Transversal Agency and Crowding Out*

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Abstract

A country’s competition agency is transversal in the sense of being active in the whole economy. We study the interaction between the competition agency and sectoral regulators and establish a scope for sectoral regulators to crowd out each other’s efforts: More effort on monitoring anti-competitive behaviour by one sectoral regulator causes others to do less. We also find that when government agencies interact under consensus the competition agency spends more effort on the industry with the more consumer-biased sectoral regulator, while the opposite is true under independent decisions.

Keywords: Competition policy; Crowding out; Government structure; Multiple regulators; Concurrency.

JEL: L43, D73, H11

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1 Introduction

Although a jurisdiction’s sectoral regulators operate in different industries, their monitoring activities may interact indirectly if each of these regulators has activities that are concurrent with those of the competition agency. In contrast to the sectoral regulators, the competition agency is transversal: it monitors the whole economy. Thus, under a binding budget constraint, more effort spent on monitoring one industry is bound to entail less effort spent elsewhere. In this paper, we develop a model with three government agencies – two sectoral regulators and one competition agency – to explore the effect of these interweaved relationships.

In our analysis of this model, we point out a crowding-out effect: when one sectoral regulator increases the monitoring of its industry, this calls for a response from the competition agency in its monitoring of the same industry, which again means a shift in the competition agency’s allocation of resources that in turn affects that agency’s activities in the other industry and thus affects the other sectoral regulator’s monitoring. We consider two formulations of how two agencies interact when operating in the same industry and find that crowding out occurs with both formulations: more monitoring by one sectoral regulator means less monitoring by the other one. This crowding out raises concerns for the success of concurrency, i.e., the institution of concurrent powers to both sectoral regulators and the competition agency: however well government gets concurrency to work in any single regulated industry, there is no escape from the various sectoral regulators fighting it off over the limited monitoring efforts of the competition agency.

If the sectoral regulators differ in their preferences over consumer and producer surpluses, then the competition agency will discriminate between them. The best way to discriminate depends on how agencies monitoring an industry interact. One possibility is what we call consensus: if there is a breach of law among firms in the industry, then the agencies are successful in establishing this breach through their monitoring when each of them is successful on its own. The other possibility is independent decisions: the agencies are now successful in establishing a breach of law when at least one of them is.

The more consumer-biased sectoral regulator – i.e., the one putting more weight on consumer surplus relative to industry profits – exerts more effort. And so, under consensus, the competition agency will spend more effort in that sectoral regulator’s industry, independently of its own preferences. This is because the two agencies’ monitoring efforts are strategic complements. Under independent decisions, we get the opposite: now, monitoring efforts are strategic substitutes, and the competition agency spends more effort in the industry with the more industry-biased sectoral regulator.

We also consider how these interactions would be affected by an increase in the competition agency’s budget, which plays such a crucial role in mediating the interdependence of sectoral regulators. In particular, we find that more of a budget increase will be spent on the industry whose equilibrium shifts more as a result.1

Finally, we consider the case of mixed decisions, where the competition agency interacts with one sectoral regulator under consensus and with the other under independent

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1In the unrealistic case of a budget so large that it is not binding the indirect linkage between sectors breaks down.
decisions. Thus, monitoring efforts are strategic complements in one industry and strategic substitutes in the other. This turns around our result on crowding out among sectoral regulators. When the interactions among agencies are the same across industries, either both consensus or both independent decisions, then sectoral regulators’ efforts are indirectly strategic substitutes and we get crowding out. Under mixed decisions, on the other hand, they are strategic complements, and so an increase in one sectoral regulator’s monitoring efforts leads to an increase also in the other’s efforts, through their interactions with the competition agency. Thus, while the case of mixed decisions may not be the empirically most relevant one to consider, our analysis of it serves to show how crucial it is for crowding out to occur that decisions are indeed not mixed.

Our work relates to previous research on multi-agency government. Most of this literature concerns a single-industry setting where multiple agencies interact in their regulation of that industry; see, e.g., Martimort (1996), Aubert and Pouyet (2004), and Barros and Hoernig (2004). Martimort (1996) discusses a case of two agencies with slightly different objectives regulating one and the same firm under asymmetric information. Aubert and Pouyet (2004) discuss a sectoral regulator regulating the dominant firm in an industry where a fringe of smaller firms are subject to monitoring by the competition agency. Barros and Hoernig (2004) compare consensus and independent decisions in the single-industry setting. None of these papers discuss cases of multiple industries, and so the significance of the competition agency being transversal does not show up in any of them.

Relatedly, Ting (2002) considers a government with multiple tasks to be carried out and discusses whether they should be done by a single agency or by one agency per task, while Ting (2003) discusses a government with multiple agencies carrying out a single task and asks what is the optimum number of agencies. The distinction between single-task agencies and a transversal one, which is crucial in our setting, does not appear in Ting’s work.

Our results on how the competition agency’s allocation of monitoring resources is affected by characteristics of the sectoral regulators add to the incipient work on how to spend resources in a competition agency. Martin (2000) and Pouyet and Verouden (2002) discuss how industries’ relative characteristics affect the resources spent on them, whereas Cosnita-Langlais and Tropeano (2013) discuss the trade-off between fighting cartels and controlling mergers. Harrington and Chang (2014) show that limited resources at the competition agency can imply that corporate leniency programmes lead to more not less cartels being formed, because following up on whistle-blowers crowds out detection of other cartels. Schinkel, et al. (2014) show that the size of the agency’s budget can strongly influence the choice of activities undertaken and that it has a non-monotonic effect on welfare. These papers have in common with ours the recognition that authorities do operate with tight budgets and therefore have to make choices in a multi-tasking environment.

The organization of competition policy is a hotly debated issue. Baker (2013) and Holland and Luoma (2014), for example, discuss concurrent powers among the competition agency and sectoral regulators in the US and the UK, respectively. Fehr (2000) asks who is best suited to do competition policy in such regulated industries, the competition agency

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2See Kovacic and Hyman (2012) for an overview of some of the issues involved.
or the sectoral regulators. Our analysis contributes to this debate by emphasizing the scope for crowding out of sectoral regulators’ monitoring efforts caused by a wide-spread implementation of concurrency.

The paper is organized as follows. In the next section, we present the model. In Section 3, we collect some preliminary results. The main analysis is contained in Section 4, and implications for the competition agency’s budget are given in Section 5. In Section 6, we discuss the effect of allowing for mixed decisions. Finally, we offer our concluding remarks in Section 7. Proofs, technical results, and elaborations are collected in the Appendix.

