Institut für Arbeitsrecht und Arbeitsbeziehungen in der Europäischen Union

IAAEU Discussion Paper Series in Economics
No. 01/2022

Endogenous Market Structure and Partisan Competition Authorities

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May 2022

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May 30, 2022

Abstract

The so-called excess-entry theorem (Mankiw and Whinston 1986, Suzumura and Kiyono, 1987) establishes conditions guaranteeing that more firms enter a homogeneous Cournot-oligopoly in equilibrium than a benevolent government prefers. We generalise the approach and analyse the behaviour of a competition authority, which attaches different weights to the firms' and consumers' payoffs, with welfare-maximisation constituting a special case. The greater the importance of consumers is, the less likely are entry restrictions, whereas a greater relevance of firms makes a monopoly more probable. The nature of entry restrictions also depends on the competition authority's instruments. The essential insights continue to apply if firms are heterogeneous concerning costs and the timing of output choices.

Keywords: Competition Authority, Cournot-Oligopoly, Excessive Entry, Monopoly, Partisan Objective

JEL-code: D 42, D 43, D 72, L 12, L 13, L 51

1. Introduction

Normative analyses of oligopolies with endogenously determined market structures are widespread. In a homogeneous Cournot-oligopoly, there will be excessive entry in the presence of business stealing (von Weizsäcker 1980, Perry 1984, Mankiw and Whinston 1986, and Suzumura and Kiyono 1987). If competition authorities employed this insight, there should be extensive entry restrictions. Although some contributions describe corresponding behaviour for Japan (Suzumura 1995; Ghosh and Morita 2007a), empirical analyses provide no consistent picture (see Berry and Waldfogel 1999, Hsieh and Moretti 2003, Maruyama 2011, Onishi et al. 2018). Consequently, investigations building on the seminal contributions by von Weizsäcker (1980), Perry (1984), Mankiw and Whinston (1986), and Suzumura and Kiyono (1987) have not focussed on the application of the excess-entry prediction to economic policy. Instead, many analyses consider exceptions to it. The policy implication resulting from the scrutiny of cases in which the excess-entry prediction does not apply, namely that competition authorities should foster entry and prevent mergers, appears to be more in line with everyday evidence. It is striking that virtually all investigations of the excess-entry theorem assume that a social planner maximises welfare. Therefore, policy conclusions are based on the presumption of an unbiased regulator.

This paper departs from this benchmark and assumes a regulatory agency, referred to as competition authority, which maximises a weighted sum of profits and consumer surplus, with welfare-maximisation constituting a special case.[1] We provide a positive analysis of such partisan competition authority and pay special attention to the relationship between the exogenous degree of its bias and the number of competitors. Moreover, we determine the circumstances which make entry regulations more or less likely. In our analysis, we distinguish between a setting in which competition authorities determine the number of firms only ('second-best') and one in which they can regulate output as well ('first-best'). This helps to ascertain how the instruments, which a competition authority has, affect its regulatory activities. In sum, the investigation can enhance our understanding of a competition authority's behaviour and rationalise the nature of entry and merger entry restrictions.

There are various reasons why a competition authority may be biased and attach different weights to the payoffs of firms and consumers. First, restricting the number of entrants

[1] This assumption has already been employed by Baron and Myerson (1982) who analyse the regulation of a monopolist and assign a greater weight to consumer surplus than profits in the regulator's objective, with welfare maximisation as the limiting case.

constitutes a public good for firms (and public bad for consumers). Since small groups can overcome a free-rider problem more easily (Olson 1965), the impact of firms on the government's payoff may exceed that of consumers (Hillman 1989). Moreover, the amount spent on the relevant good is likely to constitute a small share of a consumer's expenditure, suggesting that firms have a greater interest in regulatory actions (Motta and Ruta 2012). These arguments are in line with Stigler's (1971, p. 3) assumption "that, as a rule, regulation is acquired by the industry" and suggest that competition authorities may act more on behalf of firms than in the interest of consumers.

Second, and in contrast to the prior argument, Amir et al. (2019) contend that competition authorities may pursue a "populist" objective, consisting of the sum of welfare and consumer surplus. One can refer to the United States in support of this assumption, where antitrust law focuses on 'consumer welfare'. The interpretation of this term extends from consumer surplus to welfare, i.e., the sum of consumer surplus and profits (see, for example, Orbach (2011) and the comprehensive discussion in Farrell and Katz (2006)). Furthermore, it is often assumed that the European Union's merger policy also aims to maximise consumer surplus (Neven and Röller 2005 and Katsoulacos et al. 2016). Consequently, the weight of consumers in the objective of the competition agency is likely to exceed that of firms and may even be greater than captured by the populist objective.

Third, if consumption predominantly takes place domestically, whereas foreign ownership of firms is more common, this may affect the behaviour of the domestic competition authority. As firms make profits if entry is constrained, the entire profit effect of such entry restriction is not realised domestically. In this case, competition authorities, which attach equal weights to domestic profits and consumer surplus, would effectively maximise an objective for which the weight of firms falls short of the weight of consumers. This argument is particularly relevant in a globalised world with substantial profit-shifting. Conversely, if there is extensive cross-border shopping, the competition authority may be biased towards firms. Thus, our analysis indicates how easily the assessment of mergers or entry restrictions by national and transnational, say European Union, competition authorities can diverge if national authorities ignore payoffs to firms or consumers residing in other countries.

Fourth, national parliaments may elect decision-making bodies, as in Switzerland. Therefore, the selection of individuals who make up competition authorities and determine their objective can mirror electoral outcomes.

Fifth, if the competition authority is subject to lobbying, its objective could attach different weights to the payoffs of firms and consumers. A competition authority may also be corruptible and maximise bribes instead of welfare.

Finally, the stance taken by the competition authority may be overruled by a political decision body. Thus, the effective objective would consist of a weighted sum of the competition authority's and, say, the government's objective, where the weights reflect the (ex-ante) probability that political interference occurs (see Motta and Ruta 2012).

In sum, there are powerful arguments why the objective of a benevolent social planner does not adequately describe the competition authority's behaviour. This view is compatible with the evidence that entry regulations are not welfare-enhancing. Gutiérrez and Philippon (2019) show for the United States that the recent decline in entry is not primarily due to an increase in its fixed costs but to lobbying and regulations. Djankov et al. (2002) analyse entry regulations for a cross-section of up to 85 countries and conclude that they are unlikely to reflect welfare-maximising behaviour.

The present study takes the seminal contributions by von Weizsäcker (1980), Mankiw and Whinston (1986), and Suzumura and Kiyono (1987) as its starting point. Firms are homogeneous and incur fixed and irreversible costs of market entry. Since output per firm declines in the number of Cournot-competitors, there is business stealing. The market equilibrium is characterised by excessive entry, that is, more than the welfare-maximising number of firms take up production. We do not incorporate further distortions in our basic set-up, which may mitigate or reverse the business-stealing externality.[2]

For such a setting, we first show that a competition authority is less likely to restrict entry at all, the greater the relevance of the consumers' payoff in its objective is. This result is due to the well-established feature that aggregate output and consumer surplus rise with the number of firms, although entry reduces output per firm and profits. Conversely, a competition authority is more likely to establish a monopoly, the less important consumers are. This basic feature is independent of the instruments the competition authority is equipped with, i. e., whether we consider a first-best or a second-best setting. Second, already modest deviations from the aim of welfare maximisation can have dramatic regulatory consequences. In an illustrative numerical example, we show that if profits represent 40% of the regulatory authority's payoff, instead of 50% as in the case of welfare maximisation, the competition authority will refrain from restricting entry, although doing so would raise welfare. Third, if a competition authority

[2] Such distortion may arise in a vertical relationship (see Ghosh and Morita (2007a, b), Mukherjee (2009), Marjit and Mukherjee (2013), and de Pinto and Goerke (2020)), such that input prices exceed the society's marginal production costs. Entry can also be insufficient if one firm, which surely enters the market, has a cost advantage (Mukherjee 2012a, Mukherjee and Tsai 2014) or in the presence of network effects (Gama and Samano 2021).

can determine entry and output per firm, entry is less likely to be restricted, and a monopoly is more likely to arise than if the authority can only regulate entry. This is because the preferred number of firms can be selected without having to take repercussions on the output choices into account. Fourth, if the competition authority solely regulates the number of firms, the existence of entry restrictions depends on marginal costs and not on entry costs and demand. The rationale is that since profits are zero in market equilibrium, limiting entry is beneficial for the competition authority if the consumers' payoff declines with the number of firms. Whether this is the case or not depends on marginal costs only.

The consequences of regulatory interventions in an oligopoly with an endogenously determined market structure by a partisan competition authority have not found much attention yet. Amir et al. (2019) and Goerke (2020) consider open economy extensions of the basic closed-economy, free-entry Cournot-oligopoly. Amir et al. (2019) built on the finding that moving from autarky to free trade raises either consumer surplus or welfare, but not both. They then show that the sum of welfare and consumer surplus, that is, the value of a populist objective that gives consumers twice the weight of firms, is always higher under free trade than autarky. Goerke (2020) investigates horizontal FDI in a multi-period setting and assumes that such activities undermine any entry restrictions. He, inter alia, shows that the government can object to FDI, although welfare rises, since its payoff may decline if it attaches different weights to the payoffs of firms and consumers. Marjit and Mukherjee (2013, 2015) and Han et al. (2022) assume that the government evaluates entry by considering the effects on domestic profits and consumer surplus. While they do not explicitly study different weights in the government's objective, they effectively utilise the third argument put forward above.[3] Chang et al. (2010) consider a setting in which a positive fraction of the good is consumed outside the jurisdiction, which is relevant for the definition of welfare. Accordingly, consumer surplus accruing in other jurisdictions reduces the optimal number of firms while not affecting entry in market equilibrium (see also Han et al. 2022). Analytically, the set-up by Chang et al. (2010) is comparable to a framework with domestic consumers only, whose weight in the welfare objective is less than that of firms. Finally, Amir and Burr (2015) analyse firms that pay a bribe-maximising official a constant share of profits. They show that this official effectively ignores consumer surplus and favours a monopoly.

[3] The distinction is also employed in other contributions not directly related to the issue we consider. Barros and Cabral (1992, 1994) use the discrepancy between domestic and, thereby, welfare-enhancing profits and profits accruing abroad to investigate the welfare effects of foreign entry and merger in open economies, respectively.

In sum, contributions considering different weights of firms and consumers in the government's or regulator's objective have assumed particular values and, therefore, not systematically investigated the effects of such biases on regulatory decisions concerning market entry. In order to do so, the paper proceeds as follows: We describe our set-up in Section 2 and derive the market outcome in Section 3. In Section 4, we analyse the behaviour of a competition authority that can solely control entry. In Section 5, the competition authority has a more comprehensive set of instruments and can also set output. In Section 6, we bring our findings together and illustrate them graphically. Section 7 analyses modifications of the basic framework and allows for two types of heterogeneity, namely a Stackelberg-setting and a world with cost differences. Section 8 briefly looks at further extensions and limitations of the analysis. The Appendix contains more elaborate computations and detailed derivations of some of the findings described in Section 7.

2. Set-up

We investigate three settings that differ according to the actors determining economic activities. First, we consider a world without regulatory intervention. In the first stage, profit-maximising firms decide about entry. They will take up production as long as it is (weakly) profitable. In stage two, the number of competitors, n, is fixed, and firms decide simultaneously about their respective output, taking as given the output decisions of other firms (Cournot-Nash behaviour). When deciding about entry, each firm correctly anticipates the equilibrium number of competitors, n^*, and their output choices, where a '*' indicates choices and outcomes in market equilibrium. A firm's output choice in (a symmetric) equilibrium is denoted by $q^*(n^*)$.

In the second setting, the competition authority decides about entry in the first stage. It will choose the number of firms, n^{sb}, that maximise its objective, V, to be specified below. Given entry, firms simultaneously decide about output, $q^{sb} = q^*(n^{sb})$, in stage two, again taking the choices of other firms as given and assuming symmetry. We refer to this setting as second-best, as indicated by the superscript 'sb', because firms choose output. We solve the model by backward induction when looking at the market equilibrium and the second-best situation.

In the third setting, the competition authority simultaneously determines the number of firms, n^{fb}, that take up production and each firms' output level, q^{fb}. In the case of a welfare-maximising competition authority, this set-up is referred to as first-best. We also adopt this labelling, irrespective of the competition authority's objective, V, and utilise the superscript 'fb'.

