Minimum Education Requirements for Professions as a Mechanism to prevent Externalities

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Abstract

This paper proposes a new justification for minimum education requirements in professional services. In our model, these requirements prevent external effects caused by low-standard professional work. The threat of losing their occupation-specific human capital makes professionals more sensitive to the punishment of being excluded from the profession, but the same human capital makes it also easier for them to do high-standard work. This mechanism is compared with alternative methods to prevent the externality.
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1 Introduction

In the last years, the regulation of professional services has become an important topic of european competition policy. The European Commission has undertaken a "stocktaking exercise" of existing regulations for lawyers, notaries, accountants, architects, engineers and pharmacists and has voiced doubts whether many of these regulations are justified.[1] Furthermore, the Commission has already issued

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[1]Commission of the European Communities, Report on Competition in Professional Services, Brussels, 9.2.2004, COM(2004) 83 final and Commission of the European Communities, Professional Services – Scope for more reform, Brussels, 5.9.2005, COM(2005) 405 final.

the first enforcement action against a professional association.[2] But the Commission's approach to evaluating justifications for professional regulations has been been critizised – not only by representatives of the professions, but also by a number of scholars in law and economics. They have questioned whether such deregulation proposals do even "attempt to understand the nature of the services"[3] or whether they suffer from an "anti-regulation bias".[4]

This paper focuses on one kind of professional regulation, namely minimum qualification requirements. The many other existing regulations, like regulations on business structure or advertising, will not be considered. Under minimum qualification requirements[5], a person who wants to offer certain professional services is required to have some legally prescribed academic and practical qualification. For example, a person who wants to give legal advice or represent others in court may be required to have a law degree or to have passed a state legal examination. But these minimum qualification requirements are still liberal in the sense that they do not fix a maximum number of practioners in the profession. Everyone who has the prescribed qualification can enter the market.

The traditional justification for education requirements stresses asymmetric informations between customers and producers in the markets for professional services. According to this justification, customers are not able to judge competently the quality of professional services. Therefore customers are in danger of receiving inferior quality. This standard explanation does not seem to be adequate.

A standard critique of this justification points out that the same effect can also be achieved by "certification".[6] Under a certification system, producers of professional services can aquire relevant qualifications, like degrees or titles, from authorized bodies and can advertise those degrees and titles. Other practitioners are also allowed to offer the service, but are prohibited from claimimg that they hold such a degree or title.[7] Customers can then choose between practitioners who hold the certified qualification and other who practice without it. For example, in this setting, everybody may offer legal advice and appear in court but only persons with a law degree may call themselves "lawyers". Using certification has the advantage that it does not choke off the low-quality/low-price segment

[2]Commission decision of 24 June 2004 (Case COMP/38.2549).

[3]Arruñada (2006).

[4]Van den Bergh and Montangie (2006).

[5]The European Commission speaks about quantitative entry restrictions; in the United States, the term "occupational licensing" is used.

[6]Friedman (1962), ch. 9.

[7]An examples of an existing certification schemes is the "Chartered Financial Analyst" (CFA); there are also numerous certification schemes in the software industry.

of the market. If this segment of the market is not available, consumers may not buy high quality gservices but may instead forego buying the service at all or may substitute "do-it-yourself work", which may be of even worse quality than the work of less-qualified producers.

Asymmetric information about the quality of professional services can also be alleviated by reputation effects. Customers may be able to learn about the quality offered by different service providers through repeated purchases or recommendations from other customers. In certain professional fields, for example corporate law, this mechanism might work very well. But it is unlikely that reputation concerns will work well in markets in which purchases happen too infrequent or where the producer side is too fragmented.

A more fundamental problem with education requirements is that they do not regulate quality directly, [8] but only regulate one input in the production of professional services – the producer's human capital. It is not self-evident that practitioners with high human capital will necessarily produce high quality. Furthermore, in most professional fields, there do exist direct regulations of service quality, both specific rules on how the professionals work should be done as well as the general rules of tort and criminal law. The problem with these direct regulations lies in the detection of their breach and the punishment of the offender. The correlation beween quality and outcome of professional work is often rather imperfect. This makes it difficult to monitor professionals and the available punishments for breach of these rules may be inadequate for deterrence. Monetary restitution for victims of bad quality may also seem to be inadequate, especially with regard to damages to life and health.

In contrast to the standard justification, our model asumes that education requirements are imposed to prevent a negative externality connected with the professional service. In the following, we will call work without the externality "good work" and work with the externality "bad work". Because customers have no incentive to prefer work without the externality, a certification scheme or reputation concerns will not ensure good work. Furthermore, we model education requirements as input regulations and endogenize the causal chain between high human capital und good work.