2 The basic set-up

We model a government with two tasks to be carried out. To be specific, the two tasks are those of monitoring activities in two identical industries. The welfare gained from the activities in each industry consists of consumer surplus, $S$, and (total industry) profits, $\Pi$, so that welfare per industry is $W := S + \Pi$. The government seeks to maximize total welfare in the economy, and for this it uses a competition agency, $CA$, monitoring both industries, and two sectoral regulators, $SR_1$ and $SR_2$, monitoring one industry each.$^3$

While we let the two industries be identical, the sectoral regulators are not: They are allowed to have different weights on consumer surplus and profits, respectively. In particular, gross of own resources spent, sectoral regulator $SR_i$ maximizes

\[ U_i := S + \lambda_i \Pi, \quad i = 1, 2, \]

where $\lambda_i > 0$. Sectoral regulator $i$ is said to be unbiased if $\lambda_i = 1$, consumer-biased if $\lambda_i \in (0, 1)$, and industry-biased if $\lambda_i > 1$. The competition agency has bias $\lambda = 1$ and maximizes $W = S + \Pi$.$^4$

Our picture of a government task is one of monitoring specific industries in order to detect violations of the law, in particular such violations that relate to anti-competitive behavior. Initially, each industry is in a state unobservable to both the sectoral regulator and the competition agency. There are two possible states, which we call “Violation” and “No violation” of the rules of law. The probability that an industry is in the violation state is $\pi$, exogenous and the same for both industries.$^5$

The two agencies involved in monitoring an industry expend effort to find out about the true state of nature in that industry. If it is found that an industry is in the state of violation, then “remedies” will be imposed. There are thus three pairs of consumer surplus and profits relevant for the discussion: $(S_V, \Pi_V)$ when the industry is in violation, but this fact is not detected by the government agencies and no remedies are imposed; $(S_R, \Pi_R)$ when the industry is in violation, this is discovered, and remedies are imposed; $(S_{RV}, \Pi_{RV})$ when the industry is in violation, but this fact is not detected by the government agencies and no remedies are imposed.

$^3$Allowing for a larger number of industries and sectoral regulators does not lead to additional effects.

$^4$As it will turn out, introducing a competition-agency bias here, with some $\lambda > 0$, would not affect our results. Our way of modelling biased agencies goes back at least to Baron and Myerson (1982). See Dal Bó (2006) for a discussion of regulatory bias.

$^5$This probability can be endogenized by considering more active firms, but this would not shed additional light on the crowding-out issue.
and \((S_N, \Pi_N)\) when there is no violation. Naturally, we assume \(\Pi_R < \Pi_V\), and \(S_R + \Pi_R > S_V + \Pi_V\). The latter inequality can be rewritten as:

\[
\Delta_S := S_R - S_V > \Delta_\Pi := \Pi_V - \Pi_R > 0.
\] (2)

In other words, remedies have a positive effect on consumer surplus and a negative effect on profits, where the former effect is larger than the latter.

The focus is on cases where each agency prefers the remedies outcome to the violation outcome. For sectoral regulator \(i\), this means that

\[
\Delta_i := (S_R + \lambda_i \Pi_R) - (S_V + \lambda_i \Pi_V) = \Delta_S - \lambda_i \Delta_\Pi \geq 0.
\] (3)

The term \(\Delta_i\) describes agency \(i\)'s gain in utility from detecting a violation. If \(\lambda_1 \geq \lambda_2\), then we have \(\Delta_1 \leq \Delta_2\). For the competition agency,

\[
\Delta := (S_R + \Pi_R) - (S_V + \Pi_V) = \Delta_S - \Delta_\Pi > 0,
\]

where the inequality follows from (2).

The condition in (3) holds always for consumer-biased regulators. However, it does not hold for regulators who are sufficiently industry-biased. Imposing the condition implies, in effect, putting limits on how industry-biased a sectoral regulator can be. We assume in the following that (3) holds for both sectoral regulators.

With this formulation, where an industry is in one of three possible states, we allow for false negatives, so-called Type II errors, in that the industry may be in violation without the agencies finding out. The formulation disregards the possibility of false positives, or Type I errors: the agencies never claim a violation and impose remedies when in fact there is no violation. The assumption of no such false positives is a reasonable one to the extent that possibilities to appeal regulatory and antitrust decisions tend to minimize Type I errors. Still, our model can be adapted to include Type I errors without changing our conclusions.\(^6\)

Each agency has a given budget at its disposal. Let \(M\) denote total resources available to the competition agency. This agency has two tasks to carry out: monitoring each of the two industries in the economy. It thus will have to decide on how to split the budget among the two tasks, with \(e_{10} = e_0\) being spent on monitoring industry 1 and \(e_{20} = M - e_0\) on monitoring industry 2.

A sectoral regulator focuses on its designated industry. Some of its resources are spent on monitoring its industry to detect violations of the law, in concurrence with the monitoring efforts of the competition agency in that same industry. Other resources are spent on aspects of regulating the industry that are unrelated to the competition agency’s monitoring. In particular, sectoral regulator \(i = 1, 2\) decides to put in resources

\(^6\)To see this, note that conditions (2) and (3) can be adjusted to the existence of mistakes. in particular, suppose that, conditional on finding a violation, it is a mistake with probability \(\nu \in [0, 1]\), and that this mistake is not observed by the agency. The state where remedies are imposed when there in fact is a violation is denoted \(RV\), while the state where remedies are imposed when there in fact is no violation is denoted \(RN\). Let now \(S_R := (1 - \nu) S_{RV} + \nu S_{RN}\) and \(\Pi_R := (1 - \nu) \Pi_{RV} + \nu \Pi_{RN}\), where, as above, the pair \((S_s, \Pi_s)\) denote consumer surplus and profits, respectively, in state \(s\).
in concurrent monitoring of its industry rather than spending these resources on other regulatory activities. We put the opportunity cost of these resources simply as $e_i$.\footnote{Thus while we do not model explicitly the sectoral regulators’ budget constraints, we do capture their trade-offs between allocating funds for monitoring or for other activities such as technical regulation.}

The resources spent by the agencies include any shadow cost of public funds, so that the CA and SRs take these into account when choosing how much to spend. We will analyze the Nash equilibrium of the game where the three agencies simultaneously choose $e_0$, $e_1$, and $e_2$, respectively.

