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Inefficiency and Regulation in Credence Goods Markets with Altruistic Experts

– Preliminary and Incomplete –

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Abstract

We study a credence goods problem – that is, a moral hazard problem with non-contractible outcome – where altruistic experts (the agents) care both about their income and the utility of consumers (the principals). Experts' preferences over income and their consumers' utility are convex, such that experts care less for consumers when their financial situation is bad. In a market setting with multiple consumers per expert, a cross-consumer externality arises: one consumer's payment raises the expert's income, which makes the non-selfish part of preferences more important and thereby induces the expert to provide higher quality services to all consumers. The externality renders the market outcome inefficient. Price regulation partially overcomes this inefficiency and Pareto-improves upon the market outcome. If market entry of experts is endogenous, price regulation should be accompanied by licensing arrangements that cap the number of experts in the market. Our theory provides a novel rationale for the wide-spread use of price regulation and licensing in real-world markets for expert services.

JEL: D64, D82, D86, L15, L51

Keywords: altruism, asymmetric information, common agency, credence goods, expert services, externality, inefficiency, moral hazard, regulation

1. Introduction

Credence goods are characterized by informational asymmetries between buyers and sellers. The expert seller is typically able to identify the quality of a good or service that fits a consumer's needs best, while the consumer cannot judge which quality he needs and may not even be able to observe the quality he received ex post (Dulleck and Kerschbamer, 2006; Balafoutas and Kerschbamer, 2020). Credence goods are often provided by representatives of the

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so-called “liberal professions” (e.g., physicians, engineers, architects, and lawyers)¹, which are among the highest-paid professions in many advanced economies.² At the same time, many of these occupations are subject to heavy price or entry regulations.³ Why are these markets so heavily regulated? Are the regulations a result of rent-seeking activities or is there a societal interest supporting them? This paper provides a novel and intuitive rationale for why price and entry regulation in credence goods markets may indeed enhance their efficiency.

We study a credence goods problem – i.e., a moral hazard problem with non-contractible outcome – where altruistic experts (the agents) care both about their income and the utility of their consumers (the principals). Crucially, we assume that an expert’s preferences over income and consumer utility are convex, such that she cares less for consumers if her income is small. If, in contrast, the expert’s income is large, she will pay more attention to the consumers’ needs.⁴ Thus, in a market setting with multiple consumers per expert, a cross-consumer externality arises: one consumer’s payment raises the expert’s income, which makes the non-selfish part of her preferences more important and induces her to provide higher quality to all consumers whom she serves.

The cross-consumer externality renders the market outcome inefficient. We show that in any subgame perfect equilibrium, all consumers propose payment offers that correspond to the expert’s acceptance threshold, and all experts provide the minimum level of quality. If other consumers raised their payments, the expert’s income would increase and thereby also the service quality that any given consumer receives. Since consumers are atomistic, however, they perceive their individual contribution to the expert’s income as negligible and have therefore no incentive to raise their payment above her acceptance threshold.

Price regulation that fixes consumers’ payments at a prescribed level partially overcomes this inefficiency and Pareto-improves upon the market outcome. A lower bound on payment offers forces consumers to raise their payments as if internalizing the externality they impose on other consumers, which counteracts the inefficiency that arises in the market equilibrium. Yet, price regulation does not lead to full efficiency: although higher payment offers lead to an increase in service quality and enhance welfare, we show that a fully efficient level of quality cannot be achieved without interfering with experts’ quality choices directly.

If entry of experts is endogenous, price regulation should be accompanied by licensing arrangements that cap the number of experts in the market. When price regulation raises experts’ profits, it may incentivize new experts to enter the market, which dilutes profits and thus undermines the desired consequences of price regulation. Entry regulation solves this problem by capping the number of active experts. Those who are allowed to enter benefit from the increased prices and decide, non-selfishly, to provide higher quality services.

Our theory offers a new argument that we believe should be taken into account when dis-

¹The European Commission defines liberal professions as professions that “[...] are of a marked intellectual character, require a high-level qualification and are usually subject to clear and strict professional regulation.” (C 267/99, ECR 2001, I-7467 (Adam), para. 3).

²E.g., in 2015, self-employed general practitioners in Austria, Canada, France, and the UK earned around three times, in Germany even four times the average wage in the country (OECD, 2016).

³The [Economic and Social Committee](#) (2014, ch. 5) summarizes the regulations for individual liberal professions in the European Union.

⁴In other words, an expert’s marginal rate of substitution between income and consumer utility decreases in income, such that she cares more for consumer utility when her income is high.

cussing (de)regulation of markets for expert services. We assume that experts are altruistic and that their preferences over income and their consumers' utility are convex, such that they care more for consumers when their income is high. The extensive literature on behavioral economics has convincingly demonstrated that other-regarding preferences – including altruism – play an important role in the utility maximization process of individuals (see [Fehr and Schmidt, 2006](#); [DellaVigna, 2009](#), for surveys). Thus, it is plausible to assume that expert sellers care about the utility of their clients.⁵ Moreover, there exists plenty of evidence from the lab, from the field, and from observational data that is consistent with our assumption that experts care more about their consumers when their income is high (see, e.g., [Carpenter, Verhoogen and Burks, 2005](#); [Rasch and Waibel, 2018](#); [Smeets, Bauer and Gneezy, 2015](#); [Wiepking and Bekkers, 2012](#)).⁶

Our results provide a novel and intuitive rationale for the wide-spread use of price and entry regulation in real-world markets for expert services. Thus, our contribution is not to propose a specific new regulation that we believe should be implemented in practice. Rather, we provide a rationale for some of the observed regulations that already exist. In addition to that, we utter a word of caution against movements towards excessive deregulation of expert markets.⁷ We do not, however, attempt to give a holistic answer as to what is the right degree of regulation in such markets.

Our results complement earlier findings whereby price regulation in credence goods markets enhances their efficiency. In particular, [Mimra, Rasch and Waibel \(2016\)](#) find that in repeated credence goods experiments that allow for reputation building, price regulation improves treatment quality. Their results, however, are only weakly related to our theory, because in their price regulation scenario they fix prices at levels only marginally above those observed in the scenarios where experts can set prices freely. In a further lab experiment, [Dulleck, Kerschbamer and Sutter \(2011\)](#) show that competition among experts entails competition in prices and lower service quality. [Pesendorfer and Wolinsky \(2003\)](#) consider a market where experts must exert costly but unobservable effort to identify the service quality a consumer needs. The authors demonstrate that experts face a trade-off between lowering prices and exerting effort; price regulation that limits competition, however, increases welfare. Our argument in favor of price regulation in credence goods markets is different from theirs, in that the central theoretical feature of our model is the combination of social preferences of agents with a common agency structure whereby multiple principals interact with each agent, while we abstract from costly pre-treatment diagnoses.

The paper proceeds as follows. Section 2 discusses the related literature on credence goods, (behavioral) contract theory, and the common agency branch of contract theory. Section 3 introduces the setup of our model. To prepare the analysis of trading mechanisms for many consumers and many experts, Section 4 considers a bilateral setting with a single expert and a single consumer which is extended to a setting with a finite number of experts and a contin-

⁵A special case in point is the Hippocratic Oath, whereby physicians swear to treat the sick to the best of their ability.

⁶We will further discuss this assumption in Section 8.

⁷The European Union has, for instance, recently launched an infringement procedure against Germany for its ordinance on architects' and engineers' fixed tariffs (European Council of Engineers Chambers, 2019). See also [Hardege \(2008\)](#) for an overview of regulations on liberal professions in OECD countries.

uum of consumers in Section 5. In Section 6, we study price regulation that fixes consumers' payments at a prescribed level. Section 7 extends the analysis to a setting with endogenous entry. Section 8 discusses the key assumptions of our model and some practical implications of our results. Section 9 concludes.

2. Related Literature

We contribute to the literature on the provision of credence goods, to the intersection of contract theory with behavioral economics ("behavioral contract theory" [Koszegi, 2014](#)) and to the common agency branch of contract theory.

Our paper makes three important contributions to the literature on credence goods. First, we develop a novel theoretical framework where experts with social preferences interact with multiple consumers. Although several existing papers incorporate social preferences, they lack a sophisticated theoretical model and do not consider altruistic experts within a common agency framework. As a result, none of them discovers the cross-consumer externality that is at the core of our contribution. [Dulleck et al. \(2011\)](#), for instance, find that experts' behavior in the lab deviates from the predictions of standard theory and relate this to the presence of social preferences. [Kerschbamer, Sutter and Dulleck \(2017\)](#) confirm that the behavior of a large majority of experts is consistent with either a taste for efficiency ([Charness and Rabin, 2002](#)) or inequity aversion ([Fehr and Schmidt, 1999](#); [Bolton and Ockenfels, 2000](#)); indeed, only 20% of their subjects behave in line with standard theory.

Next, our model unveils a cross-consumer externality as an additional and so far unknown driver of inefficiency in credence goods markets with altruistic experts. In a market setting with multiple consumers per expert, a higher payment offer on behalf one consumer would increase the expert's income and thereby the service quality that any consumer receives. The individual consumer, however, does not take this into account, which renders the market outcome inefficient. In contrast to that, the lion's share of research on the inefficient provision of credence goods is devoted to expert fraud; the seminal paper by [Dulleck and Kerschbamer \(2006\)](#) provides a theoretical framework that is complemented with a battery of lab and field experiments that uncover undertreatment, overtreatment, and overcharging on behalf of the expert (e.g., [Dulleck et al., 2011](#); [Balafoutas, Beck, Kerschbamer and Sutter, 2013](#); [Beck, Kerschbamer, Qiu and Sutter, 2014](#); [Rasch and Waibel, 2018](#); [Mimra et al., 2016](#); [Kerschbamer et al., 2017](#); [Schneider, 2012](#); [Gottschalk, Mimra and Waibel, 2018](#); [Kerschbamer and Sutter, 2017](#), the latter provide a survey on lab and field experiments on credence goods).

Third, as a consequence of the cross-consumer externality, we provide a novel rationale for price and entry regulation in credence goods markets. We demonstrate that a lower bound on payment offers would force consumers to raise their payments as if internalizing the externality they impose on other consumers. Moreover, if entry is endogenous, we show that price regulation should be accompanied by licensing arrangements to prevent that excessive entry of competing experts undermines the desired consequences of price regulation. Thereby, our considerations go beyond arguments in favor of price and entry regulation that have previously been uttered. In particular, while liability of the expert and verifiability of

the service quality theoretically suffice to achieve efficiency (Dulleck and Kerschbamer, 2006), such conditions can often not be implemented.⁸ As a result, policy makers use price and entry regulations as alternative options, arguing that a lower bound on prices and an upper bound on entry forestall competition and thereby enable experts to provide appropriate quality since (e.g., Haucap, Rasch and Waibel, 2017). Our results complement findings Mimra et al. (2016) and Pesendorfer and Wolinsky (2003) who show that price regulation enhances efficiency in credence goods markets. In contrast to Mimra et al. (2016), however, we do not consider repeated credence goods experiments that allow for reputation building on behalf of the expert, and in contrast to Pesendorfer and Wolinsky (2003), we do not consider a market where experts must exert costly effort to make a diagnosis.⁹ Note that our results on entry regulation do not contradict Schaumans and Verboven (2008) who develop an empirical entry model for physicians and pharmacies in Belgium. They find that existing entry restrictions have reduced the number of pharmacies by about 50% and argue that a removal of licensing arrangements would generate a shift in rents to consumers. Yet, the model neither accounts for informational asymmetries between consumers and experts and potential expert fraud nor for altruistic experts and cross-consumer externalities.¹⁰

Our major contribution to the literature on behavioral contract theory is the combination of social preferences of agents – and especially the type of preferences where the degree of agents' altruism increases in their own material payoff – with a common agency structure whereby multiple principals interact with each agent. While several papers study social preferences of agents (see Englmaier, 2005; Koszegi, 2014, for surveys), some of which are consistent with our assumption, they lack the dependence of agents' altruism on their own material payoff, which gives rise to the cross-buyer externality and thus to all our main results. Related to our model are Itoh (2004) and Englmaier and Wambach (2010), who incorporate inequity averse agents into a principal-agent model with moral hazard. Furthermore, Dur and Glazer (2008) and Bartling and Von Siemens (2010) consider agents who envy their boss and Herweg, Müller and Weinschenk (2010) modify a principal-agent model with moral hazard by assuming that the agent is expectation-based loss averse according to Köszegi and Rabin (2006).