As has been pointed out in the current policy debate, the standard at which a professional service is executed can have effects on persons different from the customer. Common examples of such external effects are physicans and the effects

[8] Leland (1979) discusses a model with direct regulation of quality.

of their work on public health and civil engineers and the relation between the structural stability of buildings and the safety of passers-by. But there are also some more subtle pathways through which professional work can have effects on third parties. In many cases professionals are tasked with so-called "gatekeeping duties". They are required to prevent misconduct of their clients by withholding their cooperation and support if they detect such misconduct (Kraakman, 1986). The reason why these gatekeeping duties are imposed is usually that the professional should ensure that interests apart from those of the parties involved are taken account of.

For example, in some civil law countries, where the participation of a notary is necessary to transfer real estate, the notary must check whether all relevant taxes have been payed for the transaction and whether the required building permits do exist.[9] In many countries, only pharmacists can sell most kinds of prescription-drugs to the public. Pharmacists are gatekeepers in the sense that they check whether the desired prescription-drug has been prescribed by an authorised person (usually a physician). This rule seems to be purely paternalistic, because its aim is to prevent customers from harming themselves through the use of inappropriate drugs. But one can justify these rules also in the sense that there is an "externality" in the form of a self-control problem – a person who has become addicted to a certain prescription drug only takes into account his short-term interest of getting the drug, not his long-term interests (a non-addicted person might consent beforehand to this limitation if he should ever become addicted). In the case of gatekeeping duties, customers who are intent on wrongdoing are usually interested in getting an especially lax practitioner, so certification will not work and reputation might even have adverse effects.

In our model, the causal chain between between high human capital und good work is as follows: education requirements make producers more sensitive to the punishment of being thrown out of the profession, because in this case they will loose their occupation-specific human capital; but education requirements also make good work easier. In other words, education that is specific to the profession is both a "hostage" to ensure good work and makes such good work easier to accomplish.

The causal chain works by making producers more sensitive to punishment by giving them a quasi-rent. Therefore, we will compare the welfare effects of education requirements with those of a quantitative entry restriction (*numerus clausus*)

[9] Comp. Arruñada (1996) and Van den Bergh and Montangie (2006).

that gives a direct rent to the producers. We show that if the regulator only cares about consumers' surplus, education requirements are always preferable to the quantitative entry restrictions. If the regulator cares about total surplus, education requirements are only preferable under certain parameters. Furthermore, we discuss bonding as an possible alternative and discuss the question why it is only infrequently seen in reality.

The idea that agents can be made more sensitive to punishment through the granting of a rent is well established in the economic literature. It is the basis of the literature on efficiency wages (Shapiro and Stiglitz, 1984); Scoppa (1997) discusses an efficiency wage modell where a firm-specific human capital investment prevents workers from shirking. That the threat of losing occupation-specific human capital influences the incentives of professionals is recognized by Svorny (1987) and Donabedian (1995), but both do not model the individual's decision problem. An extensive discussion of the questions of externalities in the notaries profession can be found in Arruñada (2006) and Van den Bergh and Montangie (2006). Shapiro (1983) shows how reputation concerns can alleviate problems of asymmetric information. Shapiro (1986) points out the nature of minimum education requirements as input regulations; in his model, these requirements have the function to make it more attractive for producers to earn a reputation for high-quality work.

2 Description of the Model

2.1 Objective Function of the agent

We consider an agents with an infinite horizon, who faces two decisions: the kind of work he produces and how much he invests in human capital. An agent produces one unit of a service by either doing good work or bad work, $w \in \{0, 1\}$, where $w = 1$ means means good work. If the agent does bad work, he creates an externality. The agent receives price p when he sells the service on the market. The regulator cannot observe this service (this rules out the provision of the service through a civil service scheme). Consumers are indifferent between service produced by good work and by bad work. The cost of good work depends on k, an investment in human capital. If $k > 0$, the cost of good work is c/k, if $k = 0$, it is ∞. The cost of bad work is normalized to zero.

The assumption that agents can only produce a fixed amount seems to be ade-

quate for professionals, because they sell services which they produce personally. There is an upper limit to the amount of time an individual professional can use to produce services. Of course there do exist big professional firms, for example in the fields of law and accounting, but they basically consist of many individual professionals selling their services together.

The basic assumption underlying the cost function is that the cost of good work decreases with the amount of human capital. There are two complementary interpretations for this assumption. First, greater knowledge about their field makes it easier for professionals to avoid errors that can cause a negative externality. Second, professional education does also include indoctrination into the "professional" way of doing work, including professional ethics.[10] Professionals who have gone through this kind of education may do good work unthinkingly or may even experience psychological costs when doing bad work that countervail the greater extertion needed for good work.

