Department of Labour Economics

Hochschule der Bundesagentur für Arbeit
University of Applied Labour Studies

HdBA Discussion Papers in Labour Economics

No. 23-01

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Informational Rents and the Excessive Entry Theorem: The Case of Hidden Action*

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Abstract

Entry in a homogeneous Cournot-oligopoly is excessive if there is business stealing. This prediction assumes that production costs reduce profits and welfare equally. However, this need not be the case. If there is asymmetric information, suppliers or employees can utilize their superior knowledge to extract informational rents. Rent payments reduce profits and deter entry, but affect neither the optimal number of firms nor welfare directly. Therefore, entry becomes insufficient if informational rents are large enough. In the context of a moral hazard model, we show that insufficient entry occurs if entry costs are sufficiently high. Such costs lower the number of firms and, thereby, raise informational rents.

Keywords: Oligopoly, excessive entry, informational rents, moral hazard

JEL Classification: D43, D82, L51

Declarations

Funding: The authors received no financial support for the research.

Conflicts of Interests: There are no conflicts of interest.

Data Availability: Does not apply.

*We are grateful for helpful comments by Clemens Buchen, David Genesove, Jörg Lingens, Jochen Michaelis, Catia Montagna, Patrick Rey, Nicolas Schutz, John Skåtun, and participants of a seminar at the University of Aberdeen, the 2020 annual congress of the Verein für Socialpolitik, the workshop on Applied Microtheory in Marburg in 2021 and the 2022 EARIE Annual Conference.

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1 Introduction

Modern economies are characterized by two features, among others: Oligopolies are the predominant market structure and staff are often paid based on performance due to informational frictions in the employer-employee relationship. Head and Spencer (2017) show, for instance, that "oligopoly is a robust characteristic of a broad set of industries in the US and around the world" (p. 1423). De Loecker et al. (2020) find evidence that price mark-ups in the US have risen substantially in the past 40 years, driven in particular by firms with relatively large market power, which supports the idea that oligopolies have become more significant. There is also strong empirical evidence for the existence of performance related pay schemes. Lemieux et al. (2009) document that between 30% and almost 80% of employees are paid according to a variable incentive scheme. Bryson et al. (2013) state that the percentage of performance related payments varies between $10 - 15\%$ in Europe and 40% in Scandinavia and the US. One implication of these two stylized facts is that oligopolists will also use performance pay schemes, a claim that is supported by anecdotal evidence. For instance, the automotive and insurance industries have an oligopolistic structure and both feature performance related payments.[1]

The consequences of oligopolies' market power have been studied intensively. In this context, it is well established not only that output choices are usually distorted, but that the decision to take up production also is. In particular, in a homogeneous Cournot oligopoly there is excessive entry in the presence of business stealing, i.e., if taking up production reduces an incumbent's output (see Mankiw and Whinston (1986), Perry (1984), Suzumura and Kiyono (1987), and von Weizsäcker (1980)). These and most subsequent analyses assume that the costs of inputs reflect the welfare-reducing use of resources. If labor constitutes the relevant input, this assumption is tantamount to a wage payment equal to the opportunity costs of labor. However, as indicated above, many firms use remuneration schemes based on performance. One reason for this is the inability to observe employees' behavior at the workplace. Labor contracts can then only

[1] Market analyses for Germany have e.g. shown that the automotive industry is dominated by a few relatively large companies, with the Volkswagen Group as the largest one in terms of revenues in 2021. A similar conclusion has been made for the insurance industry, where the Allianz Group dominated the market in 2019 (see Statista (2022a,b)).

base remuneration on verifiable output and include informational rent payments. In the presence of such informational rents, production costs partly constitute transfers that do not result in a welfare-reducing use of resources. This begs the question of how the excessive entry theorem is affected by the existence and magnitude of informational rents.

To investigate this issue, we employ a model à la Mankiw and Whinston (1986): Firms incur fixed costs of market entry, produce a homogeneous good and compete in quantities, taking the behavior of other oligopolistic firms as given. We extend this framework by introducing informational rent payments. Initially, we assume their existence, in order to highlight the main mechanisms at work. Subsequently, we focus on the employer-employee relationship to gain further insights. Employees as agents have better knowledge than the employer, the principal, about the state of the world and their productive activities. This gives rise to the possibility of hidden actions. In consequence, the principal pays a salary and an informational rent to ensure that a financially constrained worker accepts the contract offer.

Our main result is that informational rents can invalidate the excessive entry theorem. Rent payments reduce profits and deter entry in market equilibrium. From a welfare perspective, however, informational rents constitute a transfer that does not affect the (second-best) optimal number of firms. This rent channel competes with the business-stealing externality, which, in isolation, causes excessive entry. If the informational rent is sufficiently large, it will overcompensate the business-stealing externality, and entry will be insufficient. In the presence of both effects – the business stealing externality and the well-known rent-efficiency trade-off – we establish that the number of firms in market equilibrium necessarily lowers the magnitude of informational rents. This reflects the competing contract effect, originally derived for adverse selection problems (see Martimort (1996)). As such, mitigating the competing contract effect by reducing the number of firms and raising rents increases, ceteris paribus, the probability of insufficient entry. In the context of the employer-employee relationship, we further show that if entry costs exceed a well-defined threshold, the number of firms will be sufficiently low to create an informational rent, which is high enough to outweigh the business-stealing externality, implying insufficient entry.