Finally, we contribute to the common agency branch of contract theory. While this literature does account for externalities between principals who are served by a common agent, agents with social preferences have not been considered so far. Bernheim and Whinston (1986) were the first to extend the bilateral principal-agent framework by Hölmstrom (1979) and Grossman and Hart (1983) to a setting where several principals simultaneously and independently attempt to influence a common agent. In line with our results, the authors observe that principals could potentially benefit from mutual cooperation when acting collectively, such as if in a bilateral agency framework. Dixit, Grossman and Helpman (1997) and Martimort and Stole

⁸Examples where not feasible or too costly.

⁹We abstract from settings where the expert's diagnosis requires special effort as in Pitchik and Schotter (1987); Sülzle and Wambach (2005); Fong (2005); Dulleck and Kerschbamer (2009) or where a fair diagnosis fee can be imposed on the consumer as in Wolinsky (1993, 1995); Emons (1997, 2001); Alger and Salanie (2006).

¹⁰Noailly and Nahuis (2010) provide a further structural model that considers entry in credence goods markets. They investigate changes in competition after a partial deregulation of the market for notary services in the Netherlands. Crucially, the level of professional standards were kept high; in other words, liability and verifiability were partially achieved. The authors' main finding is that the deregulation did not entail much entry.

(2002), for instance, draw similar conclusion.

3. Setup

We set up a model with many consumers who need a service and many experts who can provide this service. Experts covertly choose the quality of the service, which creates moral hazard. Moreover, consumer utility is not contractible, which makes the service a credence good (e.g., [Dulleck and Kerschbamer, 2006](#)).

3.1. Consumers

There is a continuum of consumers (or, buyers) indexed by $b \in B$. The mass of consumers $|B|$ is denoted M . Consumer b 's utility is

$$u_b = v(a_b) - p_b \tag{1}$$

if the consumer receives a service of quality a_b and pays p_b in return. If the consumer receives no service, he gets outside utility \underline{v} .¹¹

We assume that v is C^2 , with $v' > 0$ and $v'' < 0$ everywhere. For interior solutions, let $v'(a) \rightarrow 0$ as $a \rightarrow \infty$.

3.2. Experts

There is a finite set of experts indexed by $e \in E := \{1, 2, \dots, N\}$. To reduce notation, let the number of experts equal the mass of consumers, $N = M$. Expert e earns an income of

$$y_e = \int_{B_e} [p_b - c(a_b)] db ,$$

where $B_e \subset B$ is the set of consumers served by expert e and $c(a_b)$ denotes the cost of providing a service of quality a_b . The cost function is C^2 with $c > 0$, $c' > 0$, and $c'' > 0$ everywhere. We restrict the quality variable to take positive values. So 0 is the minimum quality an expert can provide.¹²

Expert e 's utility is given by

$$u_e = W(y_e) + \int_{B_e} [v(a_b) - p_b] db. \tag{2}$$

Hence, experts care about their material payoff y_e but also about the utility of their clients. The function W is C^2 with $W' > 1$. This ensures that the expert always values her own income more than her clients' incomes at the margin. Crucially, we also assume that the marginal utility from income is decreasing, that is, $W'' < 0$ everywhere. This makes the expert's

¹¹We use 'he' when we speak of a consumer and 'she' when we speak of an expert.

¹²We can interpret 0 as a quality threshold such that consumers can observe whether the quality they receive exceeds 0 or not. Consumers can then condition payments on this, making experts always provide at least 0 quality. Alternatively, take 0 as a minimum service that is costless to the expert, such that she is always willing to provide this minimum.

degree of selfishness contingent on her income level. If the expert earns little, she will focus on increasing her income with little regard to consumers' utility. If in contrast the expert is financially well situated, she will pay more attention to her clients' needs.

We impose two further sensible assumptions on preferences to simplify the analysis. Our main results do not depend on these assumptions. First, we transform consumers' utility function such that $v(0) - c(0) = 0$. This implies that experts do not derive moral satisfaction (i.e., utility through the non-selfish part of their preferences) by serving consumers the minimum quality 0 at the price of its cost. Second, let consumers' outside utility be small, $\underline{v} \leq 0$. This excludes uninteresting cases where consumers refuse to participate in the market.

3.3. Information

We assume throughout the paper that only experts themselves observe the quality of their services. Thus, consumers cannot enforce contracts that make payments contingent on quality. Moreover, we assume that consumer utility is not contractible either.¹³ This precludes standard approaches to moral hazard problems.

With purely selfish preferences, these assumptions would make the case for consumers hopeless. Experts would never have an incentive to provide more than the minimum level of quality. Non-selfish experts, however, may provide higher quality services because they care for their clients. This makes our setup well-suited to study the impact of non-selfish preferences on credence goods provision in isolation from other considerations.

Note at this point that, in contrast to standard moral hazard and credence goods problems, our setting does not include a stochastic, potentially unobservable state. We can easily incorporate such a state in the analysis, but this does not add any relevant insights.

4. Bilateral Trade

To prepare the analysis of trading mechanisms for many consumers and many experts, consider first a bilateral setting with a single expert e and a single consumer b . The consumer is as described above. The expert however does not perceive the consumer as atomistic, because he is her only client. Hence the expert's utility is

$$\tilde{u}_e = W(p_b - c(a_b)) + v(a_b) - p_b$$

if she provides her service to the consumer, and $W(0)$ otherwise.

Suppose now the consumer offers a payment p_b to the expert, who can then accept or reject the offer. If the expert accepts the offer, she chooses the quality a_b and provides the service.

If the expert accepts an offer p_b , she will choose the quality a_b of her service to maximize utility. Expert utility is strictly concave in a_b and a_b must be non-negative by assumption, so

¹³In the jargon of the credence goods literature, we consider a setting without verifiability (of treatments) and liability (e.g., [Dulleck and Kerschbamer, 2006](#)).

the following Kuhn-Tucker conditions uniquely determine the optimal quality $\tilde{a}_b^{IC}(p_b)$.

$$\begin{aligned} \left[W'(p_b - c(\tilde{a}_b^{IC}))c'(\tilde{a}_b^{IC}) - v'(\tilde{a}_b^{IC}) \right] \tilde{a}_b^{IC} &= 0 \\ W'(p_b - c(\tilde{a}_b^{IC}))c'(\tilde{a}_b^{IC}) - v'(\tilde{a}_b^{IC}) &\geq 0 \\ \tilde{a}_b^{IC} &\geq 0. \end{aligned} \quad (3)$$

For concreteness, assume now that

$$W'(0)c'(0) \geq v'(0). \quad (4)$$

This implies that the expert chooses the minimum quality of 0 if her income is zero. In particular, she will not incur monetary losses (negative income) to provide a quality higher than necessary.

Consider now the expert's acceptance decision. Suppose the offer is $p_b = c(0)$. If accepting this offer, the expert will choose a quality of 0 and obtain utility $W(0)$, equal to her outside option. For simplicity we assume throughout the paper that, when indifferent between two actions one of which leads to the outside option, all individuals decide against the outside option. Hence, the expert accepts the payment $c(0)$. Moreover, her utility strictly increases in p_b (recall that $W' > 1$), so she accepts all offers above $c(0)$ and rejects all offers below.

Anticipating these decisions of the expert, the consumer chooses his payment offer. In particular, he takes into account the effect of his payment on service quality. By condition (3), this effect is positive: a higher payment raises the expert's income, which reduces the marginal utility of income and makes the expert pay more attention to consumer utility. Thus, the consumer's offer choice is non-trivial; he may well choose a payment above $c(0)$ to receive a service of higher quality.

Let p^* denote the optimal offer for the consumer, that is,

$$p^* \in \operatorname{argmax}_{p_b \geq c(0)} \left\{ v \left(\tilde{a}_b^{IC}(p_b) \right) - p_b \right\}. \quad (5)$$

To focus on the most interesting case, we assume henceforth that v , W , and c indeed leave some scope for mutually beneficial exchange above the minimum quality 0. Formally, the minimum offer $c(0)$ (and the resulting minimum quality service) shall not maximize consumer utility:

$$c(0) \notin \operatorname{argmax}_{p_b \geq c(0)} \left\{ v \left(\tilde{a}_b^{IC}(p_b) \right) - p_b \right\}. \quad (6)$$

Figure 1 illustrates the results of the bilateral setting. The curve \tilde{a}_b^{IC} marks the set of feasible allocations from the consumer's perspective. The consumer chooses the point $(p^*, \tilde{a}_b^{IC}(p^*))$ on the curve, where his indifference curve I_b is tangent to the graph of \tilde{a}_b^{IC} . The expert's indifference curves I_e are such that expert utility is maximized at $\tilde{a}_b^{IC}(p_b)$ for any p_b . Hence they have slope infinity at any point (p_b, \tilde{a}_b^{IC}) .

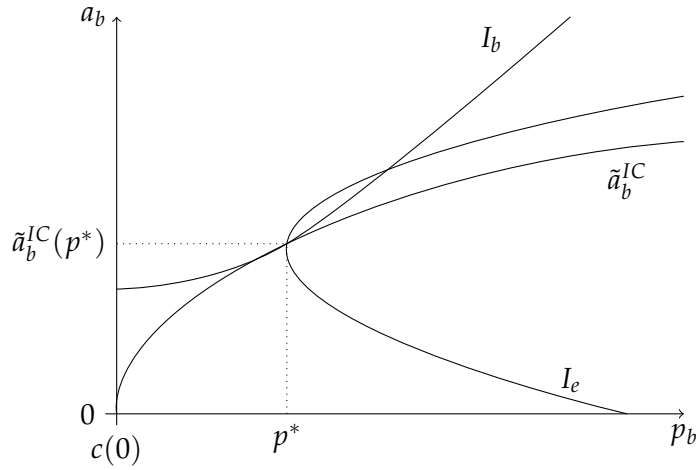


Figure 1. The figure displays indifference curves of the expert, I_e , and of the consumer, I_b , together with the graph of expert's quality choices \tilde{a}_b^{IC} . The point $(p^*, \tilde{a}_b^{IC}(p^*))$ maximizes consumer utility on the curve \tilde{a}_b^{IC} .

5. Market Trade

Consider now again the setup with a finite number of experts and a continuum of consumers. As in the bilateral setting we study a trading mechanism in which consumers offer payments in exchange for the expert service and experts accept or reject.

In Appendix A we analyze a mechanism where experts offer prices and consumers decide which offer to accept. This mechanism yields essentially the same outcome as the consumer-proposing mechanism studied here. The only difference is that the expert-proposing mechanism gives rise to additional equilibria (with different outcomes), which heavily rely on coordination across consumers. We argue in the appendix that these equilibria are not very plausible and provide two selection criteria, restricting consumers' ability to coordinate. Both criteria leave only the equilibrium that replicates the outcome of the consumer-proposing mechanism. To avoid these complications here, we focus directly on the consumer-proposing mechanism.

In particular, consider the following mechanism.

Stage 1 Each consumer b is matched randomly to an expert e and offers a payment p_b to the expert.¹⁴

Stage 2 Experts accept or reject the payments offered to them. If a consumer b 's offer is rejected, he obtains outside utility \underline{v} . If b 's offer is accepted, the accepting expert chooses a quality level a_b , and consumer b receives utility (1). Each expert e receives utility (2), where B_e is the set of consumers whose offers the expert accepted.¹⁵

Stages 1 and 2 describe an extensive form game with complete information. We study its subgame perfect equilibria by backward induction. For that, suppose payments $\{p_b\}_{b \in B}$ and

¹⁴We assume that for each consumer the matching probability is uniform across experts. Thus, each expert will be matched to a mass M/N of consumers.