To model the possibility that at same point the agent will be thrown out of the profession, we include a time dimension. The model assumes that the agent has the opportunity to provide the service in continous time from zero to infinity. The agent is risk-neutral and maximizes expected present value of utility with discount rate $r \in (0, 1)$. If the agent does bad work, the probability of detection per unit time is $\phi \in (0, 1)$ and is set exogenously. So at time t the probability that the agent is still in the market is $e^{-\phi t}$. If the agent is found out doing bad work, he is prohibited from offering the service in the future.

The professionals human capital is worthless outside the profession. On the other hand, exclusion from the profession is the only available sanction to punish bad work. This assumption of "limited liability" is crucial to our model. In most real-world professional contexts there will exist other punishments, but they might not be harsh enough to deter bad work. Punishment that are harsh enough might be unavailable because of moral or legal standards, or might be unwise for reasons of marginal deterrence.

Let $V(w, p, k)$ denote the expected discounted lifetime utility of the agent, conditional on his decision on good work/bad work, education and on the market price p.

[10] This indoctrination may happen through formal education but also – in practical training – through students observing and imitating practitioners.

If the agent does good work ($w = 1$), we have:

$$V(1, p, k) = \int_0^\infty \left(p - \frac{c}{k}\right) e^{-r\,t} dt - k$$

If the agent does bad work ($w = 0$), we have:

$$V(0, p, k) = \int_0^\infty (p - 0)\, e^{-r\,t} e^{-\phi t} dt - k$$

If we evaluate these integrals, we get:

$$V(1, p, k) = \frac{p - \frac{c}{k}}{r} - k \quad \text{and} \quad V(0, p, k) = \frac{p}{r + \phi} - k$$

2.2 Market equilibrium

There exists an unlimited supply of identical agents willing to enter the profession. The market demand for the service is given by $D(p)$, with $D(p) \geq 0$ and $D'(p) \leq 0$. So if agents of mass n have entered the market, the market price is $D^{-1}(n)$.

We assume that agents have rational expectations. They only enter the profession if they expect to earn non-negative profits at the equilibrium price. If some agents are forced to leave the profession, they are replaced with new agents (note that those agents face the same decision problem).

A market equilibrium is characterized by values $\hat{w}, \hat{p}$, $\hat{k}(\hat{w})$ and $\hat{k}(1 - \hat{w})$ which satisfy the following conditions (all agents choose the same kind of work and the same level of investment):

$$\begin{aligned}
\hat{k}(\hat{w}) &\in \operatorname*{argmax}_k V(\hat{w}, \hat{p}, k), & \\
\hat{k}(1 - \hat{w}) &\in \operatorname*{argmax}_k V(1 - \hat{w}, \hat{p}, k) & \text{(1) profit maximization} \\
V(\hat{w}, \hat{p}, \hat{k}(\hat{w})) &\geq V(1 - \hat{w}, \hat{p}, \hat{k}(1 - \hat{w})) & \text{(2) incentive compatibility} \\
V(\hat{w}, \hat{p}, \hat{k}(\hat{w})) &= 0 & \text{(3) zero profit as a result of free entry}
\end{aligned}$$

Condition 1 ensures that all agents choose the optimal amount of human capital, given the expected market price and their kind of work they plan to do. Condition 2 makes sure that given that agents prefer to do the kind of work $\hat{w}$, given the market price and the amount of human capital that is optimal for the respective kind of work. (Additional constraints that make sure that the agents does not prefer the other kind of work with the wrong kind of capital are superfluous.)

Condition 3 represents free entry — as long as positive profits can be earned, further agents will enter the market.

We begin by determining the optimal choice of human capital. This depends on the intended kind of work. If the agent plans to do bad work, his objective function is

$$V(0, p, k) = \frac{p}{r + \phi} - k$$

and so the optimal k is zero. If the agent plans to do good work, his objective function is

$$V(1, p, k) = \frac{p - \frac{c}{k}}{r} - k$$

and the optimal k is given by:

$$k(1) = \sqrt{\frac{c}{r}}$$

With this results, the incentive compatibility constraint for $\hat{w} = 1$ can be written as:

$$V\left(1, \hat{p}, \sqrt{\frac{c}{r}}\right) \geq V(0, \hat{p}, 0)$$

This constraint is only fulfilled if:

$$\hat{p} \geq \left(1 + \frac{r}{\phi}\right) \cdot 2\sqrt{rc}$$

We define C as the long-run costs of good work, which are:

$$C = \frac{c}{k(1)} + rk(1) = 2\sqrt{rc}$$

It is now easy to see that the agent must receive a rent (positive profits) to do good work:

$$\hat{p} \geq \left(1 + \frac{r}{\phi}\right) \cdot C \ > C$$

Recall the zero profit condition. With this constraint we cannot have $\hat{p} > C$. So there is no equilibrium with good work ($\hat{w} = 1$).

