Four Essays in Industrial Organization and Political Economy

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[1] This chapter is based on joint work with Ray Rees.

Preface

This doctoral dissertation deals with two distinct areas of research in applied microeconomic theory. Chapters 1 and 4 are from the field of industrial organization and are concerned with the provision of product characteristics in two specific situations, namely the case of vertically related markets and the case of insurance markets. Chapters 2 and 3 try to shed light on a central issue in political economics, the provision of incentives for public officials like politicians and bureaucrats. The single chapters are arranged in the order of their inception and can be read independently.

Chapter 1 deals with the impact of vertical integration on product quality. The theoretical literature in this field (in particular Tirole, 1988, and Economides, 1999) has emphasized that vertically related firms tend to underprovide quality relative to an integrated firm because if one firm improves the value of its component, this allows the other firm to charge more for its own component. Hence, quality provision in vertical chains exerts positive externalities between the firms that are not internalized, which leads to underprovision.[2]

Chapter 1 tackles the view that integration necessarily improves incentives to provide product quality. It sets up a model of successive monopolies which, among other things, improves on previous approaches

[2] This argument is well in line with the legal strategies that a number of firms have pursued in antitrust cases and regulatory hearings, where the maintenance of quality standards is often quoted as a justification for upholding a dominant position. See Chapter 1 for specific examples.

by allowing general demand and cost functions. As it turns out, an exclusive focus on quality externalities to determine the equilibrium quality is grossly misleading. Instead, it is shown that the provision of quality depends on three distinct effects that work in opposing directions. First, the "demand effect" lowers quality under integration: Because double marginalization is overcome after integration, the product is sold to a larger group of people. This implies that the average valuation of quality decreases as customers with a smaller willingness to pay for a product typically also tend to have a smaller willingness to pay for quality improvements. Second, the "commitment effect" increases quality under integration: This effect arises because independent upstream firms strategically reduce the quality of their component in order to deter the downstream firm from placing a high mark-up on the final product. Finally, the "scale effect" increases quality under integration: Because an integrated firm increases output, the provision of quality is cheaper whenever it affects the fixed costs of production. These effects are extensively discussed in the chapter. This allows a deeper analysis of important applications of the model, including the producer/retailer relationship, the intermediate good/final good producer relationship and the provision of promotional services by retailers.

The two following chapters contain models of political agency. In a democracy, public officials are agents whose purpose it ultimately is to serve the public interest by implementing the will of the electorate.[3] This has given rise to a field of research which has aimed at explaining institutional outcomes at a positive level and proposing optimally designed incentive contracts at the normative level.

Research focussing on the lower branches of government has often emphasized the danger of corruption which arises because bureaucratic

[3] Arrow (1951) has forcefully demonstrated that it may not be obvious what "the will of the electorate" actually is because the derivation of a social preference ordering from individual preferences can be a delicate task. This is an issue this dissertation will not be concerned with and it is assumed throughout that social preferences are well defined.

agents may have the power to extract rents from the people and firms they deal with.[4] Banerjee (1997) and Acemoglu and Verdier (2000) in particular have stressed that, due to informational asymmetries between bureaucratic agents and their principals, the danger of misconduct is inherent in any kind of state intervention into free markets. Therefore, there exists a fundamental trade-off between government intervention to correct market failures on the one hand and accepting misgovernance on the other.

Yet, even if one is willing to accept some degree of corruption as an unpleasant by-product of government activity, one will still want to know how to reduce corruption given the degree of state intervention. Much of the discussion on this topic has centered around the use of competition in bureaucracies (see Shleifer and Vishny, 1993, Bliss and Di Tella, 1997, and Ades and Di Tella , 1999). This branch of the literature has provided a number of encouraging results which show how horizontal competition, that is competition between bureaucrats that provide substitutable kinds of public services, can mitigate the problem of corruption in much the same way as competition between firms limits excessive pricing. It has also stressed, however, that vertical competition, that is competition between bureaucrats that provide complementary kinds of public services, will lead to excessive corruption in much the same way as vertical chains overprice their respective components due to double marginalization. As a consequence, levels of corruption arise that are too high not only from a welfare perspective but also from the point of view of a corrupt bureaucracy. I.e., even if the government was corrupt it would want to reduce *uncoordinated* corruption.

This gives rise to a disturbing puzzle: when vertical competition between bureaucrats is bad for everybody, why is it that it is such a pervasive phenomenon in many developing countries, where private activ-

[4]Important contributions include Shleifer and Vishny (1993), Banerjee (1997), Ades and Di Tella (1999), Acemoglu and Verdier (2000) and Svensson (2005). Surveys are provided by Bardhan (1997) and Aidt (2003).

ity often involves approval of dozens of different government agencies?[5] Chapter 2 of this dissertation addresses this very question. It first formalizes the informal arguments in Shleifer and Vishny (1993), the central paper in this field, and derives a number of comparative statics results that highlight the workings of vertical competition in corruption. The model is then extended to allow for rent-extractors which are outside the reach of the government but nevertheless harm private activity. This is done because one of the distinguishing features of many corrupt societies is the prevalence of both organized crime and street crime, and the ability of seemingly innocuous private organizations and interest groups to extract rents.[6] The central result of the chapter is that the government may voluntarily refrain from coordinating its officials when they set their bribe demands in order to be more aggressive in the fight for rents against outsiders even though this limits the overall graft income that can be extracted from the private sector. Therefore, the observed level of vertical competition in corrupt societies may not be an accidental form of inefficient governance, but expression of the deliberate intent to collect graft income.

The political economy research that has focussed on the higher branches of government has typically pursued a different direction, namely the provision of incentives for politicians via elections.[7] These papers are much in the spirit of managerial agency models that explain how optimal contracts can solve problems like moral hazard, adverse selection or multitasking.[8] Yet, despite the apparent similarities between those fields, real world incentive schemes for politicians take quite a differ-

[5] See De Soto (2000) for discouraging anecdotal evidence.

[6] See Chapter 2 for examples.

[7] Important contributions include Barro (1973), Ferejohn (1986), Persson, Roland and Tabellini (1997), Besley and Burgess (2002), Maskin and Tirole (2004) and Messner and Polborn (2004). See Persson and Tabellini (2000) and Besley (2006) for surveys.

[8] Among the many contributions see in particular Holmström (1979), Grossman and Hart (1983), Hart (1983) and Holmström and Milgrom (1991). Prendergast (1999) is an excellent survey of the topic.

ent form than the typical incentive contract for a manager. In particular, "employment contracts" for politicians usually involve unconditional appointment for a fixed amount of time (the length of a term) during which the agents are not subject to any kind of evaluation.[9] Managers, on the other hand, can usually be dismissed instantaneously after bad performance (possibly at the expense of having to pay a contractually specified compensation). The literature's stance towards this institutional detail has been to take it as given. This is unsatisfying for two reasons. First, one would like to know why the public restricts itself by committing not to oust politicians for a given period of time—especially since recall elections in California have shown that instantaneous evaluation of politicians is practically feasible. Second, this commitment is the very source of inefficiency in the seminal model of political agency which was developed by Barro (1973), Ferejohn (1986) and Persson, Roland and Tabellini (1997). Introducing the possibility of recall elections would restore the first best in this model, invalidating the negative conclusions the authors draw.

Chapter 3 of this dissertation tries to derive the structure of political terms from first principles by setting up a dynamic principal-agent model where reference to a specific context enters only via a parameter that measures the contractibility of outcomes. My interpretation of the model is that high contractibility refers to a situation of managerial agency (as firm success is often readily measurable) while low contractibility refers to a situation of political agency (as political outcomes are often vague and difficult to describe ex-ante).

In the model, a principal faces a sorting problem, since agents are of different ability, and a moral hazard problem, as the agent's investments incentives may not be aligned with the public interest. The central result of the chapter is that the principal may want to commit not to displace

[9] Although this constitutional form is typical in almost all democratic administrations around the world, there is the notable exception of some US states, including the State of California, where recall elections are possible. With this provision, politicians are subject to evaluation at any instant.

the agent for a given period of time in order to implement the efficient investment decision whenever contractibility is low. If contractibility is high, however, such commitment will never be optimal as explicit incentives can achieve the desired behavior in this case. This explains why fixed terms are prevalent in the sphere of politics while they are rarely found in the private sector.

Chapter 4, finally, deals with the provision of product characteristics in a specific market, the market for insurance. All major insurance markets in the world are regulated, particularly with regard to firms' capital resources and the composition of their asset portfolio. Typically, insurance companies have to provide a minimum capital level (which in practice may depend on specific firm characteristics like the size of the customer base and the types of insurance contracts that are sold). In addition to that, many regulators restrict the investments that insurance companies can make into risky assets like stocks, options or futures (at least if these investments are speculative and do not have the purpose of hedging other risks).

The early literature on insurance regulation (e.g., Borch, 1981, Munch and Smallwood, 1981, and Finsinger and Pauly, 1984) has given a theoretical foundation for this type of regulation by noting that insurance firms have an incentive to underprovide capital by cashing out reserves that should protect their customers' risks. Rees, Gravelle and Wambach (1999) have shown that this result rests on the heroic assumption that insurance demand is exogenous and independent of the financial health of an insurance company. They demonstrate that providing consumers with information on the financial strength of insurance firms restores an efficient capital level and investment policy because high risk firms would simply attract no demand.