The timing of decisions deserves some further discussion. Any of the agencies may actually start an investigation. There is no particular reason why one should move earlier than the other. The start of an investigation is triggered by some information received or suspicions raised at any of the agencies. As long as, after the official start of an investigation, the other agency monitoring the same industry becomes aware of it and is able to start its own investigation before the other one is concluded, we can consider this as simultaneous moves by the two government agencies monitoring a particular industry. An alternative would be that the competition agency is assigned the role of lead investigator. This will have no effect on the equilibrium outcome, an observation we elaborate on in Section 7.

The probability that the two agencies involved in a task are successful – i.e., that their monitoring is successful in finding violations in the industry (meaning finding sufficient evidence to hold up the case in court, if necessary) – depends on the resources the agencies spend on the task. It also depends on the type of interaction between the agencies.

We write the probability for industry 1 as $P_1 (e_{10}, e_1) = P_1 (e_0, e_1)$, and for industry 2 as $P_2 (e_{20}, e_2) = P_2 (M - e_0, e_2)$. We assume each of the two functions to be twice continuously differentiable, increasing, and strictly concave in each argument, with $P_i (0, 0) = 0$ (without any effort, nothing can be proved).

We model two distinct modes of interaction between two government agencies, in our case between the competition agency and a sectoral regulator. One mode corresponds to consensus among the two agencies. It implies that a task is successfully completed by the two agencies involved if and only if each agency is successful on its own. In other words, violation is successfully identified and remedies imposed if and only if both agencies have found enough evidence of violation. We include here situations where a mandatory opinion from the other agency is required for a final decision to be reached, as is often the case with sectoral regulators in sensitive industries such as banking and media. Conditional on a violation taking place in industry $i$, the competition agency finds enough evidence for action with probability $p(e_{i0})$. The sectoral regulator correspondingly obtains sufficient information with probability $p(e_i)$. Here, $p(e)$ is a function that maps resources of an agency into a probability of success, with $p(0) = 0$, $p'(0) < 0$, $p'' > 0$, $p(0) = 0$, and $\lim_{e \to \infty} p(e) = 1$.

**Definition 1** Consensus: the probability $P_i$ of successful completion of task $i$, by the two agencies involved, is

$$P_i^C = p(e_{i0})p(e_i).$$

The other mode of interaction between government agencies is called independent decisions and implies that a task is completed by the two agencies if at least one of them
completes it. In other words, a violation is successfully identified and remedies imposed if at least one of the two agencies involved has succeeded in finding evidence of violation.

**Definition 2 Independent decisions:** the probability \( P_1 \) of successful completion of task \( i \), by the two agencies involved, is

\[
P_i^f = 1 - [1 - p(e_0)] [1 - p(e_i)].
\]  

(5)

3 Crowding out

The monitoring of industry 1 is performed by \( CA \) and \( SR_1 \). Given the decision \( e_0 \) by \( CA \), \( SR_1 \)’s optimum effort is the solution to

\[
\max_{e_1 \geq 0} E[U_1] - e_4 = P_1(e_0, e_1) [\pi U_{1R} + (1 - \pi) U_{1N}]
\]

\[
+ [1 - P_1(e_0, e_1)] [\pi U_{1V} + (1 - \pi) U_{1N}] - e_1.
\]

Reorganizing and collecting constant terms, we can rewrite this objective function as

\[
E[U_1] - e_1 = P_1(e_0, e_1) \pi \Delta_1 - e_1 + \text{const}.
\]

We can now express the best response of \( SR_1 \), \( \hat{e}_1(e_0) \), as follows: If \( \frac{\partial}{\partial e_1} P_1(e_0, 0) < \frac{1}{\pi \Delta_1} \), then \( \hat{e}_1(e_0) = 0 \). If \( \frac{\partial}{\partial e_1} P_1(e_0, 0) \geq \frac{1}{\pi \Delta_1} \), then \( \hat{e}_1(e_0) \) solves

\[
\frac{\partial}{\partial e_1} P_1(e_0, \hat{e}_1(e_0)) = \frac{1}{\pi \Delta_1}.
\]  

(6)

Similarly, the best response of \( SR_2 \) is as follows: If \( \frac{\partial}{\partial e_2} P_2(M - e_0, 0) < \frac{1}{\pi \Delta_2} \), then \( \hat{e}_2(e_0) = 0 \). If \( \frac{\partial}{\partial e_2} P_2(M - e_0, 0) \geq \frac{1}{\pi \Delta_2} \), then \( \hat{e}_2(e_0) \) solves

\[
\frac{\partial}{\partial e_2} P_2(M - e_0, \hat{e}_2(e_0)) = \frac{1}{\pi \Delta_2}.
\]  

(7)

The problem of the competition agency, active in both industries, is

\[
\max_{0 \leq e_0 \leq M} E[W_1 + W_2] = [P_1(e_0, e_1) + P_2(M - e_0, e_2)] [\pi W_R + (1 - \pi) W_N]
\]

\[
+ \{[1 - P_1(e_0, e_1)] + [1 - P_2(M - e_0, e_2)]\} [(\pi W_V + (1 - \pi) W_N)],
\]

where \( W_i \) denotes welfare in industry \( i = 1, 2 \). We can rewrite this objective function as

\[
E[W_1 + W_2] = [P_1(e_0, e_1) + P_2(M - e_0, e_2)] \pi \Delta + \text{const}.
\]

(8)

Note how the problem of the competition agency differs slightly from that of a sectoral regulator: the alternative use of resources spent on monitoring industry \( i \) is to spend them

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8Since \( P_1 \) is strictly concave in \( e_1 \), the sufficient second-order condition holds and there is a unique best response.
on monitoring industry \( j \neq i \). The consequence is that the term \( \pi \Delta \) in (8) is simply a multiplier. Thus, as long as the competition agency makes use of all resources available, results are not dependent on its bias. Its problem simplifies to

\[
\max_{0 \leq e_0 \leq M} P_1(e_0, e_1) + P_2(M - e_0, e_2).
\]

The best response \( \hat{e}_0(e_1, e_2) \) solves

\[
\frac{\partial}{\partial e_{10}} P_1(\hat{e}_0(e_1, e_2), e_1) = \frac{\partial}{\partial e_{20}} P_2(M - \hat{e}_0(e_1, e_2), e_2). \quad (9)
\]

We can now state the following immediate result.

**Proposition 1** The efforts \((e_0^*, e_1^*, e_2^*)\) constitute an interior Nash equilibrium if and only if they satisfy conditions (6), (7), and (9).