Our paper is primarily related to studies of the robustness of the excessive entry theorem in the presence of vertical relationships. Basak and Mukherjee (2016), Ghosh and Morita (2007a,b) and Mukherjee (2009), for instance, consider settings with upstream and downstream markets. Firms in at least one of these markets are Cournot-oligopolists and decide on market entry. If firms in the other market can charge a price above marginal costs, that is, if they have market power, while two-part tariffs are infeasible, additional entry by oligopolists creates profits in the other markets which the entrant does not take into account. This is the so-called business creation effect (Basak and Mukherjee (2016), Ghosh and Morita (2007a)), which is analytically equivalent to the impact of a rent payment and sometimes also interpreted in this way (see Antelo and Bru (2006) and Ghosh and Morita (2007a)). Bonazzi et al. (2021) provide a micro-foundation for the inability of the upstream firm to extract all the downstream firms' surplus by assuming that the latters' profits depend on unobservable effort and the realization of a demand parameter. They show that limitations on the upstream firms' pricing behavior influence the magnitude of rent payments and thereby the extent of entry. Therefore, asymmetric information gives rise to rents in the context of a free-entry Cournot oligopoly. In contrast to our setting with asymmetric information, in Bonazzi et al. (2021) rents emerge because of imperfectly competitive markets for the products sold from upstream to downstream firms. Moreover, all agents pursue the same objective. Consequently, the rent effect on market entry could be overcome by integrating firms.

This mechanism to internalize the rent effect is not feasible in settings in which upstream and downstream agents have different, and possibly conflicting, objectives. In de Pinto and Goerke (2020) and Marjit and Mukherjee (2013), trade unions and Cournot-oligopolists bargain over the division of the surplus. Effectively, the trade union represents the upstream agent. If workers are remunerated in excess of their reservation wage, firms pay them rents which may give rise to insufficient entry. While such outcomes are due to rent payments within firms, they do not rely on the existence of asymmetric information.[2]

[2]There are other contributions integrating labor into Cournot-models with free entry. Mukherjee and Tsai (2014) consider a management delegation model, such that only a fraction of the firm's costs affect the manager's output choice. Since a zero-profit constraint governs entry and production costs reduce welfare, there is no rent impact on entry. de Pinto and Goerke (2019) investigate a world with efficiency wages. Once again, rent payments play no role and efficiency wages even aggravate excessive entry. Finally, Mukherjee (2013) analyses a setting in which a foreign firm with lower marginal costs

In summary, rent payments may invalidate the excessive entry theorem. While our paper reaches a similar conclusion, the source of the rent is fundamentally different, since it stems from informational asymmetries within the firm. In consequence, resulting inefficiencies cannot be avoided by integrating firms. Therefore, our main contribution is to clarify how standard features of the production process, namely asymmetric information between those individuals who decide on market entry and those who determine output, can invalidate the excess-entry prediction.

Our analysis is also related to papers that investigate the consequences of asymmetric information in settings with oligopolistic output markets. For the adverse selection case, Martimort (1996), Piccolo (2011), Etro and Cella (2013) and de Pinto et al. (2023) take this aspect into account. A study which includes moral hazard in a competitive duopoly market is Bénabou and Tirole (2016). In contrast to these studies, we are interested in the effect on entry and, therefore, assume that the free-entry condition endogenously determines the number of competitors.

The remainder of our paper is structured as follows: In Section 2, we build up our model and show how informational rents generically affect or reverse the excessive entry result. In Section 3, we explicitly model the employer-employee relationship and provide more insights about the determinants of insufficient entry. Section 4 concludes the paper.

2 A General Framework

2.1 Model

We consider an oligopoly with n, $n > 1$, symmetric firms, indexed by $i \in \{1, 2, ..., n\}$, which sell a homogeneous good and compete in quantities q_i. Inverse demand $P(Q)$, $P'(Q) < 0$, is log-concave, with Q denoting total output. In a Cournot-Nash setting, each firm takes the behavior of the remaining $(n-1)$ firms and their output $Q_{-i} = \sum_{j \neq i}^{n} q_j$ as given.

A firm's costs consist of three components: Variable production costs $c(q_i)$, $c'(q_i) \geqslant 0$,

competes with domestic oligopolists that face a monopoly trade union. Mukherjee (2013) investigates the consequences of a trade cost reduction on wages and entry in market equilibrium.

entry costs F, which are sunk, and non-negative informational rent payments $\Omega(q_i)$. The first two cost components describe the value of resources used in production and, ceteris paribus, reduce welfare. Rent payments, however, constitute a transfer and are, ceteris paribus, welfare-neutral. In this section, we do not explicitly model the source of the rent and assume that it depends positively on q_i, $\Omega'(q_i) > 0$. This dependence on the firm's quantity, first, enables us to directly relate the subsequent investigation of the excessive entry prediction to the analysis of the set-up involving a moral hazard problem. Second, it captures the well-known rent-efficiency trade-off (see e.g., Laffont and Martimort (2002)). Third, the specification of the rent can easily be extended to include further determinants, without altering our basic results.[3]

Profits π_i of firm i are

$$\pi_i(q_i, Q_{-i}, F) = P(Q_{-i} + q_i)q_i - c(q_i) - \Omega(q_i) - F. \tag{1}$$

Welfare W is defined as the difference between the consumers' willingness to pay for the commodity and the value of the resources used in the production process (Amir et al. (2014), Mankiw and Whinston (1986), von Weizsäcker (1980)). In our setting, it equals the sum of total profits, $\sum_{i=1}^{n} \pi_i$, consumer surplus, CS, and total rents, $\sum_{i=1}^{n} \Omega(q_i)$. Consumer surplus increases in quantity and is defined by

$$CS(Q) = \int_0^Q P(\check{Q})d\check{Q} - P(Q)Q. \tag{2}$$

We analyze two different settings. In market equilibrium, the number of firms is determined by the free-entry condition $\pi_i(q_i, Q_{-i}, F) = 0$. In the (second-best) optimum, a social planner maximizes welfare W by choosing the number of competitors, taking as given the firms' quantity decisions.[4] Therefore, the timing is as follows:

1. Firms enter the market, either by their own decision (market equilibrium) or according to the decision of the planner (social optimum).

[3] The rent could, for example, vary with output market characteristics or choices by competitors, i.e., aggregate output. In the latter case, the entry-deterring impact of informational rents would, for example, rise with the output of other firms if rent payments were an increasing function of total output.