As often in the analysis of the excess-entry prediction, we view the number of firms, n, as a continuous variable and assume that there is at least one producer. Moreover, we consider a static set-up in which entry is only feasible once, and exit is impossible.[4]

Throughout the analysis, demand is linear to facilitate the calculation of explicit solutions and the comparison with other contributions. Revenues of firm j, j = 1, …, n, equal the product of the price, $P(Q) = a - Q$, and output, q_j. The choke price is given by a, $a > 0$, and Q denotes aggregate output. It equals the sum of the firm j's production, q_j, and output of all other firms, Q_{-j}, $Q := q_j + Q_{-j}$. Each firm incurs quadratic production costs, $c(q_j) = c_0 q_j + 0.5 c q_j^2$, $c_0 \geq 0$, $c > 0$, and fixed costs of entry, F, which are sunk and can generate economies of scale.

We denote profits of firm j by π_j.

$$\pi_j(q_j) = \left(a - \left(q_j + Q_{-j}\right)\right) q_j - c_0 q_j - \frac{c q_j^2}{2} - F \tag{1}$$

If costs were linear, $c = 0 < c_0$, aggregate production costs would be lowest for the smallest feasible number of firms. Therefore, the first-best number of firms, n^{fb}, would be minimal. To make the decision problem of the competition authority an interesting one, costs have to be convex. For simplicity, we assume them to be quadratic (see von Weizsäcker 1980). Moreover, the term $a - c_0$ has to be sufficiently large to ensure positive profits. To streamline notation, and without loss of generality, we set $c_0 = 0$.

The competition authority's objective, V, is given by

$$V = \alpha \sum_{j=1}^{n} \pi_j + (1-\alpha)\frac{Q^2}{2} = \alpha \sum_{j=1}^{n} \left((a - Q) q_j - \frac{c q_j^2}{2} \right) - \alpha n F + (1-\alpha)\frac{Q^2}{2}, \tag{2}$$

where the parameter α, $0 < \alpha < 1$, measures its partisanship. If $\alpha >$ (<) 0.5 holds, the competition authority is biased towards the interests of firms (consumers). If $\alpha = 0.5$, it weighs the payoffs of firms and consumers equally and maximises welfare.

If competition authorities do not maximise welfare, they may prefer a number of active firms that is too high to guarantee each producer non-negative profits. We assume below that the profit constraint does not bind, for example, because firms can be paid to enter the market. The required resources could be obtained by imposing a lump-sum tax on consumers, all potential

[4] See, for example, Seade (1980) for the assumption that the number of firms can vary continuously. Amir and Lambson (2003) provide a dynamic Cournot framework with integer constraint and show that this extension does not fundamentally affect the excess-entry prediction.

entrants, or other firms in the economy.[5] Therefore, the competition authority does not have to be able to determine the number of firms directly. To isolate the effects, which result from partisan entry regulations and separate them from the consequences of budgetary needs, we disregard the mechanism that induces firms to enter the market and assume that the number of firms is a choice variable of the competition authority.

3. Market Equilibrium

This section describes the market equilibrium and, thus, assumes that the competition authority plays no role. In stage two, the number of firms is given. Maximisation of firm j's profits with respect to output, q_j, yields:

$$\frac{\partial \pi_j}{\partial q_j} = a - Q - q_j - cq_j = 0 \tag{3}$$

As all firms behave equally, we omit the firm index j and utilise Q = qn. Since the derivative of (3) with respect to $q = q_j$ is negative, the second-order condition is satisfied, and profit-maximising output equals:

$$q^*(n) = \frac{a}{1 + c + n} \tag{4}$$

There is business stealing because output per firm declines with their number, n.

In stage one, firms enter the market as long as profits are non-negative.[6]

$$\pi(n^*) = \left(a - n^* q^*(n^*)\right) q^*(n^*) - \frac{c\left(q^*(n^*)\right)^2}{2} - F = \frac{(2 + c)a^2}{2(1 + c + n^*)^2} - F = 0 \tag{5}$$

Solving (5), the number of firms is (see von Weizsäcker 1980):

$$n^* = a\sqrt{\frac{2 + c}{2F}} - (1 + c) \tag{6}$$

To ensure that at least one firm enters in market equilibrium, $n^* \geq 1$, the choke price, a, has to exceed a critical level. Thus, we base our analysis on:

[5] Such lump-sum transfers are payoff-neutral if they do not affect behaviour, and the weight of the tax payers in the competition authority's objective who finance the transfer equals the weight, α, of firms.

[6] The market equilibrium, described by equations (3) and (5), is stable, if the determinant of the system of these equations is positive. Given a linear demand schedule and quadratic costs, this condition is fulfilled.

Assumption A: $M := \frac{a^2}{2F} > 2 + c := M^{Min}$

Combining equations (4) and (6), we calculate aggregate production, Q*, in market equilibrium as:

$$Q^* = n^* q^* = n^* \sqrt{\frac{2F}{2+c}} = a - \sqrt{\frac{2F}{2+c}}(1+c) \tag{7}$$

4. Entry Regulation

This section assumes that the competition authority determines the number of firms, such that a second-best outcome results. Alternatively, the competition authority may impose an entry tax T > 0 (pay a subsidy T < 0), which raises (reduces) a firm's fixed costs to F + T. A tax reduces a firm's willingness to enter the market while a subsidy enhances it.[7] Therefore, from an analytical vantage point, a setting in which a competition authority can directly determine the number of firms, n, is equivalent to a modelling set-up in which it can tax or subsidise entry. For simplicity, we consider the former case.

Given identical firms and the assumption that firms choose output in a profit-maximising manner in stage two, as captured by equation (4), the competition authority's objective in stage one is:

$$V(n) = \alpha n\left(\left(a - nq^*(n)\right)q^*(n) - \frac{cq^*(n)^2}{2} - F\right) + (1-\alpha)\frac{\left(nq^*(n)\right)^2}{2} \tag{8}$$

Maximising V(n), using equations (4) and (5), the definition of M, and collecting terms, we can express the first-order condition as:

$$\frac{dV(n)}{dn} = \alpha\pi + \alpha n\left(P\left(Q(n)\right) - cq^*(n)\right)\frac{dq^*}{dn} + Q(n)\left(q^*(n) + n\frac{dq^*}{dn}\right)(1-2\alpha)$$

$$= \alpha\pi + \frac{na^2[(1+c)(1-2\alpha) - \alpha]}{(1+c+n)^3} \tag{9A}$$

$$= \frac{a^2}{2(1+c+n)^3}\left[\alpha(2+c)(1+c) + n[2(1+c) - \alpha(4+3c)]\right] - \alpha F$$

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[7] Suppose profits are given by π = (a – Q)q – 0.5cq^2 – (F + T). The number of entrants in market equilibrium would then equal $a\sqrt{(2+c)/(2(F+T))} - (1+c)$ (cf. equation (6)), and decline in T, such that the competition authority could employ such payment to determine the number of firms.

$$= a^2 \frac{\alpha(2 + c)(1 + c) + n[2(1 + c) - \alpha(4 + 3c)] - \alpha \frac{(1 + c + n)^3}{M}}{2(1 + c + n)^3} = 0 \qquad (9B)$$

The second derivative of V(n) is:

$$\frac{d^2V(n)}{dn^2} = a^2 \frac{[2(1 + c) - \alpha(4 + 3c)](1 + c - 2n) - (1 + c)3\alpha(2 + c)}{2(1 + c + n)^4} \qquad (10)$$

The derivative in equation (10) is negative for $(1 + c)/(5 + 3c) < \alpha < (1 + c)/(2 + 1.5c)$ and, therefore, for $\alpha = 1/3$ and $\alpha = 0.5$. However, its sign may become positive if the weight, α, of firms in the competition authority's objective is sufficiently low. Because the numerator of (9B) is a third-order polynomial in n, and the number of firms must be non-negative, there can at most be two interior and meaningful solutions. For our subsequent analysis, we assume that an interior solution for the competition authority's maximisation problem is unique, as is the case for the values of α we pay special attention to. Moreover, we will discuss a non-interior outcome for the second-best optimal number of firms, n^{sb}.

The expression in equation (9A), evaluated at the market equilibrium ($\pi = 0$), is zero for a weight of firms in the competition authority's objective equal to:

$$\frac{1}{2} > \alpha^{L,sb} = \frac{1 + c}{3 + 2c} > \frac{1}{3} \qquad (11)$$

If $\alpha = \alpha^{L,sb}$, competition authorities evaluate the increase in consumer surplus due to more competition so highly that they allow the same number of firms to enter, as is the case in market equilibrium. If $\alpha < \alpha^{L,sb}$, competition authorities prefer more active firms than n^*, and entry is insufficient (Ritz 2018, see also Armstrong et al., 1994, p. 108). If $\alpha > \alpha^{L,sb}$ there are too many firms, and entry is restricted. Consequently, we obtain the standard excess-entry prediction for a welfare-maximising ($\alpha = 0.5$) competition authority as a special case (cf. Mankiw and Whinston 1986, Suzumura and Kiyono 1987, and Amir et al. 2014). Note that $\alpha^{L,sb}$ increases in the indicator of marginal costs, c, and exceeds 1/3 since $c > 0$. Therefore, if the weight of the consumers' payoff in the competition authority's objective is at least twice as that of firms ($1 - \alpha \geq 2/3$), there will be no entry restriction. Put differently, competition authorities, which pursue a populist objective (cf. Amir et al. 2019), given by $\alpha = 1/3$, always foster competition.

The expression in (9B) is negative for $n = 1$, if the weight, α, is greater than:

$$\alpha^{H,sb} = \frac{2M(1 + c)}{(2 + c)^3 + M(2 - c^2)} \qquad (12)$$

This implies that competition authorities restrict entry to one firm, i.e., establish a monopoly, if the firm's weight in their objective is weakly greater than $\alpha^{H,sb}$. Although aggregate output and, thus, consumer surplus, rise in the number of firms, the reduction in profits due to fewer competitors more than outweighs this effect if the importance of firms is sufficiently large.

Since $M = a^2/(2F) > 2 + c$, the critical value $\alpha^{H,sb}$ is surely greater than 1/3 and surpasses $\alpha^{L,sb}$.[8] Moreover, $\alpha^{H,sb}$ rises with the choke price, a, and declines with market entry costs, F. Fixed costs reduce profits, and the competition authority's gain from expanding the number of firms. If this gain declines, the competition authority prefers a smaller number of firms and the critical value of the weight of firms in its objective falls, which ensures that the preferred number is one. Thus, a monopoly results for a greater range of values of the firms' weight, α. A higher choke price, a, in contrast, enhances the gain from increasing the number of competitors by more than the competition authority's costs of doing so. Therefore, the critical value $\alpha^{H,sb}$ rises, and a monopoly is less likely to occur. Furthermore, $\alpha^{H,sb}$ varies with the indicator of marginal cost, c, in an ambiguous way because it is uncertain whether higher marginal costs have a stronger impact on marginal (aggregate) profits or marginal consumer surplus (cf. equation (9B)). Finally, the exact value of $\alpha^{H,sb}$ depends crucially on the assumption that the number of firms can vary continuously. In the presence of an integer constraint, $\alpha^{H,sb}$ would exceed the value defined in equation (12), and the magnitude of the deviation, inter alia, hinges on the difference in the competition authority's payoffs (cf. equation (8)) that result for one and two entrants, i.e., $V(n = 1) – V(n = 2)$.

5. Entry and Output Regulation

This section assumes that the competition authority has a set of instruments, which allows it to regulate entry <u>and</u> determine each firm's production quantity. Given identical firms, the first-order conditions for a maximum of $V(n, q)$ (cf. equations (2) and (8)) are:

$$\frac{\partial V}{\partial n} := V_n = q\left[\alpha\left(a - 2Q - cq + \frac{cq}{2} - \frac{F}{q}\right) + (1-\alpha)Q\right] = \alpha\pi + (1-2\alpha)Qq = 0 \quad (13)$$

[8] If the monopolist is profitable, $F < 0.5a^2/(2 + c)$ holds. This restriction then ensures $\alpha^{H,sb} > 0.5$. If the competition authority can cover a firm's losses, the profit constraint does not bind and $\alpha^{H,sb} < 0.5$ becomes feasible. Furthermore, we have $\alpha^{H,sb} - \alpha^{L,sb} = \frac{[M-(2+c)](1+c)(2+c)^2}{((2+c)^3+M(2-c^2))(3+2c)} > 0$.

$$\frac{\partial V}{\partial q} := V_q = n[\alpha(a - 2Q - cq) + (1 - \alpha)Q] = n[\alpha(a - cq) - Q(3\alpha - 1] = 0 \qquad (14)$$

The second-order sufficiency conditions require 3α > 1.[9] As in the second-best setting, we initially focus on an interior outcome. The comparison of equations (13) and (14) shows that the first-order conditions necessitate (see von Weizsäcker 1980 or Konishi 1990):

$$q^{fb} = \sqrt{\frac{2F}{c}} \qquad (15)$$

Rewriting equation (14) for $Q = qn^{fb}$, yields:

$$n^{fb}(q^{fb}) = \frac{\alpha(a - cq^{fb})}{q^{fb}(3\alpha - 1)} = \frac{\alpha}{3\alpha - 1}\left[\sqrt{Mc} - c\right] \qquad (16)$$

The first-best number of firms declines in the weight, α, of the firms' payoff and is given by the expression in square brackets in equation (16) if authorities maximise welfare (α = 3α – 1 = 0.5; cf. von Weizsäcker 1980). The welfare-maximising, first-best number of firms, $n^{fb}(\alpha = 0.5)$, may well be higher than the second-best number, $n^{sb}(\alpha = 0.5)$, if the indicator of marginal costs, c, is high enough (see Appendix 10.1 for a derivation and intuition).