We will assume that there is a unique interior Nash equilibrium.\(^9\)

Denote the slopes of the best responses of \( SR_i \) by \( r_i \). Similarly, denote by \( S_i \) the slope of \( CA \)’s best response with respect to \( e_i \), given \( e_j \). Specifically, from (6), (7), and (9), they are:

\[
r_i = \frac{de_i}{de_{i0}} = -\frac{\partial^2 P_i}{\partial e_{i0}\partial e_i}; \quad \text{and} \quad S_i = \frac{de_{i0}}{de_i} = \frac{\partial^2 P_i}{\partial e_{i0}^2} + \frac{\partial^2 P_i}{\partial e_j^2}. \quad (10)\]

Since denominators are negative, by our assumptions on \( p(\cdot) \), the signs of the slopes of \( r_i \) and \( S_i \) are always the same and equal to the sign of \( \frac{\partial^2 P_i}{\partial e_{i0}\partial e_i} \). We note, from (4) and (5), that \( \frac{\partial^2 P_i}{\partial e_{i0}\partial e_i} = p'(e_0)p'(e_i) > 0 \) under consensus, and \( \frac{\partial^2 P_i}{\partial e_{i0}\partial e_i} = -p'(e_0)p'(e_i) < 0 \) under independent decisions. Thus, we have (Barros and Hoernig, 2004):

**Proposition 2** Under consensus, the efforts of the two agencies monitoring the same industry are strategic complements. Under independent decisions, they are strategic substitutes.

Thus, consensus appears to represent a mode of interaction between agencies that government should strive for – with one agency’s monitoring effort building up under, and motivating, the effort of the other agency. However, as we shall see shortly, this is not as simple when we look at the whole of government. Because of the transversal nature of the competition agency, there is an indirect relationship between sectoral regulators. And for this relationship, consensus between the competition agency and each sectoral regulator does not avoid crowding out.

\(^9\)Under consensus, there is also always a degenerate boundary Nash equilibrium where nobody exerts effort and the \( CA \) does not use its budget.
We will be doing comparative statics on the equilibrium outcome below. It is therefore necessary to make sure that the equilibrium is stable. Using the notation in (10) and (11), we state: \(^{10}\)

**Lemma 1** A Nash equilibrium is stable if and only if

\[
\alpha := 1 - r_1 S_1 - r_2 S_2 > 0. \tag{12}
\]

We will assume throughout that condition (12) holds, so that the equilibrium is stable.

In this model, sectoral regulators crowd each other out. In order to see this, we first record the following intermediate result.

**Proposition 3** Indirectly, the efforts of \(SR_1\) and \(SR_2\) are strategic substitutes if the product of the slopes of the best responses of the sectoral regulators is positive \((r_1 r_2 > 0)\), and strategic complements if it is negative \((r_1 r_2 < 0)\).

By sectoral regulators’ efforts being “strategic substitutes indirectly”, we mean that they behave as strategic substitutes when a change in one effort has been translated into an accompanying change in the competition authority’s effort. The intuition for the result is the following: If, say, efforts are strategic complements in both tasks, then a rise in \(SR_1\)’s effort leads the \(CA\) to spend more on this task and less on the other, which in turns triggers a reduction in \(SR_2\)’s effort. Other cases follow the same logic.

With the product of their best responses to the competition agency’s efforts determining the nature the indirect relationship between the sectoral regulators, the mode of agency interaction in a single industry does not play any role, as long as \(r_1\) and \(r_2\) have the same sign:

**Proposition 4** Irrespective of whether decisions are by consensus or independent in both industries, the efforts of the sectoral regulators are strategic substitutes.

Thus, one sectoral regulator’s monitoring effort crowds out that of the other one. Instituting consensus as the proper mode of interaction between government agencies with concurrent powers of regulation in the same industry does not give an escape from this.

4 The transversal agency

We can now go deeper into the question of where the transversal competition agency puts in its efforts and how its decision relates to the biases of the sectoral regulators and to the mode of interaction between agencies.

\(^{10}\)The proofs of this and other results are in the Appendix.
Suppose first that decisions are by consensus, so that (4) holds. Based on this equation as well as those defining the Nash equilibrium – (6), (7), and (9) – equilibrium efforts are given by the following set of conditions:

\[ p'(e_0)p(e_1) = p'(M - e_0)p(e_2); \quad (13) \]
\[ p'(e_1)p(e_0) = \frac{1}{\pi \Delta_1}; \quad (14) \]
\[ p'(e_2)p(M - e_0) = \frac{1}{\pi \Delta_2}. \quad (15) \]

In this case, efforts of the two agencies active in an industry are strategic complements. We have the following result:\(^{11}\)

**Proposition 5** If agencies’ monitoring decisions are by consensus, then

(i) the more consumer-biased sectoral regulator exerts more effort than the other; and

(ii) the competition agency exerts more effort on the industry with the more consumer-biased sectoral regulator.

Because of strategic complementarity, the competition agency gets, on the margin, more mileage out of effort spent on the industry with the more consumer-biased sectoral regulator, because this sectoral regulator is more inclined to spend effort itself than the other one is. Thus, under consensus, the effect of the difference in biases of the sectoral regulators is amplified by the presence – and intervention – of the competition agency.

Suppose next that decisions are independent in both industries, so that (5) applies in stead of (4). The equilibrium efforts are now given by the following set of equations:

\[ p'(e_0) [1 - p(e_1)] = p'(M - e_0) [1 - p(e_2)]; \quad (16) \]
\[ p'(e_1) [1 - p(e_0)] = \frac{1}{\pi \Delta_1}; \quad (17) \]
\[ p'(e_2) [1 - p(M - e_0)] = \frac{1}{\pi \Delta_2}. \quad (18) \]

Now, efforts of the two agencies involved in an industry are strategic substitutes. This turns on its head the previous result on the competition agency’s resource allocation. Now, it gets more out of its effort when spending it on the industry whose sectoral regulator is less interested in putting in own effort.\(^{12}\)

**Proposition 6** If agencies’ monitoring decisions are independent, then

(i) the more consumer-biased sectoral regulator spends more effort than the other; and

(ii) the competition agency spends more effort on the industry with the less consumer-biased sectoral regulator.

Let us now see how equilibrium efforts react to a change in bias by a sectoral regulator. The results depend on the mode of interaction.

\(^{11}\)Recall our assumption of identical industries. If there were differences across industries, in addition to the difference across sectoral regulators’ preferences, the results of this Section might not hold.

\(^{12}\)The proof parallels that of Proposition 5 and is therefore omitted from the Appendix.
Proposition 7 If a sectoral regulator becomes more consumer-biased, then:
(i) its own effort increases while that of the other sectoral regulator decreases;
(ii) the competition agency increases its effort in this industry under consensus and decreases it under independent decisions.