[4] Like many others (see Seade (1980), Ghosh and Morita (2007a,b)), we ignore the integer constraint.

2. Firms choose quantities (Cournot-Nash setting).

3. Payments are made and profits are realized.

2.2 Solution

The firm's first-order condition reads

$$\frac{\mathrm{d}\pi_i(q_i, Q_{-i}, F)}{\mathrm{d}q_i} = P'(Q)q_i + P(Q) - c'(q_i) - \Omega'(q_i) = 0. \tag{3}$$

We follow Amir and Lambson (2000), Amir et al. (2014) and Polo (2018), and assume that the derivative of the first-order condition (3) with respect to the firm's output, holding constant aggregate output, is negative.[5] The restriction

$$\Delta(q_i, Q) \equiv -P'(Q) + c''(q_i) + \Omega''(q_i) > 0, \tag{4}$$

together with log-concavity of the inverse demand function, ensures, first, the second-order condition and, second, a unique symmetric equilibrium (see Amir and Lambson (2000), Theorem 2.3.).[6]

For notational convenience, we suppress subscripts in the following. Moreover, $q_i = q(n)$ and $\mathrm{d}q/\mathrm{d}n < 0$ hold (see Polo (2018)). The inequality $\mathrm{d}q/\mathrm{d}n < 0$ indicates business-stealing, i.e., firm entry reduces output and, therefore, revenues of the incumbents. We denote the number of firms in market equilibrium, which is determined by $\pi(n^e, F) = 0$,

[5] It can be shown that this is equivalent to the assumption that the cross partial derivative of profits with respect to Q and Q_{-i} is positive (Amir and Lambson (2000)).

[6] To explicitly prove that the second-order condition holds, we compute the second derivative as

$$\frac{\mathrm{d}^2\pi_i(q_i, Q_{-i}, F)}{\mathrm{d}q_i^2} = P''(Q)q_i + P'(Q) - \Delta(q_i, Q).$$

If $P''(Q) < 0$, the second-order condition is fulfilled, given the assumptions $P'(Q) < 0$ and $\Delta(q_i, Q) > 0$. The same finding results for $P''(Q) \geqslant 0$. Using (3), we obtain

$$q_i = -\frac{P(Q) - c'(q_i) - \Omega'(q_i)}{P'(Q)},$$

which leads to

$$P''(Q)q_i + P'(Q) = -P''(Q)\frac{P(Q) - c'(q_i) - \Omega'(q_i)}{P'(Q)} + P'(Q) < -P''(Q)\frac{P(Q)}{P'(Q)} + P'(Q) \leqslant 0.$$

The last inequality holds because of the log-concavity of $P(Q)$.

as $n^e(F)$, where the superscript e indicates an equilibrium outcome.

The maximization problem of the social planner reads $\max_n W(n,F) = n\pi(n,F) + CS(n) + n\Omega(n)$. The socially optimal number of entrants is then implicitly defined by the first-order condition

$$\begin{aligned}\frac{\mathrm{d}W(n,F)}{\mathrm{d}n} &= \pi(n,F) + n\frac{\mathrm{d}\pi(n,F)}{\mathrm{d}n} + \frac{\mathrm{d}CS(n)}{\mathrm{d}n} + \Omega(n) + n\frac{\mathrm{d}\Omega(n)}{\mathrm{d}n} \\ &= \pi(n,F) + n(P(Q(n)) - c'(q))\frac{\mathrm{d}q}{\mathrm{d}n} + \Omega(n) = 0,\end{aligned} \tag{5}$$

where the second summand in the second line of (5) is negative, because the price exceeds marginal production costs if firms choose quantities [see the first-order condition (3)].[7]

2.3 Informational Rents and the Excessive Entry Theorem

Evaluating the derivative in (5) at n^e, we obtain

$$\left.\frac{\mathrm{d}W(n,F)}{\mathrm{d}n}\right|_{n=n^e} \equiv Z = n^e \underbrace{\left[P(Q(n^e)) - c'(q(n^e))\right]}_{>0} \underbrace{\frac{\mathrm{d}q}{\mathrm{d}n}}_{<0} + \Omega(n^e). \tag{6}$$

The first summand in (6) measures the magnitude of the business stealing externality, denoted by BS.

Therefore, entry will be insufficient if

$$Z > 0 \Leftrightarrow \Omega(n^e) > \underbrace{-n^e \left[P(Q(n^e)) - c'(q(n^e))\right] \frac{\mathrm{d}q}{\mathrm{d}n}}_{BS(n^e)} > 0 \tag{7}$$

and excessive if $Z < 0$.[8] This yields:

[7]The second-order condition is assumed to be fulfilled. Differentiating W twice w.r.t. n, we obtain

$$\frac{\mathrm{d}^2 W}{\mathrm{d}n^2} = \underbrace{(P(nq) - c'(q))}_{>0} \underbrace{\left(2\frac{\mathrm{d}q}{\mathrm{d}n} + n\frac{\mathrm{d}^2 q}{\mathrm{d}n^2}\right)}_{X} + \left(q + n\frac{\mathrm{d}q}{\mathrm{d}n}\right)^2 P'(nq) - nc''(q)\left(\frac{\mathrm{d}q}{\mathrm{d}n}\right)^2.$$

Given the business stealing effect ($\mathrm{d}q/\mathrm{d}n < 0$) and a convex cost function, either a concave (individual) output in n ($\mathrm{d}^2q/\mathrm{d}n^2 \leqslant 0$) or a relatively not too convex one – i.e., $X := \mathrm{d}^2Q(n)/\mathrm{d}n^2 = \mathrm{d}^2(nq(n))/\mathrm{d}n^2$ is relatively small – ensure strict concavity of W. Alternatively, as in Ohkawa and Okamura (2003), restrictions on the third derivatives of the demand and costs functions can be assumed.

[8]Equation (7) implicitly defines a threshold level of the number of firms below which entry will become insufficient. In Section 3, we will provide further details on this condition by using a specific example to generate explicit functional forms. Therefore, we can relate this threshold to entry costs, F.