The production level per firm, q^{fb}, exceeds the equilibrium quantity ($q^{fb} > q^*(n^*)$) and is independent of α. The first-best quantity trades off the impact of fixed and variable costs and ensures that the price equals marginal costs, implying that production is efficient. The number of firms then determines how the surplus is divided between firms and consumers. In particular, profits per firm are zero for α = 0.5 and rise with α.

If the market equilibrium results in more entry than desired by competition authorities depends on its bias. Since the first-best number of firms, $n^{fb}(\alpha)$, declines in α, whereas the equilibrium number is unaffected, entry is too high from the authority's perspective if it is (weakly) biased in favour of firms (α ≥ 0.5).[10] Solving $n^* - n^{fb}(\alpha) = 0$ yields a critical value that ensures that competition authorities favour the equilibrium number of firms.

$$\alpha^{L,fb} = \frac{\sqrt{M}\sqrt{2 + c} - (1 + c)}{\sqrt{M}\left(3\sqrt{2 + c} - \sqrt{c}\right) - (3 + 2c)} \qquad (17)$$

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[9] They are $V_{nn} = q^2(1 - 3\alpha) < 0$, $V_{qq} = -n[\alpha c + 3\alpha - 1] < 0$ and $V_{nn}V_{qq} - (V_{qn})^2 = Qq\alpha c(1 - 3\alpha) < 0$.

[10] We have: $n^* - n^{fb}(\alpha = 0.5) = \sqrt{M}(\sqrt{2 + c} - \sqrt{c}) - 1 > \sqrt{2 + c}\left(\sqrt{2 + c} - \sqrt{c}\right) - 1$
$= 1 + c - \sqrt{2 + c}\sqrt{c} = \sqrt{1 + 2c + c^2} - \sqrt{2c + c^2} > 0$

The critical value $\alpha^{L,fb}$ declines in the choke price, a, and rises with the fixed costs of entry, F, since $M = a^2/(2F)$, such that $\alpha^{L,fb} < 0.5$.[11] The effects of a variation in c are ambiguous for the same reasons as outlined above for $\alpha^{H,sb}$. If the actual weight of firms in the competition authority's objective falls below $\alpha^{L,fb}$, the authority prefers more firms to enter the market than do so in equilibrium. If $\alpha > \alpha^{L,fb}$, it will restrict entry.

Comparing the critical values for a first- and second-best setting, which induce competition authorities not to limit but rather to foster entry, we find:

$$\alpha^{L,fb} - \alpha^{L,sb} = \frac{\sqrt{M}\left(\sqrt{c}(1+c) - c\sqrt{2+c}\right)}{\left(\sqrt{M}\left(3\sqrt{2+c} - \sqrt{c}\right) - (3+2c)\right)(3+2c)} > 0 \qquad (18)$$

Consequently, it is more likely that the actual value, α, is less than the lower critical value in a first-best setting, $\alpha^{L,fb}$, than in a second-best environment, $\alpha^{L,sb}$. Competition authorities may want to restrict entry because of business-stealing and since it reduces profits. As the first effect is absent in a first-best situation, the incentives to restrict entry at all are weaker if competition authorities can also determine quantities.

If the indicator of marginal costs is unity (c = 1), the critical value $\alpha^{L,sb}$ equals 0.4 and $\alpha^{L,fb}$ exceeds this value (cf. equation (18)). A competition authority that attaches a weight of 60% to consumers in its objective, and 40% to firms, will not restrict entry, although this would enhance welfare. Therefore, one could argue that already a modest degree of partisanship results in rather dramatic regulatory consequences, irrespective of the instruments at hand.

If the weight α exceeds the value

$$\alpha^{H,fb} = \frac{1}{3 + c - \sqrt{M}\sqrt{c}} > \frac{1}{3}, \qquad (19)$$

the competition authority allows only a single firm to enter and establishes a monopoly. The critical value $\alpha^{H,fb}$ rises with the choke price, a, and the measure of marginal costs, c, declines with the fixed costs, F, and reaches a value of unity for $M^{Max} = (2+c)^2/c$.[12]

[11] Since $\alpha^{L,fb}$ declines in M, it is maximal for $M^{Min} = 2 + c$. Replacing this expression for M in (17) shows that $\alpha^{L,fb} \leq 1/(3 + c - \sqrt{c(2+c)}) < 1/(3 + c - \sqrt{(1+c)^2}) = 0.5$.

[12] The effects of a and F are obvious and the derivative with respect to c is:

$$\frac{\partial\alpha^{H,fb}}{\partial c} = \frac{\frac{1}{2\sqrt{c}}\sqrt{M} - 1}{\left(3 + c - \sqrt{cM}\right)^2} > \frac{\frac{1}{2\sqrt{c}}\sqrt{2+c} - 1}{\left(3 + c - \sqrt{cM}\right)^2} = \frac{\frac{\sqrt{4+4c+c^2}}{\sqrt{4c}} - 1}{\left(3 + c - \sqrt{cM}\right)^2} > 0$$

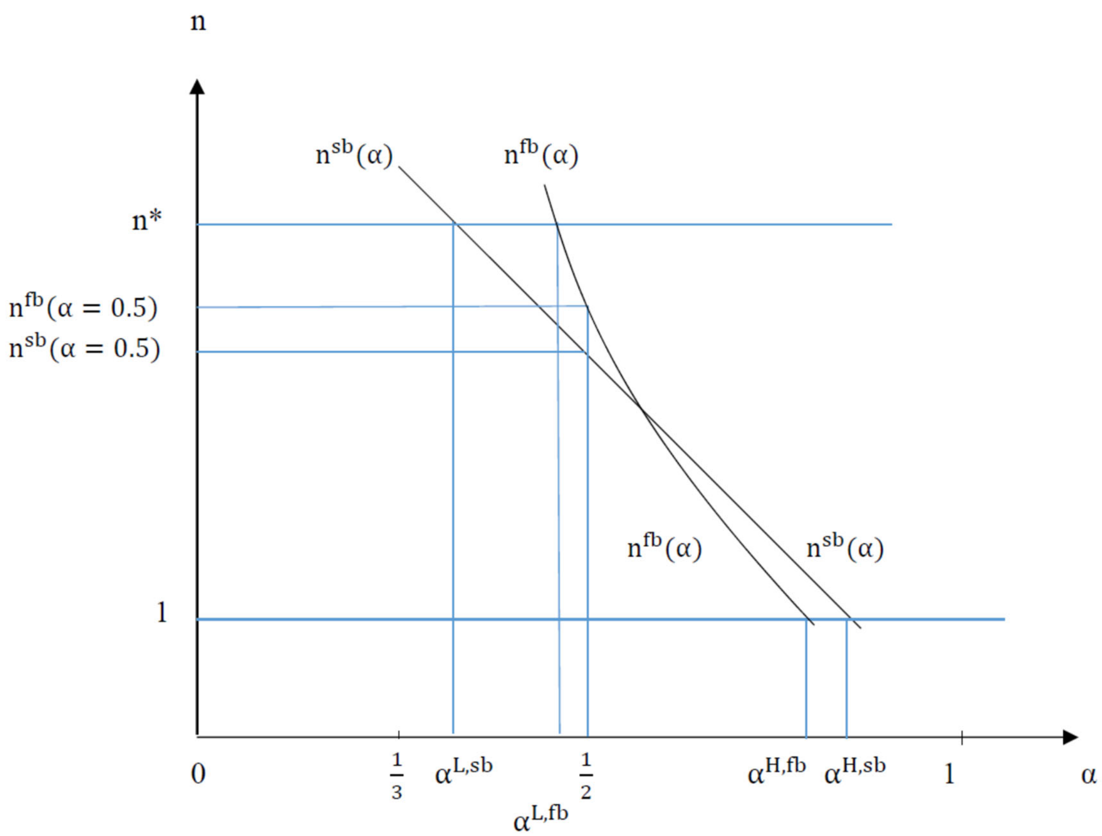
Moreover, the difference between $\alpha^{H,fb}$ and $\alpha^{L,fb}$ is positive (see Appendix 10.2).

The difference between $\alpha^{H,fb}$ and $\alpha^{H,sb}$ is positive for low values of $M = a^2/(2F)$, then becomes negative and is zero for the maximum value M^{Max} (for the proof, see Appendix 10.3). For c = 1, $\alpha^{H,sb} > \alpha^{H,fb}$ holds for about 90% of all possible values of M. Therefore, the range for the firms' weight in the competition authority's objective, which induces it to limit entry to one firm, is smaller if the competition authority can regulate entry only ('second-best') than if it can determine output per firm, as well ('first-best'). Put differently, for a wide range of values of M, it is more likely that the competition authority does not establish a monopoly if the set of its instruments is restricted (to determining entry).

6. Summary

Figure 1 relates the number of firms preferred by the competition authority to the critical values of the firms' weight, α, in its objective, as derived above. The number of firms in the first-best situation, $n^{fb}(\alpha)$, falls in the firms' weight, α, at a declining rate (cf. equation (16)). A higher value of α also reduces the preferred number of firms in a second-best setting (see Appendix 10.4). The curvature of $n^{sb}(\alpha)$ cannot be readily established, and we have depicted it as linear for simplicity. The number of firms in market equilibrium, n*, is independent of α.

Figure 1: Graphical Summary



A competition authority, which can only determine the number of firms, prefers a greater number than n* if $\alpha < \alpha^{L,sb}$. This critical value exceeds 1/3, as indicated in Figure 1. If the competition authority can determine output and the number of firms, it prefers more than n* producers for any $\alpha < \alpha^{L,fb} > \alpha^{L,sb}$, where $\alpha^{L,fb} < 0.5$.

If α = 0.5, the first-best number is lower than the second-best welfare-maximising number of firms in case of linear costs because there is no trade-off between the number of firms and output if the competition authority can regulate both. However, there exists such trade-off in a second-best setting. Moreover, in a world with quadratic costs, marginal costs rise with output per firm, such that the first-best welfare-maximising number of firms is likely greater than one, as depicted in Figure 1. It will also be larger than the second-best welfare-maximising number if the indicator of marginal costs, c, is sufficiently high (see Appendix 10.1).

If the weight of the firms' payoff in the competition authority's objective exceeds $\alpha^{H,fb}$, the first-best number of firms is one. We assume $\alpha^{H,fb} > 0.5$ in Figure 1. In addition, if M is sufficiently large, a competition authority, which can only regulate entry, prefers a monopoly for a higher value of the firms' weight than if it can determine entry and output, that is, $\alpha^{H,fb} < \alpha^{H,sb} < 1$ (see Section 5 and Appendix 10.3).

From Figure 1 we obtain four main insights:

1. A competition authority, which determines the number of firms and output, is less likely to restrict entry at all than a regulatory agency, which can limit entry only.
2. If a competition authority maximises the sum of welfare and consumer surplus, implying that α = 1/3 holds, it never restricts entry.
3. If the weight of firms in the competition authority's objective is sufficiently high, the authority establishes a monopoly, irrespective of the instruments at its disposal.
4. a) A competition authority, which can regulate entry and output, is more likely to establish a monopoly than an authority, which can restrict entry only if the consumers' maximal willingness to pay is sufficiently high relative to market entry costs.
   b) If the competition authority can regulate entry only, the likelihood of entry restrictions is independent of the choke price, a, and the fixed costs of entry, F.

