depends on the CS level $W(\overline{e})$.

Welfare standard

Because total welfare is higher than the firms' profit, the effort q exerts a positive externality on the CS and thus is always lower than the socially optimal level of effort. If we denote by $qW^T(\overline{e}) + (1-q)W^T(\underline{e}) - F(q)$ the expected total welfare, this function always increases with the effort exerted at the equilibrium. Therefore, if we compare the different rules for $qW^T(\overline{e}) + (1-q)W^T(\underline{e})$ instead of $qW^T(\overline{e}) + (1-q)W^T(\underline{e}) - F(q)$, the conclusions are only affected by the effort cost differences but the impact of q on both welfare functions is qualitatively the same. As a result, the qualitative analysis remains valid for a total welfare objective.

The CA's commitment

Let us examine the impact of the CA's commitment on a decision rule according to the signal observed. Whenever the merger is accepted for a signal in H and prohibited for a signal in L, the commitment on a different decision rule would turn out as inefficient *ex post* and as less efficient *ex ante* in terms of effort incentive. A prohibition for a signal in M at the equilibrium is also *ex ante* optimal since a systematic approval would be both *ex post* inefficient and would reduce the incentive to exert effort. Instead, for a signal in M in the semi-separating equilibrium case, the CA may be better off committing not to accept the merger so as to increase the effort exerted. This effort effect due to the commitment could improve the efficiency of the FED rule.

5. Conclusion

This paper draws attention to the likely consequences of the adoption of an ED procedure, given the general current context of its application, i.e. asymmetric information for the CA and generalized use of merger remedies. The former point was actually invoked to delay the European ED, by arguing costly implementation issues. We claim here that a possible *ex ante* positive effect, in the shape of incentives to undertake more efficient mergers, should equally be accounted for, despite the asymmetric information problem. The second point is intimately related to the first, due to the interaction between the remedies and the ED. The study of this interplay is the original and more important contribution of our paper. We examine the impact of remedies on the incentives provided by the ED, and conclude on the opportunity of combining them with the ED, depending on the quality of information underlying the merger assessment.

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6. Appendix

6.1. Proof of Proposition 1

- **Under the SED rule**

We have $d^{ED}(s) = 1$ for s in H and $d^{ED}(s) = 0$ for s in L. If s in M is observed, the updated belief is $b(s/ED) = q$. The expected CS is thus $qW(\overline{e}) + (1-q)W(\underline{e})$, which is negative by assumption. Therefore $d^{ED}(s) = 0$ for s in M.

- **Under the R rule**

The merger is cleared iff remedies are proposed.

6.2. Proof of Lemma 1

- **The signal $s \in L$ or $\in H$**

For a signal s in H, then $b(sr/ED) = 1$ and thus the optimal choice is $d^{ED}(sr) = 1$ and $d^{R}(sr) = 0$

For a signal s in L, then $b(sr/ED) = 0$ and thus the optimal choice is $d^{ED}(s) = 0$ and $d^R(sR) = 1$

- **The signal** $s \in M$

The CA clears a merger without remedies for a signal $s\varnothing$ with a probability $d > 0$ iff the updated beliefs $b(s\varnothing, ED)$ are such that $b(s\varnothing, ED)W(\overline{e}) + (1 - b(s\varnothing, ED))W(\underline{e}) = 0$. As a result, if the signal is sR, we have also $b(sR, ED)W(\overline{e}) + (1 - b(sR, ED))W(\underline{e}) = 0$ so that the optimal choice is $d^{ED}(sR) = d$ and thus $d^R(sR) = 0$. If $d = 0$, then it must be that $b(s\varnothing, ED)W(\overline{e}) + (1 - b(s\varnothing, ED))W(\underline{e}) < 0$. Thus, if the signal is sR, then $b(sR, ED)W(\overline{e}) + (1 - b(sR, ED))W(\underline{e}) < 0$. Thus the optimal decision for the CA is $d^{ED}(sR) = 0$ and $d^R(sR) = 1$.