Part (i) of this Proposition states, in other words, that a sectoral regulator becoming more consumer-biased makes it crowd out activity by the other one even more.

5 The size of the budget

What happens if additional funds become available to the competition agency? At what level should the optimal budget for the competition agency be?

Let us take these questions in turn. Assume the competition agency receives an additional Euro – which industry should it spend more on? Or should it take away effort from one industry and hand over more than a Euro’s worth of effort to the other industry? The following Proposition states how budget increases will be split.

Proposition 8 If the competition agency’s budget increases, then it spends more of the increase on the industry where a larger shift in the equilibrium will occur.

Note that this result does not mean that the competition agency always spends additional money on both tasks. In particular, even under the stability condition (12), it is not clear that an increase in the competition agency’s budget will not entail a reduction in its effort in the industry with the smaller shift. See Appendix A.2 for an elaboration of this point.

Let us next consider the size of the optimal budget for the competition agency. In particular, how do sectoral regulators’ biases affect the optimal budget?

A social planner maximizing welfare has an objective function equal to that of the unbiased competition agency. While he has the same aim of detecting violations of the law, he will take into account the spending of all three agencies. Total welfare (neglecting constants) is:

\[ W = [P_1(e_0^*, e_1^*) + P_2(M - e_0^*, e_2^*)] \pi \Delta - e_1^* - e_2^* - M. \]  

We assume that the social planner only has powers to define the size of the competition agency’s budget, but cannot interfere with any agency’s effort. This implies that \((e_0^*, e_1^*, e_2^*)\) are the Nash equilibrium efforts in the game played out by the agencies and are therefore functions of \(M\). We have the following result.

Proposition 9 (i) If both sectoral regulators are unbiased, then the optimal budget does not constrain the competition agency.

(ii) Assume that sectoral regulator 1 is biased and sectoral regulator 2 is unbiased. The competition agency’s optimal budget is smaller if a larger bias of sectoral regulator 1 makes the latter’s effort increase more (or decrease less) in the size of the budget of the competition agency.
Part (i) of the Proposition implies that, with unbiased sectoral regulators, the competition agency should be able to exert effort without restrictions. That is, the social planner should provide the competition agency with enough funds to cover the costs for the efforts the competition agency decides to make.

Part (ii) of Proposition 9 says that, if a sectoral regulator’s bias magnifies the effect of a change in the budget on the sectoral regulator’s effort, then the budget should be reduced to correct for this effect. This holds for both consumer and industry bias. By Proposition A-1 in Appendix A.1, \( \frac{d^2e_1^i}{dM} = r_1 \frac{\alpha_2}{\alpha} \). Thus, the effect has two components:

\[
\frac{d^2e_1^i}{d\Delta_1 dM} = \frac{d}{d\Delta_1} \left( \frac{\alpha_2}{\alpha} \right) r_1 + \frac{\alpha_2}{\alpha} \frac{dr_1}{d\Delta_1}.
\]

The first term describes the effect of the change in the distribution of additional money in the budget, while the second term is the strategic effect of how the sectoral regulator’s reaction to a higher competition-agency effort changes.

A related question is whether the optimal budget for a competition agency should be larger under consensus or under independent decisions. With unbiased sectoral regulators, we can provide a quick answer. It is easy to see that both the competition agency and the sectoral regulators choosing the same level of effort \( m \) such that \( \frac{\partial P}{\partial e}(m,m) = \frac{1}{\pi \Delta} \) defines the optimal budget \( M = 2m \). Then, when the probability of detection under an equal surplus division across sectors is higher than 0.5 under consensus, a higher budget is required under consensus than under independent ones. If the probability is less than 0.5, then the reverse occurs: the budget of the competition agency needs to be higher under independent decisions. To see this, note that the above condition for a maximum becomes, under consensus (\( C \)) and independent (\( I \)) decisions, respectively,

\[
p' \left( \frac{M^C}{2} \right) p \left( \frac{M^C}{2} \right) = \frac{1}{\pi \Delta},
\]

\[
p' \left( \frac{M^I}{2} \right) \left( 1 - p \left( \frac{M^I}{2} \right) \right) = \frac{1}{\pi \Delta}.
\]

If \( p \left( \frac{M^C}{2} \right) \), \( p \left( \frac{M^I}{2} \right) > 1/2 \) then \( p' \left( \frac{M^C}{2} \right) < p' \left( \frac{M^I}{2} \right) \) and thus \( M^C > M^I \), while for \( p \left( \frac{M^C}{2} \right) < 1/2 \) the opposite holds. Only for \( p \left( \frac{M^C}{2} \right) = 1/2 \) will the two optimal budgets be the same.

6 Mixed decisions

We have so far assumed that the mode of interaction among agencies is the same throughout government: either consensus in both industries, or independent decisions in both industries. This is arguably also the most sensible assumption to make. But it should be noted that our results on crowding out hinge on it. To see how, we consider in this Section the case of mixed decisions, i.e., with consensus among agencies in one industry and independent decisions in the other.

In the analysis so far, the SRs’ best responses have had either positive or negative slopes, thus \( r_1r_2 > 0 \). When decisions are mixed, one SR’s best response has positive
slope, while the other one has negative slope, so that we have $r_1r_2 < 0$. Thus, we can add to Propositions 3 and 4 the following:

**Proposition 10** If decisions are mixed, so that they are by consensus in one industry and independent in the other, then the sectoral regulators’ efforts are strategic complements.

An increase in the competition agency’s effort in one industry obviously implies a reduction of its effort in the other industry. When decisions are either both by consensus or both independent, this means that the sectoral regulators have opposite incentives in supplying effort. This is what leads to the crowding-out of others’ activities. When decisions are mixed, however, the sectoral regulators’ incentives are aligned and the crowding out disappears.

Suppose, say, that $SR_1$ and $CA$ have consensus, while $SR_2$ and $CA$ have independent decisions. Equilibrium efforts are now determined by the three equations (14), (18), and

$$p'(e_0)p((e_1) = p'(M - e_0)(1 - p(e_2)).$$

(20)

We can add to Proposition 7, which holds when decisions in the two industries are either both by consensus or both independent, the following.

**Proposition 11** Suppose decisions are mixed, with consensus in one industry and independent decisions in the other. If a sectoral regulator becomes more consumer-biased, then its own effort as well as that of the other sectoral regulator increases.