To provide intuition for Insight 1, note that entry restrictions have a greater benefit for a competition authority that can affect the number of competitors than for a regulatory body that can also directly control output. This is because fewer entrants result in higher output per firm. Since output per firm is too low in Cournot-oligopoly, the incentives to limit entry are stronger in a world where competition authorities can affect market outcomes solely via entry constraints. Because $1 - \alpha^{L,fb}$ and $1 - \alpha^{L,sb}$ define the range for which entry restrictions are imposed, and since $\alpha^{L,fb} > \alpha^{L,sb}$ holds, Insight 1 suggests that a competition authority is less inclined to limit entry at all if its set of instruments is more comprehensive. This generates the empirically testable hypothesis that there are fewer entry restrictions in countries with more powerful competition authorities. Conversely, if competition authorities in different legal environments have the same regulatory instruments, the existence or absence of entry restrictions can provide information about the authorities' objectives.

Insight 2 indicates that competition authorities may not restrict entry because of a focus on consumer interests. Extending this insight to merger policy, we can deduce that populist competition authorities will be hesitant to allow take-overs, since reducing the number of competitors is likely to lower consumer surplus by more than it raises welfare.

Insight 3 shows that if competition authorities are sufficiently partisan and biased towards the interests of firms, they limit competition, irrespective of the instruments they have at their disposal. This is because the adverse consequences of restricting entry on aggregate output only have a small impact on the competition authority's payoff, which is dominated by the rise in profits resulting from less intensive competition.

According to Insight 4a, strict entry restrictions resulting in a monopoly are more likely if competition authorities regulate entry <u>and</u> a firm's behaviour. This is the case because a more comprehensive set of instruments mitigates or eliminates the adverse production effects of limiting competition. Consequently, the gains from restraining entry are larger than if competition authorities can solely limit the number of competitors. Insight 4a suggests that welfare may increase even if a competition authority, which is biased towards firms, is endowed with greater power and allowed to affect output decisions as well.

Finally, higher fixed entry costs reduce profits and, ceteris paribus, make entry less attractive to competition authorities. However, also the number of firms in market equilibrium declines. In a second-best setting, the incentives to restrict entry due to higher fixed costs are the same as in market equilibrium. This is the case because firms decide about production levels. Therefore, the weight of firms in the competition authority's objective, which has to be exceeded to restrict entry, is independent of the fixed costs of entry, F, as Insight 4b clarifies. A similar line of argument applies to the choke price, a. Therefore, a competition authority, which can only determine the number of firms, restricts entry independently of consumers' (maximal) willingness to pay and the firms' fixed cost of entry. In a first-best setting, the gain from restricting entry due to higher fixed costs is less pronounced because the output is determined optimally. Therefore, the desired number of firms shrinks by less than in market equilibrium. Accordingly, entry restrictions are less likely in a first-best world, the higher fixed costs of entry, F, are. The reverse argument applies to the choke price, a (see Insight 4a). The findings summarised in Insight 4b also generate empirically testable predictions, which differ according to the competition authority's regulatory power.

7. Firm Heterogeneity – Two Extensions

The base model assumes that firms are identical. However, firm heterogeneity can affect both the number of firms in market equilibrium and the socially optimal extent of entry. Accordingly, insufficient entry may result in the presence of heterogeneous firms in a setting in which there would be too many homogeneous oligopolists. To investigate in how far differences between firms affect the findings summarised in Section 6, we consider two types of differences. One of them concerns the output market, and the other focuses on inputs. Section 7.1 assumes that one firm can determine its quantity prior to all other oligopolists. The existence of a Stackelberg-leader can deter entry and, thereby, raise welfare (Etro 2007, 2008). Therefore, the question arises of whether sequential output choices also affect the competition authority's behaviour. Section 7.2 reverts to a Cournot-setting and assumes that production costs differ across firms. When deciding about entry, firms do not know about the cost realisation and face uncertainty. Since such cost uncertainty raises expected profits, it enhances entry in market equilibrium and a second-best setting (de Pinto and Goerke 2022). Once more, a partisan competition authority's incentives to regulate entry may change.

7.1 Stackelberg-setting

In a Stackelberg-world, the leader may have an incentive to raise its output level beyond the Cournot-quantity to reduce the followers' production. Consequently, the strength of the business-stealing externality changes, and there may no longer be excessive entry (Etro 2007, 2008, Mukherjee 2012b). Since sequential output choices are likely to affect output as well as profits, both the market outcome and the competition authority's choices will vary.

Suppose, therefore, that a leader, indexed by the subscript L, enters the market in stage one at costs F. In stage two, n_S, followers enter the market, where the subscript S indicates the Stackelberg-setting. Each follower incurs the same fixed costs of entry, F. In stage three, the leader chooses its quantity q_L. Finally, in stage four, the followers determine their respective output levels.[13] The other ingredients of the model outlined in Section 2 remain unaffected.

We assume that entry by the leader is profitable and desirable from the competition authority's vantage point. Therefore, we can focus on the entry decisions of followers. Moreover, in market equilibrium entry is profitable also for at least one follower. We consider the various settings in the same order as the main analysis.

Market Equilibrium

To ascertain the effects of sequential output choices in market equilibrium, we initially determine the followers' decisions. Profits of follower j can be expressed as

$$\pi_{Sj} = \left(a - q_L - q_{Sj} - Q_{S_j}\right) q_{SJ} - c\frac{\left(q_{Sj}\right)^2}{2}, \tag{20}$$

where Q_{S_j} denotes the output of all followers other than firm j. When follower j decides about q_{Sj}, entry decisions and the output choice of the leader have already been made. Furthermore, for firm j the quantities produced by other followers are given. Assuming symmetric followers and, therefore, omitting the subscript j, we can calculate the output of a follower as:

$$q_S(n_S, q_L) = \frac{a - q_L}{1 + c + n_S} \tag{21}$$

Given n_S followers, and anticipating their quantity responses, the leader chooses

$$q_L(n_S) = \frac{a(1 + c)}{Z(n_S)}, \tag{22}$$

where we use $Z(n_S) := (2 + c)(1 + c + n_S) - 2n_S = (2 + c)(1 + c) + n_S c$ for notational convenience. The output of followers and aggregate output are:

$$q_S(n_S) = \frac{a}{1 + c + n_S}\left[1 - \frac{1 + c}{Z(n_S)}\right] \tag{23}$$

$$Q_S(n_S) = \frac{a}{1 + c + n_S}\left[n_S + \frac{(1 + c)^2}{Z(n_S)}\right] = a - (1 + c)q_s(n_S) \tag{24}$$

[13] Since entry is a long-term choice, we suppose that the Stackelberg-leader chooses its output after the followers have decided about entry (see Mukherjee (2012b) and Chao et al. (2017) for comparable approaches in the analysis of entry decisions). In contrast, Etro (2007, 2008) and Cato and Matsumura (2018) assume that the Stackelberg-leader chooses its quantity before followers can enter. Ino and Matsumura (2012) denote the alternative settings as weakly and strongly persistent-leadership models.

The leader produces a higher quantity than a follower, and the aggregate quantity rises in the number of followers, n_S (see Appendix 10.5).

The number of entrants, which ensures that profits of followers are zero in market equilibrium, is denoted by n_S^*. Substituting equations (22) and (23) into (20), we can calculate the output level, q_S^*, which ensures that exactly n_S^* followers enter. This output level, $q_S(n_S^*)$, is the same as selected by a Cournot-oligopolist, $q_S(n_S^*) = q^*$ (see equation (7)). The same equivalence results for aggregate output:

$$Q_S(n_S^*) = Q_S^* = a - (1+c)q_S^* = a - (1+c)\sqrt{\frac{2F}{2+c}} = Q^* \tag{25}$$

The number of followers in market equilibrium is (see Appendix 10.5):

$$n_S^* = \sqrt{\frac{M(2+c)}{4} + \frac{(1+c)^2}{c^2}} - \frac{(1+c)^2}{c} + \frac{\sqrt{M(2+c)}}{2} < n^* - 1 \tag{26}$$

Therefore, the equilibrium number of firms in a Stackelberg-setting is lower than in a Cournot-oligopoly.[14]

Entry Regulation

The first-order condition, which characterises the number of firms a competition authority prefers if it can regulate entry, is somewhat involved. Therefore, comparing the number of firms in market equilibrium, $n_S^* + 1$, with the second-best number of followers, $n_S^{sb}(\alpha)$, yields no meaningful insights. This is due to the co-existence of a quadratic cost function and asymmetric firms. Therefore, we attempt to gain further insights by assuming linear costs, cq. This is feasible because the excess-entry prediction in a second-best setting obtains in the presence of constant and also increasing marginal costs (cf. von Weizsäcker (1980), Mankiw and Whinston (1986), and Suzumura and Kiyono (1987)).

The analysis shows (see Appendix 10.6), first, that the number of followers in market equilibrium exceeds the number preferred by a welfare-maximising competition authority.[15]

[14] Etro (2008) derives the same result in a setting with quadratic costs in which the leader determines its output before followers decide about entry and can thereby affect the followers' entry decisions. This linkage does not exist in the present framework.

[15] Mukherjee (2012b) considers a comparable analytical framework in which, however, the leader's marginal costs are lower than the followers' marginal costs. Mukherjee (2012b) shows that there is excessive entry if the cost difference is not too large. If the leader determines output prior to the followers' entry decision, the market equilibrium is characterised by entry deterrence, such that there is no follower (see Etro 2007, 2008). Therefore, the sequence of decisions is important in a Stackelberg-framework (see also Ino and Matsumura 2012).

Second, this implies that the weight of firms in the competition authority's objective, which induces the authority to choose the equilibrium number of entrants, is less than 0.5. It stems from a smaller range than $\alpha^{L,sb}$, but is higher than the respective value for a Cournot-setting with linear costs. Third, the competition authority prefers no entry of followers and, hence, a monopoly leader for a broad range of values of the firm's weight in its partisan objective. It exceeds the value, which induces the competition authority to prefer the market equilibrium with at least one follower and, thus, mirrors the findings that $\alpha^{H,sb} > \alpha^{L,sb}$ for a Cournot-setting with quadratic costs (see equations (10) and (11)). Moreover, the value of the firms' weight in the competition authority's objective, which ensures that it prefers a monopoly in a Stackelberg-setting with linear costs, is higher than the respective value for Cournot-competition with linear costs because the decline in profits when moving to a duopoly is smaller in a Stackelberg-world.

In summary, the findings for the Stackelberg-setting with linear production costs for a second-best world qualitatively resemble the ones derived for a Cournot-setting with either quadratic or linear costs. This suggests that the nature of competition in the output market does not fundamentally affect the analysis of a partisan competition authority if it can regulate entry.

Entry and Output Regulation

In a first-best world, comparing the market equilibrium in a Stackelberg-setting with the competition authority's choice is straightforward in the presence of increasing marginal costs. This is the case because leader and followers face the same quadratic cost function. Therefore, aggregate profits are maximal for a given number of firms and any aggregate output if each firm produces the same quantity. Therefore, there will be no distinction between leader and follower in the first-best setting, irrespective of the competition authority's objective, and it faces the same optimisation problem as in a Cournot-setting.

The output level imposed by the competition authority and the number of followers it induces to enter are given by $q_S^{fb} = \sqrt{2F/c}$ (cf. equation (14)) and $n_S^{fb} = n^{fb} - 1$ (see equation (16)). The first best-number of firms of a welfare-maximising competition authority falls short of the number of entrants in market equilibrium, implying that $n^{fb}(\alpha = 0.5) < n_S^* + 1$ holds. Thus, the critical value $\alpha_S^{L,fb}$, which ensures $n_S^* - n^{fb}(\alpha) = 0$, will be less than 0.5, as it is the case in a Cournot-setting.[16] Finally, the value of the firms' weight in the competition authority's

[16] An explicit value of $\alpha_S^{L,fb}$ can be obtained by setting equal equations (26) and (16), and solving the equality for α. The resulting expression does not lend itself to an insightful analysis.

objective, which ensures that it prefers a monopoly in a first-best world, is given by equation (18) and the same as in a Cournot-setting.

We can summarise that the main results concerning the behaviour of a partisan competition authority facing a Cournot-oligopoly also hold in a Stackelberg-setting. While the exact values of the weight of firms, respectively consumers, in the competition authority's objective, which induce it to behave in a particular way (see, for example, Insight 2), depend on the structure of the oligopolistic market, the essential features appear to be the same.

7.2. Heterogeneous Costs

Suppose next that production costs vary across firms. For simplicity, we assume that costs are either high or low with the same probability for a given quantity and equal $0.5c_i(q_{ji})^2$, $i = h, l$, $c_h = c + \varepsilon \geq c \geq c - \varepsilon = c_l > 0$. Since this the only modification in comparison to the basic set-up, for $\varepsilon = 0$ the findings outlined below collapse to those of Sections 3 to 5.