¹⁵Note that consumers cannot condition their payments on the service quality they receive. This follows from our assumption that quality is hidden to consumers and final outcomes are not contractible.

acceptance sets B_e are given. Then, experts choose quality levels a_b to maximize utility subject to the non-negativity constraint $a_b \geq 0$ for all b . Let a_b^{IC} denote the optimal quality choice of expert e for consumer $b \in B_e$. As in the bilateral setting, this quality is uniquely determined by the following Kuhn-Tucker conditions.¹⁶

$$\begin{aligned} \left[W'(y_e)c'(a_b^{IC}) - v'(a_b^{IC}) \right] a_b^{IC} &= 0 \\ W'(y_e)c'(a_b^{IC}) - v'(a_b^{IC}) &\geq 0 \\ a_b^{IC} &\geq 0. \end{aligned} \tag{7}$$

Before choosing quality, experts decide which offers to accept. Formally, each expert e assesses for each of her offers the marginal utility of adding the offer to her acceptance set B_e . The set B_e must therefore satisfy the following conditions.

$$W'(y_e) \left(p_b - c(a_b^{IC}) \right) + v \left(a_b^{IC} \right) - p_b \begin{cases} \geq 0 & \forall b \in B_e \\ < 0 & \text{for all } b \text{ whose offer } e \text{ rejects} \end{cases} \tag{8}$$

Using experts' quality choices, these conditions lead to a simple characterization of acceptance decisions contingent on an expert's income.

Lemma 1. *Given payment offers $\{p_b\}_{b \in B}$, any expert e 's acceptance set B_e and income y_e must satisfy, for any b matched to e on stage 1,*

$$b \in B_e \Leftrightarrow p_b \geq \begin{cases} c(0) & \text{if } y_e \leq 0 \\ \tilde{p}(y_e) & \text{if } y_e > 0 \end{cases}$$

with $\tilde{p} : y_e \mapsto \tilde{p}(y_e)$ decreasing in y_e and $\tilde{p}(y_e) \leq c(0)$ for all $y_e > 0$.

Proof. See Appendix B. □

Lemma 1 provides an acceptance threshold for consumers' offers. Anticipating this threshold and experts' subsequent quality choices, consumers decide about their offers.

Importantly, here the quality provided by expert e does not depend on any individual payment p_b . In particular, by condition (7) the quality an expert provides is fully determined by her income. But since consumers are atomistic, they perceive their contribution to the expert's income as negligible. Hence, in contrast to the bilateral setting, consumers have no incentive to raise their payment above the acceptance threshold. The relevant piece of the threshold then becomes $c(0)$.

Proposition 1. *Consider the game described by stages 1 and 2. In any subgame perfect equilibrium all consumers offer $c(0)$ and receive zero quality, that is, $p_b = c(0)$ and $a_b = 0$ for all $b \in B$.*

Proof. See Appendix B. □

Proposition 1 stands in stark contrast to the result from the bilateral setting. Intuitively, this discrepancy stems from an externality across buyers. If other buyers raised their payments, experts' incomes would increase and thereby the service quality any given buyer receives.

¹⁶Expert utility is strictly concave in $\{a_b\}_{b \in B_e}$, such that the Kuhn-Tucker conditions identify a unique maximizer.

Note that the key assumption for this result is that experts' preferences over income and consumer utility are convex, such that the marginal rate of substitution between the two goods decreases in income. This makes experts care more for their consumers and provide higher quality services when their income is high.

6. Regulation and Efficiency

The cross-buyer externality suggests to study regulation policy. We study price regulation that fixes consumers' payments at a prescribed level.¹⁷

In particular, consider the game described by stages 1 and 2 but with buyers' offers p_b fixed at the level \bar{p} . Since buyers then have no decisions left, the game collapses to experts' acceptance and quality decisions. These must again satisfy conditions (7) and (8).

From Lemma 1 we already know that experts accept all offers if the regulation \bar{p} is greater or equal to $c(0)$. Otherwise, they reject all offers. We can therefore implement an allocation $\{p_b\}_{b \in B}$, $\{B_e\}_{e \in E}$, $\{a_b\}_{b \in \cup_{e \in E} B_e}$ via price regulation if and only if it satisfies the following conditions.¹⁸

- (i) Payments are uniform across buyers, $p_b = p_{b'}$ for all $b, b' \in B$, and $p_b \geq c(0)$ for all $b \in B$.
- (ii) The sets B_e have equal size, $|B_e| = 1$ for all $e \in E$, and they are disjoint, $B_e \cap B_{e'} = \emptyset$ for all $e \neq e'$.
- (iii) Service quality is uniform across buyers, $a_b = a_{b'}$ for all $b, b' \in B$, and satisfies the Kuhn-Tucker conditions (7).

We call such allocations implementable. In an implementable allocation, consumer utility is given by

$$v(\bar{a}^{IC}(\bar{p})) - \bar{p},$$

where the quality level $\bar{a}^{IC}(\bar{p})$ follows from the Kuhn-Tucker conditions (7). Using the symmetry of implementable allocations implied by (i) and (ii), the Kuhn-Tucker conditions simplify to

$$\begin{aligned} \left[W'(\bar{p} - c(\bar{a}^{IC})) c'(\bar{a}^{IC}) - v'(\bar{a}^{IC}) \right] \bar{a}^{IC} &= 0 \\ W'(\bar{p} - c(\bar{a}^{IC})) c'(\bar{a}^{IC}) - v'(\bar{a}^{IC}) &\geq 0 \\ \bar{a}^{IC} &\geq 0. \end{aligned}$$

The thus defined quality \bar{a}^{IC} is identical to the quality \bar{a}^{IC} from the bilateral setting. Hence consumer utility as a function of the regulated price \bar{p} is identical to consumer utility as a

¹⁷If payments were restricted by a lower bound instead of fixed, consumers would set their offers at the lower bound as long as the lower bound does not fall short of the competitive level $c(0)$. Hence, a price floor yields essentially the same results as a fixed price.

¹⁸Via $\bar{p} < c(0)$ we can also implement the trivial allocation where $B_e = \emptyset$ for all $e \in E$. We ignore this allocation here.

function of the consumer's payment offer in the bilateral setting. This identity implies that the price p^* (as defined by equation (5)) maximizes consumer utility among all implementable allocations.

Turning to experts' utility under regulation \bar{p} , we obtain

$$\max_{a \geq 0} \{W(\bar{p} - c(a)) + v(a) - \bar{p}\} .$$

This is strictly increasing in \bar{p} . Since $p^* > c(0)$ by assumption (6), experts prefer the regulation p^* to the competitive equilibrium outcome (described in Proposition 1). We have therefore established that price regulation at p^* Pareto-improves upon the competitive outcome.¹⁹

Proposition 2. *The allocation implemented by price regulation p^* (defined in equation (5)) Pareto-dominates the competitive equilibrium outcome described in Proposition 1.*

Intuitively, price regulation forces consumers to raise their payments as if internalizing the externality they impose on other consumers. This counteracts the inefficiency that arises in the competitive equilibrium.

Note at this point that a subsidy could not achieve such efficiency gains. A subsidy would lower experts' acceptance thresholds. Anticipating this, consumers would reduce their offers, leaving producer prices at $c(0)$. The incidence of the subsidy therefore falls completely on consumers. It thereby fails to raise experts' profits such that service quality remains unchanged.

To understand the potential of price regulation more completely, consider the set of constrained efficient allocations. This is the set of implementable allocations that are not Pareto-dominated by any other implementable allocation.

Since the regulation p^* maximizes consumer utility, the allocation induced by p^* is constrained efficient. When raising the price above p^* , experts gain and consumers lose. Hence, regulation levels $\bar{p} > p^*$ are constrained efficient as well. Any allocation implemented by $\bar{p} < p^*$ in contrast is not constrained efficient, as both consumers and experts prefer the allocation under p^* . The set of constrained efficient allocations is therefore the set of allocations implementable by price regulation $\bar{p} \geq p^*$.²⁰

Compare now the set of constrained efficient allocations to the set of fully efficient allocations. An allocation is fully efficient if and only if it is not Pareto-dominated by any other allocation. In the proof of Proposition 3 below, we show that an allocation is fully efficient if and only if $a_b = a^{**}$ for all consumers b , where the (fully) efficient quality a^{**} is given by

$$v'(a^{**}) = c'(a^{**}) .$$

Intuitively, fully efficient allocations maximize surplus, defined as $\int_B (v(a_b) - c(a_b)) db$. Starting from an allocation that does not maximize surplus, we can move to a surplus-maximizing allocation and redistribute the gains over experts and consumers to make everyone better off.

¹⁹We say that an allocation Pareto-dominates another allocation, if no agent is worse off and a non-zero measure of agents is strictly better off in the first allocation.

²⁰By the way we set up the analysis of price regulation, we ignore participation constraints of consumers. If we were to include such constraints, they would imply an upper bound on the regulation \bar{p} , beyond which consumers no longer participate. Otherwise, the results would remain unchanged.

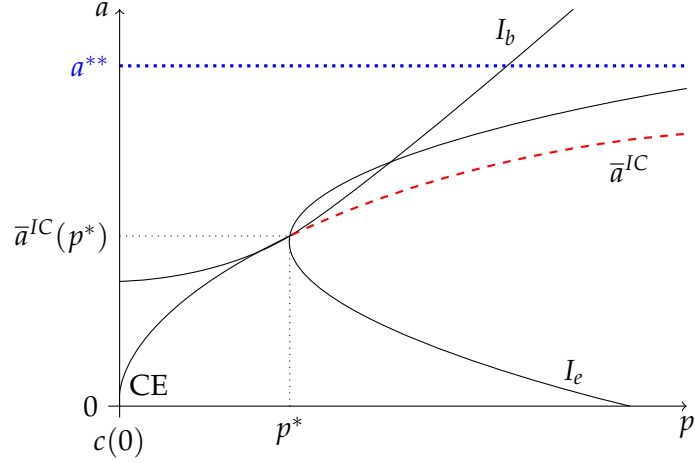


Figure 2. The figure displays indifference curves of experts, I_e , and of consumers, I_b , among symmetric allocations represented by a common payment p and a common service quality a . The function \bar{a}^{IC} returns experts' optimal quality choice given a common payment offer p . The point CE marks the competitive equilibrium outcome from Proposition 1, the red dashed segment of \bar{a}^{IC} is the set of symmetric constrained efficient allocations, and the blue dotted line is the set of symmetric fully efficient allocations.

Inspecting the Kuhn-Tucker conditions for experts' quality choices, we find that expert e chooses the fully efficient quality a^{**} if and only if $W'(y_e) = 1$. In words, to provide fully efficient quality, experts must be indifferent regarding marginal redistribution of money between them and their consumers. Since we excluded this by assumption ($W' > 1$), we can never achieve fully efficient service quality without interfering with experts' quality choices directly. So, the sets of constrained efficient and fully efficient allocations are disjoint; price regulation never achieves full efficiency.

We summarize our findings on the structure of efficient allocations as follows.

Proposition 3. *The set of constrained efficient allocations equals the set of allocations implementable by price regulation $\bar{p} \geq p^*$, where p^* is given by equation (5).*

The regulation p^ maximizes consumer utility. Expert utility increases strictly in the regulation \bar{p} . Moreover, the sets of constrained efficient and fully efficient allocations are disjoint.*

Proof. See Appendix B. □

Proposition 3 is illustrated by Figure 2. The figure focuses on symmetric allocations, represented by a common payment p and a common quality level a across consumers.

The curve \bar{a}^{IC} marks all symmetric allocations implementable via price regulation. Of these, all allocations on the red (dashed) part of the curve are constrained efficient, as they have $p \geq p^*$. There is no intersection with the set of fully efficient symmetric allocations marked by the blue (dotted) line. The competitive outcome CE at $(0, c(0))$ is neither constrained nor fully efficient.