On the other hand, for $\hat{w} = 0$, $\hat{p} = 0$, $\hat{k} = 0$ all three equilibrium conditions are fullfilled. For $\hat{w} = 0$, the optimal choice of human capital is capital is $\hat{k}(0) = 0$. Entry will drive down $\hat{p}$ to long-run costs, which are zero. So we get the following result:

Proposition 1. *There is only one market equilibrium, where* $\hat{w} = 0$, $\hat{p} = 0$, $\hat{k}(0) = 0$ *and* $\hat{k}(1) = \sqrt{\frac{c}{r}}$.

So without regulation, agents will aquire zero human capital and produce bad work. The intuition for this is easy. As long as the price is above $(1 + \frac{r}{\phi}) \cdot 2\sqrt{rc}$, it is optimal for agents to aquire human capital before entering the market and as long as p does not sink below $2\sqrt{rc}$, it is profitable to do so. But entering *without* human capital is profitable for any positive price, and with $p \leq 2\sqrt{rc}$ it is optimal to do so. Therefore, agents expect that entry will drive down prices to zero. At this price, entry with human capital is no longer profitable, so only agents without human capital will enter.

This situation is also demonstrated in Figure 1, where V_0 is the expected payoff for $w = 0$ and $k(0) = 0$ and V_1 the expected payoff for $w = 1$ and $\hat{k}(1) = \sqrt{\frac{c}{r}}$. At the point where good work becomes unprofitable — the V_1 line crosses the zero-line — bad work (the V_0 line) will still give a positive payoff.

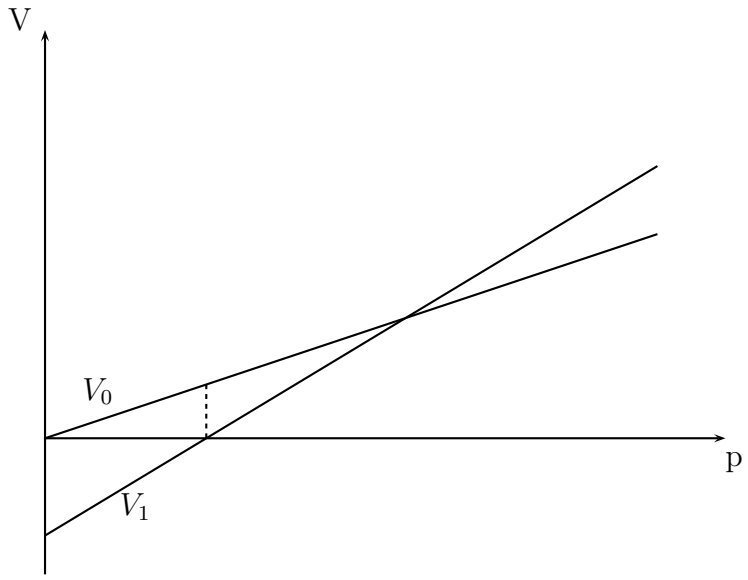

Figure 1: Payoffs without regulation

2.3 Regulatory Interventions

A government regulator may intervene in this situation in several possible ways. He can restrict entry so that prices reach a level that makes it optimal to produce good work. He may impose a level of minimum human capital to achieve the

same aim. He could also do a combination of both. (Because we assume that the service cannot be observed by the state, it is not possible to give a subsidy to agents who provide the service.)

The government regulator can simply restrict the entry to the profession so that prices remain high enough for agents to prefer good work over bad work, i.e. set entry numbers so that:

$$\overline{p} = \left(1 + \frac{r}{\phi}\right) \cdot C$$

Then it is optimal to aquire human capital and produce good work.

Proposition 2. *The regulator can ensure good work by restricting entry to the profession at a level so that*

$$\overline{p} = \left(1 + \frac{r}{\phi}\right) \cdot C$$

.

The other alternative is to set a minimal level of education k^* that agents must aquire before they enter the market; the level has to be set so that it is optimal to provide good work and must be consistent with free entry, which implies zero profits.