If firms learn about the cost realisation before entry, and there are sufficiently many potential low-cost entrants, no high-cost firm would enter the market in equilibrium. Moreover, the competition authority would only allow low-cost firms to produce. Therefore, cost differences can have an impact if neither a potential entrant nor the competition authority can observe the cost realisation prior to the entry decision. If variable costs become known subsequent to having incurred the fixed costs, F, the entry decision occurs under uncertainty.

In our setting, uncertainty occurs only at the firm level but not in aggregate. In particular, we suppose that the ex-ante distribution of marginal production costs is also realised ex-post. Moreover, no entrants produce zero output. These assumptions imply that half of the firms face high costs ex-post, and the other 50% of entrants are characterised by low marginal production costs. This simplification enables us to focus on the impact of cost heterogeneity.[17] Firms learn about their costs after entering the market and determine output knowing their cost realisation. The entry decision in market equilibrium is based on expected profits, π^e. The competition

[17] Cost uncertainty in Cournot models with free entry has been looked at by Creane (2007), Deo and Corbett (2009), and de Pinto and Goerke (2022). None of these contributions compares a partisan regulator's choices in a first- and second-best setting. The present analysis builds on de Pinto and Goerke (2022) who focus on the impact of greater cost uncertainty, that is, the effects of an increase in the parameter, ε, for example, on the extent of excessive entry. They derive the main results for a setting with linear costs. However, de Pinto and Goerke (2022) also report the findings from the investigation of a model with quadratic production costs, akin to the one we look at here. Therefore, we can relate some of our findings to those reported in de Pinto and Goerke (2022). Moreover, de Pinto and Goerke (2022) establish a qualitative equivalence of a setting without aggregate uncertainty and no integer constraint relating to the number of firms and a model, which features aggregate uncertainty and contains an integer constraint.

authority maximizes the weighted sum of aggregate expected profits and consumer surplus. Except for output levels per firm, which we indicate by the subscripts h and l, for high and low costs, respectively, we denote all variables with the subscript d, signposting the existence of costs differences. The sequence of decisions is the same as in the base model of Section 2.

Market Equilibrium

Expected profits of firm j, facing marginal production costs $c_i q_{ji}$, are:

$$\pi_j^e = \frac{1}{2}(\pi_{jl} + \pi_{jh}) = \frac{1}{2}\left[(a - Q_d)(q_{jl} + q_{jh}) - (c + \varepsilon)\frac{(q_{jh})^2}{2} - (c - \varepsilon)\frac{(q_{jl})^2}{2}\right] - F \quad (27)$$

For a given number of entrants, the firms' optimisation decisions in market equilibrium result in an aggregate output level, $Q_d^*(n_d)$ (see Appendix 10.7 for the calculations):

$$Q_d^*(n_d) = \frac{n_d a(1 + c)}{(1 + n_d + c)(1 + c) - \varepsilon^2} \quad (28)$$

Expected profits are:

$$\pi^e(n_d) = a^2 \frac{(2 + c)(1 + c)^2 - c\varepsilon^2}{2\left((1 + n_d + c)(1 + c) - \varepsilon^2\right)^2} - F \quad (29)$$

Solving $\pi^e(n_d) = 0$, we obtain:

$$n_d^* = \frac{\sqrt{M}\sqrt{(2 + c)(1 + c)^2 - c\varepsilon^2} + \varepsilon^2}{1 + c} - (1 + c) \quad (30)$$

The number of entrants in market equilibrium, n_d^*, rises with the indicator of cost heterogeneity, ε. Therefore, $n_d^* > n^*$ holds for $\varepsilon > 0$. Cost heterogeneity allows firms with low costs to expand production, whereas high-cost firms curtail output, relative to a setting in which costs are certain and equal to the average amount at a given output level. In consequence, expected profits rise, and entry becomes more attractive.[18]

[18] The mechanism at work has initially been explored in the analysis of price variability on firms' output choices. Such price or cost variability can be beneficial for firms and consumers because of the convexity of the profit function (see Waugh (1944), Oi (1961), and Massell (1969) for the seminal contributions on price variability).

Entry Regulation

Turning to the competition authority, we initially assume that it can only determine the number of firms. The first-order condition for a maximum of its objective, $V_d(n_d) = \alpha n_d \pi^e(n_d) + (1-\alpha)0.5(Q_d(n_d))^2$, is:[19]

$$\frac{dV_d}{dn_d} = \alpha\left[\pi^e(n_d) - \frac{n_d a^2(1+c)\big((2+c)(1+c)^2 - c\varepsilon^2\big)}{\big((1+n_d+c)(1+c)-\varepsilon^2\big)^3}\right]$$

$$+(1-\alpha)\frac{n_d a^2(1+c)^2((1+c)^2-\varepsilon^2)}{\big((1+n_d+c)(1+c)-\varepsilon^2\big)^3} = 0 \tag{31}$$

If the first-order condition holds, the term in square brackets in (31) is negative as the second summand is greater than zero. Therefore, the derivative in (31) declines in the weight of firms, α, in the competition authority's objective.

The weight, $\alpha_d^{L,sb}$, of firms in the competition authority's objective such that it prefers the number of equilibrium entrants is:

$$\alpha_d^{L,sb} = \frac{(1+c)^2-\varepsilon^2}{(1+c)(3+2c)-\varepsilon^2} \tag{32}$$

Because $\alpha_d^{L,sb}$ declines with ε, it is smaller than the respective value in the absence of cost heterogeneity, i.e. $\alpha_d^{L,sb} < \alpha^{L,sb} < 0.5$. Therefore, it can be argued that cost heterogeneity aggravates excess entry (see de Pinto and Goerke 2022).

A competition authority, which cannot affect quantity choices, prefers a monopoly if the weight of firms in its objectives exceeds $\alpha_d^{H,sb}$.

$$\alpha_d^{H,sb} = \frac{2(1+c)^2M((1+c)^2-\varepsilon^2)}{M[(1+c)^3(2-c^2)+\varepsilon^2(1+c)2(1+2c)-c\varepsilon^4]+\big((2+c)(1+c)-\varepsilon^2\big)^3} \tag{33}$$

This value cannot be related directly to other critical values of the firms' weight.

[19] We assume that (31) defines a maximum for V for all values of α of interest. The second-order condition is:

$$\frac{d^2V_d(n^d)}{d(n^d)^2} = \alpha\frac{d\pi^e}{dn^d}$$

$$-a^2\frac{(1+c)((1+c)(1+c-2n_d)-\varepsilon^2)}{\big((1+n_d+c)(1+c)^2-\varepsilon^2\big)^4}\big(\alpha((2+c)(1+c)^2-c\varepsilon^2)-(1-\alpha)(1+c)((1+c)^2-\varepsilon^2)\big)$$

Entry and Output Regulation

We next consider a setting in which the competition authority chooses the number of firms and their output. Since each firm knows its marginal costs when deciding about output, we assume that the competition authority can likewise differentiate the output levels of high- and low-cost firms. Its objective is:

$$V_d\left(n^d, q_l, q_h\right) = \alpha n^d \left\{\left(a - n^d \frac{(q_l + q_h)}{2}\right)\frac{(q_l + q_h)}{2} - \frac{(c+\varepsilon)(q_h)^2}{4} - \frac{(c-\varepsilon)(q_l)^2}{4} - F\right\} + \frac{(1-\alpha)}{2}\left(n^d \frac{q_l + q_h}{2}\right)^2 \quad (34)$$

From the first-order conditions, we compute output per firm and their first-best number (see Appendix 10.7).

$$q_l^{fb} = \sqrt{\frac{4F(c+\varepsilon)}{2c(c-\varepsilon)}} > q^{fb} > q_h^{fb} = \sqrt{\frac{4F(c-\varepsilon)}{2c(c+\varepsilon)}} \quad (35)$$

$$n_d^{fb}(\alpha) = \frac{\alpha}{3\alpha - 1}\left(\sqrt{M\frac{c^2-\varepsilon^2}{c}} - \frac{c^2-\varepsilon^2}{c}\right) \quad (36)$$

The first fraction in (36) declines in α and attains a value of unity for α = 1. Therefore, the first-best number of firms will be greater than one if $\sqrt{M(c^2-\varepsilon^2)/c} > (c^2-\varepsilon^2)/c$ and $\sqrt{M(c^2-\varepsilon^2)/c} > 1$. The derivative of n_d^{fb} with respect to ε is:

$$\frac{\partial n_d^{fb}}{\partial \varepsilon} = \frac{2\varepsilon\alpha}{(3\alpha-1)c}\left(1 - \frac{1}{\sqrt{M\frac{c^2-\varepsilon^2}{c}}}\right) \quad (37)$$

Given $n_d^{fb} \geq 1$, greater cost heterogeneity raises the first-best number of firms.

The weight in the competition authority's objective, $\alpha_d^{L,fb}$, which ensures that it prefers the equilibrium number of firms, n_d^*, can be computed in the same manner as in equation (16):

$$\alpha_d^{L,fb} = \frac{n_d^*}{3n_d^* - n_d^{fb}} \quad (38)$$

Substituting for n_d^* and n_d^{fb} in line with equations (30) and (36) yields no further insights. In particular, an analytical proof that $\alpha_d^{L,fb} < 0.5$ holds for all potential values of the parameter measuring cost heterogeneity, ε, is not feasible without further restrictions.

A value of $\alpha \geq \alpha_d^{H,fb}$ induces the competition authority to prefer a monopoly:

$$\alpha_d^{H,fb} = \frac{1}{3 - \left(\sqrt{M\frac{c^2 - \varepsilon^2}{c}} - \frac{c^2 - \varepsilon^2}{c}\right)} \tag{39}$$

This value of the firms' weight in the objective of the competition authority is greater than 1/3 since $n_d^{fb} > 0$ requires that the term in brackets in the denominator of (39) is positive.

We can conclude that a partisan competition authority faces fundamentally the same trade-off, which induces it to restrict the number of firms either to the market equilibrium outcome or to one, in the presence of cost heterogeneity, as in the absence of differences in marginal costs. The findings concerning excessive entry for a second-best setting, in which only the number of firms can be determined, are also qualitatively the same as in the absence of cost heterogeneity. How differences in marginal costs affect a partisan competition authority's incentives to establish a monopoly may depend on the extent of the cost heterogeneity. In sum, most but not all insights for the basic set-up summarised in Section 6 also apply in a word with cost heterogeneity.

8. Limitations and Further Extensions

We have derived the results summarised in Section 6 under several, possibly restrictive assumptions. The analysis in Section 7 clarifies that modifications of the basic setting may sometimes require additional assumptions for the main results to hold. Moreover, not all insights stated in Section 6 can be derived for the modified set-ups. In this concluding section, we briefly discuss some further potentially important simplifications of our basic framework.

First, the demand schedule is linear, and the cost function is quadratic. These assumptions help to explicitly compute some outcomes and the critical values of the weight of firms, α, and consumers, 1 – α, in the competition authority's objective. Since the excess-entry result holds for a much broader class of demand schedules and cost functions (cf. Amir et al. 2014), our findings are unlikely to be affected qualitatively. The critical values computed for α and the numerical examples obviously depend on the simplifying assumptions.

Second, given entry, a firm can only decide about output. Especially in a long-run setting, it is likely that firms can undertake investments to alter production technologies and reduce marginal costs. The respective incentives depend on output levels and, hence, the competition authority's objective if entry is regulated. While the excess-entry result can also arise in settings with innovation (Chao et al., 2017, Mukherjee, 2012a, Okuno-Fujiwara and Suzumura, 1993), this does not necessarily imply that our findings are robust to such extension. This is the case because there is a second channel of adjustment, which may influence entry in market equilibrium differently than in a regulated setting.

Third, we have analysed a model in which the weight of firms and consumers in the competition authority's objectives is given exogenously. The value of α could also be determined endogenously and hinge on lobbying contributions (see Introduction). Equilibrium contributions would then depend on payoff levels and the means to overcome the public good character of regulation. They would, accordingly, vary with the exact specification of the demand schedule, cost functions, the mechanism used to aggregate firms' and consumers' preferences, and the treatment of lobbying contributions in the competition authority's objective.

In summary, the basic trade-off we have identified is likely to be important in more elaborate settings, as well. Our investigation provides the first step for a more comprehensive examination of partisan competition authorities in oligopolistic markets.

9. References

Amir, Rabah and Chrystie Burr (2015), Corruption and Socially Optimal Entry, Journal of Public Economics 123, 30-41.

Amir, Rabah and Val. E. Lambson (2003), Entry, Exit, and Imperfect Competition in the Long Run, Journal of Economic Theory 110(1), 191-203.