Proposition 1.

(i) If there are no informational rents, i.e., $\Omega(n^e) = 0$*, entry will be excessive.*

(ii) If there are informational rents, i.e., $\Omega(n^e) > 0$*, entry can be insufficient. This will be the outcome whenever the informational rent exceeds the business stealing externality.*

Proof Proposition 1.

See equation (7). ∎

Part (i) reflects the basic insights derived in the seminal papers by von Weizsäcker (1980), Perry (1984), Mankiw and Whinston (1986), and Suzumura and Kiyono (1987). To provide intuition for part (ii), observe that the magnitude of the informational rent determines the extent to which the resulting fall in profits deters a firm from entering the market. Since the rent payment does not affect the (second-best) welfare-maximizing number of entrants, the difference between the number of firms in market equilibrium and the socially optimal number declines with the rent. If Ω exceeds the magnitude of the business-stealing externality, entry will be insufficient. In the limiting case where both effects balance out, entry is second-best optimal.

As a consequence of the rent-efficiency trade-off and business-stealing, we obtain

$$\frac{\mathrm{d}\Omega}{\mathrm{d}n} = \underbrace{\Omega'(q)}_{>0} \underbrace{\frac{\mathrm{d}q}{\mathrm{d}n}}_{<0} < 0, \tag{8}$$

i.e., the rent is decreasing in the number of firms. This reflects the well-established competing contract effect, described by Martimort (1996) for the case of adverse selection. A decline in the number of competitors, ceteris paribus, raises the magnitude of the informational rent making insufficient entry more likely. If this channel is strong enough to dominate possible repercussions via changes in the magnitude of the business stealing externality, there will eventually be a critical number of competitors below which $Z > 0$ holds, i.e., entry becomes insufficient. If such a threshold exists, any effect which reduces n^e below the critical value contributes to the existence of insufficient entry.

The above analysis of the excess-entry theorem in the presence of informational rent payments has been based on the assumption that the transfer, $n\Omega(n)$, is costless from the society's perspective and, thus, welfare-neutral. However, it could also be assumed that this is only true for a part of the transfers, while some positive fraction of payments $n\Omega(n)$ describes the use of resources. Such a situation could arise if distributing the payment by firms to other members of society cannot be achieved costlessly. Alternatively, the marginal value of money of transfer recipients may be less than that of firms. In such cases, the welfare-maximizing number of firms is affected in two ways. First, since the transfer per firm effectively shrinks, the rent impact declines and excessive entry becomes, ceteris paribus, more likely, relative to the situation without costs of transfers. Second, because firm entry reduces the magnitude of the rent and, therefore, also the costs of transferring resources, excessive entry becomes, ceteris paribus, less likely. We show in Appendix A.1 that Proposition 1 basically continues to hold if part of the transfer does not constitute a rent payment. However, to establish insufficient entry, not only the magnitude of the business-stealing externality and the rent have to be compared. The costs of making transfers and the impact of the change in the number of firms on transfers per firm, $\mathrm{d}\Omega/\mathrm{d}n$, also play a role.

3 An Example: Employer-Employee Relationship

In Section 2, we have interpreted Ω as an informational rent, but there is nothing in its specification which requires the existence of asymmetric information. To give substance to our perspective, we provide an illustrative example and consider the determinants of insufficient entry more thoroughly in this section. We choose the employer-employee relationship since rent payments are then generated within firms, rather than between them, which adds a new perspective to the literature as pointed out in the Introduction.

In general, asymmetric information between an employer and an employee can arise before or after a contract has been signed. In the former case, it is usually assumed that an individual's abilities are their private knowledge (hidden information). In the latter case, workers' behavior cannot be perfectly observed by the firm (hidden action).

In our example, we focus on post-contractual informational frictions, which implies that employers pay informational rents because of moral hazard.[9]

3.1 Model

In our set-up, there are three types of actors: employees (workers), employers (firms), and consumers. As in the general framework, there is an oligopoly with n, $n > 1$, symmetric firms, indexed by $i \in \{1, 2, ..., n\}$. For simplicity, workers are homogeneous and each firm employs one worker.

Production, q_i, of firm i depends on the effort of its worker, e_i, $e_i \in [0, \infty]$, and a random term ϵ_i with zero expected value, $\mathbb{E}[\epsilon_i] = 0$. Therefore, the production function reads $q_i = e_i + \epsilon_i$. Moreover, we assume that uncertainty cancels out in aggregate, i.e., $\sum_{i=1}^{n} \epsilon_i = 0$.[10] The outcome of the production process is observable and verifiable, while effort and the random term are not. Consequently, effort is not contractible and a moral hazard problem arises.

Since our focus is on the consequences of informational asymmetries, firm i implements a linear incentive scheme, $w_i + B_i q_i$, where w_i is a fixed wage and B_i a bonus per unit of output. By choosing w_i and B_i, firm i determines the worker's effort, e_i, and, accordingly, expected output, $\mathbb{E}[q_i]$. Moreover, we assume w.l.o.g. that the firm's variable costs result solely from the incentive scheme. The firm's outside option equals entry costs F.

The utility of a worker employed in firm i equals $u_i = w_i + B_i q_i - K(e_i)$ in realization, where $K(e_i)$ denotes effort costs. We assume that workers are financially constrained, such that $w_i \geqslant 0$ and $w_i + B_i \geqslant 0$. Effort costs, $K(e_i)$, describe the value of resources used in production and, ceteris paribus, lower welfare. They are given by $K(e_i) = e_i^2/(2D)$. The

[9] The employer-employee relationship can also be interpreted as association between a firm's owner and a manager. The firm's owner faces the cost of setting up the production process and delegates managerial activities to an expert (manager). The rent payment constitutes the agency cost arising from the misaligned incentives in a situation with a separation between ownership and control (Jensen and Meckling (1976)).