In this case the regulator solves the problem

$$\min k^*, \text{ subject to}$$

$$V(1, p, k^*) \geq V(0, p, k^*) \text{ (IC)}$$

$$\text{and } \; V(1, p, k^*) = 0 \; \text{ (zero profits)}$$

The two constraints imply:

$$\frac{p - \frac{c}{k^*}}{r} \geq \frac{p}{r + \phi} \quad \text{and} \quad \frac{p - \frac{c}{k^*}}{r} - k^* = 0$$

Solving the second for p and plugging into the first gives: $k^* \geq \sqrt{\frac{c}{\phi}}$, which establishes the following result:

Proposition 3. *The regulator can ensure good work by setting a minimum human capital level of:*

$$k^* \geq \sqrt{\frac{c}{\phi}}$$

Figure 2 illustrates the situation under minimum education requirements. The V_0-line has been shifted down because all agents are required to invest in human capital, even if it is useless for them because they want to provide bad work. (In this example V_1-line is unchanged but this will in general not be the case).

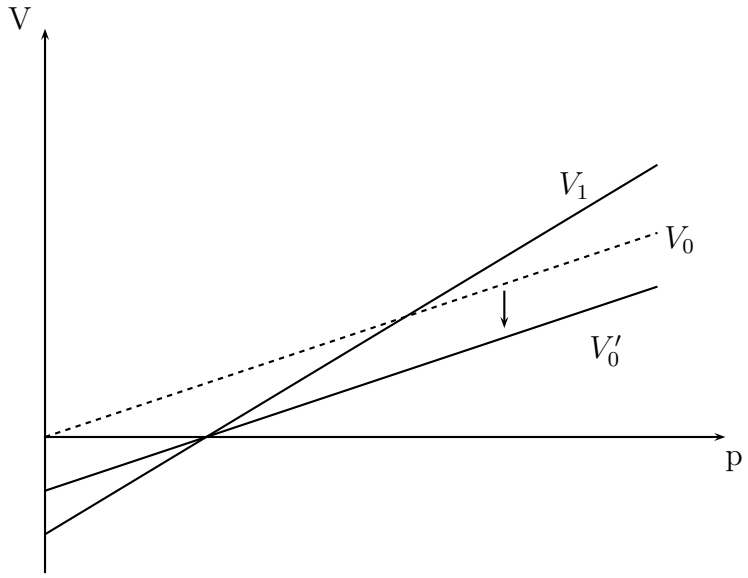

Figure 2: Payoffs with minimum human capital

3 Welfare Analysis

In the following we make a welfare comparison of entry restrictions and minimum human capital requirements. We assume that the externality is so big that it always pays to prevent it. In other words, we only compare different ways to prevent the externality, not whether the externality should be prevented at all.

It is not obvious which welfare standard is most appropriate to compare the two outcomes. The standard approach in industrial organization is to use total welfare (consumers' surplus plus producers' surplus). But one could argue that using only consumers' surplus is more appropriate here. If the regulator imposes a numerical limit of places in the profession and this leads to the professionals earning economic rents, applicants may spend resources to get one of those places. Because of this "rent dissipation" (Posner, 1975), a great part of the producers' surplus might get lost.

Proposition 4. *Under both the total welfare standard and the consumers' surplus*

standard, the first-best-outcome is:

$$p = C = 2\sqrt{rc} \quad \textit{and} \quad \hat{k}(1) = \sqrt{\frac{c}{r}}$$

Because it is optimal to prevent the externality (by assumption), the first best w is good work. Given that, the optimal human capital level is given by cost minimization. The service should be provided to all consumer willing to pay at least the long-run cost of its provision.

There are two relevant kinds of distortion from the first best. The price of the service might be higher as in the first best and there might be excessive investment in education.

Under certain parameters, the regulator can achieve good work costlessly through minimum human capital requirements. If $\phi > r$, we have

$$\hat{k}(1) = \sqrt{\frac{c}{r}} > \sqrt{\frac{c}{\phi}} = k^*$$

In this case, the minimum level of human capital necessary to ensure good work is lower than the capital level that is profit maximizing for doing good work. Entrants to the profession, given that they are forced to aquire at least a capital level of $k^* = \sqrt{\frac{c}{\phi}}$, will — in their own self-interest — choose the higher and socially optimal capital level of $\sqrt{\frac{c}{r}}$. Free entry will drive down prices to long-run costs, which leads to the following result:

Proposition 5. *If $\phi > r$, the first-best can be implemented with education requirements.*

In comparison, entry restrictions will never implement the first-best because they imply prices that are higher than long-run costs.

This can also be seen graphically. As long as the imposed minimum capital level is below the optimal capital level for good work, changes in minimum capital only affect the V_0-line (because for agents doing good work, the minimum education requirement is not binding). In these cases, if minimun human capital increases, only the V_0-line shifts down. Indeed, Figure 2 depicts the situation where education requirements implement the first-best, because only the V_0 gets shifted down.