In short, raising prices up to p^* is Pareto-improving. Raising prices further benefits experts and hurts consumers.

7. Extension: Market Entry

When price regulation raises experts' profits it may incentivize new experts to enter the market. This may dilute profits and thereby undermine the desired consequences of regulation. To address this concern we extend the analysis to a setting with endogenous entry.

In particular, suppose now that there is a (countably) infinite set of experts who initially decide whether to enter the market at a fixed cost $F > 0$ or not. To finance the entry cost even in a situation where prices equal marginal cost, suppose that experts operate decreasing returns to scale technologies. Formally, let the income of an expert e who entered the market be

$$\hat{y}_e = \int_{B_e} [p_b - c(a_b)] db - k(|B_e|) - F, \quad (9)$$

where all recurrent variables have the same meaning as before. The new cost function k is C^2 and satisfies $k(0) = 0$, $k' > 0$, and $k'' > 0$. Without loss of generality we can now impose the normalization $c(0) = 0$. The function k then measures a fixed cost per consumer served that is independent of service quality. It is convex in the mass of consumers served to capture decreasing returns to scale.²¹

Expert e 's utility becomes

$$\hat{u}_e = W(\hat{y}_e) + \int_{B_e} (v(a_b) - p_b - v(0) + k'(|B_e|)) db. \quad (10)$$

Compared to the previous sections we adjust the other-regarding part of experts' utility by $|B_e|(-v(0) + k'(|B_e|))$. This adjustment ensures that experts do not derive immaterial benefits or losses from serving a consumer the minimal quality at marginal cost. It mirrors our assumption of $v(0) - c(0) = 0$ from the previous sections. As in the previous sections, the assumption serves to simplify the analysis without substantively changing the results.

Consumers are modeled exactly as before (see section 3), except for that we replace the assumption $\underline{v} \leq 0$ by

$$\underline{v} \leq v(0) - k'(M).$$

This again ensures that consumers' outside utility is small enough to exclude uninteresting cases where consumers refuse to participate in the market.

7.1. Market Trade with Entry

We consider now the following timing of events.

Stage 1' Experts decide whether to enter the market or not. If they do not enter, they receive utility $W(0)$.

Stage 2' Denote by $E = \{1, 2, \dots, N\}$ the set of experts who enter the market. Each consumer $b \in B$ is matched randomly to an expert $e \in E$ and offers a payment p_b to the expert.²²

²¹Decreasing returns to scale may for example stem from increasing difficulties to coordinate appointments with consumers, frictional interaction with a growing number of employees, or disproportional wear and tear of equipment.

²²Let the matching probability again be uniform, such that each expert is matched to mass M/N of consumers.

Stage 3' Experts accept or reject offers. If an offer p_b is rejected, consumer b receives the outside option v . If p_b is accepted, the corresponding expert chooses a_b and the consumer receives utility (1). Finally, each expert $e \in E$ receives utility according to (10), where B_e is the set of consumers whose offers e accepts.

This defines a sequential game with perfect information and we can again study its subgame perfect equilibria by backward induction.

Given a set of active experts E , payment offers $\{p_b\}_{b \in B}$ and a matching $\{B_e\}_{e \in E}$, experts' quality choices \hat{a}_b^{IC} are determined by the Kuhn-Tucker conditions (7) as in Section 5. The only difference is that income y_e is replaced by \hat{y}_e as given by equation (9).

Moving backwards, the acceptance decisions of each expert $e \in E$ must satisfy

$$W'(\hat{y}_e) \left(p_b - c(\hat{a}_b^{IC}) - k'(|B_e|) \right) + v(\hat{a}_b^{IC}) - p_b - v(0) + k'(|B_e|) \begin{cases} \geq 0 & \forall b \in B_e \\ < 0 & \text{for all } b \text{ whose offer } e \text{ rejects} \end{cases}$$

The condition computes the marginal benefit from expanding the set B_e by consumer b . If this marginal benefit is positive, the expert accepts b 's offer, otherwise not. The condition leads to the following intermediate result.

Lemma 2. *Given payment offers $\{p_b\}_{b \in B}$, each active expert e 's acceptance decisions B_e and income \hat{y}_e must satisfy, for any consumer b matched to e on stage 2',*

$$b \in B_e \Leftrightarrow p_b \geq \begin{cases} k'(|B_e|) & \text{if } \hat{y}_e \leq 0 \\ \hat{p}(y_e, B_e) & \text{if } \hat{y}_e > 0 \end{cases}$$

with $\hat{p} : (\hat{y}_e, B_e) \mapsto \hat{p}(\hat{y}_e, B_e)$ decreasing in \hat{y}_e and $\hat{p}(\hat{y}_e, B_e) \leq k'(|B_e|)$ for all $\hat{y}_e > 0$ and all B_e .

Proof. See Appendix B. □

Lemma 2 provides an acceptance threshold, which consumers anticipate when making their offers on stage 2'. Determining equilibrium offers is now complicated by inframarginal rents, which may induce positive profits. We therefore proceed with a case distinction.

Lemma 3. *Take a non-empty set of active experts E and consider the subgame after E described by stages 2' and 3'. Distinguish the following cases.*

1. If

$$\frac{M}{N} k' \left(\frac{M}{N} \right) - k \left(\frac{M}{N} \right) - F > 0,$$

payment offers and expert utilities must satisfy

$$p_b \leq k' \left(\frac{M}{N} \right) \quad \text{and} \quad \hat{u}_e > W(0)$$

for all $b \in B$ and $e \in E$.

2. If

$$\frac{M}{N} k' \left(\frac{M}{N} \right) - k \left(\frac{M}{N} \right) - F = 0,$$

payment offers and expert utilities must satisfy

$$p_b = k' \left(\frac{M}{N} \right) \quad \text{and} \quad \hat{u}_e = W(0)$$

for all $b \in B$ and $e \in E$.

3. If

$$\frac{M}{N} k' \left(\frac{M}{N} \right) - k \left(\frac{M}{N} \right) - F < 0,$$

payment offers and expert utilities must satisfy

$$p_b = k' \left(\frac{M}{N} \right) \quad \text{and} \quad \hat{u}_e < W(0)$$

for all $b \in B$ and $e \in E$.

Proof. See Appendix B. □

Case 3 is not compatible with entry decisions on stage 1', as experts' utility falls short of their outside option. Hence, the equilibrium number of experts \hat{N} must satisfy the conditions of cases 1 or 2. At $\hat{N} + 1$ however we need case 3, such that expert $\hat{N} + 1$ finds it unprofitable to enter:

$$\frac{M}{\hat{N}} k' \left(\frac{M}{\hat{N}} \right) - k \left(\frac{M}{\hat{N}} \right) - F \geq 0 \tag{11}$$

$$\frac{M}{\hat{N} + 1} k' \left(\frac{M}{\hat{N} + 1} \right) - k \left(\frac{M}{\hat{N} + 1} \right) - F < 0. \tag{12}$$

To resolve the cumbersome case distinction, suppose now that the mass of consumers is large, $M \rightarrow \infty$. Then, conditions (11) and (12) imply $M/\hat{N} \rightarrow m$, where m satisfies

$$mk'(m) - k(m) - F = 0. \tag{13}$$

Hence,

$$\frac{M}{\hat{N}} k' \left(\frac{M}{\hat{N}} \right) - k \left(\frac{M}{\hat{N}} \right) - F \rightarrow 0$$

as $M \rightarrow \infty$. In words, when we get rid of the integer problem with finite N , we approach case 2 of Lemma 3, where experts make zero profits and payments equal marginal cost.

Proposition 4. *Consider the game described by stages 1' to 3'. Suppose $M \rightarrow \infty$. Then, in any subgame perfect equilibrium consumers' offers approach marginal cost and quality levels approach zero, that is, $p_b \rightarrow k'(m)$ and $a_b \rightarrow 0$ for all $b \in B$, where m is defined by equation (13).*

Proof. See Appendix B. □

Proposition 4 shows that for large M the equilibrium allocation with market entry approaches the competitive outcome of minimal quality and marginal cost pricing familiar from Section 5. The only difference is that here marginal cost is given by $k'(m)$ instead of $c(0)$.

7.2. Regulation with Entry

We consider now a joint regulation of prices and entry, represented by the tuple (\bar{p}, \bar{N}) . Such a regulation induces a game described by stages 1' to 3' with two modifications. First, only a number of \bar{N} experts decides whether to enter the market on stage 1'. This caps the number of active experts at \bar{N} . Second, as in Section 6 price regulation fixes buyers' offers at \bar{p} .

Hence under regulation (\bar{p}, \bar{N}) , experts decide whether to enter the market, whether to accept the fixed payment offers, and which quality to provide. Consumers have no choices. In the following we construct a regulation that Pareto-improves upon the competitive outcome of Proposition 4.

Note first that for a given number of active experts \tilde{N} , experts accept all offers if $\bar{p} \geq k'(M/\tilde{N})$. In such a situation, condition (7) for experts' quality choices simplifies to

$$\begin{aligned} \left[W' \left(\frac{M}{\tilde{N}} \bar{p} - \frac{M}{\tilde{N}} c(\hat{a}^{IC}) - k \left(\frac{M}{\tilde{N}} \right) - F \right) c'(\hat{a}^{IC}) - v'(\hat{a}^{IC}) \right] \hat{a}^{IC} &= 0 \\ W' \left(\frac{M}{\tilde{N}} \bar{p} - \frac{M}{\tilde{N}} c(\hat{a}^{IC}) - k \left(\frac{M}{\tilde{N}} \right) - F \right) c'(\hat{a}^{IC}) - v'(\hat{a}^{IC}) &\geq 0 \\ \hat{a}^{IC} &\geq 0. \end{aligned}$$

This defines the quality $\hat{a}^{IC}(M/\tilde{N}, \bar{p})$ as a function of the consumer to expert ratio M/\tilde{N} and the price level \bar{p} . Consumer utility then also becomes a function of M/\tilde{N} and \bar{p} . We denote the price that maximizes consumer utility at a given consumer to expert ratio by $\hat{p}^*(M/\tilde{N})$:

$$\hat{p}^* \left(\frac{M}{\tilde{N}} \right) \in \max_{\bar{p} \geq k'(\frac{M}{\tilde{N}})} \left\{ v \left(\hat{a}^{IC} \left(\frac{M}{\tilde{N}}, \bar{p} \right) \right) - \bar{p} \right\}. \quad (14)$$

Assume now that for large M and at the unregulated expert number \hat{N} (as given by conditions (11) and (12)), there is scope for trade above the minimum quality level of zero. Formally, if the expert to consumer ratio approaches its limit value m from the unregulated case (as given by equation (13)), marginal cost pricing is not collectively optimal for consumers:

$$k'(m) \notin \max_{\bar{p} \geq k'(m)} \left\{ v \left(\hat{a}^{IC}(m, \bar{p}) \right) - \bar{p} \right\}. \quad (15)$$

This assumption is analogous to assumption (6) in the setting without entry.

As a consequence of assumption (15), if we can regulate entry such that the number of active experts remains the same as in the unregulated equilibrium, we can Pareto-improve upon the unregulated outcome by raising prices to $\hat{p}^*(m)$ when M is large. Proposition 5 shows that capping entry at the number of experts from the unregulated outcome, $\bar{N} = \hat{N}$, yields the desired result.²³ In addition, Proposition 5 shows that the entry-related component of the regulation is important.

Proposition 5. *Consider the regulation $(\hat{p}^*(m), \hat{N})$, where \hat{p}^* is the consumer optimal price given by equation (14) and \hat{N} is the number of active experts in the unregulated equilibrium given by conditions*

²³Intuitively, raising prices above the marginal cost $k'(m)$ makes entry more attractive, such that the cap at \hat{N} is binding and therefore equal to the actual number of active experts.

(11) and (12). There exists a value \bar{M} such that for all $M > \bar{M}$, the allocation implemented by the described regulation Pareto-dominates the unregulated equilibrium outcome described in Proposition 4.