While maintaining the assumption of rational consumer choice, Chapter 4 improves upon previous approaches by setting up a new model of the insurance market that reflects important market details. First, it allows for consumer heterogeneity, which will be shown to be a source of inefficiency in the market, while previous models have essentially been one-consumer models. Second, it introduces imperfect capital markets which generates a cost of holding capital. The chapter shows that an insurance firm with market power has an incentive to underprovide capital and to invest too much into risky assets. The origin of the effect is similar to Spence (1975) and Sheshinski's (1976) finding that a product market monopolist will not provide the efficient amount of product quality. In both cases, firms are concerned with marginal consumers more than with intramarginal consumers. As the marginal insurance buyer desires a lower capital level and riskier investments than intramarginal consumers, the result follows. The chapter then goes on to show that the implementation of the optimal level of capital and investments necessitates not only regulation of these variables, but also setting a price cap. If price regulation is not desired or not feasible, it may be the case that *any* insolvency regulation decreases welfare because it induces firms to raise prices by too much.

Chapter 1

Successive Monopolies with Endogenous Quality

1.1 Introduction

This chapter addresses the impact of vertical integration on product choice in supply chains with market power. In particular, it tries to shed light on the question how product quality is affected by the market structure.

In antitrust cases, defendants often argue that a vertically integrated firm provides a higher level of product quality than separate entities. During the process of privatizing the German railway, for instance, Deutsche Bahn contended that a vertical separation of railway system and passenger transport should be avoided to maintain quality. Similarly, in *Hilti v. European Commission*, the Hilti Corporation, a producer of nail guns used in construction, held that its guns should only be loaded with cartridges containing its own nails because potential downstream competitors allegedly produced inferior components of a dangerous nature.

These arguments find support in the theoretical literature. Tirole (1988) argues that in the provision of retailers' services that make the manufacturer's good more attractive to consumers, there is downstream moral hazard in the sense that retailers do not take the positive externality into account that service provision exerts on producers. This suggests that independent retailers provide a lower service level than vertically integrated firms. In a more complete model, Economides (1999) indeed finds that vertical integration of successive monopolies increases the provision of quality.

It turns out, however, that Economides's (1999) result largely rests on a number of specific assumptions concerning demand, costs and the timing of pricing. While the particular situation he describes fits well for the special case of two complementary network goods that are provided in a horizontal structure, it may be less suited to analyze regular vertical chains (like the relationships between a manufacturer and a retailer or between an intermediate good and a final good producer).[1] This, however, is the focus of this chapter and as will be shown below, quality may in general be increased or decreased by integration, depending on the structure of the problem.

Moreover, it will be shown that Tirole's (1988, p. 178) focus on the service externality is misleading as an independent retailer actually provides a *higher* level of services than an integrated firm. In fact this higher level of services is efficient in the sense that it maximizes joint profits of manufacturer and retailer—despite the existence of a service externality.

Section 1.2 presents a model of successive monopolies with endogenous quality choice that improves on previous approaches by allowing general demand and cost functions. In contrast to Economides (1999) firms act sequentially and not simultaneously. While this complicates matters technically, it better suits the description of a vertically related industry. As in the previous literature, quality choice will be driven by the impact of double marginalization. The level of quality is shown to depend on three distinct effects which are separately analyzed in Sections 1.3, 1.4, and 1.5. Section 1.6 contains some welfare analysis. Section 1.7 discusses a number of extensions and Section 1.8 concludes.

1.2 The Model

Consider the market for a vertically differentiated product which is characterized by its quality $q \geq 0$. Demand at price p is given by the function $x(p,q)$ with inverse $p(x,q)$. Assume that $p(\cdot)$ is smooth in both arguments and that $p_x(x,q) < 0$ and $p_q(x,q) > 0$ for all x and q, where subscripts denote partial derivatives. Moreover, it will be assumed that $p_{xq}(x,q) < 0$, implying that consumers with a higher willingness to pay

[1] See Economides (1996, p. 690) for a discussion of how his paper relates to the general literature on network externalities.

for the product also have a larger preference for quality.[2]

The good is produced in a vertical production process which consists of a monopoly upstream firm (indexed by 1) and a monopoly downstream firm (indexed by 2), which may or may not be vertically integrated. The upstream firm first produces an intermediate good of quality $q_1 \geq 0$ which it sells at transfer price p_t to the downstream firm. The downstream firm in turn produces the final good by choosing a quality $q_2 \geq 0$ to refine the input.[3] The good is then sold to the market at price p. The final quality q is determined by the quality levels provided by the two firms, so that $q = q(q_1, q_2)$, where it is assumed that $q(\cdot)$ is weakly increasing in both q_1 and q_2. Firms $i = 1, 2$ have smooth cost functions $C^i(x, q_i)$ which are strictly increasing in both arguments. Throughout the chapter, it will be assumed that second order conditions hold to guarantee the existence of a solution.

In the general form presented here, the equilibrium of the model is determined by several interacting effects. As a consequence, stubbornly solving the firms' maximization problems yields little in the way of understanding the structure of the solution. We will therefore proceed by an alternative route, identifying the three distinct effects that govern the relationship between vertical integration and product quality. Table 1.1 gives a summary of the effects and whether they tend to increase or decrease quality under integration. As can be seen there, the first of the three effects is always present, while the second and the third effect only appear under specific circumstances. Section 1.3 will first analyze the model under the assumption that those circumstances are not fulfilled. It will be demonstrated that in this case, indeed, quality under integration is lower than with separate firms. Sections 1.4 and 1.5 then add

[2] For most circumstances this is a natural assumption which is routinely made in the literature on price discrimination (e.g., Mussa and Rosen, 1978). Section 1.7 discusses how the results of the paper change when instead $p_{xq}(x, q) > 0$.

[3] While the model is formulated here as an intermediate/final good producer relationship, it can equivalently be interpreted as a manufacturer/retailer relationship with wholesale price p_t.

the characteristics needed for the second and third effect, demonstrating that both tend to increase the quality under integration. As will be seen, this separation of effects will allow us to study important special cases of vertical chains like the manufacturer/retailer relationship, the intermediate/final good producer relationship and the provision of promotional services.

Effects	Direction	Occurrence
1.3 Demand Effect	$-$	always
1.4 Commitment Effect	$+$	Condition 1.1 does not hold
1.5 Scale Effect	$+$	Condition 1.2 does not hold

Table 1.1: Quality Effects

1.3 The Demand Effect

We will first analyze the problem under conditions that ensure that the second and third effect are absent. These conditions turn out to be that the upstream firm has no impact on quality and that the cost of quality provision does not decrease with the scale of production. More formally, we will assume the following in this section.

Condition 1.1 $\partial q/\partial q_1 = 0$.

Condition 1.2 $\frac{\partial C^i/\partial q_i}{x} \leq \frac{\partial^2 C^i}{\partial q_i \partial x}$ *for* $i = 1, 2$.

Condition 1 of course implies that $q_1 = 0$ in equilibrium so that $q = q(0, q_2)$. Without loss of generality, we let the downstream firm choose q directly, setting $q_2 = q$, so we have downstream investment.

To get a clearer picture which types of cost functions satisfy Condition 2, consider the cost structure with fixed costs $F(q)$ and marginal costs $c(q)$. If the provision of quality only increases c, then indeed the costs of providing quality do not decrease with the scale of production. If quality provision also increases F, however, Condition 2 is not met.

The conditions laid out in this section correspond to an intermediate/final good producer relationship in industries with large scale production. Manufacturers buy a homogeneous input from the upstream firm which is then refined to a final product. As the good is already produced at a significant scale, further increases in the volume of production do not make the provision of quality cheaper. As an example, one could think of a car manufacturer that buys steel as an input.

We will begin by analyzing the equilibrium under the vertically integrated structure. In that case the integrated firm's profit function is

$$\pi = xp(x,q) - C^1(x) - C^2(x,q).$$

Maximizing profits with respect to x and q gives

$$\frac{\partial \pi}{\partial x} = p + xp_x - C^1_x - C^2_x = 0 \tag{1.1}$$

and

$$\frac{\partial \pi}{\partial q} = xp_q - C^2_q = 0. \tag{1.2}$$

The corresponding second order conditions are

$$\frac{\partial^2 \pi}{\partial x^2} = 2p_x + xp_{xx} - C^1_{xx} - C^2_{xx} < 0, \tag{1.3}$$

$$\frac{\partial^2 \pi}{\partial q^2} = xp_{qq} - C^2_{qq} < 0, \tag{1.4}$$

and

$$\begin{aligned} \frac{\partial^2 \pi}{\partial x^2}\frac{\partial^2 \pi}{\partial q^2} - \left(\frac{\partial^2 \pi}{\partial x \partial q}\right)^2 &= (2p_x + xp_{xx} - C^1_{xx} - C^2_{xx}) \\ &\quad \times (xp_{qq} - C^2_{qq}) - (p_q + xp_{xq} - C^2_{xq})^2 > 0. \end{aligned} \tag{1.5}$$

The solution is characterized by the usual equality of marginal cost and marginal revenue on the one hand, and of marginal willingness to pay for quality and marginal cost of quality on the other hand.