If $r > \phi$, it will not be sufficient to shift down only the V_0-line. Because in this cases, when the imposed minimum human capital reaches the optimal human

capital, it is still preferable to do bad work. And if the imposed minimum capital level exceeds the optimal capital level for good work, changes in minimum human capital affect both lines. Both the V_0-line and the V_1-line are shifted down, but the shift is greater for the V_0-line, because increases in human capital even above the optimal level do still decrease the costs of good work but are useless if the agent does bad work. This is the situation depicted in Figure 3.

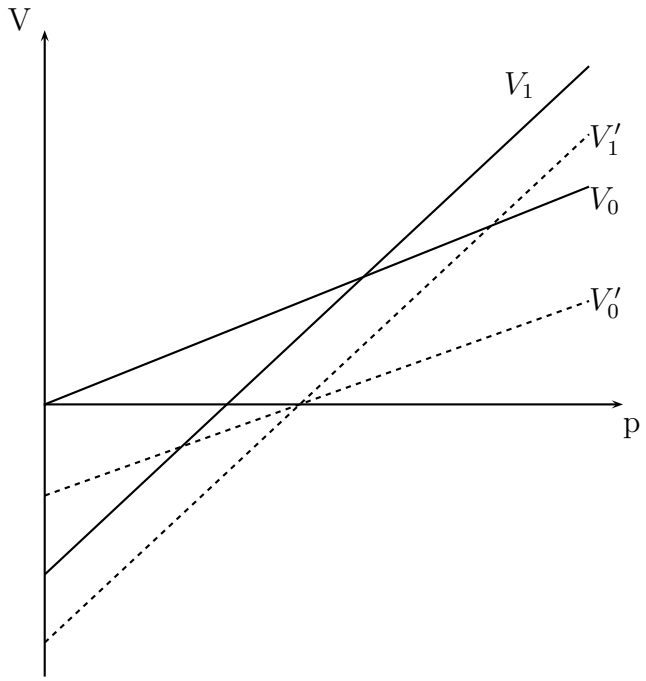

Figure 3: Payoffs with minimum human capital (not costless)

If $r > \phi$, the results depend on the welfare standard employed. If we use the consumers'-surplus-standard, welfare is a decreasing function of price only. It can be shown that education requirements imply a lower price than entry restrictions if $4r > \phi$. But because $r > \phi$ (by assumption), we can state:

Proposition 6. *If $r > \phi$, and we use the consumers'-surplus-standard, minimum education requirements are at least weakly prefered to entry restrictions.*

Proof in the Appendix.

If we use the welfare standard of total surplus, things are no longer so clear. We have to consider a specific demand function. For example, using a linear demand demand function, we get the following result:

Proposition 7. *If $r > \phi$, we use the welfare standard of total surplus and demand is given by $D(p) = 1 - p$ for $0 \leq p \leq 1$ and $D(p) = 0$ otherwise, education requirements are at least weakly preferable if*

$$\sqrt{c} > \frac{\sqrt{\phi} - 2\sqrt{r}\frac{\phi}{r+\phi}}{2\frac{r^2}{\phi} - 1.5r + \frac{1}{2}\phi}$$

Proof in the Appendix.

4 Bonding as an Alternative?

An important argument against our justification for minimum education requirements is the possibility of bonding. Under bonding — as defined here — the potential professional is required to deposit a certain amount of money with the regulator. The money earns the going rate of interest. If the professional is caught doing bad work, the money is taken by the regulator as a punishment. The amount of money is set to a level so that the professional prefers to do good work. Under the assumption that there are no costs of bonding, this policy achives the first best allocation.

One problem with bonding is that we do not see it very often. In some regulatory contexts, there are minimum net worth requirements for professionals; in many contexts there is at least the requirements that the professional should not be heavily indebted. But many schemes in professional regulation that are called "bonding" work differently. They involve so called "surety bonds" where a third party (usually an insurance company) agrees to pay if the professional causes a damage to a customer or the state. These kind of bonds do not have the effect of making the professional more sensitive to punishment. Instead, they are a protection against against possible losses, if the professional becomes insolvent (but may also create a selection effect). In the following, we will only talk about "real" bonding as defined in the previous paragraph and not about surety bonds.

Bonding seems to be so attractive because it is usually assumed that there are no social costs associated with it. So there is a costless way to circumvent the limited liability assumption of our model. But it is not so clear whether bonding is socially costless in reality, although the reasons for this are outside our modelling framework. Bonding has the effect that only agents who have the necessary amount of capital available will be able to enter the profession (note that a bank

will not lend the money to the professional if it believes that he will do bad work, because if the agent is caught, there is no way to recover it). This may have an negative selection effect on the persons entering the profession, restricting it to those persons who have adequate capital but no better way to use it, for example in business. Of course the requirement of an initial investment in human capital will also exlude applicants who do not have the means to finance this investment. But there may be significant differences between the class of persons who are able to finance an investment in human capital – where a large part of the costs are only opportunity cost – and the class of people able to finance a pure monetary investment.