Consider in contrast the pure price regulation $(\hat{p}^*(m), \infty)$. There exists a value \bar{M}' such that for all $M > \bar{M}'$, the allocation implemented by the pure price regulation is Pareto-dominated by the allocation implemented by the joint price and entry regulation described above.

Proof. See Appendix B. □

Proposition 5 shows that price regulation should be accompanied by entry regulation when entry is endogenous. Adding the entry regulation \hat{N} to the pure price regulation $(\hat{p}^*(m), \infty)$ yields a Pareto-improvement.

To understand this result, note that the purpose of price regulation is to make experts behave less selfishly by raising their profits. But with endogenous entry, any attempt to raise profits via price regulation attracts new entrants, which counteracts the increase in profits. The desired effect on service quality is therefore mitigated. Entry regulation solves this problem by capping the number of active experts. Those who are still allowed to enter benefit from the increased prices and decide, non-selfishly, to provide higher quality services. Thus, entry regulation restores the effectiveness of price regulation.

Whether the pure price regulation alone already achieves a Pareto-improvement over the competitive outcome is unclear. For large M , experts' utility is approximately unaffected by pure price regulation, because entry drives down experts' utility to their outside option. For consumers the effect is ambiguous. On the one hand, increased prices reduce utility. On the other hand, although mitigated by entry the pure price regulation can still have a positive effect on service quality. This is because the regulation raises prices above marginal cost, which has a negative effect on experts' utility through the non-selfish part of their preferences: experts feel bad because consumers pay "too much" for what they receive. This immaterial utility loss must be compensated by material gains to make experts enter the market. Hence, entry stops before the income level drops to zero. Since income is positive, service quality can be positive as well.

8. Discussion

In the following we discuss the key assumptions of our model and some practical implications of our results.

Experts Have Social Preferences Our model assumes that experts are altruistic, i.e., experts care about the utility of their clients. We believe that this is an uncontroversial assumption. The literature on behavioral economics has long established the existence of social preferences, ranging from inequity aversion (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000), fairness concerns (Rabin, 1993), and a taste for efficiency (Charness and Rabin, 2002) to various types of altruism, including pure altruism (Becker, 1976), impure altruism (Andreoni, 1989, 1990; Andreoni and Miller, 2002), and conditional altruism (Konow, 2010). The role of altruism in economic decision making has also been stressed by Landes and Posner (1978); Eckel and Grossman (1996); Fehr and Fischbacher (2003); Fehr and Rockenbach (2003).

Representatives of the liberal professions are particularly likely to care about their clients' well-being. Liberal professionals "contribute to the peaceful and productive coexistence of citizens [whereby] they guarantee a framework for the public-welfare oriented social and economic division of labour." ([Economic and Social Committee, 2014](#), p.12), i.e., experts who self-select into such occupations are likely to have social preferences. Physicians, for instance, swear by the Hippocratic Oath to treat the sick to the best of their ability. Thus, altruism on behalf of the experts is a plausible assumption.

Expert Preferences are Convex in Income and Consumer Utility On top of the assumption that experts are altruistic, we impose that experts' preferences are convex in income and consumer utility; in other words, we assume that experts care less for consumers when their own income is small. While it is plausible that experts who are financially better situated can "afford" to be more altruistic, we provide three further arguments to support this assumption.

First of all, [Rasch and Waibel \(2018\)](#) provide direct evidence of the relationship between experts' income and pro-social behavior. They use data on car repairs – i.e., expert services – in Germany and find that a critical financial situation of a car garage is associated with a higher amount of overcharging incidences.

Second, a large number of dictator games shows that the level of giving depends increases in the dictator's stakes. For instance, [Carpenter et al. \(2005\)](#) show that an increase in the dictator's stakes leads to absolutely larger donations, while the relative amount given remains constant. Similarly, [Korenok, Millner and Razzolini \(2012\)](#) and [Chowdhury and Jeon \(2014\)](#) conclude an increase in a dictator's income increases the absolute amount given. See also [Engel \(2011\)](#) for a meta study on dictator games.

Third, evidence from the field / charitable giving. For instance, [Smith, Kehoe and Cremer \(1995\)](#) document that while household income has no effect on the decision to give, it has a significant effect on the size of the donation. Moreover, [Smeets et al. \(2015\)](#) show that the level of giving by millionaires is "much higher than in other experiments we are aware of" (p. 10,641) and [Andreoni, Nikiforakis and Stoop \(2017\)](#) demonstrate that rich households behave more pro-socially when receiving misdelivered envelopes than poor households. Finally, [Wiepking and Bekkers \(2012\)](#) review over 50 studies showing that income and wealth have a positive effect on the level of philanthropic donations.

9. Conclusion

This paper studies a credence goods problem, where altruistic experts care about their income and the utility of their clients. Crucially, we assume that experts' preferences over income and their consumers' utility are convex, such that experts care less for consumers when their financial situation is bad. Due to a cross-consumer externality, the market outcome is inefficient; price regulation partially overcomes this inefficiency, though. We also show that when entry is endogenous, price regulations should be accompanied by licensing arrangements that cap the number of experts in the market.

Our theory provides a novel rationale for the wide-spread use of price regulation and licens-

ing in real-world markets for expert services that already exist. For instance, there exist legally binding notary fee scales in many OECD countries, including Belgium, Germany, France, Italy, Luxembourg, Malta, Austria, Romania, Spain and the Czech Republic. Moreover, the German Lawyers Remuneration Act (RVG) prescribes fees for the representation of clients in court that may not be undercut; fee increases, on the other hand, are valid if they do not exceed the limit of moral standards ([Economic and Social Committee, 2014](#)). We support such regulation: our analysis demonstrates that price floors in a credence goods market can Pareto-improve upon the market outcome, since experts provide higher quality. The paper thereby opposes recent movements towards the deregulation of markets for expert services; see [Hardege \(2008\)](#) for an overview. The main argument of such endeavors is that entry and competition in expert markets lead to lower prices and thereby increase consumer surplus. We show that this logic does not apply. In our setting, consumers offer prices equal to the experts' acceptance threshold, and minimum price offers entail minimum quality provision on behalf of the experts. Implementing a lower bound on prices, on the other hand, Pareto-improves upon the market outcome.

A. Price Competition

In this section we present an alternative trading mechanism where experts instead of consumers make price (or payment) offers. The environment is the same as in the main text, that is, the one introduced in Section 3. The mechanism works as follows.

Stage 1" Each expert $e \in E$ makes price offers $\{p_{e,b}\}_{b \in B}$ to all consumers.

Stage 2" Each consumer $b \in B$ observes his offers $\{p_{e,b}\}_{e \in E}$ but not the offers received by other consumers. Consumer b then accepts or rejects each of his offers. Each consumer can accept at most one offer.

Stage 3" For each expert e , let $B_e \subset B$ denote the set of consumers who accepted e 's offers. Expert e observes consumers' acceptance decisions and chooses the service quality a_b for each consumer $b \in B_e$.²⁴

For each consumer $b \in \cup_{e \in E} B_e$, set p_b equal to the offer consumer b accepted, that is, $p_b = p_{e,b}$ for e such that $b \in B_e$. Then, each expert receives utility 2. Each consumer $b \in \cup_{e \in E} B_e$ receives utility 1, and all other consumers receive the outside option \underline{v} .

Note that in contrast to the consumer-proposing mechanism from the main text, consumers receive offers from all experts instead of being matched to only one expert each. Our results are robust to adding a matching stage where consumers are matched to only a few, but at least two, experts whom they receive offers from. The minimum number of two experts per consumer is necessary to initiate price competition.

The second noteworthy assumption is that consumers do not observe the offers received by other consumers. This seems appropriate in the context of service provision, where sellers

²⁴Whether experts observe only the acceptance decisions on their own offers or on all experts' offers does not matter for our results. For concreteness we assume here that experts observe all acceptance decisions of all consumers.

interact directly, and often privately, with each buyer to deliver the service. The assumption is not relevant for our first result on the existence of an equilibrium that replicates the outcome of the consumer-proposing mechanism from the main text. The structure of other equilibria however may change when making a different informational assumption.

A.1. Competitive Outcome

Since consumers do not observe other consumers' offers, stages 1'' to 3'' describe a sequential game of imperfect information. We study its perfect Bayesian equilibria (PBE) in the following. We start by constructing a PBE that replicates the competitive outcome of the consumer-proposing mechanism from Proposition 1.

Proposition 6. *Consider the game described by stages 1'' to 3''. There exists a PBE in which all consumers accept offers at marginal cost, $p_b = c(0)$ for all $b \in B$, and receive a service of zero quality, $a_b = 0$ for all $b \in B$.*

Proof. We construct a PBE with the desired properties. The PBE consists of the following elements.

- Expert strategies (for all $e \in E$): for any set B_e , expert e 's quality choices on stage 3'' are determined by the Kuhn-Tucker conditions (7). Moreover, expert e 's price offers on stage 1 are $p_{e,b} = c(0)$ for all $b \in B$.
- Consumer strategies (for all $b \in B$): for any set of offers $\{p_{e,b}\}_{e \in E}$, consumer b accepts the smallest offer if

$$\min_{e \in E} p_{e,b} \leq v(0) - \underline{v}. \quad (16)$$

Otherwise, b rejects all offers. If there are multiple smallest offers satisfying equation (16), b chooses one of them randomly (the exact distribution of the randomization does not matter).

- Expert beliefs: experts' beliefs about the history at any of their information sets is consistent with their observations. Since they observe all events, this uniquely identifies experts' beliefs.
- Consumer beliefs: at any of his information sets, any consumer $b \in B$ believes that all experts $e \in E$ offered $p_{e,b'} = c(0)$ to all other consumers $b' \in B \setminus \{b\}$.

Note first that the proposed beliefs are consistent with equilibrium strategies.

Second, strategies are sequentially rational. To see this, start with experts' quality choices given B_e . Since experts' problem of choosing quality levels to maximize utility is (strictly differentially) concave, the Kuhn-Tucker conditions (7) identify the unique solution to this problem. Moreover, given that consumers always accept the lowest price if it does not exceed the threshold $v(0) - \underline{v}$ and given that all other experts make offers at $c(0)$, there is no profitable deviation from the proposed equilibrium offers. Hence, offers $p_{e,b} = c(0)$ for all $b \in B$ are rational for all experts $e \in E$.

Turning to consumers, note that any consumer b 's belief together with other consumers' equilibrium strategies implies $y_e = 0$ for all experts $e \in E$ and at any information set of b . Hence, consumers believe to receive zero quality at all of their information sets. So, choosing any of the lowest offers if they are below $v(0) - \underline{v}$ and rejecting all offers otherwise is rational for consumers given their belief. \square

The intuition behind Proposition 6 is standard. Consumers accept the lowest prices and experts undercut each other's prices until they hit marginal cost.

In contrast to standard price competition à la Bertrand, however, equilibria with other outcomes exist. Such equilibria are of two types. In the first type, consumers coordinate to buy only from certain sellers but not from others. Suppose for example that all consumers accept the offer of expert 1 as long as it does not exceed a certain threshold level. Expert 1 will then offer the threshold price and all other experts' offers become irrelevant. Consumers may act rationally in this situation because all experts except for expert 1 have zero income and would therefore provide low quality services.

In the second type of equilibrium, consumers coordinate to buy only from those experts who offer a specific price. As soon as some expert deviates from this offer, consumers believe her profits to be zero, because they believe that no other consumer buys from this expert anymore. So, consumers believe that such a deviating expert provides zero quality and may thus indeed shun her rationally.

Both types of equilibria require a high degree of coordination between consumers. For the first type, consumers must believe all other consumers to accept offers only from a certain, arbitrary set of experts. For the second type, they must believe all other consumers to accept only offers at a certain, arbitrary price. We consider such coordination among consumers implausible as a description of many real-world credence goods markets.

To make this reasoning precise, we propose two criteria for equilibrium selection tailored to our environment.²⁵ The criteria restrict consumers' ability to coordinate. Both of them leave only those equilibria that lead to the competitive outcome described in Proposition 6.