Amir, Rabah, De Castro, Luciano and Leonidas Koutsougeras (2014), Free Entry Versus Socially Optimal Entry, Journal of Economic Theory 154, 112-125.

Amir, Rabah, Jin, Jim Y. and Michael Tröge (2019), Improving on Free Trade in Cournot Oligopoly, manuscript.

Armstrong, Mark, Cowan, Simon and John Vickers (1994), Regulatory Reform: Economic Analysis and British Experience, Cambridge (Mass.) and London: The MIT Press.

Baron, David P. and Roger B. Myerson (1982), Regulating a Monopolist with Unknown Costs, Econometrica 50(4), 911-930.

Barros, Pedro P. and Luis M. B. Cabral (1992), Foreign Entry and Domestic Welfare, 101-116., in: Amaral, João Ferreira, Lucena, Diogo and António S. Mello (Eds), The Portuguese Economy Towards 1992, Boston: Kluwer Academic Publishers.

Barros, Pedro P. and Luis M. B. Cabral (1994), Merger Policy in Open Economies, European Economic Review 38(5), 1041-1055.

Berry, Steven T. and Joel Waldfogel (1999), Free Entry and Social Inefficiency in Radio Broadcasting, The RAND Journal of Economics 30(3), 397-420.

Cato, Susumu and Toshihiro Matsumura (2019), Entry License Tax: Stackelberg versus Cournot, Journal of Institutional and Theoretical Economics 175(2), 258-271.

Chang, Juin-jen, Lai, Ching-Chong and Ping Wang (2010), Casino Regulations and Economic Welfare, Canadian Journal of Economics/ Revue canadienne d'économique 43(3), 1058-1085.

Chao, Angela A., Lee, Jen-Yao and Leonard F.S. Wang (2017), Stackelberg Competition, Innovation and Social Efficiency of Entry, The Manchester School 85(1), 1-12.

Creane, Anthony (2007), Note on Uncertainty and Socially Excessive Entry, International Journal of Economic Theory 3(4), 329-334.

de Pinto, Marco and Laszlo Goerke (2020), Welfare-enhancing Trade Unions in an Oligopoly with Excessive Entry, The Manchester School 88(1), 60-90.

de Pinto, Marco and Laszlo Goerke (2022), Cost Uncertainty in an Oligopoly with Endogenous Entry , Bulletin of Economic Research (forthcoming)

Deo, Sarang and Charles J. Corbett (2009), Cournot Competition Under Yield Uncertainty: The Case of the U.S. Influenza Vaccine Market, Manufacturing and Service Operations Management 11(4), 563-576.

Djankov, Simeon, La Porta, Rafael, Lopez-de-Silanes, Florencio and Andrei Shleifer (2002), The Regulation of Entry, The Quarterly Journal of Economics 117(1), 1-37.

Etro, Federico (2007), Competition, Innovation, and Antitrust – A Theory of Market Leaders and its Policy Implications, Springer-Verlag: Berlin and Heidelberg.

Etro, Federico (2008), Stackelberg Competition with Endogenous Entry, The Economic Journal 118 (Iss 532), 1670-1697.

Farrell, Joseph and Michael L. Katz (2006), The Economics of Welfare Standards in Antitrust, Competition Policy International 2(2), 3-28.

Gama, Adriana and Mario Samano (2021), Free and Second-best Entry in Oligopolies with Network Effects, Journal of Public Economic Theory 23, 746-759.

Ghosh, Arghya and Hodaka Morita (2007a), Free Entry and Social Efficiency under Vertical Oligopoly, The RAND Journal of Economics 38(3), 541-554.

Ghosh, Arghya and Hodaka Morita (2007b), Social Desirability of Free Entry: A Bilateral Oligopoly Analysis, International Journal of Industrial Organization 25(5), 925-934.

Goerke, Laszlo (2020), A Political Economy Perspective on Horizontal FDI in a Dynamic Cournot-Oligopoly with Endogenous Entry, European Journal of Political Economy, 63, Article 101897.

Gutiérrez, Germán and Thomas Philippon (2019), The Failure of Free Entry, NBER Working Paper No. 26001.

Han, Tien-Der, Haque, M. Emranul and Arijit Mujherjee (2022), Social Efficiency of Entry in an Open Economy, The B.E. Journal of Economic Analysis & Policy 22(1), 203-219.

Hillman, Arye L. (1989), The Political Economy of Protection, Harwood Academic Publishers: Chur.

Hsieh, Chang-Tai and Enrico Moretti (2003), Can Free Entry be Inefficient? Fixed Commissions and Social Waste in the Real Estate Industry, Journal of Political Economy 111(5), 1076-1122.

Ino, Hiroaki and Toshihiro Matsumura (2012), How Many Firms should be Leaders? Beneficial Concentration Revisited, International Economic Review 53(4), 1323-1340.

Katsoulacos, Yannis, Metsiou, Eleni and David Ulph (2016), Optimal Substantive Standards for Competition Authorities, Journal of Industry, Competition and Trade 16(3), 273-295.

Konishi, Hideki (1990), Final and Intermediate Goods Taxation in an Oligopolistic Economy with Free Entry, Journal of Public Economics 42(3), 371-386.

Mankiw, N. Gregory and Michael D. Whinston (1986), Free Entry and Social Inefficiency, The RAND Journal of Economics 17(1), 48-58.

Marjit, Sugata and Arijit Mukherjee (2013), Foreign Competition and Social Efficiency of Entry, Economic Modelling 12(1), 108-112.

Marjit, Sugata and Arijit Mukherjee (2015), Endogenous Market Structure, Trade Cost Reduction, and Welfare, Journal of Institutional and Theoretical Economics 171(3), 493-511.

Maruyama, Shiko (2011), Socially Optimal Subsidies for Entry: The Case of Medicare Payments to HMOs, International Economic Review 52(1), 105-129.

Massell, Benton F. (1969), Price Stabilization and Welfare, The Quarterly Journal of Economics 83(2), 284–298.

Motta, Massimo and Michele Ruta (2012), A Political Economy Model of Merger Policy in International Markets, Economica 79, No. 313, 115-136.

Mukherjee, Arijit (2009), Excessive Entry in a Bilateral Oligopoly, Economics Bulletin 29(1), 199-204.

Mukherjee, Arijit (2012a), Endogenous Cost Asymmetry and Insufficient Entry in the Absence of Scale Economies, Journal of Economics 106(1), 75-82.

Mukherjee, Arijit (2012b), Social Efficiency of Entry with Market Leaders, Journal of Economics & Management Strategy 21(2), 431-444.

Mukherjee, Arijit and Yingyi Tsai (2014), Managerial Delegation, Cost Asymmetry and Social Efficiency of Entry, Economic Record 90, No. 288, 90-97.

Neven, Damien J. and Lars-Hendrik Röller (2005), Consumer Surplus vs. Welfare Standard in a Political Economy Model of Merger Control, International Journal of Industrial Organization 23(9-10), 829-848.

Ohkawa, Takao, Okamura, Makoto, Nakanishi, Noritsugu and Kazuharu Kiyono (2005), The Market Selects the Wrong Firms in the Long-run, International Economic Review 46(6), 1143-1165.

Oi, Walter Y. (1961), The Desirability of Price Instability under Perfect Competition, Econometrica 29(1), 58-64.

Okuno-Fujiwara, Masahiro and Kotaro Suzumura (1993), Symmetric Cournot Oligopoly and Economic Welfare, Economic Theory 3(1), 43-59.

Olson, Mancur Jr. (1965), The Logic of Collective Action, revised edition 1971, New York: Schocken Books.

Onishi, Ken, Hashimoto, Chiyo, Wakamori, Naoki and Shun-ichiro Bessho (2018), The Welfare Consequences of Free Entry in Vertical Relationships: The Case of the MRI Market, Manuscript.

Orbach, Barak Y. (2011), The Antitrust Consumer Welfare Paradox, Journal of Competition Law & Economics 7(1), 133–164.

Perry, Martin K. (1984), Scale Economies, Imperfect Competition, and Public Policy, The Journal of Industrial Economics 32(3), 313-333.

Ritz, Robert A. (2018), Oligopolistic Competition and Welfare, pp. 181-200, in: Corchón, Luis C. and Marco A. Marini (Eds.), Handbook of Game Theory and Industrial Organization Vol. I, Edward Elgar: Cheltenham (UK) and Northampton (USA)

Seade, Jesus (1980), On the Effects of Entry, Econometrica 48(2), 479-489.

Stigler, George J. (1971), The Theory of Economic Regulation, The Bell Journal of Economics and Management Science 2(1), 3-21.

Suzumura, Kotaro (1995), Competition, Commitment, and Welfare, Clarendon Press: Oxford.

Suzumura, Kotaro and Kazuharu Kiyono (1987), Entry Barriers and Economic Welfare, Review of Economic Studies 54(1), 157-167.

von Weizsäcker, Carl Christian (1980), A Welfare Analysis of Barriers to Entry, The Bell Journal of Economics 11(2), 399-420.

Waugh, Frederick V. (1944), Does the Consumer Benefit from Price Instability?, The Quarterly Journal of Economics 58(4), 602–614.

10. Appendix

10.1 First-best versus Second-best Welfare-maximising Number of Firms

To compare $n^{fb}(\alpha = 0.5) = \sqrt{Mc} - c$ (cf. (16)) and $n^{sb}(\alpha = 0.5)$, we evaluate equation (9) at n^{fb}.

$$\frac{dV(n)}{dn}_{|\alpha=0.5,n=n^{fb}} = \frac{F}{(1+c+n^{fb})^3}\left\{M\left[(2+c)(1+c)+n^{fb}c\right] - \left(1+c+n^{fb}\right)^3\right\}$$

$$= \frac{F}{(1+c+n^{fb})^3}\left\{M\left[(2+c)(1+c)+(\sqrt{Mc}-c)c\right] - \left(1+\sqrt{Mc}\right)^3\right\}$$

$$= \frac{F}{(1+c+n^{fb})^3}\left\{2M-1-3\sqrt{Mc}\right\} \qquad (A.1.1)$$

The expression in curly brackets is positive for c → 0 because M weakly exceeds $M^{Min} = 2 + c$, and decreases in c. Moreover, it increases in M, since the derivative with respect to M,

$$\frac{\partial\left(2M-1-3\sqrt{Mc}\right)}{\partial M} = 2 - \frac{3\sqrt{c}}{2\sqrt{M}} > 2 - \frac{3\sqrt{c}}{2\sqrt{M^{Min}}} = 2 - \frac{3\sqrt{c}}{2\sqrt{2+c}} > 0, \qquad (A.1.2)$$

is positive for $M = M^{Min} = 2 + c$ and rises in M.

Assuming c = 1 (c = 2), the derivative in (A.1.1) is positive for any M > $(\sqrt{17}+3)^2/16$ ($M > \sqrt{13/8} + \sqrt{9/8}$). Therefore, if c is relatively low (c = 1), the derivative in (A.1.1) may well be positive, such that the second-best number of firms exceeds the first-best number. If, however, marginal costs are higher (c = 2), the reverse may be true.

The intuition for the uncertain relationship between n^{fb} and n^{sb} is as follows: The gains from restricting the number of production sites, in order to reduce market entry costs, F, become smaller the higher marginal costs are. Moreover, output per firm declines in the number of firms, n, if it is chosen by producers (cf. equation (4)), whereas it does not vary with n in a first-best setting (cf. equation (15)). Therefore, the increase in the indicator of marginal costs, c, ceteris paribus, has a lower impact via the convexity of the cost function if firms choose output than if the competition authority determines the production level, as well.

10.2 Comparison of $\alpha^{H,fb}$ and $\alpha^{L,fb}$

From equation (19) we know that $\alpha^{H,fb}$ rises in M. Using equation (17), we see that $\alpha^{L,fb}$ falls in M.

$$\frac{\partial\alpha^{L,fb}}{\partial\sqrt{M}}=\frac{(1+c)\left(3\sqrt{2+c}-\sqrt{c}\right)-\sqrt{2+c}(3+2c)}{\left(\sqrt{M}\left(3\sqrt{2+c}-\sqrt{c}\right)-(3+2c)\right)^2}$$

$$=\frac{c\sqrt{2+c}-(1+c)\sqrt{c}}{\left(\sqrt{M}\left(3\sqrt{2+c}-\sqrt{c}\right)-3-2c\right)^2}=\frac{\sqrt{2c^2+c^3}-\sqrt{c+2c^2+c^3}}{\left(\sqrt{M}\left(3\sqrt{2+c}-\sqrt{c}\right)-3-2c\right)^2}<0\quad (A.2.1)$$

Computing the difference between $\alpha^{H,fb}$ and $\alpha^{L,fb}$ at $M^{Min}=2+c$, yields:

$$\alpha^{H,fb}\left(\sqrt{M}=\sqrt{2+c}\right)-\alpha^{L,fb}\left(\sqrt{M}=\sqrt{2+c}\right)$$

$$=\frac{1}{3+c-\sqrt{(2+c)c}}-\frac{1}{3(2+c)-\sqrt{(2+c)c}-(3+2c)}=0\qquad (A.2.2)$$

Since the difference rises in M, it is positive for $M > M^{Min}$.