Without further assumptions, no generic ordering of efforts by sectoral regulators or by the competition agency across modes of interaction or according to consumer bias can be established; we show this with an example. In Appendix A.3, we show that spending can still be compared if the individual probabilities of successfully completing a task are either all very low or all very high.

Now, consider the example, with consensus in industry 1 and independent decisions in industry 2. Assume $p(x) = 1 - \exp(-x)$, $M = 3$, and $\pi \Delta_1 = 10$, and compute the equilibrium effort values for a range of $\Delta_2$ values, defined by $\Delta_2 = \gamma \Delta_1$, with $\gamma$ ranging from 0.5 to 2.0. Figure 1 reports equilibrium efforts. We observe that efforts from sectoral regulators have no general ordering. They change relative positions, in our example, with higher effort under consensus (flat red line) for $\gamma < 1.441$, and lower effort otherwise. Also, the competition agency devotes more resources, $e_0 > M/2$, to the industry where decisions are by consensus for $\gamma > 0.515$, and less otherwise.
7 Concluding remarks

In this paper we have developed a model of a transversal government agency in order to have a closer look at concurrency between the competition agency and various sectoral regulators. Such concurrency creates interactions that should not be overlooked. How the institutional framework establishes the formal relationships between different agencies is not neutral from an economic point of view, as they affect their incentives to intervene. In particular, we have established conditions for crowding out to occur among sectoral regulators.

The model is in many ways a simple one. Let us briefly elaborate on some of our simplifying assumptions, in addition to the discussions of them included in Section 2. First, there are only two industries, and therefore only two sectoral regulators, in our model. Increasing the number of sectoral regulators would not bring about a qualitative change in our result that they crowd each other out: A change concerning one sectoral regulator has a similar effect on all others (if decisions are not mixed, of course).

Secondly, we make the assumption that all agencies do their monitoring simultaneously. An alternative would be to consider the transversal agency as a leader taking its effort decisions before the sectoral regulators do, which would not change the nature of the outcome. Assume, for example, that the best response function of sectoral regulator 1 shifts upwards, which could be due to a stronger consumer bias. This tends to increase the competition authority’s efforts in this market under consensus,\(^{13}\) which will lead to a reduction in effort in the other market. The latter then leads to a reduction in effort by sectoral regulator 2 under consensus in the second market, thus we obtain a similar crowding-out effect. Corresponding arguments apply to the other cases.

\(^{13}\)This holds true as long as the curvature of the CA’s profits in the SR’s effort is not too large.
Thirdly, we assume that agencies’ monitoring eﬀorts preclude false positives. Such false positives, or Type I errors, can easily be included into the analysis, though. Suppose, contrary to our assumptions above, that ﬁnding a violation may be a mistake. In particular, suppose that, conditional on ﬁnding a violation, it is a mistake with probability smaller than one. As long as conditions implying that total surplus is higher under remedies than under violation of competition rules and agencies prefer the remedies outcome to the violation outcome still hold, though, the introduction of false positives only changes the value of some parameters but does not alter the analysis.\footnote{In other work on competition policy with errors, the interaction between errors of Type I and Type II is more crucial than it is here; see, e.g., Schinkel and Tuinstra (2006), Katsoulacos and Ulph (2009), and Sørgard (2009).}

The main contribution of our analysis lies in pointing out the mediation of strategic eﬀects, in the choices of eﬀort by sectoral regulators, through the competition agency. Not only agencies in direct contact within the same industry interact, but there are also interactions across industries. Thus the design of government agencies, their responsibilities, and their relationships with each other must not neglect the strategic interactions that result. Seemingly innocuous and sector-related institutional design decisions can have surprising consequences when seen in the larger context of competition policy in general. To be speciﬁc, the UK government comes forward as a strong proponent of providing sectoral regulators with concurrent powers in competition cases.\footnote{See, e.g., statements made by the UK Department for Business, Innovation, and Skills in BIS (2012), as well as the discussion in Holland and Luoma (2014).} Our analysis suggests that more caution is warranted and that one possible consequence of a proliferation of concurrency is that sectoral regulators may crowd out each others’ activities.

\section*{A Appendix}

\subsection*{A.1 Stability and Comparative Statics}

\textbf{Proof of Lemma 1.}

\textbf{Proof:} With \( A_i = -\frac{\partial^2 P_i}{\partial e_i \partial e_0} > 0 \), \( A = A_1 + A_2 \), \( B_i = -\frac{\partial^2 P_i}{\partial e_i} > 0 \), and \( c_i = \frac{\partial^2 P_i}{\partial e_i \partial e_i} \), we can write \( r_i = \frac{c_i}{B_i} \) and \( S_i = \frac{c_i}{A_i} \). The Hessian of the system (6), (7), and (9) is

\[ \Phi = \begin{bmatrix} -A & c_1 & -c_2 \\ c_1 & -B_1 & 0 \\ -c_2 & 0 & -B_2 \end{bmatrix}. \]

The equilibrium is stable if \( \Phi \) is negative deﬁnite, which is true if the following conditions hold: \(-A < 0, -B_i < 0\) for \( i = 1, 2 \), and \( B_1 B_2 > 0 \), which are true by concavity; \( AB_i - c_i^2 > 0 \) for \( i = 1, 2 \), which is equivalent to \( r_i S_i < 1, i = 1, 2 \); and \( -AB_1 B_2 + c_1^2 B_2 + c_2^2 B_1 < 0 \), which is equivalent to the stronger condition \( r_1 S_1 + r_2 S_2 < 1 \). \hfill \Box

\textbf{Proof of Proposition 3.}

\textbf{Proof:} Since the sign of \( S_i \) is equal to that of \( \frac{\partial^2 P_i}{\partial e_i \partial e_0} \), \( S_i \) has the same sign as \( r_i \) for both \( i = 1, 2 \), so that \( 0 < r_i S_i < 1 \) in a stable equilibrium. Thus, an SR’s and the CA’s
efforts are either strategic substitutes or strategic complements to each other. For given $e_1$, say, consider partial equilibrium efforts $e_0 = \hat{e}_0 (e_1, e_2)$ and $e_2 = \hat{e}_2 (M - e_0)$. Totally differentiating both equations we obtain $de_0 = S_1 de_1 + S_2 de_2$ and $de_2 = -r_2 de_0$. Solving this for $de_0$ and $de_2$ leads to

$$\frac{de_0}{de_1} = \frac{S_1}{1 + r_2 S_2}, \quad \frac{de_2}{de_1} = -\frac{r_2 S_1}{1 + r_2 S_2}.$$  

The latter has clearly the same sign as $-r_1 r_2$.