The capital needed for bonding is also not available for investment in the professional's firm. Under imperfect capital markets, the professional may not be able to borrow this money from a bank. In other words, the assumption of costless bonding implies that the capital used for bonding will be put to its socially optimal use – under imperfect capital markets this may not be the case. Although professional firms usually only need a relativ small amount of physical capital, there are often some start-up losses to be financed at the beginning of the establishment.

It should also be pointed out that bonding is in a sense comparable to the sale of offices, a practice that was once widespread but has now been totally abolished. The similiarity is especially great if it is possible to sell the office on retirement. In such a system, the applicant does not deposit money with the state, but purchases the office from his predecessor. On retirement, he can sell the office to his successor, but he can lose his office and its monetary value if he is convicted of misconduct.

One example of such a system was the so called "purchase system" in the United Kingdom.[11] This system, abolished only in 1871, did concern officers' commission in most regiments of the British Army. The main justification for this system, according to contemporary accounts, was to make sure that officers came predominatly from the ruling class, the great landowners. But it was also acknowledged, that the prospect of losing the value of own's commission was an incentive to ensure good conduct and loyality on part of the officer. However, any economic analysis of the system has to deal with the fact that joining the relevant regiments as an officer was a clearly a decision motivated by non-pecuniary reasons, because the required or expected expenses and the annuity value of the commis-

[11] For an extensive treatment comp. Bruce (1980).

sion's purchase price were higher than officers' pay.

5 Conclusion

In this paper we have shown that minimum human capital requirements can be an attractive mechanism to prevent external effects in connection with professional services. A regulation that is limited to certification cannot achieve this goal, because individual customers have inadequate incentives to prevent these external effects.

It is an open question whether our approach can indeed justify minimum education requirements in the individual professions. It seems to be clear that it is only applicable in professions where bad work can cause significant effects not only for the customer, but also for others and with no other effective punishments besides dismissal from the profession.

It should also be pointed out that our theory makes no clear predictions about the appropriate level of human capital requirements. Many existing regulations might impose excessive minimum education requirements. If incumbent professionals are setting these requirements, they might have an incentive to set them too high to protect their incomes.

Further work in this area might extend our model to cases where there is a positive correlation between product quality and absence of negative external effects. It would also be interesting to compare pure entry restrictions and minimum education requirements under the aspect of how they compare in cases where the regulator is uncertain about the demand function.

A Proof of Proposition 6

Under the consumers' surplus standard the regulators objective function is given by:

$$CS(p) = \int_p^\infty D(\tilde{p})d\tilde{p}$$

The effect of price changes on CS is given by:

$$\frac{dCS}{dp} = -D(p)$$

which is negative if $D(p) > 0$. So consumers' surplus is a decreasing function of price, except for prices so high that demand is zero.

That means that under the the consumers' surplus a policy is at least weakly preferable if it implies a lower price.

The market price under minimum human capital ($k^* \geq \sqrt{\frac{c}{\phi}}$) is:

$$p^* = \frac{c}{k^*} + rk^* = \frac{c}{\sqrt{\frac{c}{\phi}}} + r\sqrt{\frac{c}{\phi}}$$

$$= \sqrt{\phi c} + r\sqrt{\frac{c}{\phi}} = (\sqrt{\phi} + \frac{r}{\sqrt{\phi}})\sqrt{c}$$

$$= (r + \phi)\sqrt{\frac{c}{\phi}}$$

The price with entry restrictions is:

$$\overline{p} = \left(1 + \frac{r}{\phi}\right) \cdot C = \left(1 + \frac{r}{\phi}\right) 2\sqrt{rc}$$

So the price is higher und entry restrictions ($\overline{p} > p^*$), if

$$\left(1 + \frac{r}{\phi}\right) 2\sqrt{rc} > (r + \phi)\sqrt{\frac{c}{\phi}}$$

$$\iff \frac{1}{\phi} 2\sqrt{rc} > \sqrt{\frac{c}{\phi}}$$

$$\iff 2\sqrt{r} > \sqrt{\phi}$$

$$\iff 4r > \phi$$

Because we only consider the case $r > \phi$, the last condition is always true. □

B Proof of Proposition 7

We first consider the case where — under both policies — the price p is low enough so that $D(p) > 0$.