A.2. Robustness to Expert Anonymity

Any consumer's decision problem is affected by other consumers' actions exclusively via experts' income levels. Beliefs about experts' incomes are hence crucial for sustaining coordination among consumers. In particular, the types of coordination described above require consumers to entertain different beliefs about different experts' incomes at some of their information sets. To curb such coordination we therefore require consumers' strategies to be optimal even under a belief that treats all experts' incomes identically.

Definition 1. A PBE is robust to expert anonymity if and only if consumer strategies satisfy the following. Take any set of offers $\{p_{e,b}\}_{e \in E}$ for any consumer b . Let $\mathbb{1}_{(e,b)}$ be an indicator function equal to one if b accepts $p_{e,b}$ and zero otherwise, and let $a^{IC}(y_e)$ denote the solution

²⁵While the first of the two criteria (see Definition 1 below) seems inherently specific to our setting with little scope for generalization, the second criterion (Definition 2) might be fruitfully generalized. We refrain from a more general discussion of the selection criteria here, as this is not the focus of our paper.

to the Kuhn-Tucker conditions (7) given y_e . Then, consumer b 's acceptance decision following the offers $\{p_{e,b}\}_{e \in E}$ must maximize

$$\int_{\mathbb{R}^N} \left[\sum_{e \in E} \infty_{(e,b)} \left(v(a^{IC}(y_e)) - p_{e,b} \right) \right] \pi(y_1, y_2, \dots, y_N) d(y_1, y_2, \dots, y_N) + \left(1 - \sum_{e \in E} \infty_{(e,b)} \right) \underline{v} \quad (17)$$

for some probability density function ϕ such that the marginal distributions of the y_e are identical for all e , that is,

$$\tilde{\pi}_e = \tilde{\pi}_{e'} \quad \text{for all } e, e' \in E,$$

where $\tilde{\pi} : y_e \mapsto \mathbb{R}_+$,

$$\tilde{\pi}_e(y_e) := \int_{\mathbb{R}^{N-1}} \pi(y_1, y_2, \dots, y_N) d(y_1, \dots, y_{e-1}, y_{e+1}, \dots, y_N),$$

is the marginal density for y_e .

Robustness to expert anonymity rules out all PBE with consumer strategies that are optimal only under beliefs that discriminate between experts. Since consumer coordination as described above requires such discriminatory beliefs, the robustness criterion excludes all PBE that rely on consumer coordination.

It turns out that only those PBE survive the selection that lead to the competitive outcome of Proposition 6.

Proposition 7. *Consider the game described by stages 1'' to 3''. In any PBE that is robust to expert anonymity (see Definition 1), all consumers accept offers at marginal cost, $p_b = c(0)$ for all $b \in B$, and receive services of zero quality, $a_b = 0$ for all $b \in B$.*

Proof. Step 1. Robustness to expert anonymity imposes a clear structure on consumer strategies. In particular, since the marginal distributions of experts' incomes are identical under π , maximizing (17) is equivalent to choosing the least price offer if

$$\min_{e \in E} p_{e,b} \leq \int_{\mathbb{R}} v(a^{IC}(y_e)) \tilde{\pi}(y_e) dy_e - \underline{v}$$

and rejecting all offers otherwise. Since $a^{IC} \geq 0$,

$$\int_{\mathbb{R}} v(a^{IC}(y_e)) \tilde{\pi}(y_e) dy_e \geq v(0).$$

So, if the minimal offer is unique and equal to $c(0)$, it is accepted with certainty.

Step 2. Given the consumer strategies from step 1 the standard logic of Bertrand competition implies that we can never have a situation where consumers accept offers strictly greater than $c(0)$. Moreover, suppose some consumer b accepts no offer. Then, some expert e could offer $p_{e,b} = c(0)$ and consumer b would accept. Both e and b would decide for this deviation, because we assumed that all agents decide against their outside option in case of indifference. So, the only PBE that are robust to expert anonymity have all consumers accept offers at marginal cost $c(0)$.

Step 3. Finally by step 2, we have $y_e = 0$ for all $e \in E$ while all consumers accept some offer.

The Kuhn-Tucker conditions (7) then imply $a_b = 0$ for all $b \in B$. This must again hold in any PBE that is robust to expert anonymity. \square

A.3. Robustness to Strategic Ambiguity

A critique of robustness to expert anonymity is that consumer strategies must be optimal only under a specific belief π . If consumers cannot coordinate and there are many different equilibrium strategies for consumers, where should such a specific belief come from?

Our second criterion allows consumers to entertain many beliefs and perceive experts' incomes as ambiguous, or uncertain in the Knightian sense. If we additionally assume that consumers are ambiguity averse in the sense of Gilboa and Schmeidler (1989), we obtain the following robustness criterion.

Definition 2. A PBE is robust to strategic ambiguity if and only if consumer strategies satisfy the following. Take any set of offers $\{p_{e,b}\}_{e \in E}$ for any consumer b . Let $\infty_{(e,b)}$ be an indicator function equal to one if b accepts $p_{e,b}$ and zero otherwise, and let $a^{IC}(y_e)$ denote the solution to the Kuhn-Tucker conditions (7) given y_e . Then, consumer b 's acceptance decision following the offers $\{p_{e,b}\}_{e \in E}$ must maximize

$$\min_{(y_1, y_2, \dots, y_N) \in \mathbb{R}^N} \sum_{e \in E} \infty_{(e,b)} \left(v(a^{IC}(y_e)) - p_{e,b} \right) + \left(1 - \sum_{e \in E} \infty_{(e,b)} \right) \underline{v}. \quad (18)$$

In a PBE that is robust to strategic ambiguity, consumer strategies are supported by two considerations. First, as is usual in a PBE, consumers can anticipate other agents' strategies, form beliefs about unobserved events accordingly, and choose their strategies as a best response to the anticipated behavior of others. Second, consumers may perceive the behavior of others as ambiguous and choose the strategies that optimize the worst-case outcome.²⁶

The only PBE that are robust to strategic ambiguity are those leading to the competitive outcome of Proposition 6.

Proposition 8. Consider the game described by stages 1'' to 3''. In any PBE that is robust to strategic ambiguity (see Definition 2), all consumers accept offers at marginal cost, $p_b = c(0)$ for all $b \in B$, and receive services of zero quality, $a_b = 0$ for all $b \in B$.

Proof. In analogy to the proof of Proposition 7, robustness to strategic ambiguity has clear implications for consumer strategies. In particular, the worst-case outcome for consumers for any acceptance decision they make is when $y_e \leq 0$ for all $e \in E$. So, maximizing (18) is equivalent to maximizing

$$\sum_{e \in E} \infty_{(e,b)} (v(0) - p_{e,b}) + \left(1 - \sum_{e \in E} \infty_{(e,b)} \right) \underline{v}.$$

²⁶Moreover, the combination of the usual PBE requirements with robustness to strategic ambiguity allows consumers to engage in considerations of the following type in equilibrium. Any given consumer anticipates that all other consumers perceive others' behavior as ambiguous and optimize their worst-case outcomes. The given consumer then chooses his strategy as a best response to this anticipated behavior of others.

This expression is maximized by accepting the least price offer if

$$\min_{e \in E} p_{e,b} \leq v(0) - \underline{v}$$

and rejecting all offers otherwise. This is essentially the same result as obtained from step 1 in the proof of Proposition 7. The remainder of the proof is then analogous to steps 2 and 3 of the proof of Proposition 7. \square

A.4. Robustness with Two Experts

As a final remark, for $N = 2$ experts the selection criteria can be relaxed substantially. In particular, with two experts it is sufficient to restrict the off-equilibrium part of consumers' strategies. For expositional reasons we focus on robustness to strategic ambiguity here.

Definition 3. A PBE is weakly robust to strategic ambiguity if and only if any consumer b 's actions following any off-equilibrium set of offers $\{p_{e,b}\}_{e \in E}$ satisfy the requirements of robustness to strategic ambiguity described in Definition 2.

The reduction to off-equilibrium actions is substantial. The weakened criterion allows consumers to believe in coordination on any arbitrary set of strategies. Only once they observe an event that is incompatible with the strategies they believed in, consumers revert to ambiguity-averse behavior without committing to any specific new belief about other agents' actions.

For two experts, the weak robustness criterion is sufficient to exclude all outcomes except for the competitive one.

Proposition 9. Consider the game described by stages 1'' to 3'' and suppose that $N = 2$. Then in any PBE that is weakly robust to strategic ambiguity (see Definition 2) and has experts play pure strategies, all consumers accept offers at marginal cost, $p_b = c(0)$ for all $b \in B$, and receive services of zero quality, $a_b = 0$ for all $b \in B$.

Proof. Note first that all consumers under all circumstances prefer to accept an offer smaller or equal to $v(0) - \underline{v}$ to rejecting all offers.

Suppose now that in some PBE as described in the proposition, some consumer b accepts no offer. Then in such a PBE, all offers for consumer b must be strictly above $v(0) - \underline{v}$. But then, expert 1 could deviate to offer $p_{1,b} = v(0) - \underline{v}$. This deviation makes consumer b optimize his worst-case outcome according to weak robustness to strategic ambiguity. Thus, b accepts the least price offer if it does not strictly exceed $v(0) - \underline{v}$. Hence, b accepts $p_{1,b}$. But since $p_{1,b} = v(0) - \underline{v} \geq c(0)$, expert 1 is better off through her initial deviation. So there cannot be a PBE as described in the proposition where some consumer rejects all offers.

Next suppose that in some PBE as described in the proposition, some consumer b accepts an offer $p_{2,b} > c(0)$. Then, expert 1 can deviate to some offer $p_{1,b}$ such that $p_{1,b} < p_{2,b}$ and $p_{1,b} \in [c(0), v(0) - \underline{v}]$. The deviation again makes b optimize his worst-case outcome, so b accepts $p_{1,b}$. This makes expert 1 better off, so the deviation is profitable for expert 1. Thus, there cannot be a PBE as described in the proposition where some consumer accepts an offer above marginal cost.

Hence we have shown that in any PBE as described in the proposition, all consumers accept offers at marginal cost $c(0)$. This immediately implies $y_e = 0$ for all experts and, by conditions (7), $a_b = 0$ for all consumers. \square

B. Omitted Proofs

This section collects all proofs omitted from the main texts.

B.1. Proof of Lemma 1

Let

$$A(p_b, y_e, a_b) := W'(y_e) [p_b - c(a_b)] + v(a_b) - p_b$$

denote the marginal utility for expert e of adding consumer b to her set of clients B_e if she provides quality a_b to b .

Expert e 's actual quality choice for consumer b follows from conditions (7) as a function of the expert's income y_e . Denote this quality by $a_b^{IC}(y_e)$. Then, the expert's actual marginal utility from serving consumer b , taking into account her quality choice $a_b^{IC}(y_e)$, becomes

$$A^{IC}(p_b, y_e) := A(p_b, y_e, a_b^{IC}(y_e)).$$

Expert e will accept an offer p_b if and only if $A^{IC}(p_b, y_e) \geq 0$. Hence, the equality $A^{IC} = 0$ defines the acceptance threshold described by Lemma 1.

Before deriving the claimed properties of the threshold, note that

$$A^{IC}(p_b, y_e) = \max_{a \geq 0} A(p_b, y_e, a) \tag{19}$$

by definition of $a_b^{IC}(y_e)$. In words, the expert chooses the service quality for b such as to maximize her utility from serving b .

Case 1: $y_e \leq 0$. By assumption (4), we have $a_b^{IC}(y_e) = 0$ for all $y_e \leq 0$. Hence, $A^{IC}(c(0), y_e) = 0$ for all $y_e \leq 0$. That is, if the expert has negative income, she just accepts an offer at $c(0)$. Since A^{IC} is strictly increasing in p_b , we have that for all $y_e \leq 0$, $A^{IC}(p_b, y_e) \geq 0$ if and only if $p_b \geq c(0)$. This proves the first piece of the acceptance threshold in Lemma 1.