Next, we will turn to the disintegrated solution. Under separation, the downstream firm's profit function is

$$\pi_2 = x\left[p(x,q) - p_t\right] - C^2(x,q).$$

Taking the transfer price p_t as given, firm 2 maximizes its profit with respect to x and q. This yields

$$\frac{\partial \pi_2}{\partial x} = p + xp_x - p_t - C_x^2 = 0 \tag{1.6}$$

and

$$\frac{\partial \pi_2}{\partial q} = xp_q - C_q^2 = 0. \tag{1.7}$$

The corresponding second order conditions are

$$\frac{\partial^2 \pi_2}{\partial x^2} = 2p_x + xp_{xx} - C_{xx}^2 < 0, \tag{1.8}$$

$$\frac{\partial^2 \pi_2}{\partial q^2} = xp_{qq} - C_{qq}^2 < 0, \tag{1.9}$$

and

$$\begin{aligned} \frac{\partial^2 \pi_2}{\partial x^2}\frac{\partial^2 \pi_2}{\partial q^2} - \left(\frac{\partial^2 \pi_2}{\partial x \partial q}\right)^2 &= (2p_x + xp_{xx} - C_{xx}^2) \\ &\quad \times (xp_{qq} - C_{qq}^2) - (p_q + xp_{xq} - C_{xq}^2)^2 > 0. \end{aligned} \tag{1.10}$$

In the first stage, the upstream firm chooses the transfer price p_t, anticipating the downstream firm's marketing decision $x(p_t)$ in the second stage. Its profit function therefore is

$$\pi_1 = x(p_t)p_t - C^1(x(p_t)).$$

The optimal transfer price is then determined by the first order condition

$$\frac{\partial \pi_1}{\partial p_t} = \frac{dx}{dp_t}\left[p_t - C_x^1(x(p_t))\right] + x = 0. \tag{1.11}$$

Comparing the two regimes, Proposition 1.1 arrives at the following result.

Proposition 1.1 *Assume Conditions 1.1 and 1.2 hold. Then successive monopolies provide a higher level of quality than a vertically integrated firm. Given output, quality is such that joint profits are maximized.*

Proof. Note first that if the upstream firm were to sell her input at marginal costs ($p_t = C_x^1$), then equations (1.1) and (1.2) would be identical to equations (1.6) and (1.7) and the integrated and the disintegrated solution would fall together. As marginal cost pricing results in zero profits, however, it is straightforward to see that we must have $p_t > C_x^1$. Applying the implicit function theorem to equations (1.6) and (1.7) then yields

$$\begin{aligned} \frac{dq}{dp_t} &= -\begin{vmatrix} \frac{\partial^2 \pi_2}{\partial x^2} & \frac{\partial^2 \pi_2}{\partial x \partial p_t} \\ \frac{\partial^2 \pi_2}{\partial x \partial q} & \frac{\partial^2 \pi_2}{\partial q \partial p_t} \end{vmatrix} \Bigg/ \begin{vmatrix} \frac{\partial^2 \pi_2}{\partial x^2} & \frac{\partial^2 \pi_2}{\partial x \partial q} \\ \frac{\partial^2 \pi_2}{\partial x \partial q} & \frac{\partial^2 \pi_2}{\partial q^2} \end{vmatrix} \qquad (1.12) \\ &= -\frac{p_q + x p_{xq} - C_{xq}^2}{(2p_x + x p_{xx} - C_{xx}^2)(x p_{qq} - C_{qq}^2) - (p_q + x p_{xq} - C_{xq}^2)^2} > 0. \end{aligned}$$

where (1.10) and the fact that by (1.7) $p_q - C_{xq}^2 = C_q^2/x - C_{xq}^2 \leq 0$ (this is Condition 1.2) have been used to determine the sign. Hence, $p_t > C_x^1$ implies that q is higher under non-integration than under integration.

For the second part of the proposition, first observe that the level of quality that maximizes joint profits for a given x is defined by (1.2). Noting that the actual quality choice by the independent downstream firm is given by (1.7) which is identical to (1.2) completes the proof. ■

The fact that disintegrated firms provide a higher level of quality has a simple intuition. Since the seller of the input good is an independent monopolist, he will charge a transfer price above marginal costs. The result is double marginalization which causes a restriction of output. Since a more exclusive group of consumers is served, there is an incentive to adjust the level of quality upwards.

As we have downstream investment here, the model is useful to evaluate the question whether retailers fall short of providing efficient services for the products they sell. In general, an upstream producer will worry that a retailer does not put enough effort into promotional activities. This problem has been termed downstream moral hazard by Tirole (1988) who shows that the retailer exerts a positive externality on the producer (increased services lead to higher demand for the producer's products). As the retailer does not internalize this externality, the provided service quality is too low given the input price.

The existence of this quality-reducing externality and the term "moral hazard" suggest that independent retailers provide less services than a vertically integrated monopolist. Whether this is actually the case can readily be analyzed within the scope of this section as Tirole's formulation is a special case of the more general model presented here, satisfying both Conditions 1.1 and 1.2. Following Proposition 1.1, the surprising result is that despite the fact that they do not take the positive externality into account that they exert on producers, independent retailers provide a higher level of promotional services

The reason for this is that there is an externality *taking the input price* p_t *as given*. However, it is of little use to take an endogenous variable in a dynamic game as exogenously given, as it is chosen strategically to affect the subsequent actions of other players. So in fact, the externality between retailer and producer is no source for downstream moral hazard. As Proposition 1.1 demonstrates, retailers really provide a level of services that maximizes joint profits.[4]

[4]Note, however, that in models with more than one retailer as in Mathewson and Winter (1984, 1993), retailers may exert positive externalities on each other. This happens, for instance, if one retailer's advertising for a product increases another retailer's demand for the product. In this case, of course, retailers may underprovide promotional activities.

1.4 The Commitment Effect

We will now relax Condition 1.1 to show that if it does not hold, a second effect appears that influences the quality provision of independent monopolists. For simplicity, we will consider a situation where only the upstream firm's investment is relevant for the overall level of quality. Corresponding to last section's procedure, it will therefore be assumed that $q = q(q_1, 0) = q_1$. As will become clear below, the results carry over to the general case where q_2 is also relevant. In addition to tractability, this approach has the advantage that it represents an important special case, namely the situation where a manufacturer sells its products via a retailer (who does not provide extensive services).

The vertically integrated solution is again given by equations (1.1) to (1.5), with the cost functions' indices exchanged as the quality investment is now made by firm one instead of firms two.[5]

If the two firms are independent, the downstream firm's profit function is

$$\pi_2 = x\,[p(x,q) - p_t] - C^2(x).$$

Given an input good of price p_t and quality q, it will therefore set the quantity such that

$$\frac{\partial \pi_2}{\partial x} = p + xp_x - p_t - C_x^2 = 0. \tag{1.13}$$

The corresponding second order condition is

$$\frac{\partial^2 \pi_2}{\partial x^2} = 2p_x + xp_{xx} - C_{xx}^2 < 0. \tag{1.14}$$

The upstream firm's profit function is

$$\pi_1 = x(p_t, q)p_t - C^1(x(p_t, q), q).$$

[5] The correspondingly altered equations will be referred to as equations (1.1a) to (1.5a) in what follows.

The optimal choice of p_t and q is then given by

$$\frac{\partial \pi_1}{\partial p_t} = \frac{dx}{dp_t}\left[p_t - C_x^1(x(p_t,q),q)\right] + x = 0 \tag{1.15}$$

and

$$\frac{\partial \pi_1}{\partial q} = \frac{dx}{dq}\left[p_t - C_x^1(x(p_t,q),q)\right] - C_q^1(x(p_t,q),q) = 0. \tag{1.16}$$

Comparing these two solution we arrive at the following proposition.

Proposition 1.2 *Assume Condition 1.2 holds. Then successive monopolies provide a higher level of quality (if the demand effect is sufficiently strong) or a lower level of quality (if the commitment effect is sufficiently strong) than a vertically integrated firm. Given output, quality is below the level that maximizes joint profits.*

Proof. The most convenient way of proving this proposition is by way of graphical representation of the equilibrium. We will first depict the vertically integrated equilibrium in (x,q) space. The equilibrium point is represented by the intersection of the two curves that are defined by equations (1.1a) and (1.2a). Using the implicit function theorem, the curve $\partial\pi/\partial x = 0$ is found to have the slope

$$\left.\frac{dq}{dx}\right|_{\partial\pi/\partial x=0} = -\frac{\frac{\partial^2\pi}{\partial x^2}}{\frac{\partial^2\pi}{\partial x\partial q}} = -\frac{2p_x + xp_{xx} - C_{xx}^1 - C_{xx}^2}{p_q + xp_{xq} - C_{xq}^1}. \tag{1.17}$$

Likewise, the curve $\partial\pi/\partial q = 0$ has slope

$$\left.\frac{dq}{dx}\right|_{\partial\pi/\partial q=0} = -\frac{\frac{\partial^2\pi}{\partial x\partial q}}{\frac{\partial^2\pi}{\partial q^2}} = -\frac{p_q + xp_{xq} - C_{xq}^1}{xp_{qq} - C_{qq}^1}. \tag{1.18}$$

By (1.3a), the numerator of (1.17) is negative and by (1.4a) the denominator of (1.18) is also smaller than zero at the equilibrium point. Hence, around the equilibrium, the slope of both curves has the same sign as

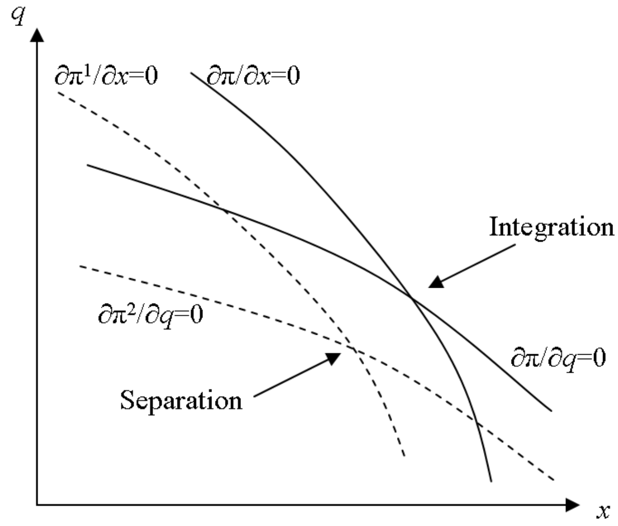

Figure 1.1: Equilibrium with upstream investment

$\partial^2\pi/(\partial x\partial q)$. By (1.2a), $p_q - C^1_{xq} = C^1_q/x - C^1_{xq} \leq 0$, where the inequality follows from Condition 1.2. Therefore, we must have $\partial^2\pi/(\partial x\partial q) < 0$ so both curves are downward sloping. Comparing (1.17) and (1.18), one finds that the curve $\partial\pi/\partial x = 0$ is strictly steeper than the curve $\partial\pi/\partial q = 0$ if and only if

$$\frac{\partial^2\pi}{\partial x^2}\frac{\partial^2\pi}{\partial q^2} > \left(\frac{\partial^2\pi}{\partial x\partial q}\right)^2.$$