6.3. Proof of Lemma 2

- **The efficient merger type:**

The profit under remedies is lower than the expected profit with ED iff
$\Pi^R(\overline{e}) \leq \beta\Pi(\overline{e}) + (1 - \beta)d\Pi(\overline{e}) \Leftrightarrow d \geq Max(\frac{\Pi^R(\overline{e}) - \beta\Pi(\overline{e})}{(1-\beta)\Pi(\overline{e})}, 0) = d_{\overline{e}}(\beta)$.
Moreover, $d_{\overline{e}}(\beta) > 0 \Leftrightarrow \beta < \frac{\Pi^R(\overline{e})}{\Pi(\overline{e})} = \overline{\beta}$.

- **The inefficient merger type:**

The profit under remedies is lower than the expected profit with ED iff
$\Pi^R(\underline{e}) \leq \beta\gamma\Pi^R(\underline{e}) + d(1 - \beta)\Pi(\underline{e}) \Leftrightarrow d \geq Min(\frac{(1-\beta\gamma)\Pi^R(\underline{e})}{(1-\beta)\Pi(\underline{e})}, 1) = d_{\underline{e}}(\beta, \gamma)$.
Furthermore, $d_{\underline{e}}(\beta, \gamma) < 1$ iff $\beta < \frac{\Pi(\underline{e}) - \Pi^R(\underline{e})}{\Pi(\underline{e}) - \gamma\Pi^R(\underline{e})} = \underline{\beta}(\gamma)$.
Finally, $d_{\overline{e}}(\beta) < d_{\underline{e}}(\beta, \gamma)$ since by assumption $\frac{\Pi^R(\underline{e})}{\Pi(\underline{e})} > \frac{\Pi^R(\overline{e})}{\Pi(\overline{e})}$.

6.4. Proof of Proposition 2

We identify here the Perfect Bayesian equilibria under the FED rule.

- **For** $\beta > \underline{\beta}$

The inefficient insiders always chooses remedies and the efficient merging firms always choose the ED. The corresponding consistent beliefs are thus $b(sr, ED) = 1$ for any r and for s in M or

H. The optimal choice of the CA is thus $d^{ED}(sr) = 1$ for s in M or H and for any r. For s in L, $d^{ED}(s\varnothing) = 0$ and $d^{ED}(sR) = R$.

This is a **separating equilibrium**.

- **For** $\beta > \overline{\beta}$ **and** $\beta < \underline{\beta}$.

The efficient insiders always choose to submit their merger without remedies. Let us identify the equilibrium.

A strategy $m(\underline{e}) = 1$ requires that $d^{ED}(s\varnothing) > 0$ so as to ensure that the expected profit when the firms propose an ED is at least the profit if they submit R. But in that case, the consistent beliefs are $b(s\varnothing, ED) = q$ leading to $d^{ED}(s\varnothing) = 0$ which contradicts the initial assumption.

If the strategy is $m(\underline{e}) = 0$, then the consistent belief are $b(s\varnothing, ED) = 0$ so that the optimal decision is $d^{ED}(s\varnothing) = 1$ contradicting the initial assumption that $\beta < \underline{\beta}$.

Consider finally a mixed strategy with $0 < m(\underline{e}) < 1$. The updated beliefs are $b(s\varnothing, ED) = (1-q)m(\underline{e})$. The inefficient type must be indifferent between proposing R and ED. Thus at the equilibrium $d^{ED}(s\varnothing) = d_{\underline{e}}(\beta, \gamma)$. Then the CA must be indifferent between clearing the merger or prohibiting it if the signal $s\varnothing$ is observed with $s \in M : W(\overline{e})q + (1-q)m(\underline{e})W(\underline{e}) = 0$. Such a $m(\underline{e})$ always exists, since for $m(\underline{e}) = 1$, $W(\overline{e})q + (1-q)W(\underline{e}) < 0$, whereas for $m(\underline{e}) = 0$, $W(\overline{e})q > 0$.

Thus for $\beta > \overline{\beta}$ and $\beta < \underline{\beta}$, there exists a unique **semi-separating equilibrium** where $d^{ED}(s\varnothing) = d_{\underline{e}}(\beta, \gamma)$, the efficient insiders attempt the ED and the inefficient ones do so with a probability $m(\underline{e}) = m^{FED}$ such that $W(\overline{e})q + (1-q)m^{FED}W(\underline{e}) = 0$.