10.3 Comparison of $\alpha^{H,sb}$ and $\alpha^{H,fb}$

$\alpha^{H,sb}$, as defined in equation (12), is increasing and concave in M.

$$\frac{\partial\alpha^{H,sb}(M,c)}{\partial M}=\frac{2(1+c)(2+c)^3}{\left((2+c)^3+M(2-c^2)\right)^2}>0>\frac{\partial^2\alpha^{H,sb}(M,c)}{\partial M^2}\qquad (A.3.1)$$

The respective value of α for the first-best setting (cf. equation (19)) rises in M.

$$\frac{\partial\alpha^{H,fb}(M,c)}{\partial M}=\frac{\sqrt{c}}{\left(3+c-\sqrt{Mc}\right)^2 2\sqrt{M}}>0\qquad (A.3.2)$$

Additionally, $\alpha^{H,fb}$ is strictly concave in M if c is sufficiently low (i.e., for values of c close to zero) and strictly convex if c is large enough (for example, for $c \geq 0.6$).

$$\frac{\partial^2\alpha^{H,fb}(M,c)}{\partial M^2}=\frac{\sqrt{c}\left(3\sqrt{Mc}-3-c\right)}{\left(3+c-\sqrt{Mc}\right)^3 4M^{1.5}}>\frac{\sqrt{c}\left(3\sqrt{2c+c^2}-3-c\right)}{\left(3+c-\sqrt{Mc}\right)^3 4M^{1.5}}\qquad (A.3.3)$$

The inequality in (A.3.3) results because M in the numerator is replaced by $M^{Min} = 2 + c$.

We next calculate the difference between the critical values $\alpha^{H,fb}$ and $\alpha^{H,sb}$.

$$\alpha^{H,fb}(M)-\alpha^{H,sb}(M)=\frac{1}{3+c-\sqrt{cM}}-\frac{2M(1+c)}{(2+c)^3+M(2-c^2)}$$

$$=\frac{(2+c)^3+M(2-c^2)-2M(1+c)(3+c)+2M(1+c)\sqrt{cM}}{\left((2+c)^3+M(2-c^2)\right)\left(3+c-\sqrt{cM}\right)}$$

$$= \frac{(2+c)^3 - M(4+8c+3c^2) + 2M^{1.5}(1+c)\sqrt{c}}{\left((2+c)^3 + M(2-c^2)\right)\left(3+c-\sqrt{cM}\right)} \qquad (A.3.4)$$

This sign of this difference depends on the sign of the numerator of equation (A.3.4), labelled $\Delta(M)$, and is positive for $M^{Min} = 2 + c$.

$$\Delta(M)_{|M=M^{Min}} = (2+c)^3 - (2+c)(4+8c+3c^2) + 2(2+c)^{1.5}(1+c)\sqrt{c}$$

$$= (2+c)2\left[\sqrt{2+c}(1+c)\sqrt{c} - c(2+c)\right]$$

$$= (2+c)2\left[\sqrt{2c+5c^2+4c^3+c^4} - \sqrt{4c^2+4c^3+c^4}\right] > 0 \qquad (A.3.5)$$

$\alpha^{H,sb}(M)$ and $\alpha^{H,fb}(M)$ attain their maximum of unity at M = M^{Max}, such that $\Delta(M^{Max}) = 0$.

$$\alpha^{H,sb}(M,c) = 1 \Rightarrow 2M(1+c) = (2+c)^3 + M(2-c^2) \Rightarrow M^{Max} = \frac{(2+c)^2}{c} \qquad (A.3.6)$$

$$\alpha^{H,fb}(M,c) = 1 \Rightarrow 3 + c - \sqrt{c}\sqrt{M} = 1 \Rightarrow M^{Max} = \frac{(2+c)^2}{c} \qquad (A.3.7)$$

Moreover, the difference $\Delta(M)$ is increasing in M at $M = M^{Max}$.

$$\frac{d\Delta(M)}{dM}_{|M=M^{Max}} = 3\sqrt{M^{Max}}(1+c)\sqrt{c} - (4+8c+3c^2)$$

$$= 3(2+c)(1+c) - (4+8c+3c^2) = 2 + c > 0 \qquad (A.3.8)$$

To summarise: For M = M^{Min}, we have $\alpha^{H,fb}(M^{Min}) - \alpha^{H,sb}(M^{Min}) > 0$. Furthermore, the critical values $\alpha^{H,fb}(M)$ and $\alpha^{H,sb}(M)$ increase in M, and $\alpha^{H,sb}(M)$ is strictly concave in M. In addition, we know that $\alpha^{H,fb}(M)$ = $\alpha^{H,sb}(M)$ for $M^{Max} = (2+c)^2/c$, and that $\alpha^{H,fb}(M) - \alpha^{H,sb}(M) < 0$ for M < M^{Max} and $\alpha^{H,fb}(M) - \alpha^{H,sb}(M) > 0$ for M > M^{Max}. Thus, the critical value in a second-best setting is higher than the critical value in a first-best framework for a range of values of M, M^{Min} < M < M^{Max}.

If we assume c = 1 and solve equation (A.3.4) for $M^{Min} = 2 + c = 3$, $\alpha^{H,fb}(M^{Min}) - \alpha^{H,sb}(M^{Min}) = 0.441 - 0.4 > 0$. The difference becomes zero at about M = 3.69 ($\alpha^{H,fb}(3.69) \approx \alpha^{H,sb}(3.69) \approx 0.481$) and remains positive for all M > 3.69 and less than $M^{Max} = 9$. Therefore, $\alpha^{H,fbB}(M) < \alpha^{H,sb}(M)$ holds for 88.5% (= (9 – 3.69)/6) of the feasible values of M.

10.4 Effect of Weight α on the Number of Firms in Second-best Setting

The effect of α on the second-best number of firms, n^{sb}, defined in equation (9), is given by:

$$\frac{dn^{sb}}{d\alpha} = -\frac{\frac{\partial^2 V(n)}{\partial n\, \partial \alpha}}{\frac{\partial^2 V(n)}{\partial n^2}} \tag{A.4.1}$$

Since the denominator of equation (A.4.1) is negative if the second-order condition holds, the sign of the numerator determines the variation in n^{sb}. Its sign is equivalent to that of the derivative of the numerator of equation (9B), denoted by Z, because the denominator of equation (9B) is independent of α.

$$\begin{aligned} Z &= \frac{a^2}{2(1+c+n)^3}\left\{(2+c)(1+c) - n(4+3c) - \frac{(1+c+n)^3}{M}\right\} \\ &< \frac{a^2}{2(1+c+n)^3}\left[2(1-2n) + 3c(1-n) + c^2 - \frac{(2+c)^3}{M^{Max}}\right] \\ &= \frac{a^2}{2(1+c+n)^3}[2(1-2n) + 3c(1-n) + c^2 - 2c - c^2] < 0 \end{aligned} \tag{A.4.2}$$

The inequality sign in (A.4.2) is due to the substitution of the last term in curly brackets by $2 + c \leq 1 + c + n$, and M in the denominator by the largest possible value $M^{Max} = (2+c)^2/c$.

10.5 Stackelberg-extension with Quadratic Costs

Output Levels

Comparing equations (22) and (23) clarifies that the leader produces a higher quantity than a follower.

$$q_L(n_S) - q_S(n_S) = \frac{a(1+c)}{Z(n_S)} - \frac{a}{1+c+n_S}\left[1 - \frac{1+c}{Z(n_S)}\right] = \frac{an_S}{Z(n_S)(1+c+n_S)} > 0 \tag{A.5.1}$$

The aggregate quantity, defined in equation (24), rises in the number of followers, n_S.

$$\begin{aligned} \frac{dQ_S(n_S)}{dn_S} &= \frac{-a}{(1+c+n_S)^2}\left[n_S + \frac{(1+c)^2}{Z(n_S)}\right] + \frac{a}{1+c+n_S}\left[1 - \frac{c(1+c)^2}{\left(Z(n_S)\right)^2}\right] \\ &= \frac{a(1+c)[(n_S)^2c^2 + (1+c)^2(2+c(2+c+2n_S)]}{(1+c+n_S)^2\left(Z(n_S)\right)^2} > 0 \end{aligned} \tag{A.5.2}$$

Number of Followers

We compute the number of followers in market equilibrium by combining equations (23) and (7).

$$q_S(n_S) = \frac{a}{1 + c + n_S}\left[1 - \frac{1 + c}{Z(n_S)}\right] = \sqrt{\frac{2F}{2 + c}} = q_S^* \tag{A.5.3}$$

Substituting for $Z(n_S)$ and using M := $a^2/(2F) > 2 + c$, we rewrite equation (A. 5.3) as:

$$(1 + c)^2 + cn_S = \frac{(1 + c + n_S)((2 + c)(1 + c) + cn_S)}{\sqrt{M}\sqrt{2 + c}} \tag{A.5.4}$$

Simplification of equation (A. 5.4) yields:

$$\frac{(1 + c)^2}{c}\left(\sqrt{M}\sqrt{2 + c} - (2 + c)\right) + \left(\frac{(1 + c)^2}{c} - \frac{\sqrt{M}\sqrt{2 + c}}{2}\right)^2$$

$$= (n_S)^2 + 2n_S\left(\frac{(1 + c)^2}{c} - \frac{\sqrt{M}\sqrt{2 + c}}{2}\right) + \left(\frac{(1 + c)^2}{c} - \frac{\sqrt{M}\sqrt{2 + c}}{2}\right)^2 \tag{A.5.5}$$

Applying the binomial formula to the right-hand side of equation (A. 5.5) and simplifying its left-hand side, we arrive at:

$$n_S + \frac{(1 + c)^2}{c} - \sqrt{\frac{M(2 + c)}{4}} = \mp\sqrt{\frac{M(2 + c)}{4} + \frac{(1 + c)^2}{c^2}} \tag{A.5.6}$$

Since the expression under the square root on the right-hand side of equation (A.5.6) exceeds the term in magnitude, which is deducted on the left-hand side, a positive number of followers requires the right-hand side of equation (A.5.6) to be positive. Solving equation (A.5.6), we obtain equation (26).

To compare the number of firms in market equilibrium in a Stackelberg-setting, $n_S^* + 1$, with the number of entrants in a Cournot-world, we deduct equation (6) from equation (26):

$$n_S^* + 1 - n^* = \sqrt{\frac{M(2 + c)}{4} + \frac{(1 + c)^2}{c^2}} - \frac{(1 + c)^2}{c} + \frac{\sqrt{M}\sqrt{2 + c}}{2} + 1 - \sqrt{M}\sqrt{2 + c} + (1 + c)$$

$$= \sqrt{\frac{M(2 + c)}{4} + \frac{1 + 2c + c^2}{c^2}} - \sqrt{\left(\frac{\sqrt{M}\sqrt{2 + c}}{2} + \frac{1}{c}\right)^2}$$

$$= \sqrt{\frac{M(2+c)}{4} + \frac{1}{c^2} + \frac{2+c}{c}} - \sqrt{\frac{M(2+c)}{4} + \frac{\sqrt{M}\sqrt{2+c}}{c} + \frac{1}{c^2}} < 0 \qquad (A.5.7)$$

Since M > 2 + c, there is more entry in a Cournot-oligopoly in market equilibrium than in a Stackelberg-setting, and we have $n_S^* < n^* - 1$.

Entry in a First-best setting

To compare the number of firms in market equilibrium, n_S^*, to the first-best number, $n_S^{fb}(\alpha = 0.5)$, we, first, utilise the feature that output of each follower is independent of their number in market equilibrium. Second, we compare aggregate output in market equilibrium to the hypothetical output that leader and followers would produce if the number of followers equalled $n^{fb}(\alpha = 0.5) - 1$. If $Q_S\left(n^{fb}(\alpha = 0.5) - 1\right) < Q_S^*$, the equilibrium number of followers exceeds $n^{fb}(\alpha = 0.5) - 1$, as aggregate output rises in their number (see equation (A.5.2)).