Around the equilibrium we know this to be the case from (1.5a). Accordingly, Figure 1.1 represents the solution with the curve $\partial\pi/\partial x = 0$ falling steeper than the curve $\partial\pi/\partial q = 0$. Next we will determine how the curves shift under independent pricing. From (1.15) we first obtain

$$p_t = -\frac{x}{\frac{dx}{dp_t}} + C^1_x. \tag{1.19}$$

Substituting (1.19) into (1.13) gives

$$\frac{\partial \pi_2}{\partial x} = p + xp_x - C_x^1 - C_x^2 + \frac{x}{\frac{dx}{dp_t}} = 0 \tag{1.20}$$

which is the curve $\partial \pi_2/\partial x = 0$ that describes the choice of x under disintegration. Note that (1.20) is exactly equal to (1.1a) with $x/(dx/dp_t)$ added. The sign of this expression is equal to the sign of

$$\frac{dx}{dp_t} = -\frac{\frac{\partial^2 \pi_2}{\partial x \partial p_t}}{\frac{\partial^2 \pi_2}{\partial x^2}} = \frac{1}{2p_x + xp_{xx} - C_{xx}^2} < 0 \tag{1.21}$$

which is derived by applying the implicit function theorem to (1.13). In view of (1.20) the question is: given some value of q, how must x be changed in equation (1.1a) to yields a positive expression such that (1.20) is fulfilled? As $\partial^2 \pi/\partial x^2 < 0$ by (1.3a), it turns out that x must be decreased. Hence, the curve $\partial \pi_2/\partial x = 0$ lies to the left of the curve $\partial \pi/\partial x = 0$ as depicted in Figure 1.1. This is the demand effect of independent quality provision: as is apparent from the graphical representation, it increases q and decreases x. The curve that describes the choice of q under disintegration is found by substituting (1.19) in (1.16) which yields

$$\frac{\partial \pi_1}{\partial q} = -\frac{dx}{dq}\frac{x}{\frac{dx}{dp_t}} - C_q^1 = 0. \tag{1.22}$$

Applying the implicit function theorem to (1.13) again we find that

$$\frac{dx}{dq} = -\frac{\frac{\partial^2 \pi_2}{\partial x \partial q}}{\frac{\partial^2 \pi_2}{\partial x^2}} = -\frac{p_q + xp_{xq}}{2p_x + xp_{xx} - C_{xx}^2}.$$

Noting that this expression is equal to $-(p_q + xp_{xq})\frac{dx}{dp_t}$ and substituting it into (1.22) then gives

$$\frac{\partial \pi_1}{\partial q} = xp_q - C_q^1 + x^2 p_{xq} = 0. \tag{1.23}$$

Note that (1.23) is exactly equal to (1.2a) with $x^2 p_{xq} < 0$ added. The question here is, how must q be changed in (1.2a) while holding x constant such that (1.2a) yields something positive, thereby fulfilling (1.23). As $\partial^2\pi/\partial q^2 < 0$ by (1.4a), it turns out that a decrease in q is necessary. This is represented in Figure 1.1 by the fact that the curve $\partial\pi_1/\partial q = 0$ lies below the curve $\partial\pi/\partial q = 0$. This is the commitment effect which is seen to decrease q and to increase x. Obviously, the exact position of q under disintegration depends on the relative strength of demand and commitment effect.

Finally, the second part of the proposition has to be demonstrated. Given an arbitrary x the level of q that maximizes joint profits is implicitly defined by (1.2a), yielding $p_q - C_q^1/x = 0$. Note, however, that rearranging (1.23), the quality that is provided under disintegration can be described by the equation $p_q - C_q^1/x = xp_{xq} < 0$. Using (1.4a) we therefore arrive at the conclusion that q is smaller than the amount that maximizes joint profits. ■

Proposition 1.2 shows that when there is upstream investment, two effects govern the quality provision of an independent upstream firm. First, there is the demand effect that tends to increase quality in the disintegrated case for the same reason as in the last section. Anticipating double marginalization, the manufacturer increases quality as goods will be sold to a more exclusive class of consumers. Second, and new in this section, is the commitment effect. As the quality level is chosen before the retailer decides on its markup, the quality level can be set strategically in order to influence the extent of double marginalization downstream. In order to prevent the downstream firm from demanding a high margin, the upstream firm strategically reduces the level of quality. The manufacturer effectively produces a mass product (in terms of quality) in order to commit the retailer not to market it as a luxury good (in terms of quantity).

Note that this commitment introduces an inefficiency into the provision of quality. The upstream firm's behavior here is akin to what a social planner does in a second best world: when there is a distortion in one dimension of the market (here the price-distortion caused by double marginalization), it becomes optimal to introduce a distortion in a second dimension (here by reducing quality). Note also that the result of Proposition 1.2 immediately carries over to the more general case where both q_1 and q_2 are important: if quality may be higher or lower under integration without downstream investment, it may also be higher or lower with downstream investment.

Economides (1999) finds that under the specific assumptions of his model, independent firms demand a higher price than an integrated firm, even if they provide lower quality. In general, however, this property does not hold. It is easy to find examples where the commitment effect is so strong that the market price p is lower under disintegration despite the presence of double marginalization. That is, double marginalization may actually *decrease* prices once quality is endogenous.

From the proof of Proposition 1.2 one can see that the demand effect is particularly strong when demand is more concave (less convex). Intuitively this corresponds to a situation where a relatively large proportion of consumers has a high willingness to pay. The commitment effect will be important whenever p_{xq} is large, implying that quality reductions are particularly effective in deterring retailers from going upmarket. In order to be able to get a more direct feel for the relative impact of the two effects, it may, however, be desirable to refer to a concrete special case that illustrates when the model tips from a lower to a higher choice of quality. Proposition 1.3 provides such a case.

Proposition 1.3 *Assume that both firms have a constant returns to scale technology. Then, if the demand function is linear in the price, successive monopolies with upstream investment provide the same level of quality as a vertically integrated firm.*

Proof. The requirement of constant returns to scale implies that the cost functions are of the form $C^1(x,q) = xc_1(q)$ and $C^2(x) = xc_2$, where

c_2 is a constant. Linearity in p implies that inverse demand takes the form $p = a(q)x + b(q)$ for some functions $a(q)$ and $b(q)$. Using these demand and cost functions, it is straightforward to show that (1.1a) now corresponds to

$$2a(q)x + b(q) - c_1(q) - c_2 = 0 \tag{1.24}$$

and that (1.2a) corresponds to

$$x = \frac{c_1'(q) - b'(q)}{a'(q)}. \tag{1.25}$$

Likewise, (1.13) is given by

$$4a(q)x + b(q) - c_1(q) - c_2 = 0 \tag{1.26}$$

and (1.16) by

$$x = \frac{c_1'(q) - b'(q)}{2a'(q)}. \tag{1.27}$$

Substituting (1.24) in (1.25) and rearranging or (1.26) in (1.27) and rearranging both yields

$$2a(q)\frac{c_1'(q) - b'(q)}{a'(q)} + b(q) - c_1(q) - c_2 = 0, \tag{1.28}$$

which is a function of q alone. Thus, the level of quality produced by independent firms is identical to the level that a vertically integrated manufacturer provides. ■

Proposition 1.3 tells us that with constant returns and linear demand, a producer with an independent retailer is equivalent to a vertically integrated manufacturer in terms of quality provision.[6,7] The acquisition of

[6] While the significance of this example should not be stressed too much, linearity may be more than a convenient focal point of the analysis. Bresnahan and Reiss (1985) estimate manufacturer and retailer margins in the car industry and can not reject the hypothesis that the demand functions for the large number of models they consider are linear.

[7] The result of Proposition 3.3 readily extends to the class of cost functions of

a retailer by a producer will therefore only affect the retail price but not the product as such. Note that only linearity in p is required, so that demand and cost functions are generally allowed to be non-linear in q. This is important because the scaling of q can only be sensibly defined up to a positive monotone transformation, which would render linearity requirements void.

1.5 The Scale Effect

After showing that a relaxation of Condition 1.1 can alter Section 1.3's conclusion that independent firms always provide more quality, we will now see that the same result can be obtained if instead Condition 1.2 is relaxed. Contrary to Section 1.3, we therefore assume that the cost function is such that quality investments become cheaper with scale. That is, the per unit costs of producing a given level of quality decreases with the number of units that are produced.

Obviously, Section 1.3's first order conditions still apply in this section. The equilibrium characteristics implied by them, however, change as Condition 1.2 can not be applied anymore. This is stated in Proposition 1.4.

Proposition 1.4 *Assume Condition 1.1 holds. Then successive monopolies provide a higher level of quality (if the demand effect is sufficiently strong) or a lower level of quality (if the scale effect is sufficiently strong) than a vertically integrated firm. Given output, quality is such that joint profits are maximized.*

Proof. The proof is immediate by following the proof of Proposition 1.1 step by step and noting that the numerator of dq/dp_t is now inde-

the form $C = F + c(q)x$, which nests all constant returns functions. The latter were chosen in the proposition merely because of their particular importance in the long run.

terminate in sign as $xp_{xq} < 0$, while $p_q - C^2_{xq} = C^2_q/x - C^2_{xq} > 0$ since Condition 1.2 does not hold. ■

The scale effect that is introduced here by assuming that Condition 1.2 does not hold tends to decrease the quality that independent firms provide. The reason is straightforward. Double marginalization reduces the quantity sold. But as the provision of quality becomes more costly when production is at a smaller scale, the downstream firm chooses to offer less of it.