- **For** $\beta < \overline{\beta}$

In this case the semi-separating equilibrium described above exists.

Because $\beta < \underline{\beta}$, we must also consider the case where the efficient type proposes remedies. The inefficient type is thus also induced to propose remedies. It is optimal for both types to submit remedies as long as $d < d_{\overline{e}}(\beta)$. Therefore the beliefs $b(s\varnothing, ED)$ are not defined. The beliefs must be such that $W(\overline{e})b(s\varnothing, ED) + (1 - b(s\varnothing, ED))W(\underline{e}) \leq 0$ to make the CA adopt $d^{ED}(s\varnothing) < d_{\overline{e}}(\beta)$, where $0 < b(s\varnothing, ED) < 1$.

Thus, there exists a **pooling equilibrium** where both types propose remedies and the CA adopts $d^{ED}(s\varnothing) < d_{\overline{e}}(\beta)$.

However, the belief $0 < b(s\varnothing) < 1$ satisfies the Cho and Kreps criterion only as long as there exists $d^{ED}(s\varnothing)$ such that it could be profitable for the inefficient insiders to choose ED (no remedies). This is the case for $d_{\underline{e}}(\beta,\gamma) < 1 \Leftrightarrow \beta < \underline{\beta}(\gamma)$.

Consequently, hereafter we will consider the pooling equilibrium only if $\beta < Min(\overline{\beta}, \underline{\beta})$.

6.5. Proof of Lemma 3

6.5.1. Proof of part (i)

Under the SED rule the probability q^{SED} is such that $\beta\Pi(\overline{e}) = F'(q^{SED})$.

Under the R rule the probability q^R is such that $\Pi^R(\overline{e}) - \Pi^R(\underline{e}) = F'(q^R)$

- **Effort comparison under FED and SED when the semi-separating equilibrium prevails**

Let us study the effort exerted under the FED.

For $\beta < \underline{\beta}$, the semi-separating prevails and the effort exerted is $q^{FED}(\beta,\gamma)$ and defined by $\beta\Pi(\overline{e}) + (1-\beta)\Pi(\overline{e})d_{\underline{e}}(\beta,\gamma) - \Pi^R(\underline{e}) = F'(q^{FED})$.

For $\beta > \underline{\beta}$, the separating equilibrium prevails and the effort exerted is defined by $\Pi(\overline{e}) - \Pi^R(\underline{e}) = F'(q^{FED})$

The effort $q^{FED}(\beta,\gamma)$ is a continuous function of β and is constant with respect to β for $\beta > \underline{\beta}$.

Moreover, for $\beta < \underline{\beta}$, we have always $q^{FED}(\beta,\gamma) > q^{SED}(\beta)$ since $(1-\beta)\Pi(\overline{e})d_{\underline{e}}(\beta,\gamma) > (1-\beta)\Pi(\underline{e})d_{\underline{e}}(\beta,\gamma) = \Pi^R(\underline{e})$.

For $\beta = 1$ where the separating equilibrium prevails, we have $q^{FED}(1,\gamma) < q^{SED}(1)$ since $\Pi(\overline{e}) - \Pi^R(\underline{e}) < \Pi(\overline{e})$.

Thus by continuity, there exists a unique $\widehat{\beta} > \underline{\beta}$ such that $q^{FED}(\beta,\gamma) \geq q^{SED}(\beta)$ iff $\beta < \widehat{\beta}$.

- **Effort comparison under FED and SED when the pooling equilibrium prevails**

We showed in the previous case that for $\beta > \underline{\beta}$, there exists a threshold above which $q^{FED}(\beta,\gamma) < q^{SED}(\beta)$.

For $\beta < \underline{\beta}$, the effort exerted under the FED is equal to q^R. The effort $q^{SED}(\beta)$ increases with β and $q^{SED}(0) < q^R$ since $\Pi^R(\overline{e}) - \Pi^R(\underline{e}) > 0$. Yet, we cannot exclude that $q^R < q^{SED}(\underline{\beta})$.

6.5.2. Proof of (ii)

To prove that $q^R \leq q^{FED}(\beta,\gamma)$, we need to show that $q^R \leq q^{FED}(0,\gamma)$ since $q^{FED}(\beta,\gamma)$ increases with β whenever the semi-separating equilibrium prevails, and is constant and higher than q^R for the separating equilibrium.