[10] This assumption implies that the variance of the error terms does not affect expected profits and expected consumer surplus. Therefore, we study a set-up in line with the general framework. Alternatively, we could include the variance of the error terms and assume that the error terms are uncorrelated across firms. In this case, with a linear demand function as we assume below, it is straightforward to see that the variance would decrease the expected producers' surplus (deterring a firm from entering the market), and increase the expected consumer surplus. The result would be that insufficient entry would be more likely to occur with a high variance.

parameter D, $D > 0$, measures ability. Intuitively, a higher ability decreases effort costs and, ceteris paribus, raises utility. As workers have the same ability, the parameter D does not capture heterogeneity but enables us to analyze the effect of different qualification levels of the workforce on the role of informational rent payments for firm entry. Ability, D, is observable to avoid further informational frictions and to isolate the impact of asymmetric information about effort choices.[11] The outside option of each worker is normalized to zero.[12]

Regarding the output market, we mostly retain the assumptions from the general framework. To obtain explicit results, we use a linear demand schedule, i.e., $P(Q) = a - bQ$, $a, b > 0$. Profits of firm i, in realization, can then be expressed as

$$\pi_i = (a - bQ_{-i} - bq_i)q_i - w_i - B_i q_i - F. \tag{9}$$

The timing is the same as in Section 2, with the exception that step 2 now has two components:[13]

2a) Firms determine the incentive scheme and post contracts.

2b) Workers accept or reject the contract. In the former case, workers exert effort, in the latter case, both parties obtain their outside options.

The social planner maximizes expected welfare, $\mathbb{E}(W(n))$, which is the sum of expected profits, expected utility, and consumer surplus.[14] This objective is qualitatively the same as analyzed in the general framework. This is the case because expected utility consists of the difference between employee income and effort costs. As the latter describe the value of resources used in the production process, any positive difference between income and effort costs constitutes a rent payment from the firm to its employee. As in the general

[11] Assuming that workers are heterogeneous and abilities are unobservable would imply that firms face an additional pre-contractual (adverse selection) problem. Firms would then pay the additional informational rent to separate types. As a consequence, the magnitude of the informational rent would be more significant, which per se, as from the general set-up, would facilitate obtaining our main result.

[12] We will show below that the expected utility of the workers exceeds the zero outside option, i.e., the worker realizes a rent. Consequently, through the incentive scheme $w_i + B_i q_i$, in addition to compensating the worker for the exerted effort, the firm faces the additional informational rent cost and, therefore, the well-known rent-efficiency trade-off arises. Hence, effort costs, K, correspond to variable production costs, c, in the general framework of Section 2.

[13] We ignore the integer constraint for the number of firms in the following as well.

[14] Because uncertainty cancels out in aggregate, expected and realized consumer surplus coincide.

set-up, therefore, a firm's total production costs exceed the value of resources actually used by the magnitude of the rent payment.

3.2 Solution

Firm i solves

$$\begin{aligned}
&\underset{\{w_i,B_i\}}{max}\,\mathbb{E}\left[\pi_i|e_i\right] = \mathbb{E}\left[\left(a - bQ_{-i} - bq_i\right)q_i - w_i - B_i q_i - F|e_i\right] \\
&s.t. \\
&\hat{e}_i = \underset{e_i}{argmax}\,\mathbb{E}\left[w_i + B_i q_i - \frac{e_i^2}{2D}\Big|e_i\right], && \text{(IC)} \\
&\mathbb{E}\left[u_i|e_i\right] = \mathbb{E}\left[w_i + B_i q_i - \frac{e_i^2}{2D}\Big|e_i\right] \geqslant 0, && \text{(PC)} \\
&w_i \geqslant 0 \text{ and } w_i + B_i \geqslant 0, && \text{(NNCs)}
\end{aligned}$$

where IC, PC and $NNCs$ denote the incentive compatibility constraint, the participation constraint and the non-negativity constraints, respectively (see Appendix A.2 for further details). Firm i maximizes expected profits by selecting the components of the incentive scheme, w_i and B_i, anticipating the worker's effort choice, and ensuring the participation constraint. As in the general framework, the equilibrium is unique and symmetric, implying that the index i can be omitted. It is characterized by:

Lemma 1.

In equilibrium, the worker's effort and the incentive scheme are

$$e(n) = B(n)D, \tag{10}$$

$$B(n) = \frac{a}{b(n+1)D+2}, \tag{11}$$

$$w = 0. \tag{12}$$

Expected utility of the worker equals the informational rent

$$\Omega(n) = \frac{1}{2}B(n)^2 D = \frac{a^2 D}{2\left[b\,(n+1)\,D+2\right]^2}. \tag{13}$$

Expected profits are

$$\begin{aligned}\mathbb{E}[\pi(n,F)] &= aB(n)D - (bnD+1)B(n)^2D - F \\ &= \frac{a^2D}{b(n+1)D+2} - \frac{(bnD+1)a^2D}{[b(n+1)D+2]^2} - F.\end{aligned} \tag{14}$$

Proof Lemma 1.

See Appendix A.3.

Lemma 1 illustrates a number of important relationships. Equation (10) clarifies that a higher bonus increases effort. Furthermore, the bonus $B(n)$ decreases in the number of firms, n [see (11)]. As a consequence, effort declines in n. An increase in the number of competitors raises aggregate output and thus reduces the output price. Therefore, the gain from expanding output declines, and the incentives to stimulate the worker's effort diminish such that the profit-maximizing bonus decreases. Consequently, firms reduce informational rent payments and effort declines. In sum, there is a negative relationship between the number of firms and the rent, as well as effort. Put differently: Output market competition undermines effort. As shown in our general set-up, the underlying mechanism is the competing contract effect. Note finally from (14) that expected profits $\mathbb{E}[\pi(n)]$ decrease in the number of firms, n.