Aggregate output at $q_S = \sqrt{2F/(2+c)}$, assuming that there are $n^{fb}(\alpha = 0.5) - 1$ followers, and using q_L from equation (22), is given by:

$$Q_S\left(n^{fb}(\alpha = 0.5) - 1\right) = \left(n^{fb}(\alpha = 0.5) - 1\right)\sqrt{\frac{2F}{2+c}} + \frac{a(1+c)}{Z(n^{fb}(\alpha = 0.5) - 1)}$$

$$= \left(\frac{a}{\sqrt{2F}}\sqrt{c} - (1+c)\right)\sqrt{\frac{2F}{2+c}} + \frac{a(1+c)}{Z(n^{fb}(\alpha = 0.5) - 1)}$$

$$= a\sqrt{\frac{c}{2+c}} - (1+c)\sqrt{\frac{2F}{2+c}} + \frac{a(1+c)}{Z(n^{fb}(\alpha = 0.5) - 1)} \qquad (A.5.8)$$

Using equation (24), and $A_S \coloneqq c\left(n^{fb}(\alpha = 0.5) - 1\right)\left(\sqrt{c} - \sqrt{2+c}\right) < 0$, we have:

$$Q_S\left(n^{fb}(\alpha = 0.5) - 1\right) - Q_S(n_S^*)$$

$$= \frac{a}{Z(n^{fb}(\alpha = 0.5) - 1)\sqrt{2+c}}\left[(1+c)\sqrt{2+c} - (\sqrt{2+c} - \sqrt{c})Z(n^{fb}(\alpha = 0.5) - 1)\right]$$

$$= \frac{a}{Z(n^{fb}(\alpha = 0.5) - 1)\sqrt{2+c}}\Big[\sqrt{c}(2+c)(1+c) + \sqrt{c}c\left(n^{fb}(\alpha = 0.5) - 1\right) + (1+c)\sqrt{2+c}$$
$$- c(n^{fb}(\alpha = 0.5) - 1)\sqrt{2+c} - \sqrt{2+c}(2+c)(1+c)\Big]$$

$$= \frac{a}{Z(n^{fb}(\alpha = 0.5) - 1)\sqrt{2 + c}} \left[\frac{(1 + c)}{\sqrt{c}} \left[c(2 + c) - \sqrt{c}\sqrt{2 + c}(1 + c) \right] + A_S \right]$$

$$= \frac{a}{Z(n^{fb}(\alpha = 0.5) - 1)\sqrt{2 + c}} \left[\frac{(1 + c)}{\sqrt{c}} \left[\left(\sqrt{2c + c^2}\right)^2 - (1 + c)\sqrt{2c + c^2} \right] + A_S \right]$$

$$= a(1 + c) \frac{\underbrace{\left[\sqrt{2c + c^2} - \sqrt{1 + 2c + c^2}\right]}_{(-)} + \underbrace{\frac{A_S}{(1 + c)\sqrt{2 + c}}}_{(-)}}{\underbrace{Z(n^{fb}(\alpha = 0.5) - 1)}_{(+)}} < 0 \qquad \text{(A.5.9)}$$

Therefore, output would be lower if there were $n^{fb}(\alpha = 0.5) - 1$ followers than the output in market equilibrium. In consequence, $n^{fb}(\alpha = 0.5) < n_S^* + 1$ holds.

10.6 Second-best Stackelberg-setting with Linear Costs

To solve the Stackelberg-model with linear costs, we proceed in the same manner as for the setting with quadratic costs. For simplicity, we use the same notation.

Profits, π_{Sj}, of follower j read:

$$\pi_{Sj} = \left(a - q_{Sj} - Q_{S\_j} - q_L - c\right)q_{Sj} - F \qquad \text{(A.6.1)}$$

Assuming symmetry, each follower produces:

$$q_S(n_S) = \frac{a - c - q_L}{1 + n_S} \qquad \text{(A.6.2)}$$

Maximisation of the leader's profits, $\pi_L = (a - n_S q_S(q_L) - q_L - c)q_L - F$, results in an output level, which is independent of the number of followers.

$$q_L^* = \frac{a - c}{2} \qquad \text{(A.6.3)}$$

Therefore, the aggregate quantity equals:

$$Q_S(n_S) = q_L^* + n_S \frac{a - c}{2(1 + n_S)} = \frac{(a - c)(1 + 2n_S)}{2(1 + n_S)} \qquad \text{(A.6.4)}$$

Employing the above information, we can calculate the profit levels, consumer surplus and the competition authority's objective, V, as functions of the number of firms, n_S, as well as the number of followers, n_S^*, in market equilibrium.

$$\pi_S(n_S) = (a - Q_S(n_S) - c)q_S(n_s) - F = \frac{(a - c)^2}{4(1 + n_S)^2} - F \qquad \text{(A.6.5)}$$

$$\pi_S(n_S) = 0 \Rightarrow n_S^* = \frac{a-c}{2\sqrt{F}} - 1 \quad \text{(A.6.6)}$$

$$\pi_L(n_S) = (a - Q_S(n_S) - c)q_L^* - F = \frac{(a-c)^2}{4(1+n_S)} - F \quad \text{(A.6.7)}$$

$$\frac{(Q_S(n_S))^2}{2} = \frac{(a-c)^2(1+2n_S)^2}{8(1+n_S)^2} \quad \text{(A.6.8)}$$

$$\begin{aligned} V(n_S) &= \alpha[n_S\pi_S(n_S) + \pi_L(n_S)] + (1-\alpha)\frac{(Q_S(n_S))^2}{2} \\ &= \alpha\left[\frac{(a-c)^2(1-4(n_S)^2)}{8(1+n_S)^2} - (1+n_S)F\right] + \frac{(a-c)^2(1+2n_S)^2}{8(1+n_S)^2} \end{aligned} \quad \text{(A.6.9)}$$

The derivatives of $V(n_S)$ are:

$$\frac{\partial V(n_S)}{\partial n_S} = -\alpha\left[\frac{(a-c)^2(1+4n_S)}{4(1+n_S)^3} + F\right] + \frac{(a-c)^2(1+2n_S)}{4(1+n_S)^3} \quad \text{(A.6.10)}$$

$$\frac{\partial^2 V(n_S)}{\partial n_S^2} = \alpha\frac{(a-c)^2(1-8n_S)}{4(1+n_S)^8} - \frac{(a-c)^2(1+4n_S)}{4(1+n_S)^4} < 0 \quad \text{(A.6.11)}$$

Setting the first-order derivative in (A. 6.10) equal to zero, evaluating it at the zero-profit level of followers, and solving the resulting expression for α, we obtain:

$$0.4 < \alpha^{L,sb} = \frac{1+2n_S^*}{2+5n_S^*} = \frac{2\frac{a-c}{2\sqrt{F}} - 1}{5\frac{a-c}{2\sqrt{F}} - 4} < \frac{3}{7}, \quad \text{(A.6.12)}$$

The upper bound is obtained by noting that $\alpha^{L,sb}$ declines in n_S^* and assuming $n_S^* = 1$. Since $\alpha^{L,sb} < 0.5$, there is excessive entry. Evaluating the derivative in (A. 6.10) at $n_S = 0$, we find that the resulting expression is negative for any α exceeding

$$\alpha^{H,sb} = \frac{(a-c)^2}{(a-c)^2 + 4F}. \quad \text{(A.6.13)}$$

Since a leader is profitable if $(a-c)^2 > 4F$ (see equation (A.6.7)), $\alpha^{H,sb} > 0.5$ under this restriction.

10.7 Cost Heterogeneity

The first-order condition for a maximum of $\pi_{ji}(q_{ji}) = (a - Q_d)q_{ji} - 0.5c_i(q_{ji})^2 - F$ is:

$$\frac{\partial \pi_{ji}}{\partial q_{ji}} = -q_{ji} + a - Q_d - c_i q_{ji} = 0 \tag{A.7.1}$$

Because all firms that face the same costs behave identically, we can solve equation (A. 7.1) for the reaction functions of firms of each type:

$$q_l(q_h, n_d) = \frac{2a - n_d q_h}{2 + n_d + 2(c - \varepsilon)} \quad \text{and} \quad q_h(q_l, n_d) = \frac{2a - n_d q_l}{2 + n_d + 2(c + \varepsilon)} \tag{A.7.2}$$

Combining these equations, equilibrium outputs by both types of firms and in aggregate can be computed as functions of the number of firms, n_d:

$$q_l^*(n_d) = \frac{a(1 + c + \varepsilon)}{(1 + n_d + c)(1 + c) - \varepsilon^2} \tag{A.7.3}$$

$$q_h^*(n_d) = \frac{a(1 + c - \varepsilon)}{(1 + n_d + c)(1 + c) - \varepsilon^2} \tag{A.7.4}$$

$$Q_d^*(n_d) = \frac{n_d}{2}\left(q_l^*(n_d) + q_h^*(n_d)\right) = \frac{n_d a(1 + c)}{(1 + n_d + c)(1 + c) - \varepsilon^2} \tag{A.7.5}$$

Using equation (27), as well as equations (A.7.3) to (A.7.5), expected profits can be computed as in equation (29).

The first-order conditions for a maximum of V_{n^d} in a first-best setting are:

$$\frac{\partial V_d}{\partial n^d} = 0$$

$$\Rightarrow V_{n^d} \coloneqq \alpha\left(a - 2Q_d - \frac{(c - \varepsilon)q_l^2}{2(q_l + q_h)} - \frac{(c + \varepsilon)q_h^2}{2(q_l + q_h)} - \frac{2F}{q_l + q_h}\right) + (1 - \alpha)Q_d = 0 \tag{A.7.6}$$

$$\frac{\partial V_d}{\partial q_l} = 0 \Rightarrow V_{q_l} \coloneqq \alpha(a - 2Q_d - (c - \varepsilon)q_l) + (1 - \alpha)Q_d = 0 \tag{A.7.7}$$

$$\frac{\partial V_d}{\partial q_h} = 0 \Rightarrow V_{q_h} \coloneqq \alpha(a - 2Q_d - (c + \varepsilon)q_h) + (1 - \alpha)Q_d = 0 \tag{A.7.8}$$

We assume that the first-order conditions characterise a maximum of V_{n^d}.[20] Combining equations (A. 7.7) and (A. 7.8) demonstrates that the competition authority chooses output levels so that marginal costs are equalised across both types of firms.

[20] The second-order derivatives are:

$$V_{n^d n^d} = V_{q_l n^d} = V_{q_h n^d} = (1 - 3\alpha)\frac{q_l + q_h}{2}$$

$$V_{n^d q_l} = \alpha\left(-n^d - \frac{(c - \varepsilon)q_l(2q_h + q_l)}{2(q_l + q_h)^2} + \frac{(c - \varepsilon)q_h^2}{2(q_l + q_h)^2} + \frac{2F}{(q_l + q_h)^2}\right) + (1 - \alpha)n^d$$

$$(c-\varepsilon)q_l = (c+\varepsilon)q_h \tag{A.7.9}$$

Combining equations (A. 7.6) and (A. 7.7) yields:

$$(c-\varepsilon)q_l = \frac{(c-\varepsilon)q_l^2}{2(q_l+q_h)} + \frac{(c+\varepsilon)q_h^2}{2(q_l+q_h)} + \frac{2F}{q_l+q_h} \tag{A.7.10}$$

Substituting in equation (A.7.10) in accordance with (A.7.9), we obtain:

$$q_l^{fb} = \sqrt{\frac{4F(c+\varepsilon)}{2c(c-\varepsilon)}} > q^{fb} > q_h^{fb} = \sqrt{\frac{4F(c-\varepsilon)}{2c(c+\varepsilon)}} \tag{A.7.11}$$

To calculate the number of firms, we substitute equation (A.7.11) into equation (A.7.8) and utilise the feature that $Q_d = 0.5n_d(q_l + q_h) = 0.5n_d\big((c+\varepsilon)q_h/(c-\varepsilon) + q_h\big)$. This yields equation (36).

$$V_{n^d q_h} = \alpha\left(-n^d + \frac{(c-\varepsilon)q_l^2}{2(q_l+q_h)^2} - \frac{(c+\varepsilon)q_h(2q_l+q_h)}{2(q_l+q_h)^2} + \frac{2F}{(q_l+q_h)^2}\right) + (1-\alpha)n^d$$

$$V_{q_l q_l} = 0.5n^d(1-3\alpha) - \alpha(c-\varepsilon);\ V_{q_l q_h} = V_{q_h q_l} = 0.5n^d(1-3\alpha);\ V_{q_h q_h} = 0.5n^d(1-3\alpha) - \alpha(c+\varepsilon)$$

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