One has that $q^R \leq q^{FED}(0,\gamma)$ iff

$\Pi^R(\overline{e}) - \Pi^R(\underline{e}) \leq \left[(\beta\Pi(\overline{e}) + (1-\gamma)\Pi(\overline{e})d_{\underline{e}}(\beta,\gamma) + \gamma\Pi^R(\overline{e})) - \Pi^R(\underline{e})\right]_{\beta=0}$.

This inequality holds since $d_{\underline{e}}(0,\gamma)\Pi(\overline{e}) = \frac{\Pi^R(\underline{e})}{\Pi(\underline{e})}\Pi(\overline{e}) > \Pi^R(\overline{e})$.

6.6. Proof of Proposition 3

Let us compare the expected CS according to the decision rule.

- **Consider first that** $\beta \geq \underline{\beta}$

In that case, the separating equilibrium prevails under the FED rule since the pooling equilibrium does not meet the Cho and Kreps criterion, so is not retained as relevant.

The expected CS are the following under each decision rule:

Under the R rule the expected CS is $q^R W^R(\overline{e}) + (1-q^R)W^R(\underline{e})$

Under the SED the expected CS is $\beta q^{SED}(\beta)W(\overline{e})$

Under the FED the expected CS is: $q^{FED}(\beta,\gamma)\cdot W(\overline{e}) + (1-q^{FED}(\beta,\gamma))\cdot W^R(\underline{e})$

First of all, the expected CS under the FED is higher than under the R rule:

$\left\{q^{FED}(\beta,\gamma)W(\overline{e}) + (1-q^{FED}(\beta,\gamma))W^R(\underline{e})\right\} - \left\{q^R W^R(\overline{e}) + (1-q^R)W^R(\underline{e})\right\}$

$> \left[q^{FED}(\beta,\gamma) - q^R\right]\left[W^R(\overline{e}) - W^R(\underline{e})\right] > 0$, since $q^{FED}(\beta,\gamma) > q^R, \forall\beta$.

Secondly, we compare the expected CS under the SED with the expected CS under the FED:

$>$From Lemma 3, one has that $q^{FED}(\beta,\gamma) < q^{SED}(\beta)$ for $\beta > \widehat{\beta}$ (where $\widehat{\beta} > \underline{\beta}$).

Thus for $\underline{\beta} < \beta < \widehat{\beta}$, the FED dominates the SED, because one has

$\beta q^{SED}(\beta)W(\overline{e}) < q^{FED}(\beta,\gamma)\cdot W(\overline{e}) + (1-q^{FED}(\beta,\gamma))\cdot W^R(\underline{e})$.

Moreover, for $\beta > \widehat{\beta}$, the expected CS under SED increases with β while the expected CS is constant under the FED.

Thus, there exists a unique β^{***} with $\widehat{\beta} < \beta^{***} < 1$ such that:

$\beta^{***}q^{SED}(\beta^{***})W(\overline{e}) = q^{FED}(\beta^{***},\gamma)W(\overline{e}) + (1-q^{FED}(\beta^{***},\gamma)W^R(\underline{e})$ iff

$q^{SED}(1)W(\overline{e}) > q^{FED}(1,\gamma)W(\overline{e}) + (1-q^{FED}(1,\gamma))W^R(\underline{e})$. Otherwise $\beta^{***} = 1$.

To sum up, for $\beta > \beta^{***}$, the SED is optimal, and for $\underline{\beta} < \beta < \beta^{***}$, the FED is optimal.

- **Consider now the case where** $\beta < \underline{\beta}$

For $\beta < \underline{\beta}$, under the FED rule both the pooling and the semi-separating equilibria obtain.