To ensure that at least one firm enters the market, we assume $\mathbb{E}[\pi(n=1)] \geqslant 0$. Evaluating (14) at $n = 1$, we obtain

$$F < \frac{a^2D}{4(bD+1)} \equiv F_{max}, \tag{15}$$

where F_{max} denotes the upper bound for entry costs. The number of firms in market equilibrium, n^e, can be determined explicitly as (see Appendix A.4)

$$n^e = -1 - \frac{2}{bD} + \frac{a}{bD}\sqrt{\frac{D\,(bD+1)}{F}}. \tag{16}$$

Turning to the determination of the number of firms preferred by the social planner, we can express expected welfare as

$$\begin{aligned}\mathbb{E}[W(n)] &= n\mathbb{E}[\pi(n,F)] + CS(n) + n\mathbb{E}[u(n)] \\ &= n\left(\mathbb{E}[P(Q(n))q(n)] - K(e(n)) - F\right) + CS(n).\end{aligned} \tag{17}$$

Maximization with respect to n yields

$$\frac{\mathrm{d}\mathbb{E}[W]}{\mathrm{d}n} = \mathbb{E}[\pi(n,F)] + n\left[P(Q(n)) - K'(e(n))\right]\frac{\mathrm{d}e}{\mathrm{d}n} + \Omega(n) = 0. \tag{18}$$

The (unique) socially optimal number of firms is implicitly given by this first-order condition (see also Appendix A.4). A comparison of (5) and (18) once more clarifies the structural equivalence of the general set-up and the moral hazard framework.

3.3 Informational Rents and the Excessive Entry Theorem

The general condition for insufficient entry (6) can be applied to the moral hazard framework and reads

$$Z = n^e\left[P(Q(n^e)) - K'(e(n^e))\right]\frac{\mathrm{d}e}{\mathrm{d}n} + \Omega(n^e). \tag{19}$$

Using the linear demand function, equation (13), and

$$\frac{\mathrm{d}e}{\mathrm{d}n} = \frac{\mathrm{d}B}{\mathrm{d}n}D = -\frac{B(n^e)bD^2}{b(n^e+1)D+2}, \tag{20}$$

we obtain

$$Z = -n^e\left(a - (bn^eD+1)B(n^e)\right)\frac{B(n^e)bD^2}{b(n^e+1)D+2} + \frac{1}{2}B(n^e)^2D. \tag{21}$$

Therefore, as described in (7), entry will be insufficient if

$$\begin{aligned}Z > 0 \Leftrightarrow \Omega(n^e) &> \underbrace{-n^e\left[P(Q(n^e)) - K'(e(n^e))\right]\frac{\mathrm{d}e}{\mathrm{d}n}}_{BS(n^e)} \\ \Leftrightarrow \frac{1}{2}B(n^e)^2D &> n^e\left(a - (bn^eD+1)B(n^e)\right)\frac{B(n^e)bD^2}{b(n^e+1)D+2}.\end{aligned} \tag{22}$$

As proven in Section 2, insufficient entry will occur if the informational rent dominates the impact of the business-stealing externality. The competing contract effect implies that such an outcome is more likely the lower the number of competitors is. Given the assumption of at least one operating firm, the informational rent is bounded from above. We formalize this rationale in:

Proposition 2.

In the moral hazard framework, entry will be insufficient if the number of competitors in the market is sufficiently low, or, equivalently, if entry costs are sufficiently large. The condition $bD < 1$ ensures that the resulting number of firms in case of insufficient entry exceeds one.

Proof Proposition 2.

Inserting (11) into (22) and rearranging yields

$$Z > 0 \Leftrightarrow n^e < \frac{2 + bD}{2b^2D^2 + bD}. \tag{23}$$

Using (16), we then get

$$Z > 0 \Leftrightarrow F > \frac{a^2D\,(1 + 2bD)^2}{4\,(1 + bD)\,(2 + bD)^2} \equiv F_{crit}. \tag{24}$$

Comparing (15) and (24) implies that $F_{crit} < F_{max}$ if $bD < 1$ holds. This completes the proof. ∎

The intuition is similar to the one for the general set-up. Suppose, for instance, that entry costs increase. This lowers the number of firms in the market equilibrium [see (16)]. As a consequence, firms pay a higher bonus and informational rent payments increase. If F exceeds the threshold level F_{crit}, the informational rent is large enough to dominate the business-stealing externality. Put differently, there exists a critical number of firms, and if n^e falls short of this threshold, the competing contract effect is less stringent, that is, the rent is large enough to imply insufficient entry despite the business stealing externality. Notably, the business stealing effect is also altered by a change in entry costs, F. Nevertheless, even if the externality rises as entry costs increase, as long as

F exceeds F_{crit}, the magnitude of the rent impact still outweighs the magnitude of the business-stealing externality.

The specification in (24) shows that the threshold level F_{crit} is an increasing function of the model's remaining parameters a, b and D (see Appendix A.5). This means that, ceteris paribus, the trade-off between the rent impact and the business-stealing externality is influenced in favor of the latter, such that the informational rent payment must become larger to ensure insufficient entry. Consequently, entry costs must increase even further, reducing the number of entrants, which weakens the competing contract effect and raises informational rent payments. A rise of the demand parameters a and b enhances the business-stealing externality because they increase profitability. The same holds true for an increase in D because workers' abilities rise, which reduces production costs.

4 Conclusion

Homogeneous oligopolies, in which firms bear entry costs and compete in quantities, are characterized by excessive entry if there is business stealing (Amir et al. (2014), Mankiw and Whinston (1986), Perry (1984), Suzumura and Kiyono (1987), von Weizsäcker (1980)). While the robustness of this prediction has frequently been analyzed, the relation between the business-stealing externality and informational frictions has not been studied. This comes as a surprise since asymmetric information characterizes many, if not all, markets in one way or another.