**Proof of Proposition 5.**

**Proof:** Assume that $SR_2$ is more consumer-biased, i.e., that $\Delta_1 \leq \Delta_2$. We will show that the unique equilibrium involves $e_0 < M/2$ and $e_1 < e_2$. Suppose that $e_0 \leq M/2$. It follows from (14), (15), and our assumptions on $p$ that $e_1 < e_2$. On the other hand, from $e_1 < e_2$ and (13), it follows that $e_0 < M/2$. Thus this outcome is always consistent with the first-order conditions and, under the assumption of uniqueness, is the only equilibrium outcome. ■

**Proposition A-1**

(i) $\frac{de_0}{d\Delta} = \frac{a_2}{\alpha}, \quad \frac{de_1}{d\Delta} = r_1 \frac{de_0}{d\Delta}, \quad \text{and} \quad \frac{de_2}{d\Delta} = r_2 \left( 1 - \frac{de_0}{d\Delta} \right)$.

(ii) $\frac{de_i}{d\Delta} > 0, \quad \frac{de_j}{d\Delta} = -r_j \frac{de_0}{d\Delta}, \quad \text{and} \quad \text{the sign of} \quad \frac{de_0}{d\Delta} \quad \text{equals} \quad \text{that of} \quad r_i$.

**Proof:** The negative inverse of $\Phi$ is

$$-\Phi^{-1} = \frac{1}{AB_1 B_2 - c_1^2 B_2 - c_2^2 B_1} \begin{bmatrix} B_1 B_2 & c_1 B_2 & -c_2 B_1 \\ c_1 B_2 & B_2 A - c_2^2 & -c_1 c_2 \\ -c_2 B_1 & -c_1 c_2 & B_1 A - c_1^2 \end{bmatrix}$$

$$= \frac{1}{A \alpha} \begin{bmatrix} 1 & r_1 & -r_2 \\ r_1 & \beta_1 & -r_1 r_2 \\ -r_2 & -r_1 r_2 & \beta_2 \end{bmatrix},$$

with $\beta_i = \frac{r_i}{S_i} (1 - r_j S_j) > 0$, for $i, j = 1, 2, i \neq j$.

The effect of a change in the size of the budget $M$ is:

$$\begin{bmatrix} \frac{de_0}{dM} \\ \frac{de_1}{dM} \\ \frac{de_2}{dM} \end{bmatrix} = -\Phi^{-1} \begin{bmatrix} A_2 \\ 0 \\ c_2 \end{bmatrix} = \begin{bmatrix} \frac{a_2}{\alpha} \\ \frac{a_2 r_1}{\alpha} \\ \frac{a_2 r_2}{\alpha} \end{bmatrix}.$$  

If, say, $\Delta_1$ increases, then

$$\begin{bmatrix} \frac{de_0}{d\Delta_1} \\ \frac{de_1}{d\Delta_1} \\ \frac{de_2}{d\Delta_1} \end{bmatrix} = -\Phi^{-1} \begin{bmatrix} 0 \\ \frac{1}{\alpha \Delta_1} \\ 0 \end{bmatrix} = \begin{bmatrix} \frac{r_1}{A \alpha \Delta_1^2} \\ \frac{\beta_1}{A \alpha \Delta_1^2} \\ -\frac{r_1 r_2}{A \alpha \Delta_1^2} \end{bmatrix}.$$  

Thus, $\frac{de_1}{d\Delta_1} > 0$, and the sign of $\frac{de_0}{d\Delta_1}$ is equal to that of $r_1$. ■
Proof of Proposition 7.

**Proof:** Suppose $\Delta_1$ increases. From Proposition A-1, we have

$$
\frac{de_0^*}{d\Delta_1} = Kr_1, \quad \frac{de_1^*}{d\Delta_1} = K \frac{r_1}{S_1} (1 - r_2 S_2), \quad \frac{de_2^*}{d\Delta_1} = -Kr_1 r_2,
$$

for some $K > 0$. We have $\frac{de_1^*}{d\Delta_1} > 0$ because $r_2 S_2 < 1$, while the other signs are obvious. ■

A.2 Results on the Budget

Proof of Proposition 8.

**Proof:** Let $A_i = -\frac{\partial^2 P_i}{\partial e_i^2} > 0$, $A = A_1 + A_2$, and

$$
\alpha_i = \frac{A_i}{A} (1 - r_i s_i),
$$

where $s_i$ is the slope of the CA’s best response in a game without the other industry. We have $1 > \alpha_1 + \alpha_2 = \alpha > 0$ by the stability condition (12). The condition of $\alpha_i$ being small, which appears below, basically requires efforts to have low sensitivity to each other, which in equilibrium means that the CA can spend more on that industry without triggering a large reaction of the $SR$. Assume now that $M$ increases. From Proposition A-1, we have $\frac{dK}{dM} = \frac{s}{s}$. Thus $\frac{dK}{dM} > \frac{1}{2}$ if $\alpha_1 < \alpha_2$, which for $\frac{\partial^2 P_1}{\partial e_1^2} \approx \frac{\partial^2 P_2}{\partial e_2^2}$ implies $r_1 s_1 > r_2 s_2$. The latter expressions, being the products of the slopes of the reaction functions, measure how strongly the equilibrium shifts.

As noted in the text, this does not mean that the competition agency always spends additional money on both tasks. Technically, the result in Proposition 8 does not depend on both the $\alpha_i$s being positive, where $\alpha_i$ is defined in (A1). While they cannot be both negative, which would violate stability, it is still possible that one is negative while the other is positive. If $\alpha_2 < 0$, say, then the money spent on task 1 actually decreases after an increase in the budget. In order to see that a negative $\alpha_i$ is not ruled out by the stability condition (12), note that $\alpha_i > 0$ is equivalent to:

$$
r_i s_i < \frac{\partial^2 P_1}{\partial e_i^2} \frac{\partial^2 P_1}{\partial e_1^2} + \frac{\partial^2 P_2}{\partial e_2^2} \frac{\partial^2 P_2}{\partial e_2^2}.
$$

The sum of these conditions, for $i = 1, 2$, implies stability, but stability does not imply that both conditions hold.

As to the intuition behind this result, note that the sign of $\alpha_i$ depends on whether $r_i s_i$ is smaller than 1 or not, where $s_i$ is defined in the above proof of Proposition 8. The former would be the case in a stable equilibrium (if it occurred at these effort levels) in the two-agency, single-industry game. Thus, a negative $\alpha_i$ corresponds to an unstable situation in industry $i$. Additional effort by the competition agency in this industry would lead to a disproportionate response by the sectoral regulator there, the anticipation of which makes the competition agency withdraw resources from the other industry.
Proof of Proposition 9.