(i) If the **semi-separating equilibrium** prevails under the FED, then the expected CS are:
Under the R rule the expected CS is: $q^R W^R(\overline{e}) + (1 - q^R) W^R(\underline{e})$
Under the SED the expected CS is: $\beta q^{SED}(\beta) W(\overline{e})$
Under the FED the expected CS is: $\beta \cdot q^{FED}(\beta,\gamma) \cdot W(\overline{e}) + (1 - q^{FED}(\beta,\gamma)) \cdot W^R(\underline{e}) \cdot \left[(1 - m^{FED}) + \beta\gamma\right]$

From Lemma 3 one has that $q^{FED}(\beta,\gamma) > q^{SED}(\beta)$ for $\beta < \widehat{\beta}$. As a result, the expected CS under the FED rule is higher than under the SED rule.
We need therefore compare the expected CS under the FED and the R rules:

First, the term $\beta \cdot q^{FED}(\beta,\gamma)) \cdot W(\overline{e})$ is increasing with β because $q^{FED}(\beta,\gamma)$ increases with β

Second, for $\beta = 0$, the expected CS under the FED is lower than under the R rule:
$\left[\beta \cdot q^{FED}(\beta,\gamma) \cdot W(\overline{e}) + (1 - q^{FED}(\beta,\gamma)) \cdot W^R(\underline{e}) \cdot (1 - m^{FED})\right]_{\beta=0} < q^R W^R(\overline{e}) + (1 - q^R) W^R(\underline{e})$.
Thus, there exists a unique $\beta \in \left[0, \underline{\beta}\right]$ such that the two expected welfare levels are equal. In that case, for any β lower than this threshold, the R rule is optimal.

(ii) If the **pooling equilibrium** prevails for $\beta < Min(\underline{\beta}, \overline{\beta})$, then the FED rule leads to the same outcome as the R rule, thus the latter becomes optimal.
In short, for both types of equilibria, there exists a β^* below which the R rule is optimal.

- **To sum up:**

(i) For any $\beta > \beta^{***}$, the SED is the best decision rule
(ii) There exists β^{**} such that for $\beta^{**} < \beta < \beta^{***}$, the FED is the best decision rule.
(iii) There exists β^* such that for $\beta < \beta^*$, the R rule is optimal.
The final point is that if the semi-separating equilibrium prevails under the FED rule, then $\beta^* = \beta^{**}$.

6.7. Proof of Corollary

The expected effort is given by the following conditions:
- FED under the separating equilibrium: $\Pi(\overline{e}) - \frac{\alpha}{2}\Pi^R(\underline{e}^R) = F'(q)$
- FED under the semi-separating equilibrium: $\beta\Pi(\overline{e}) + (1 - \beta)\Pi(\overline{e}) d_{\underline{e}}(\beta) - \frac{\alpha}{2}\Pi^R(\underline{e}^R) = F'(q)$
- under the R rule: $\Pi^R(\overline{e}) - \frac{\alpha}{2}\Pi^R(\underline{e}^R) = F'(q)$

Thus, given the final section discussion on investment in information acquisition, a decrease in α leads to the same increase in effort under both rules.

Next we compare the SED rule and the FED rule whenever the separating equilibrium prevails. In that case the expected CS is $q^{FED}(\beta) \cdot W(\overline{e}) + (1 - q^{FED}(\beta))\frac{1}{2}\alpha W^R(\underline{e})$. An decrease in α is ambiguous. Nevertheless, if $W(\overline{e})$ is high enough, then the impact is positive and thus the FED rule becomes more efficient than the SED rule.

So as to compare now the FED rule with the R rule, we need to consider the FED under the semi-separating equilibrium. The levels of expected CS are as follows:

- under the FED rule: $\beta \cdot q^{FED}(\beta) \cdot W(\overline{e}) + (1 - q^{FED}(\beta))\frac{1}{2}\alpha W^R(\underline{e}^R) \cdot (1 - m^{FED}) = q^{FED}(\beta)(\beta + \alpha\frac{W^R(\underline{e}^R)}{W(\underline{e}^R)}) \cdot W(\overline{e}) + (1 - q^{FED}(\beta))\frac{1}{2}\alpha W^R(\underline{e}^R)$
- under the R rule: $q^R W^R(\overline{e}) + (1 - q^R)\frac{1}{2}\alpha W^R(\underline{e})$

The decrease in α has a direct negative impact on the expected CS, which is however lower under the FED rule than under the R rule. The decrease in α also has a positive indirect impact on the effort exerted, and the magnitude of this indirect effect under the FED rule increases with $W(\overline{e})$.