The strength of the scale effect is directly determined by the characteristics of the cost function. Most importantly, if the provision of quality tends to increase fixed cost, the scale effect will be important, while it will be of less relevance if quality provision predominantly affects marginal costs.

1.6 Welfare

The analysis so far has been positive, describing in some detail how vertical integration influences product choice. In this section, we will now turn to the normative question whether vertical integration is desirable from a welfare point of view. There are two parts to this. First, vertical integration allows to overcome double marginalization which is unambiguously desirable as prices are decreased and profits increased. Second, however, we must consider the impact of integration on quality. As Spence (1975) and Sheshinski (1976) have shown, if output is taken as given, monopolies provide too little quality from a welfare point of view when $p_{xq} < 0$. Hence, whenever higher quality levels can be achieved under disintegration, this makes integration *less* attractive. In principle, therefore, the general wisdom that vertical integration of successive monopolies is beneficial could loose its validity once the endogeneity of product characteristics is acknowledged.

To analyze this question formally, let us begin by inspecting the market solution of Chapter 1.3, where Conditions 1.1 and 1.2 hold. The welfare function $W(x,q)$ consists of gross consumer surplus minus the costs of production.

$$W(x,q) = \int_0^x p(z,q)dz - C^1(x) - C^2(x,q) \tag{1.29}$$

Maximizing (1.29) with respect to x and q gives the first order conditions

$$\frac{\partial W}{\partial x} = p(x,q) - C_x^1 - C_x^2 = 0 \tag{1.30}$$

and

$$\frac{\partial W}{\partial q} = \int_0^x p_q(z,q)dz - C_q^2 = 0. \tag{1.31}$$

with the associated second order conditions

$$\frac{\partial^2 W}{\partial x^2} = p_x - C_{xx}^1 - C_{xx}^2 < 0, \tag{1.32}$$

$$\frac{\partial^2 W}{\partial q^2} = \int_0^x p_{qq}(z,q)dz - C_{qq}^2 < 0 \tag{1.33}$$

and

$$\begin{aligned}\frac{\partial^2 W}{\partial x^2}\frac{\partial^2 W}{\partial q^2} - \left(\frac{\partial^2 W}{\partial x \partial q}\right)^2 \quad = \quad & (p_x - C_{xx}^1 - C_{xx}^2) \\ & \times \left[\int_0^x p_{qq}(z,q)dz - C_{qq}^2\right] - (p_q - C_{xq}^2)^2 > 0.\end{aligned} \tag{1.34}$$

It will again be useful to depict the optimum graphically. Figure 1.2 shows it as the intersection of the curves $W_x = 0$ and $W_q = 0$, which are given by (1.30) and (1.31). To prove that both curves are indeed downward sloping around the optimum, the implicit function theorem is

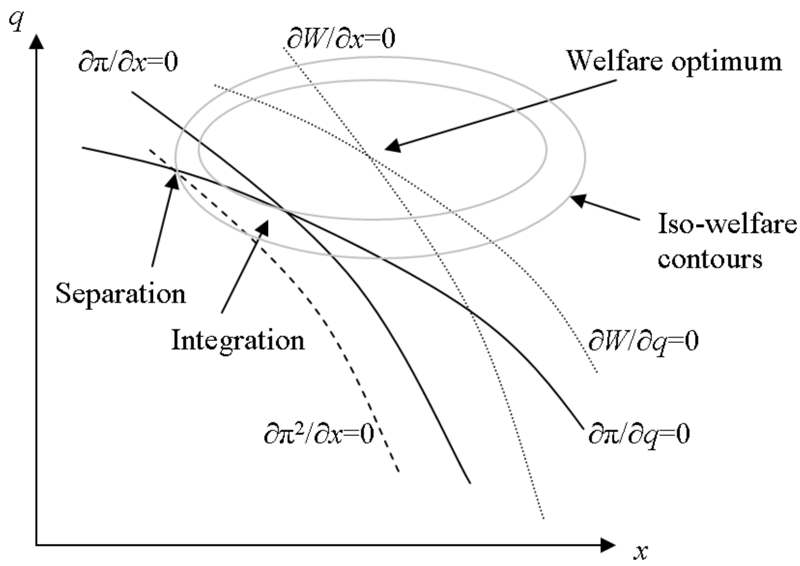

Figure 1.2: Welfare comparison

applied to (1.30) and (1.31) to yield

$$\left.\frac{dq}{dx}\right|_{\partial W/\partial x=0} = -\frac{\frac{\partial^2 W}{\partial x^2}}{\frac{\partial^2 W}{\partial x \partial q}} = -\frac{p_x - C^1_{xx} - C^2_{xx}}{p_q - C^2_{xq}} < 0 \tag{1.35}$$

and

$$\left.\frac{dq}{dx}\right|_{\partial W/\partial x=0} = -\frac{\frac{\partial^2 W}{\partial x \partial q}}{\frac{\partial^2 W}{\partial q^2}} = -\frac{p_q - C^2_{xq}}{\int_0^x p_{qq}(z,q)dz - C^2_{qq}} < 0. \tag{1.36}$$

The negative signs can be inferred from (1.32), (1.33) and the fact that $\partial^2 W/(\partial x \partial q) = p_q - C^2_{xq} < 0$. To see that this latter cross-derivative is negative first note that by Condition 1.2, $C^2_{xq} \geq C^2_q/x$. By (1.31) in turn, $C^2_q/x = \left[\int_0^x p_q(z,q)dz\right]/x$. As $p_{xq} < 0$ by assumption, we must also have $\left[\int_0^x p_q(z,q)dz\right]/x > p_q$. Thus, $C^2_{xq} > p_q$, the desired result.

Comparing the relative slopes of (1.35) and (1.36), we immediately find that the curve $W_x = 0$ is steeper than the curve $W_q = 0$ by (1.34) as depicted in Figure 1.2, which completes the picture for the welfare optimum.

Along the lines of the proof of Proposition 1.2 we can also represent the integrated and separated monopoly solution graphically, which are depicted in Figure 1.2 as the intersection of the curves $\pi_x = 0$ and $\pi_q = 0$ for the integrated case and $\pi_x^2 = 0$ and $\pi_q = 0$ for the disintegrated case. Using the same techniques as in the proof of Proposition 1.2 allows to demonstrate that the three monopoly curves indeed lie strictly below the respective welfare curves.

In order to compare the welfare properties of the integrated and disintegrated solution, Figure 1.2 shows the iso-welfare contours that pass through the monopoly solutions. The contours are drawn such that welfare is higher under integration than under separation (the better-direction is inwards), but it is easy to see that this will in general depend on their specific shape.

The slope of the iso-welfare contour passing through an arbitrary point (x, q) can be derived as

$$\left.\frac{dq}{dx}\right|_{W=W(x,q)} = -\frac{\partial W/\partial x}{\partial W/\partial q} = -\frac{p(x,q) - C_x^1 - C_x^2}{\int_0^x p_q(z,q)dz - C_q^2} \tag{1.37}$$

by using (1.30) and (1.31). Somewhat unfortunately, this expression (which primarily consists of first order derivatives) seems quite unrelated to the slopes of the other curves in the figure (which primarily consist of second order derivatives). Hence, no meaningful assertion can be made about the relative positions of the two iso-welfare contours, even if one were able to deduce other properties of them (e.g., that their upper contour sets are convex).[8]

The author is hesitant to conclude from this seeming indeterminacy of the relative positions of the iso-welfare contours that a welfare improve-

[8]It can be shown (by using the first order conditions of the respective maximization problems) that both contours have a negative slope at the two equilibrium points, but this is not inconsistent with the possibility that welfare can be higher or lower under disintegration.

ment through vertical separation must in general be possible. The main reason for this is that in a simplified two-type version of the model, it can be shown that welfare under integration is always higher.[9] A number of simulations have been run to find an example for a welfare improvement through separation—but alas to no avail.

1.7 Extensions and Discussion

This section will discuss a number of aspects of the basic model and analyze some important extensions.

Double Marginalization

In the basic model, the driving force behind the quality provision of successive monopolies is double marginalization. In principle, contractual solutions exist that prevent double marginalization and so one may wonder why firms not simply write optimal nonlinear contracts that implement the integrated allocation.

The problem with those schemes, however (and the reason why contractual solutions are often ruled out in the literature), is that they fail to prevent double marginalization in settings that are more realistic than the idealized textbook exhibition of vertically related markets. For instance, note that nonlinear pricing schemes leave all potential risk with the downstream firm if demand is uncertain. Transferring some of the risk to the upstream firm then necessarily involves a wholesale price above marginal costs (Rey and Tirole, 1986), so double marginalization reappears. But even if it were optimal for the downstream firm to carry the whole risk, pricing above marginal costs would still be necessary if there is asymmetric information between the firms concerning future demand conditions (Gallini and Wright, 1990). Moreover, a variety of historical and regulatory reasons make coordination difficult (see Smith, 1982). Tirole (1988, p. 176-177) contains a discussion and further arguments why

[9] This model is available from the author upon request.

contractual solutions will in general not make it possible to eradicate double marginalization.[10]

What Happens if $p_{xq} > 0$?