Case 2: $y_e > 0$. As in Lemma 1, denote the acceptance threshold for $y_e > 0$ by $\tilde{p}(y_e)$, that is, $A^{IC}(\tilde{p}(y_e), y_e) = 0$.

First note that $A(c(0), y_e, 0) = 0$ for all y_e . Hence, $A^{IC}(c(0), y_e) \geq 0$ for all y_e . Therefore, the acceptance threshold satisfies $\tilde{p}(y_e) \leq c(0)$ for all y_e .

It remains to show that $\tilde{p}(y_e)$ is decreasing in y_e . For that, consider $y_e^{(2)} > y_e^{(1)} > 0$. From the definition of A we see that A is increasing in y_e if $p_b \leq c(0)$. Since $\tilde{p}(y_e^{(1)}) \leq c(0)$, we

obtain the following inequalities:

$$\begin{aligned}
A^{IC} \left(\tilde{p} \left(y_e^{(2)} \right), y_e^{(2)} \right) &= 0 \\
&= A \left(\tilde{p} \left(y_e^{(1)} \right), y_e^{(1)}, a_b^{IC} \left(y_e^{(1)} \right) \right) \\
&\leq A \left(\tilde{p} \left(y_e^{(1)} \right), y_e^{(2)}, a_b^{IC} \left(y_e^{(1)} \right) \right) \\
&\stackrel{\text{by (19)}}{\leq} A \left(\tilde{p} \left(y_e^{(1)} \right), y_e^{(2)}, a_b^{IC} \left(y_e^{(2)} \right) \right) \\
&= A^{IC} \left(\tilde{p} \left(y_e^{(1)} \right), y_e^{(2)} \right).
\end{aligned}$$

Using that A^{IC} is always increasing in p_b , the inequality between the first and the last expression implies $\tilde{p}(y_e^{(2)}) \leq \tilde{p}(y_e^{(1)})$.

B.2. Proof of Proposition 1

We prove Proposition 1 via the following lemma.

Lemma 4. *Consider the game described by stages 1 and 2. In any subgame perfect equilibrium all offers are symmetric, $p_b = p_{b'}$ for all $b, b' \in B$, all offers are accepted, and all quality levels are symmetric, $a_b = a_{b'}$ for all $b, b' \in B$.*

Proof. **Step 1.** The thresholds in Lemma 1 imply that an offer $p_b = c(0)$ is always accepted. Since $v(0) - c(0) \geq \underline{v}$ and agents always opt against their outside option in case of indifference, consumers always prefer to make the offer $c(0)$ over any offer that is not accepted. Hence, offers that are not accepted are strictly dominated and cannot be part of a subgame perfect equilibrium.

Step 2. Consider now all consumers $b \in B_e$ for a given expert e . By the Kuhn-Tucker conditions (7), these consumers all receive the same quality level. Moreover, they face the same acceptance threshold. Since all consumers take expert e 's income as given, they anticipate the quality they receive to be independent of their offers. Hence, they offer exactly the acceptance threshold, which is the same across all consumers.

Step 3. By Step 2, any expert e receives the same offers from all consumers matched to her. Suppose now that these offers are strictly higher for some expert e than for another expert e' . Denote the offer level for e by p and for e' by p' . By Step 1, all offers are accepted. So, experts' revenue equals their offer level,

$$\int_{B_e} p_b db = p > \int_{B_{e'}} p_b db = p'.$$

Using this in the Kuhn-Tucker conditions (7), it is easy to show that expert e will also have greater income than expert e' , $y_e \geq y_{e'}$. But then, by Lemma 1, the acceptance threshold of expert e is smaller than that of expert e' . Hence, consumers matched to e offer lower payments than consumers matched to e' . This contradicts the initial assumption of $p > p'$.

We have therefore established that all consumers offer the same payments and all offers are accepted in any subgame perfect equilibrium. The Kuhn-Tucker conditions (7) then im-

mediately imply that quality levels are the same for all consumers in any subgame perfect equilibrium as well. \square

Proposition 1 is now proven as follows. By Lemma 4, there is a common offer level $p = p_b$ for all $b \in B$. By Lemma 1, offers $p_b = c(0)$ are always accepted. Moreover, consumers always offer payments exactly equal to the expert's acceptance threshold. So, the common offer level p can be at most $c(0)$.

Suppose that $p < c(0)$. Then, any expert e has negative income, $y_e \leq 0$. But for $y_e \leq 0$, Lemma 1 says that offers below $c(0)$ are rejected. Hence, we must have $p = c(0)$ in any subgame perfect equilibrium. The Kuhn-Tucker conditions (7) then imply $a_b = 0$ for all $b \in B$ in any subgame perfect equilibrium.

B.3. Proof of Proposition 3

The only part of the proposition that remains to be shown is that an allocation is fully efficient if and only if $a_b = a^{**}$ for almost all $b \in B$.

(\Rightarrow) We first prove the "only if" part of the claim. To show that no allocation other than those described above is fully efficient, take an arbitrary allocation q , $\{p_b^q\}_{b \in B}$, $\{B_e\}_{e \in E}$, $\{a_b^q\}_{b \in B}$, with $a_b^q \neq a^{**}$ for some non-zero measure of consumers. Construct a new allocation r with $a_b^r = a^{**}$ for all $b \in B$, $B_e^r = B_e^q$ for all $e \in E$, and

$$p_b^r = p_b^q + v(a_b^r) - v(a_b^q).$$

Comparing r to q , the utility of consumers is unchanged by construction of r . For an expert e the utility change is $W(y_e^r) - W(y_e^q)$. Its sign depends on the difference in incomes $y_e^r - y_e^q$. Using the construction of payments p_b^r in allocation r , this income difference becomes

$$y_e^r - y_e^q = \int_{B_e^q} [v(a_b^r) - c(a_b^r) - v(a_b^q) + c(a_b^q)] db.$$

Since a^{**} uniquely maximizes $v(a) - c(a)$, the income difference is positive, $y_e^r - y_e^q > 0$. Hence, experts strictly prefer allocation r to q . Since consumers are indifferent between the two, allocation r Pareto-dominates q . Allocation q can therefore not be fully efficient.

(\Leftarrow) To see that any allocation with $a_b = a^{**}$ for almost all b is fully efficient, suppose such an allocation (call it s) is Pareto-dominated by some other allocation (call it t). If t has $a_b \neq a^{**}$ for a non-zero measure of consumers, part (\Rightarrow) above implies that there exists an allocation t' with $a_b^{t'} = a^{**}$ almost everywhere that Pareto-dominates t . By transitivity, t' will then also Pareto-dominate s . Hence, we can focus on allocations t that feature $a_b^t = a^{**}$ for almost all b .

Allocations s and t then only differ in the distribution of payments over experts and consumers. Since this distribution is zero-sum, none of the allocations can Pareto-dominate the other. We have thereby established that any allocation with $a_b = a^{**}$ almost everywhere is fully efficient.

B.4. Proof of Lemma 2

Given a non-empty set of active experts E , the subgame described by stages 2' and 3' is very similar to the game with exogenous entry described by stages 1 and 2 in Section 5. The main difference is that expert e 's marginal cost of serving an additional consumer b is $c(a_b) + k'(|B_e|)$ instead of $c(a_b)$ only. The proof of the acceptance threshold in Lemma 2 therefore proceeds in close analogy to the proof of the acceptance threshold from the exogenous entry setting in Lemma 1.

Let

$$\hat{A}(p_b, B_e, \hat{y}_e, a_b) := W'(\hat{y}_e) [p_b - c(a_b) - k'(|B_e|)] + v(a_b) - p_b - v(0) + k'(|B_e|)$$

denote expert e 's marginal utility from adding consumer b to her set of clients B_e if she provides quality a_b to the consumer.

Expert e 's actual quality choice follows from the Kuhn-Tucker conditions (7) as a function of \hat{y}_e . Denote this quality by $\hat{a}_b^{IC}(\hat{y}_e)$. Then, the expert's actual marginal utility from accepting the offer p_b , taking into account her quality choice $\hat{a}_b^{IC}(\hat{y}_e)$, becomes

$$\hat{A}^{IC}(p_b, B_e, \hat{y}_e) := \hat{A}(p_b, B_e, \hat{y}_e, \hat{a}_b^{IC}(\hat{y}_e)).$$

Expert e will accept p_b if and only if $\hat{A}^{IC}(p_b, B_e, \hat{y}_e) \geq 0$. The equality $\hat{A}^{IC} = 0$ therefore defines the acceptance threshold from Lemma 2.

Note at this point that

$$\hat{A}^{IC}(p_b, B_e, \hat{y}_e) = \max_{a \geq 0} \hat{A}(p_b, B_e, \hat{y}_e, a) \quad (20)$$

by definition of $\hat{a}_b^{IC}(\hat{y}_e)$.

Case 1: $\hat{y}_e \leq 0$. Assumption (4) implies $\hat{a}_b^{IC}(\hat{y}_e) = 0$ for all $\hat{y}_e \leq 0$. So, $\hat{A}^{IC}(k'(|B_e|), \hat{y}_e) = 0$ for all $\hat{y}_e \leq 0$. That is, at negative income the expert just accepts an offer at marginal cost $k'(|B_e|)$. Since \hat{A}^{IC} is strictly increasing in p_b , it holds for all $\hat{y}_e \leq 0$ that $\hat{A}^{IC}(p_b, B_e, \hat{y}_e) \geq 0$ if and only if $p_b \geq k'(|B_e|)$. We have thus proven the first piece of the acceptance threshold in Lemma 2.

Case 2: $\hat{y}_e > 0$. Denote the acceptance threshold for $\hat{y}_e > 0$ by $\hat{p}(\hat{y}_e, B_e)$, that is, $\hat{A}^{IC}(\hat{p}(\hat{y}_e, B_e), B_e, \hat{y}_e) = 0$.

Note that $\hat{A}(k'(|B_e|), B_e, \hat{y}_e, 0) = 0$ for all \hat{y}_e and B_e . Thus, $\hat{A}^{IC}(k'(|B_e|), B_e, \hat{y}_e) \geq 0$ for all \hat{y}_e and B_e . Hence, we have $\hat{p}(\hat{y}_e, B_e) \leq k'(|B_e|)$ for all \hat{y}_e and B_e .

It remains to prove that $\hat{p}(\hat{y}_e, B_e)$ is decreasing in \hat{y}_e . Take any B_e and any two income levels $\hat{y}_e^{(2)} > \hat{y}_e^{(1)} > 0$. From the definition of \hat{A} , it is clear that \hat{A} increases in \hat{y}_e if $p_b \leq k'(|B_e|)$. Since

$\hat{p}(\hat{y}_e^{(1)}, B_e) \leq k'(|B_e|)$, the following applies:

$$\begin{aligned}
\hat{A}^{IC} \left(\hat{p} \left(\hat{y}_e^{(2)}, B_e \right), B_e, \hat{y}_e^{(2)} \right) &= 0 \\
&= A \left(\hat{p} \left(\hat{y}_e^{(1)}, B_e \right), B_e, y_e^{(1)}, \hat{a}_b^{IC} \left(\hat{y}_e^{(1)} \right) \right) \\
&\leq \hat{A} \left(\hat{p} \left(\hat{y}_e^{(1)}, B_e \right), B_e, \hat{y}_e^{(2)}, \hat{a}_b^{IC} \left(\hat{y}_e^{(1)} \right) \right) \\
&\stackrel{\text{by (20)}}{\leq} \hat{A} \left(\hat{p} \left(\hat{y}_e^{(1)}, B_e \right), B_e, \hat{y}_e^{(2)}, \hat{a}_b^{IC} \left(\hat{y}_e^{(2)} \right) \right) \\
&= \hat{A}^{IC} \left(\hat{p} \left(\hat{y}_e^{(1)}, B_e \right), B_e, \hat{y}_e^{(2)} \right).
\end{aligned}$$

Since \hat{A}^{IC} always increases in p_b , the inequality between the first and the last expression implies $\hat{p}(\hat{y}_e^{(2)}, B_e) \leq \hat{p}(\hat{y}_e^{(1)}, B_e)$.