Therefore, in this paper, we investigate how informational rents, which are paid to overcome hidden action problems, affect the excessive entry theorem. We show in a general set-up that insufficient entry can occur despite the business-stealing externality if the informational rent is sufficiently high. We use the employer-employee relationship as an example of a hidden action problem. In this moral hazard framework, two frictions interact. Firms face the externality effect present in oligopoly markets and cannot observe workers' effort. The latter leads the firm to pay an informational rent to financially constrained workers. The rent-efficiency trade-off and the business stealing effect also give rise to the competing contract effect in our moral hazard set-up. Therefore, we can disentangle how the market's profitability makes insufficient entry more likely.

Our findings have implications for competition policies. Asymmetric information in the employer-employee relationship could result in labor contracts which entail rent payments. Consequently, firms' entry might need to be increased in oligopolistic industries, and policymakers might opt to allow more entry rather than restrict it.

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A Appendix

A.1 Costly Transfers

Assume that a fraction $\alpha, 0 \leq \alpha \leq 1$, of a firm's transfer, $\Omega(n)$, does not constitute a rent payment, but a loss of resources, where $\alpha = 0$ represents the case considered in the main text. This modification does not affect firm behavior. Consequently, output choices as well as entry decisions, the resulting levels of aggregate output and production costs, the number of firms, n^e, in market equilibrium, aggregate transfers, and the market price are independent of the value of α. The same holds true for consumer surplus. However, the level of welfare, denoted by W^{alt}, ceteris paribus, declines with α

$$W^{alt}(n, F) = n\pi(n, F) + CS(n) + (1 - \alpha)n\Omega(n). \tag{A.1}$$

The derivative of welfare, W^{alt}, with respect to n is

$$\frac{\mathrm{d}W^{alt}(n, F)}{\mathrm{d}n} = \pi(n, F) + n(P(Q(n)) - c'(q))\frac{\mathrm{d}q}{\mathrm{d}n} - \alpha n\frac{\mathrm{d}\Omega}{\mathrm{d}n} + (1 - \alpha)\Omega(n). \tag{A.2}$$

Evaluating the derivative in (A.2) at n^e, we obtain

$$\begin{aligned} \left.\frac{\mathrm{d}W^{alt}(n, F)}{\mathrm{d}n}\right|_{n=n^e} &= \underbrace{n^e\left[P(Q(n^e)) - c'(q(n^e))\right]\frac{\mathrm{d}q}{\mathrm{d}n}}_{BS(n^e)} - \alpha n^e\frac{\mathrm{d}\Omega}{\mathrm{d}n} + (1 - \alpha)\Omega(n^e) \\ &= BS(n^e) + \Omega(n^e)[1 - \alpha(1 + \epsilon_{\Omega,n})], \end{aligned} \tag{A.3}$$

where $\epsilon_{\Omega,n} < 0$ is the elasticity of the rent Ω with respect to n. Given $\mathrm{d}\Omega/\mathrm{d}n < 0$, the second term in the last line of (A.3) is positive. Moreover, the term surely rises in α if $\epsilon_{\Omega,n} < -1$.

Equation (A.3) clarifies that the basic mechanism analysed in Section 2 also exists if part of the firm's transfer does not represent a rent payment but constitutes a loss of resources and, thereby, welfare. However, whether a difference between the rent received and the transfer paid aggravates or mitigates the excess-entry problem, relative to the absence of such differences, is ambiguous. On the one hand, costs of transfers, $\alpha > 0$, make excessive entry for a given rent more likely, because they do not constitute a positive externality. Firms take the welfare reducing impact of this part of the transfers into account. This is in contrast to rent payments, which do not affect welfare. On the other hand, raising the number of firms, n, reduces the rent per firm ($\mathrm{d}\Omega/\mathrm{d}n < 0$). In consequence, the welfare loss due to the costs of transfers declines for a given number of firms. The second (first) effect dominates, such that insufficient entry becomes more (less) likely, if the elasticity of the rent with respect to the number of firms, $\epsilon_{\Omega,n}$, is greater (smaller) than one in absolute value.

We conclude that Proposition 1 basically continues to hold and can be restated as:

Proposition A.1.

(i) If there are no informational rents, i.e., $\Omega(n^e) = 0$, entry will be excessive.

(ii) If there are informational rents, i.e., $\Omega(n^e) > 0$, entry can be insufficient. This will be the outcome whenever the product of the informational rent, $\Omega(n^e)$, and $1 - \alpha(1 + \epsilon_{\Omega,n})$ exceeds the business stealing externality, $BS(n^e)$, where $\alpha, 0 \leq \alpha \leq 1$ is the fraction of a firm's transfer, which represents a loss of resources.

Proof Proposition A.1.

See equation (A.3). ■

A.2 The Optimization Problem

To simplify the firm's program, we first compute expected profits for every possible effort level and obtain

$$\begin{aligned}
\mathbb{E}\left[\pi_i | e_i\right] &= \mathbb{E}\left[(a - bQ_{-i} - bq_i)q_i - w_i - B_i q_i - F | e_i\right] \\
&= ae_i - b\mathbb{E}\left[(Q_{-i} - bq_i)q_i \mid e_i\right] - w_i - B_i e_i - F \\
&= ae_i - b\mathbb{E}\left[\left(\sum_{j=1}^{n} e_j + \sum_{j=1}^{n} \epsilon_j\right)(e_i + \epsilon_i) \mid e_i\right] - w_i - B_i e_i - F \\
&= ae_i - b\mathbb{E}\left[(\sum_{j=1}^{n} e_j)\,(e_i + \epsilon_i) \mid e_i\right] - w_i - B_i e_i - F \\
&= ae_i - b[(\sum_{j=1, j \neq i}^{n} e_j)e_i + e_i^2] - w_i - B_i e_i - F.
\end{aligned}$$

Hence, we can write expected profits as

$$\mathbb{E}[\pi_i|e_i] = ae_i - b\mathbb{E}[Q_{-i}]e_i - be_i^2 - w_i - B_ie_i - F. \tag{A.4}$$