The assumption that $p_{xq} < 0$ was needed at several points in the chapter. It turns out that, if one assumes instead that $p_{xq} > 0$, the direction of the demand effect and the commitment effect change signs. In fact, the output contraction that is caused by double marginalization would lead firms to *decrease* quality because consumers with a higher willingness to pay then have a lower preference for quality. As a result, upstream firms would have an incentive to *increase* quality in order to stop downstream firms from restricting output to luxury consumers. The scale effect, on the other hand, is not affected by the sign of p_{xq}.

Ex-ante Investments

In the basic model it was assumed that firms make their choice of quality at the same time they decide on their price. This is certainly the right order of events in many vertical chains. In others, it may be more realistic to assume that firms first simultaneously decide on the level of quality they want to offer and then start a sequential pricing game. This is the case whenever quality choice is determined by long-standing investments, for example by the construction of a particular type of production plant or the acquisition of a certain machine.

In the situation analyzed in Section 1.4, where the upstream firm provides quality, obviously nothing changes as the upstream firm moves first anyhow. The case of downstream investment analyzed in Section 1.3, however, does change. When the downstream firm makes her quality choice prior to the upstream firm's price decision, the level of quality can be selected strategically to prevent excessive pricing by the upstream firm. So, maybe not surprisingly, the upstream firm will consider the

[10] These theoretical arguments are supported by a number of empirical studies that provide evidence for double marginalization in different industries. See, for instance, Bresnahan and Reiss (1985), Lafontaine (1995) and West (2000).

commitment effect. In this case Proposition 1.3, which shows that integration does not affect quality in linear environments, can be extended to the case of downstream investment. In general, quality may be higher or lower under integration, depending on the same three effects that were illustrated in the basic model.

Price Discrimination

As consumers are heterogeneous in their preference for quality, it pays for firms to price discriminate between them by offering different qualities. This, however, does not change the general intuition of the effects that are analyzed in this chapter. In fact, it can be shown that the results of the basic model qualitatively carry over to the case of price discrimination. For instance, the demand effect implies that successive monopolies provide a smaller range of qualities containing only higher levels of quality. Likewise, the commitment effect implies that independent firms sell a larger range of qualities, also containing lower levels of quality.

1.8 Conclusion

Economides (1999) has shown that under certain conditions, successive monopolies provide a lower level of quality and demand a higher price than a vertically integrated monopolist.[11] As it turned out, however, both results do not hold in general. This chapter has presented a framework to analyze vertical quality provision. It was shown that the choice of quality is governed by three distinct effects which were isolated in the model. This has allowed us to provide a more nuanced view at important special cases like the intermediate/final good producer relationship, the producer/retailer relationship and the provision of promotional services.

[11] The precise conditions are that consumers' utility functions are linear in price and quality, that there are no variable costs of production, that the two firms' qualities are perfect complements, that firms invest in product choice before setting prices and that prices are chosen simultaneously.

It would be interesting to extend the model to a competitive downstream industry, with downstream firms offering differentiated products as in Perry and Groff (1985) and Kühn and Vives (1999). Likewise, a further investigation into the simultaneous provision of quality by upstream and downstream firms could be rewarding. This would allow to characterize the impact of different production technologies $q(q_1, q_2)$ on equilibrium quality (e.g., complementary versus substitutable qualities). Both directions appear to be promising avenues for future research.

Chapter 2

Uncoordinated Corruption as an Equilibrium Phenomenon

2.1 Introduction

In an influential paper, Shleifer and Vishny (1993) show that the problem of bureaucratic corruption is particularly harmful when different public agencies independently demand bribes for their service. This uncoordinated corruption leads to significantly higher bribe levels than coordinated corruption since the agencies exert a negative externality on each other that is not internalized. The effect is comparable to the double marginalization problem that arises when independent monopolists of complementary goods overprice their respective components.

Uncoordinated rent extraction has devastating consequences for economic development. Landes (1998) argues that it is one of the main reasons why continental Europe was lagging behind England at the start of the Industrial Revolution. Bardhan (1997), De Soto (1989) and Klitgaard (1990) make similar points for bureaucratic corruption in present day Asia, Latin America and Africa. In many sub-Saharan countries in particular, the extent of independent corruption is so pervasive that economic development in the formal sector seems hard to sustain.

A simple response to the problem is reducing competition between bureaucrats who issue complementary permits and licenses. If all necessary documents can be obtained out of one hand (or if different officials coordinate) the problem of uncoordinated corruption disappears. It is important to note that the resulting lower graft payments benefit both economic actors *and* the bureaucracy. Notably, rapacious administrations gain because the bribe revenues that can be extracted are higher due to the absence of double marginalization. One might therefore expect that efforts are undertaken to reduce vertical competition between government agencies.

Yet, De Soto (2000) presents striking evidence that in many developing countries quite the contrary is the case. Obtaining legal authorization to build a house on public land in Peru requires the completion of 207 bureaucratic procedures involving 52 different government offices. Similar endeavours in Egypt and the Philippines need approval of 31 agencies in the former and 53 agencies in the latter case (and a multitude of administrative steps). Analogous problems arise in obtaining the necessary permits and licenses to open even a small business. De Soto's attempt to legally operate a one-worker garment shop in Lima started a bureaucratic process that took 289 days until completion. By that time he had paid $1,231 in "fees"—more than thirty times the monthly minimum wage in Peru. It appears to be feasible to reduce this incredible obstacle to development without excessive effort—if there is a political will to do so.

This chapter attempts to explain why there might be no such will even though a coordination of competing agencies improves the welfare of both society and rent extractors. The origin of the problem will be linked to the fact that governments may only control part of the rent extraction process. Section 2.2 formalizes Shleifer and Vishny's (1993) model of independent bribery and derives their result of excessive corruption in formal terms (Proposition 2.1). After observing some simple comparative statics properties (Proposition 2.2), the main result of this chapter will state that a coordination of government agents may be detrimental to the bribe revenue the bureaucracy can extract (Proposition 2.3). It will be noted that if government control is sufficiently low, it may even pay to increase the number of independent bureaucracies (Proposition 2.4). Section 2.3 concludes.

2.2 The Model

Consider an economy where entrepreneurs decide whether or not to start an enterprise. There are $I \geq 2$ bureaucratic agents (indexed by i) that independently extract bribes $b_i \geq 0$, $i = 1, ..., I$, from firms. Each agent represents a different government office at which entrepreneurs have to obtain a permit. Let $b = \sum_i b_i$ denote the total level of bribes an entrepreneur has to pay when starting an enterprise. Given b, a mass of $N(b) \geq 0$ entrepreneurs will actually be active, where the function $N(\cdot)$

is assumed to be twice continuously differentiable. As bribes impede entrepreneurship, $N'(b) < 0$. Moreover, it will be assumed that $N''(b) \leq 0$. That is, the higher the bribe level, the more devastating the effect on entrepreneurial activity both in absolute and in marginal terms. As bribes are monetary transfers that reduce efficient economic activity, welfare is maximized when $b = 0$ and thus $N = N(0)$.

Agents independently set their bribe demand b_i to maximize bribe revenue $R_i = b_i N(b)$.[1] Hence, the equilibrium bribes $(\hat{b}_1, ..., \hat{b}_I)$ are characterized by the I first order conditions

$$N(\hat{b}) + \hat{b}_i N'(\hat{b}) = 0 \text{ for all } i = 1, ..., I \tag{2.1}$$

where $\hat{b} = \sum_i \hat{b}_i$. The associated second order conditions are

$$2N'(\hat{b}) + \hat{b}_i N''(\hat{b}) < 0 \text{ for all } i = 1, ..., I. \tag{2.2}$$

As $\hat{b}_i = -N(\hat{b})/N'(\hat{b})$ for all i by (2.1), the solution is symmetric. Summing (2.1) over all i gives

$$IN(\hat{b}) + \hat{b}N'(\hat{b}) = 0. \tag{2.3}$$

Taking the derivative with respect to $\hat{b}$ of this expression yields $(I + 1)N'(\hat{b}) + \hat{b}N''(\hat{b}) < 0$. Thus, there exists at most one value $\hat{b} > 0$ that fulfills (2.3), so the solution is also unique.

The following proposition compares this non-cooperative equilibrium with a situation where agents agree on an optimal common bribe level b^*.

Proposition 2.1 *(Shleifer and Vishny, 1993) Independent agents demand higher total bribes per entrepreneur than coordinated agents.*

[1] Following Shleifer and Vishny (1993) it will be assumed that agents do not risk detection as higher ranked officials participate in the graft revenue.

Proof. The coordinated solution b^* is characterized by

$$N(b^*) + b^* N'(b^*) = 0. \tag{2.4}$$

Suppose that $b^* \geq \hat{b}$. Then we would have $N(\hat{b}) \geq N(b^*)$ and, by the symmetry of equilibrium bribes, $\hat{b}_i < b^*$ for all $i = 1, ..., I$. Using (2.1) and (2.4) we must also have $N'(\hat{b}) < N'(b^*)$. By our assumptions on $N(\cdot)$, however, this would imply $\hat{b} > b^*$, a contradiction. ■

According to Proposition 2.1, independent bribery induces a level of corruption beyond the profit maximizing amount. As a result, both public officials and entrepreneurs are worse off. Proposition 2.2 conveys that this inefficiency becomes worse the more independent agencies there are.