Total welfare with entry restrictions is given by consumers' surplus (CS) plus total rent earned by agents (Π):

$$\begin{aligned}
\Pi &= n \cdot (p - C) \\
&= D(p) \cdot (p - C) \\
&= (1 - p)(p - C) \\
&= p - C - p^2 + pC
\end{aligned}$$

$$\begin{aligned}
CS &= \frac{1}{2}(1 - p)^2 \\
&= \frac{1}{2} - p + \frac{1}{2}p^2
\end{aligned}$$

$$\begin{aligned}
CS + \Pi &= p - C - p^2 + pC + \frac{1}{2} - p + \frac{1}{2}p^2 \\
&= \frac{1}{2} - \frac{1}{2}p^2 - C + pC
\end{aligned}$$

The regulator restricts entry so that

$$p = \frac{r + \phi}{\phi} C$$

Plugging in we get:

$$CS + \Pi = \frac{1}{2} - \frac{1}{2}\left(\frac{r + \phi}{\phi}\right)^2 C^2 - C + \frac{r + \phi}{\phi} C^2$$

Plugging in $C = 2\sqrt{rc}$ we get:

$$\begin{aligned} CS + \Pi &= \frac{1}{2} - \frac{1}{2}\left(\frac{r+\phi}{\phi}\right)^2 4rc - 2\sqrt{rc} + 4\frac{r+\phi}{\phi}rc \\ &= \frac{1}{2} - \left(2\left(\frac{r+\phi}{\phi}\right)^2 - 4\frac{r+\phi}{\phi}\right)rc - 2\sqrt{rc} \end{aligned}$$

Total welfare under minimum human capital requirements:

Under human capital requirements, total welfare is equal to consumer's surplus — because of free entry there is no rent.

We have again:

$$CS = \frac{1}{2}(1-p)^2 = \frac{1}{2} - p + \frac{1}{2}p^2$$

The price with minimum human capital requirements is (comp. Appendix A):

$$p = (r+\phi)\sqrt{\frac{c}{\phi}}$$

So total welfare is:

$$\frac{1}{2} - (r+\phi)\sqrt{\frac{c}{\phi}} + \frac{1}{2}(r+\phi)^2\frac{c}{\phi}$$

So minimum human capital requirements are better than entry restrictions, if

$$\frac{1}{2} - (r+\phi)\sqrt{\frac{c}{\phi}} + \frac{1}{2}(r+\phi)^2\frac{c}{\phi} > \frac{1}{2} - \left(2\left(\frac{r+\phi}{\phi}\right)^2 - 4\frac{r+\phi}{\phi}\right)rc - 2\sqrt{rc}$$

$$\frac{1}{2}(r+\phi)^2\frac{c}{\phi} + \left(2\left(\frac{r+\phi}{\phi}\right)^2 - 4\frac{r+\phi}{\phi}\right)rc > (r+\phi)\sqrt{\frac{c}{\phi}} - 2\sqrt{rc}$$

$$\sqrt{c}\left(\frac{1}{2}\frac{(r+\phi)^2}{\phi} + 2r\left(\frac{r+\phi}{\phi}\right)^2 - 4r\frac{r+\phi}{\phi}\right) > \frac{r+\phi}{\sqrt{\phi}} - 2\sqrt{r}$$

$$\sqrt{c}\left(\frac{1}{2}(r+\phi) + 2r\frac{r+\phi}{\phi} - 4r\right) > \sqrt{\phi} - 2\sqrt{r}\frac{\phi}{r+\phi}$$

$$\sqrt{c}\left(\frac{1}{2}r + \frac{1}{2}\phi + 2\frac{r^2}{\phi} + 2r - 4r\right) > \sqrt{\phi} - 2\sqrt{r}\frac{\phi}{r+\phi}$$

$$\sqrt{c}\left(2\frac{r^2}{\phi} - 1.5r + \frac{1}{2}\phi\right) > \sqrt{\phi} - 2\sqrt{r}\frac{\phi}{r+\phi}$$

$$\sqrt{c} > \frac{\sqrt{\phi} - 2\sqrt{r}\frac{\phi}{r+\phi}}{2\frac{r^2}{\phi} - 1.5r + \frac{1}{2}\phi}$$

We now cover cases where $D(p) = 0$. If $D(p) = 0$ under both alternatives, total surplus is zero in both cases and the regulator is indifferent between the two alternatives. If $D(p) = 0$ under entry restrictions but $D(p) > 0$ under education requirements, total surpuls is zero under the former and positive under latter. With $r > \phi$ we know that p is higher under entry restrictions, so it cannot be the case that $D(p) > 0$ under entry restrictions but $D(p) = 0$ under education requirements. □

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