Second, we compute expected utility as

$$\mathbb{E}\left[u_i|e_i\right] = E\left[w_i + B_iq_i - \frac{e_i^2}{2D}\middle|e_i\right] = w_i + B_ie_i - \frac{e_i^2}{2D}. \tag{A.5}$$

The utility maximizing level of effort, $e_i = B_iD$, can be computed straightforwardly. Using (A.4) and (A.5), we can rewrite the firm's optimization problem as

$$\max_{\{w_i,B_i,e_i\}} \mathbb{E}\left[\pi_i|e_i\right] = ae_i - b\mathbb{E}\left[Q_{-i}\right]e_i - be_i^2 - w_i - B_ie_i - F$$

$$s.t.\ the\ NNCs\ and$$

$$e_i = B_iD, \tag{IC}$$

$$\mathbb{E}\left[u_i|e_i\right] = w_i + B_ie_i - \frac{e_i^2}{2D} \geqslant 0. \tag{PC}$$

From (IC) and $w_i \geqslant 0$, it immediately follows that the constraint $w_i + B_i \geqslant 0$ is slack. Therefore, the set of non-negativity constraints reduces to $w_i \geqslant 0$.

A.3 Proof of Lemma 1

Since w_i enters the maximization with negative sign and does not affect the (IC), the solution requires it to be as small as possible, i.e., $w_i = 0$. From (IC), the bonus is necessarily positive to obtain a positive effort. As a result, the non-negativity constraints (NNCs) are satisfied, and the (PC) is slack.

Inserting (IC) into the objective function, the problem reduces to

$$\max_{B_i} \mathbb{E}\left[\pi_i|e_i\right] = aB_iD - b\mathbb{E}[Q_{-i}]B_iD - bB_i^2D^2 - B_i^2D - F. \tag{A.6}$$

The first-order condition reads

$$\frac{\mathrm{d}\mathbb{E}\left[\pi_i|e_i\right]}{\mathrm{d}B_i} = 0 \Leftrightarrow a - b\mathbb{E}[Q_{-i}] - 2bB_iD - 2B_i = 0. \tag{A.7}$$

The second-order condition is fulfilled.

Since workers are equal and firms face a symmetric problem, the bonus and effort are equal across firms. Therefore, in what follows, we suppress the subscript i, and obtain $\mathbb{E}[Q_{-i}] = \sum_{j\neq i}^{n} e_j = (n-1)BD$. Substituting these expressions into (A.7), and solving for B, we obtain (11). Inserting the result into the utility-maximizing effort level leads to (10). Expected aggregate output is then given by $\mathbb{E}[Q(n)] = ne(n)$.

The worker's expected utility coincides with the rent and equals

$$\Omega(n) = \mathbb{E}[u|e(n)] = B(n)e(n) - \frac{(e(n))^2}{2D} = \frac{a^2 D}{2\left[b\left(n+1\right)D+2\right]^2} > 0, \tag{A.8}$$

which is identical to (13). Inserting $\mathbb{E}[Q_{-i}] = (n-1)BD$ into expected profits as in (A.6), rearranging as well as using (11) leads to (14). This completes the proof.

A.4 Market Equilibrium and Socially Optimal Number of Firms

To calculate the number of firms in market equilibrium, n^e, we use the free-entry condition

$$\mathbb{E}\left[\pi(n)\right] = 0 \Leftrightarrow \frac{a^2 D}{b(n+1)D+2} - \frac{(bnD+1)a^2 D}{[b(n+1)D+2]^2} - F = 0. \tag{A.9}$$

Solving for n, $n > 0$, we obtain (16). Inserting (16) into (11), (10) and (13), we get

$$B^e = \left(\frac{F}{D(bD+1)}\right)^{1/2}, \tag{A.10}$$

$$e^e = \left(\frac{DF}{bD+1}\right)^{1/2}, \tag{A.11}$$

$$\Omega^e = \frac{F}{2(bD+1)}. \tag{A.12}$$

The first-order condition of the social planner reads

$$\begin{aligned}&\frac{\mathrm{d}\mathbb{E}[W]}{\mathrm{d}n} = 0 \iff \\ &\mathbb{E}[\pi(n)] + n\left(a - b\mathbb{E}[Q(n)] - \frac{e(n)}{D}\right)\frac{-abD^2}{(bD(n+1)+2)^2} + \Omega(n) = 0.\end{aligned} \tag{A.13}$$

Using the linear demand function, the quadratic cost function, and (13) as well as simplifying the resulting expression leads to

$$\frac{\mathrm{d}\mathbb{E}[W]}{\mathrm{d}n} = 0 \iff \frac{a^2 D\,(2b^2D^2 + bD(n+7) + 6)}{2(bD(n+1)+2)^3} - F = 0, \tag{A.14}$$

which implicitly determines the socially optimal n. This number is unique because

$$\frac{\mathrm{d}^2\mathbb{E}[W]}{\mathrm{d}n^2} = -\frac{a^2bD^2\,(3b^2D^2 + bD(n+10) + 8)}{(bD(n+1)+2)^4} < 0. \tag{A.15}$$

A.5 On the Threshold Level of Entry Costs F_{crit}

Differentiating (24) with respect to a, b and D implies:

$$\begin{aligned}
\frac{\mathrm{d}F_{crit}}{\mathrm{d}D} &= \frac{a^2(1+2bD)(2+bD(11+8bD))}{4(1+bD)^2(2+bD)^3} > 0,\\
\frac{\mathrm{d}F_{crit}}{\mathrm{d}b} &= \frac{a^2D^2(4+9bD-4b^3D^3)}{4(1+bD)^2(2+bD)^3} > 0,\\
\frac{\mathrm{d}F_{crit}}{\mathrm{d}a} &= \frac{aD(1+2bD)^2}{2(1+bD)(2+bD)^2} > 0.
\end{aligned}$$

Note that $\mathrm{d}F_{crit}/\mathrm{d}b$ is positive due to our assumption that $bD < 1$.