Proposition 2.2 *An increase in the number of independent agents has the following effects. (i) Total bribes per entrepreneur strictly increase. (ii) Individual agents' bribe demands per entrepreneur strictly decrease. (iii) Total welfare decreases. (iv) Individual agents' revenues strictly decrease. (v) The total revenue from bribes decreases.*

Proof. From (2.3)

$$\frac{d\hat{b}}{dI} = -\frac{N(\hat{b})}{(1+I)N'(\hat{b}) + \hat{b}N''(\hat{b})} > 0,$$

where the inequality follows from (2.2) and the fact that $I \geq 2$. This proves (i). From (2.1) we have $\hat{b}_i = -N(\hat{b})/N'(\hat{b})$. Hence,

$$\frac{d\hat{b}_i}{dI} = -2N(\hat{b})\frac{d\hat{b}}{dI} + \frac{[N(\hat{b})]^2 N''(\hat{b})}{[N'(\hat{b})]^2} < 0 \tag{2.5}$$

for all $i = 1, ..., I$. So (ii) is also correct. Furthermore, as b increases, N must decrease, that is welfare goes down. This is part (iii). (iv) follows as both b_i and N go down. Finally, (v) must be true because the total revenue function $bN(b)$ is globally concave in b and the equilibrium value $\hat{b}$ is different from the maximum value b^*. ■

As the government controls all corrupt agents, it has a clear incentive to prevent independent bribe extraction. A rapacious administration would want different agencies to coordinate on an overall bribe level of b^* to maximize graft income.

In many middle- and low-income countries, however, a substantial amount of rent extraction involves agents who are not under the government's control. Criminal organizations like the Russian mafia or Chinese triads demand payments that represent a serious financial obstacle to private enterprise and foreign direct investment. Moreover, urban areas in developing countries often display soaring levels of street crime. The situation in suburban zones (like Brazil's favelas) and rural areas (like the southern Philippines) may not be much more secure due to the power of criminal factions. Furthermore, independent political groups like Columbia's guerrillas and paramilitary militias may possess significant power to extract rents. And even *within* the administration there are often agencies the government—for lack of political power—can not control.

Therefore, we will now consider a situation where in addition to the I bureaucrats, there exists a set of A autonomous agents $I+1, ..., J$ that are not controlled by the government. Hence, there is a total amount of $J = I + A$ rent extractors. As a matter of notation, the J equilibrium bribes resulting from independent corruption will be denoted as $(\hat{b}_1, ..., \hat{b}_J)$ with a total level of bribes $\hat{b}$. As before, these can be inferred from (2.1), with J replacing I. The solution where government agencies coordinate will be denoted as $(\tilde{b}_1, ..., \tilde{b}_J)$ with $\tilde{b} = \sum_i \tilde{b}_i$. The following proposition characterizes how a possible coordination of government agents affects the different groups and their behavior in this case.

Proposition 2.3 *A coordination of government agents has the following* *effects. (i) Total bribes per entrepreneur strictly decrease. (ii) Government agents' bribe demands per entrepreneur strictly decrease. (iii) Autonomous agents' bribe demands per entrepreneur strictly increase. (iv) Total welfare increases. (v) Autonomous agents' revenues increase. (vi) Government agents' revenues increase if and only if the government controls a sufficiently large proportion of all agents. (vii) The total revenue from bribes increases.*

Proof. (i) follows directly from Proposition 2.2 (i) as a coordination of I agents is equivalent to a situation where there are $I-1$ agents less.[2] To prove (ii), we apply the implicit function theorem to (2.1) and derive

$$\frac{db_i}{db_{-i}} = -\frac{N' + b_i N''}{2N' + b_i N''} \in (-1, 0), \tag{2.6}$$

where $b_{-i} = \sum_{j \neq i} b_j$ denotes the bribes of all agents except i. db_i/db_{-i} is the slope of agent i's reaction function to an exogenous change in bribes of the other agents. Defining $\psi_i := db_i/db_{-i}$, we therefore have $db_i = \psi_i db_{-i}$. Adding $\psi_i db_i$ on both sides of this equation yields $(1+\psi_i)db_i = \psi_i db$ which is equivalent to $db_i = [\psi_i/(1+\psi_i)]db$. Summing up this equation for all agents except one (say, agent j) we obtain $db_{-j} = \sum_{i \neq j}[\psi_i/(1+\psi_i)]db$. Subtracting db on both sides gives $-db_j = \left[\sum_{i \neq j}[\psi_i/(1+\psi_i)] - 1\right] db$. Rearranging we find

$$\frac{db}{db_j} = \frac{1}{1 - \sum_{i \neq j} \frac{\psi_i}{1+\psi_i}} \in (0, 1) \tag{2.7}$$

for all $j = 1, ..., J$ by (2.5). That is, if one agent or a group of agents increase their bribe demand, the others will reduce their bribe demand but by less, so the overall level of bribes rises. As a consequence, if the coordinated government agents would increase their demand for bribes

[2] Mathematically, the reaction function of the A autonomous agents remain the same. The I first order conditions of the coordinated agents, however, are now all given by $N + \sum_{i=1}^{I} b_i N'(b) = 0$. Defining $\bar{b} = \sum_{i=1}^{I} b_i$, we thus have $N + \bar{b}N'(b) = 0$. Hence, the coordinated agents act as if they were one combined agent.

relative to the uncoordinated equilibrium ($\sum_{i=1}^{I} \tilde{b}_i \geq \sum_{i=1}^{I} \hat{b}_i$), the overall level of bribes would also rise ($\tilde{b} \geq \hat{b}$). But this contradicts (i). Therefore, (ii) must also hold. When (ii) holds, (iii) is implied by (2.6). Moreover, by (i) we have $N(\tilde{b}) > N(\hat{b})$ which proves (iv). (v) follows from the fact that both autonomous bribe demands $\tilde{b}$ and the number of active entrepreneurs $N(\tilde{b})$ are increased. To prove (vi) we will first consider the case where only two of the I government agents coordinate. Denoting by $R_i(J)$ the uncoordinated bribe revenue from agent i when there are J agents overall, total bribe revenue of government agents is $IR_i(J)$. After coordination of two government agents, the revenue is $(I-1)R_i(J-1)$ as coordination is equivalent to one government agent disappearing. Therefore, the resulting change in bribe revenue is $\Delta = -I[R_i(J) - R_i(J-1)] - R_i(J-1)$. Continuing to denote the total number of agents as J, this is equivalent to

$$\Delta = -I\frac{dR_i(J-1)}{dJ} - R_i(J-1). \tag{2.8}$$

Using (2.1), an individual agent's bribe revenue is

$$R_i(J) = -\frac{[N(b(J))]^2}{N'(b(J))}. \tag{2.9}$$

From this we obtain

$$\frac{dR_i}{dJ} = -N\frac{db}{dJ}\left(2 - \frac{N''}{(N')^2}\right) < 0. \tag{2.10}$$

Plugging both (2.9) and (2.10) in (2.8) and rearranging we find that

$$\Delta = \underbrace{\gamma J N(b(J-1))\frac{db(J-1)}{dJ}\left[2 - \frac{N''(b(J-1))}{[N'(b(J-1))]^2}\right]}_{\text{positive effect}} + \underbrace{\frac{[N(b(J-1))]^2}{N'(b(J-1))}}_{\text{negative effect}} \tag{2.11}$$

where $\gamma = I/J$ denotes the proportion of government agents. Equation (2.11) conveys the costs and benefits of coordination: There is a positive effect caused by higher bribes per agent and more entrepreneurial activity. The negative effect arises because, effectively, one of the government's agents disappears from the scene. Holding J constant we immediately obtain $d\Delta/d\gamma > 0$. It has already been shown that $\Delta > 0$ for $\gamma = 1$. Moreover, (2.11) conveys that $\lim_{\gamma \to 0} \Delta < 0$. Therefore, $d\Delta/d\gamma > 0$ implies that there exists a threshold $\bar{\gamma} \in (0, 1)$ such that coordination between two government agents is detrimental if $\gamma < \bar{\gamma}$ but profitable if $\gamma \geq \bar{\gamma}$. Since this is true for two government agents it will also be true for an arbitrary number of government agents as a coordination of $I > 2$ agents can be split in $I - 1$ successive steps of coordination by the participating agents. Finally, (vii) follows from the reduction of active agents and Proposition 2.2 (v). ■

The central result here is that a coordinated strategy can actually *harm* the administration. This may appear counterintuitive at first glance: how can it be bad to act with combined forces? The following heuristic argument describes the mechanism at work: Coordinated government agents are aware that their bribe demand exerts a negative externality on other government agents. Therefore, they ask for lower bribes relative to the uncoordinated case. Autonomous agents, however, exploit this fact by demanding higher bribes. As a final result, government agents may be worse off than without coordination.[3] A simple linear example illustrates that the existence of a single autonomous agent may be sufficient to prevent coordination.

Example Consider a situation where $N(b) = \alpha - \beta b$ with $\alpha > 0$ and $\beta > 0$. Let $I = 2$ and $A = 1$, so there are two government agents and one autonomous agent (the mafia, say) that try to obtain bribes. Simple algebra yields $\hat{b}_1 = \hat{b}_2 = \hat{b}_3 = \frac{1}{4}\frac{\alpha}{\beta}$ implying $\hat{b} = \frac{3}{4}\frac{\alpha}{\beta}$ and $N(\hat{b}) = \frac{1}{4}\alpha$ in the independent case. The revenue of the two government agents is therefore

[3] A helpful analogy might be that mergers in Cournot oligopoly which do not involve all active firms possibly reduce the profit of the participating firms (Salant et al., 1983).