B.5. Proof of Lemma 3

To prepare the proofs of Lemma 3 and Proposition 4, we prove the following lemma.

Lemma 5. *Take any non-empty set of active experts E and consider the subgame after E described by stages 2' and 3'. In any subgame perfect equilibrium of this subgame all offers are symmetric, $p_b = p_{b'}$ for all $b, b' \in B$, all offers are accepted, and all quality levels are symmetric, $a_b = a_{b'}$ for all $b, b' \in B$.*

Proof. Take a non-empty set of active experts E and consider the subgame after E described by stages 2' and 3'. This subgame is almost equivalent to the game with exogenous entry described by stages 1 and 2 in Section 5. Hence, the proof of Lemma 5 closely follows the proof of Lemma 4.

Step 1. The maximum size of B_e for any expert e is M . Hence, Lemma 2 implies that experts always accept an offer $p_b \geq k'(M)$. Since $v(0) - k'(M) \geq \underline{v}$ and agents always decide against their outside option in case of indifference, any consumer b prefers the offer $p_b = k'(M)$ over any offer that is not accepted. So, consumers only make offers that are accepted in equilibrium.

Step 2. This step is identical to step 2 in the proof of Lemma 4. We repeat it here for convenience. Consider all consumers $b \in B_e$ for a given expert e . By the Kuhn-Tucker conditions (7) (using \hat{y}_e instead of y_e in the conditions), these consumers all receive the same quality level. Moreover, they face the same acceptance threshold. Since all consumers take expert e 's income as given, they anticipate the quality they receive to be independent of their offers. Hence, they offer exactly the acceptance threshold, which is the same across all consumers.

Step 3. By Step 2, any expert e receives the same offers from all consumers matched to her. To derive a contradiction, suppose that these offers are strictly higher for some expert e than for another expert e' . Denote the offer level for e by p and for e' by p' . By Step 1, all offers are accepted. So, the revenues of e and e' are given by

$$\int_{B_e} p_b db = \frac{M}{N} p > \frac{M}{N} p' = \int_{B_{e'}} p_b db.$$

Using this together with the fact that $|B_e| = |B_{e'}|$, the Kuhn-Tucker conditions (7) imply that expert e will have a greater income than e' , $\hat{y}_e \geq \hat{y}_{e'}$. Then, again because $|B_e| = |B_{e'}|$, Lemma

2 implies that the acceptance threshold of expert e is smaller than that of e' . So, consumers matched to e make smaller offers than those matched to e' , contradicting the initial assumption $p > p'$.

We have therefore established that all consumers offer the same payments and all offers are accepted in any subgame perfect equilibrium. The Kuhn-Tucker conditions (7) then immediately imply that quality levels are the same for all consumers in any subgame perfect equilibrium as well. \square

We prove now each of the three cases of Lemma 3. Since by Lemma 5 all offers are accepted, we can set $|B_e| = M/N$ for all active experts $e \in E$ throughout the proof.

1. We first show that $\hat{y}_e > 0$ for all $e \in E$. To derive a contradiction, suppose that $\hat{y}_e \leq 0$ for some $e \in E$. Using Lemma 2, this implies that all consumers $b \in B_e$ offer $p_b = k'(M/N)$. Moreover, the Kuhn-Tucker conditions (7) imply that $a_b = 0$ for all $b \in B_e$. But then we obtain for expert e 's income:

$$\hat{y}_e = \frac{M}{N}k' \left(\frac{M}{N} \right) - k \left(\frac{M}{N} \right) - F > 0 ,$$

a contradiction.

So, $\hat{y}_e > 0$ for all $e \in E$. From Lemma 2 we then obtain $p_b \leq k'(M/N)$ for all $b \in B$.

For experts' utility, note that $a_b \geq 0$ and $p_b \leq k'(M/N)$ for all b imply

$$v(a_b) - p_b - v(0) + k' \left(\frac{M}{N} \right) > 0 .$$

Hence, using $\hat{y}_e > 0$,

$$W(\hat{y}_E) + \int_{B_e} \left[v(a_b) - p_b - v(0) + k' \left(\frac{M}{N} \right) \right] db > W(0)$$

for all $e \in E$.

2. We show that $\hat{y}_e = 0$ for all $e \in E$. To derive a contradiction, suppose first that $\hat{y}_e > 0$ for some $e \in E$. But then $p_b \leq k'(M/N)$ for all $b \in B_e$ by Lemma 2. Together with $a_b \geq 0$ for all b , this implies

$$\hat{y}_e \leq \frac{M}{N}k' \left(\frac{M}{N} \right) - k \left(\frac{M}{N} \right) - F = 0 ,$$

a contradiction. Suppose now that $\hat{y}_e < 0$ for some $e \in E$. Then, $p_b = k'(M/N)$ for all $b \in B$ by Lemma 2. Moreover, expert e 's quality choice yields $a_b = 0$ for all $b \in B_e$ by conditions (7). Hence we obtain for expert e 's income:

$$\hat{y}_e = \frac{M}{N}k' \left(\frac{M}{N} \right) - k \left(\frac{M}{N} \right) - F = 0 ,$$

a contradiction.

So, $\hat{y}_e = 0$ for all $e \in E$. Using Lemma 2, we obtain $p_b = k'(M/N)$ for all $b \in B$.

Moreover, $\hat{y}_e = 0$ for all $e \in E$ implies $a_b = 0$ for all $b \in B$. So,

$$v(a_b) - p_b - v(0) + k'(M/N) = 0$$

for all $b \in B$. Experts' utility thus becomes

$$W(0) + \int_{B_e} \left[v(0) - k' \left(\frac{M}{N} \right) - v(0) + k' \left(\frac{M}{N} \right) \right] db = W(0)$$

for all $e \in E$.

3. We first show that $\hat{y}_e < 0$ for all $e \in E$. To derive a contradiction, suppose $\hat{y}_e \geq 0$ for some $e \in E$. Then, $p_b \leq k'(M/N)$ for all $b \in B_e$ by Lemma 2. Using $a_b \geq 0$ for all b , we obtain

$$\hat{y}_e \leq \frac{M}{N} k' \left(\frac{M}{N} \right) - k \left(\frac{M}{N} \right) - F < 0,$$

a contradiction.

So, $\hat{y}_e < 0$ for all $e \in E$. With Lemma 2 we then obtain $p_b = k'(M/N)$ for all $b \in B$.

Moreover, $\hat{y}_e < 0$ for all e implies $a_b = 0$ for all b . Experts' utility hence satisfies

$$W(\hat{y}_e) + \int_{B_e} \left[v(0) - k' \left(\frac{M}{N} \right) - v(0) + k' \left(\frac{M}{N} \right) \right] db < W(0)$$

for all $e \in E$.

B.6. Proof of Proposition 4

Since all offers are accepted by Lemma 5, we can again set $|B_e| = M/N$ throughout the proof.

From conditions (11) and (12), we have $M/N \rightarrow m$ as $M \rightarrow \infty$. Moreover,

$$\frac{M}{N} k' \left(\frac{M}{N} \right) - k \left(\frac{M}{N} \right) - F \rightarrow 0.$$

We first show that $\hat{y}_e \rightarrow 0$ for all $e \in E$ as $M \rightarrow \infty$. For that, take any unbounded sequence of consumer masses M . To derive a contradiction, suppose first that there exists a subsequence such that \hat{y}_e is positive and bounded away from zero along this subsequence. Since $p_b \leq k'(M/N)$ for all $b \in B$ by Lemma 2 and because $a_b \geq 0$ for all b , we have

$$\hat{y}_e \leq \frac{M}{N} k' \left(\frac{M}{N} \right) - k \left(\frac{M}{N} \right) - F.$$

But the right-hand-side of the inequality converges to zero along the subsequence. Hence, \hat{y}_e cannot be positive and bounded away from zero.

Suppose now that there is a subsequence of consumer masses along which \hat{y}_e remains negative and bounded away from zero for some $e \in E$. Then by Lemma 2, $p_b = k'(M/N)$ along the subsequence. Moreover, $a_b = 0$ for all $b \in B_e$ along the subsequence by conditions

(7). Thus,

$$\hat{y}_e = \frac{M}{N}k' \left(\frac{M}{N} \right) - k \left(\frac{M}{N} \right) - F \rightarrow 0,$$

a contradiction.

We have therefore established that $\hat{y}_e \rightarrow 0$ for all $e \in E$ as $M \rightarrow \infty$. From conditions (7), we then immediately obtain $a_b \rightarrow 0$ for all $b \in B$.

Finally by Lemma 5, there is a common payment level p and a common quality level a for all consumers. Income of expert e thus becomes

$$\hat{y}_e = \frac{M}{N}p - \frac{M}{N}c(a) - k \left(\frac{M}{N} \right) - F,$$

and hence

$$p = \frac{N}{M}\hat{y}_e + c(a) + \frac{N}{M}k \left(\frac{M}{N} \right) + \frac{N}{M}F.$$

Since $M/N \rightarrow m$, $a \rightarrow 0$, and $\hat{y}_e \rightarrow 0$, we can use the definition of m to show that the right-hand-side of the equation goes to $k'(m)$ as $M \rightarrow \infty$. Therefore, $p_b \rightarrow k'(m)$ for all $b \in B$.

B.7. Proof of Proposition 5

Part 1. Consider first the regulation (\hat{p}^*, \hat{N}) . In the main text we have already shown that the proposed regulation Pareto-dominates the unregulated (or, competitive) outcome for sufficiently large M if the actual number of active experts \tilde{N} equals the cap \hat{N} . To see that we will indeed have $\tilde{N} = \hat{N}$, consider the competitive outcome at a given M . From Proposition 4, it is easy to see that experts' utility in the competitive outcome approaches $W(0)$ as $M \rightarrow \infty$. Again from Proposition 4, we know that $p_b \rightarrow k'(m)$ for all b as $M \rightarrow \infty$. Hence, for sufficiently large M the regulated price \hat{p}^* strictly exceeds the competitive price. Holding the number of active experts constant at \hat{N} , an increase in the level of payments strictly increases experts' utility. So for large M and holding the number of experts at \hat{N} , experts' utility from the regulated price \hat{p}^* strictly exceeds $W(0)$. But that means that all \hat{N} experts indeed choose to enter the market under the regulation (\hat{p}^*, \hat{N}) for sufficiently large M . Hence, the cap of \hat{N} is binding, $\tilde{N} = \hat{N}$.

Part 2. Consider next the pure price regulation (\hat{p}^*, ∞) . Denote the number of active experts under this regulation by \tilde{N} and compare it to the regulated number of experts \hat{N} from Part 1. By Part 1, experts' utility under the joint regulation (\hat{p}^*, \hat{N}) converges to a level strictly above $W(0)$. Moreover as $M \rightarrow \infty$, the impact of an additional entrant on experts' utility approaches zero. Hence, without entry regulation the expert $\hat{N} + 1$ finds it beneficial to enter the market. So, $\tilde{N} > \hat{N}$. Since experts' utility declines in the number of active experts for given prices, experts' utility is strictly smaller under the pure price regulation than under the joint regulation of Part 1.

Moreover, suppose that experts' income \hat{y}_e is greater under the pure price regulation than under the joint regulation. This would imply that service quality is higher under the pure price regulation as well. But with a higher service quality and a larger number of active experts, income must be strictly smaller under the pure price regulation than under joint regulation. Hence, experts' income is indeed strictly smaller under the pure price than under

the joint regulation.

Finally, under the joint regulation we have $a_b > 0$ for all consumers. So experts' quality choice problem has an interior solution. In the neighborhood of such an interior solution, quality strictly decreases in income. So, service quality must be strictly smaller under the pure price regulation than under the joint regulation. Since the payments p_b are the same in both cases, we obtain that consumers' utility is strictly smaller under the pure price regulation than under the joint regulation. This establishes that the joint regulation Pareto-dominates the pure price regulation.

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