Proof: (i) The social planner maximizes \( W \) over \( M \), where \( (e_0^*, e_1^*, e_2^*) \) are defined by the first-order conditions (6), (7) and (9). The first-order condition for an interior maximum is the following:

\[
\frac{dW}{dM} = \left( \frac{\partial P_2}{\partial e_0} \pi \Delta - 1 \right) + \left( \frac{\partial P_1}{\partial e_1} - \frac{\partial P_2}{\partial e_2} \right) \pi \Delta \frac{de_0^*}{dM} + \left( \frac{\partial P_1}{\partial e_1} \pi \Delta - 1 \right) \frac{de_1^*}{dM} + \left( \frac{\partial P_2}{\partial e_2} \pi \Delta - 1 \right) \frac{de_2^*}{dM} = 0.
\]

By (9), we have \( \frac{\partial P_1}{\partial e_0} = \frac{\partial P_2}{\partial e_0} \), and by (6) and (7), \( \frac{\partial P_1}{\partial e_1} \pi \Delta = 1 \). Plugging these in we obtain

\[
\frac{dW}{dM} = \left( \frac{\partial P_2}{\partial e_2} \pi \Delta - 1 \right) + \frac{\Delta - \Delta_1}{\Delta_1} \frac{de_1^*}{dM} + \frac{\Delta - \Delta_2}{\Delta_2} \frac{de_2^*}{dM} = 0.
\]

This condition defines the optimal budget \( M^* \) implicitly. If both \( SRs \) are unbiased, then the optimal budget is given by the conditions

\[
\frac{\partial P_1}{\partial e_0} \pi \Delta = \frac{\partial P_2}{\partial e_2} \pi \Delta = 1.
\]

These are exactly the conditions that would describe the \( CA \)'s choice of effort if it were not subject to a budget constraint, but were to take into account its expenses.

(ii) In order to see how the optimal budget changes with the bias of a sectoral regulator, assume that \( \Delta_1 \) changes. We want to find \( \frac{dM^*}{d\Delta_1} \), which has the same sign as \( \frac{d^2W}{d\Delta_1 dM} \). It turns out to be simpler to use the following route: First compute, using the three first-order conditions and \( \Delta_2 = \Delta \),

\[
\frac{dW}{d\Delta_1} = 0 + \frac{\Delta - \Delta_1}{\Delta_1} \frac{de_1^*}{d\Delta_1} + 0,
\]

then immediately

\[
\frac{d^2W}{d\Delta_1 dM} = \frac{\Delta - \Delta_1}{\Delta_1} \frac{d^2e_1^*}{d\Delta_1 dM}.
\]

Clearly, at \( \Delta_1 = \Delta \), we have \( \frac{d^2W}{d\Delta_1^2} = 0 \) and thus \( \frac{dM^*}{d\Delta_1} = 0 \). If \( \frac{d^2e_1}{d\Delta_1 dM} > 0 \) (a larger bias makes the effort of the \( SR \) increase more, or decrease less, with an increase in the \( CA \)'s budget), then \( \frac{dM^*}{d\Delta_1} > (>) 0 \) if \( \Delta_1 < (>) \Delta \), which implies that \( M^* \) has a local maximum at \( \Delta_1 = \Delta \). The opposite logic (local minimum if \( \frac{d^2e_1}{d\Delta_1 dM} < 0 \)) does not apply if the social planner cannot force the \( CA \) to spend its budget on the two industries. ■

A.3 Additional Results for Mixed Decisions

As shown above, no straight results are available for the case of mixed decisions as to which task the \( CA \) spends more effort on. If we allow for some specific assumptions about which range of values the individual probabilities of detection can take, some of which break with the general assumptions made in the text, then we can provide conclusive results.
Proposition A-2 Consider a case of mixed decisions, with decisions by consensus in one industry and independent decisions in the other.

a) If $p(x) < 1/2, \forall x$, then:

i) If the more consumer-biased sectoral regulator is in the industry with independent decisions, then it spends more effort than the other. If it is in the industry with consensus, then it may spend more or less effort than the other.

ii) The competition agency spends more effort on the industry with independent decisions.

b) If $p(0) > 1/2$, then:

i) If the more consumer-biased sectoral regulator is in the industry with consensus, then it spends more effort than the other. If it is in the industry with independent decisions, then it may spend more or less effort than the other.

ii) The competition agency devotes more effort on the industry with consensus.

Proof: Denote the industry with consensus by $C$ and the other industry $I$. The set of first-order conditions defining the equilibrium values are:

\[
p'(e_C)p(e_{C0}) = \frac{1}{\pi \Delta_C} \quad \text{(A2)}
\]

\[
p'(e_I)(1 - p(e_{I0})) = \frac{1}{\pi \Delta_I} \quad \text{(A3)}
\]

\[
p'(e_{C0})p(e_C) = p'(e_{I0})(1 - p(e_I)) \quad \text{(A4)}
\]

Part a): Assume $p(x) \leq 1/2, \forall x$. Then $p(e_C) < 1 - p(e_I), \forall e_I, e_C$. From (A4), $p'(e_{C0}) > p'(e_{I0})$, implying $e_{C0} < e_{I0}$; the CA always does more effort in industry $I$. If $\Delta_C \leq \Delta_I$ ($SR_I$ is more consumer-biased), then, from (A2) and (A3), $p'(e_I) < p'(e_C)$ and $e_I > e_C$. However, if $\Delta_C > \Delta_I$ ($SR_C$ is more consumer-biased), then it is only when $\Delta_C$ is sufficiently large that $e_C > e_I$.

Part b): Assume $p(0) \geq 1/2$. Then $p(e_C) > 1 - p(e_I)$, for $e_C > 0, e_I > 0$. Now, from (A4), $p'(e_{C0}) < p'(e_{I0})$, and $e_{C0} > e_{I0}$; the CA devotes more effort in industry $C$. If $\Delta_C \geq \Delta_I$ ($SR_C$ is more consumer-biased), then, from (A2) and (A3), $p'(e_I) > p'(e_C)$ and $e_C > e_I$. However, if $\Delta_I > \Delta_C$ ($SR_I$ is more consumer-biased), then it is only when $\Delta_I$ is sufficiently large that $e_I > e_C$. ■
References


Competition Policy Analysis (E. Hope, ed.). Routledge, pp. 165-199.