$\frac{1}{8}\frac{\alpha^2}{\beta}$. Coordination of agents 1 and 2 then results in a new equilibrium where $\tilde{b}_1 = \tilde{b}_2 = \frac{1}{6}\frac{\alpha}{\beta} < \frac{1}{4}\frac{\alpha}{\beta}$ (assuming that they have agreed to share their proceeds evenly), while $\tilde{b}_3 = \frac{1}{3}\frac{\alpha}{\beta} > \frac{1}{4}\frac{\alpha}{\beta}$. In this case $\tilde{b} = \frac{2}{3}\frac{\alpha}{\beta} < \frac{3}{4}\frac{\alpha}{\beta}$ and $N(\tilde{b}) = \frac{1}{3}\alpha > \frac{1}{4}\alpha$. The coordination has improved the situation both for rent extractors in total and for entrepreneurs. The combined revenue of government agents, however, is only $\frac{1}{12}\frac{\alpha^2}{\beta} < \frac{1}{8}\frac{\alpha^2}{\beta}$, so coordinating the two agencies reduces the administration's revenue from bribes. ■

This has very unfortunate consequences for societies with limited political control. Not only do rapacious administrations in such societies have little incentive to alleviate the situation by coordinating public officials. Worse even, they may have an incentive to increase the number of independent government bureaucrats artificially to generate higher graft revenues. That is, the very recklessness in bribery that causes uncoordinated corruption to be so harmful to society in the first place makes it attractive to use in the fight for rent extraction against autonomous agents. This will be recorded in the following proposition.

Proposition 2.4 *If the government controls a sufficiently small proportion of agents, it will be able to increase its revenue by creating new government agencies that independently extract bribes.*

Proof. From the proof of Proposition 2.3 (vi) it immediately follows that the positive effect of establishing another agency is larger than the negative effect whenever I/J is sufficiently small. ■

2.3 Discussion

When criminal organizations collect bribes from enterprises or when the government has no effective control over some public agencies, bureaucratic coordination may not be beneficial for rent extraction anymore. While it surely increases the revenue from bribery that corrupt agents in total can extract, it also shifts the *distribution* of revenue in favor of outsiders. Due to low control, the government may even have an incentive to artificially expand the bureaucratic apparatus, aggravating the problem of corruption although bribery is already beyond revenue maximizing levels. This explains oddities as the 207 procedures necessary to legally purchase a small peace of land at the outskirts of Lima.

The result accords well with Mauro's (1995) observation that bureaucratic efficiency and political stability are highly correlated. In politically unstable societies, the government's control of public agencies is often limited and organized crime is powerful.[4] As a reaction, the administration may expand its reach to enhance its share of rent extraction vis-à-vis defecting agencies and criminal organizations. Therefore, the model predicts that low political stability immediately implies bureaucratic inefficiency of the sort discussed in the Introduction.

An implicit assumption of this chapter has been that there is no agency problem between the government and the I bureaucrats that are under its control, implying that superior public officials observe the bribes obtained by their subordinates. Waller et al. (2002) show that if the government can identify payments only with a given probability, total bribes per entrepreneur may increase as subordinates surcharge. Note, however, that by changing the wage structure, graft money may be redirected towards the central administration even if it has no way at all of observing bribes paid to bureaucrats. For instance, if the government decides to split a public agency because this increases bribe income for public officials, a correspondingly lower wage is sufficient to attract people to the job. The revenue maximizing scheme for a rapacious government with limited control is therefore to operate a large number of inefficiently competing agencies and to pay meagre salaries to its (corrupt) employees, an infamous if frequently observed combination.

[4]Note that criminal organizations may blossom precisely because prosecutors are corrupt and get paid to look away (see Kugler et al., 2005, for a model). This is how countries like Nigeria and Kenya have simultaneously reached the bottom of crime and corruption statistics.

Chapter 3

Optimal Incentive Contracts in Political Agency Problems

3.1 Introduction

There is a large and growing literature that shows how constitutional mechanisms like elections and referenda provide incentives to alleviate agency problems in politics.[1] The problems that these mechanisms address are, in principle, the same that incentive contracts for managers are supposed to solve. Accordingly, the way they are analyzed in the literature is very similar. For instance, a managerial agency model may specify that a manager will be fired if the profit of his unit is low (e.g., Radner, 1986), while optimal behavior in a voting model may involve that a politician will not be re-elected if he was unsuccessful (e.g., Persson, Roland and Tabellini, 1997).[2]

But despite this theoretical congruence, real world incentive schemes for politicians differ markedly from their counterparts for managers. In particular, politicians are usually elected for a fixed period of time. Contrary to many managers, they can therefore be dismissed only at certain prespecified times but not before—no matter how bad their interim performance may have been.[3] This means that although states of the world may realize ex-post in which it is inefficient to continue the principal-agent relationship, the parties ex-ante commit themselves to hang on to each other.

The origin of the problem is that a contract that stipulates the length of the relationship beforehand can not react to occurrences that were not contractible at the time the initial contract was written. A contract that is less complete in the sense that it does not bind the parties to continue their relationship if certain contractible contingencies are met

[1] Among many others, see Barro (1973), Ferejohn (1986), Persson, Roland and Tabellini (1997), Besley and Burgess (2002), Maskin and Tirole (2004) and Messner and Polborn (2004). Surveys are provided by Persson and Tabellini (2000) and Besley (2006).

[2] See Banks and Sundaram (1998) for a general treatment.

[3] Notable exceptions are the recall-elections that are possible in several US states including the State of California and the Canadian province of British Columbia. The only country where the constitution currently allows a recall at the federal level is Venezuela.

can not only react to contractible but may also be able to react to non-contractible variables if they are observable. For instance, if a principal writes a two-period contract with an agent, the re-employment decision after period one may only be made contingent on the output the agent produces. If the contract leaves the re-employment decision open, however, the principal can also decide on the basis of non-contractible variables like whether the agent "gets along well with the rest of the team". Such voluntary contractual incompleteness was first highlighted by Bernheim and Whinston (1998) as a strategic asset. The question arises why contracting parties would voluntarily write long-term contracts that do not make use of the strategic possibilities that a less complete contract would offer. Moreover, one would like to know why such arrangements are made in the sphere of politics but much less often so in the business world, where agents can often be dismissed instantaneously. This seems particularly puzzling given that successful recall elections in California have shown that a different system is practically feasible.

A potential explanation for the protection of politicians from recall elections or other forms of instantaneous evaluation is the desire to induce them to take decisions which are in the long-term interest of their voters, even if they involve short-term hardships. But, while there is some truth to this, it can not be the whole story. If implementing the right action involves that good outcomes will be more likely in the medium term rather than the short term, then this only calls for patience of the principal—but not for self-restraint.[4]

In the political economy literature it is typically assumed from the

[4]A common response to this argument is that the typical voter does not understand that farsighted politics may involve short-term hardships (which the holder of such an opinion of course does) and that the constitution must therefore protect the naïve citizen from his unreflected impatience. There are two reasons why this is not particularly appealing. First, it suggests to leave the ground of rational decision making, something that economists have been reluctant to do, and with good reason. Second, it stands in blatant contrast to the whole purpose of giving the people electoral power in the first place. If the public was so fundamentally myopic, why let it vote at all?

outset that voters can not recall political agents during a term. In many models, this exogenous restriction is clearly not optimal. A point in case is the seminal agency model developed by Barro (1973), Ferejohn (1986) and Persson, Roland and Tabellini (1997). All incentive problems that arise in the model ultimately stem from the restriction that political agents are untouchable during the length of a term. If the electorate were to change the constitution such that instantaneous dismissal of the ruling politician can take place whenever a majority of voters calls for it in a referendum, one would be able to achieve the first best. In that sense the presence of electoral terms is indeed at the heart of the political agency problem.

This chapter describes the precise circumstances under which commitment to long-term relationships in agency problems is ex-ante efficient even though ex-post efficiency would call for a termination of the relationship in some states of the world. In order to do so, a principal-agent model is set up that is sufficiently general to encompass political and managerial agency as important special cases. It turns out that commitment to long-term contracts may be optimal if and only if the contractibility of outcomes is sufficiently low. It will be argued that low contractibility is precisely what distinguishes political agency problems from managerial agency problems, thereby explaining why commitment to long-term labor contracts is common in politics but less so in private enterprises. The chapter goes on to show that the inefficiency that possibly arises from committing to long-term contracts may be outweighed by the fact that such commitment induces more efficient investments, highlighting a trade-off that the electorate faces in political agency between inducing efficient political decisions and ousting unsuccessful candidates.

The fact that the model links commitment to long-term contracts with limited contractibility is encouraging because the latter can also explain a second particularity of political agency, namely the absence of monetary incentive schemes. As Holmstrom and Milgrom (1991) have shown, giving explicit incentives on contractible tasks may fire back when other tasks are not contractible since the agent may shift too much attention to the things he gets paid for. Therefore, low contractibility of political outcomes can explain both distinguishing features of political agency mechanisms: the unconditionality of long-term contracts and the absence of incentive pay.

The chapter is organized as follows. Section 3.2 first discusses the related literature. Section 3.3 then presents a simple model of the principal-agent relationship. Section 3.4 continues to show which allocations are implementable, characterizes appropriate contracts that implement them and analyzes which contracts are chosen under which circumstances. Section 3.5 discusses possible extensions and Section 3.6 concludes.

3.2 Related Literature

The contract theory literature, including Farrell and Shapiro (1989), MacLeod and Malcomson (1993), Guriev and Kvossov (2006) and Ellman (2006), has stressed the benefits of long-term contracts in mitigating the hold-up problem. At the heart of these models, however, is the ex-post expropriation of the benefits of ex-ante relationship-specific investments, a minor concern in the sphere of politics. In another direction, Aghion and Bolton (1987) show how the contract duration can be used by a monopolist to deter entry into its industry.

Turning to the political economy literature, Akemann and Kanczuk (2000) argue, as this chapter does, that prolonging electoral terms increases politicians' incentives to reflect the long term benefits of a decision. However, they consider only constitutional mechanisms which are arbitrary in the sense that they do not belong the set of *optimal* mechanisms in their paper. By contrast, this chapter endogenously derives an optimal contract from first principles, which turns out to have the structure of a political term (the premise of Akemann and Kanczuk's analysis) only under very specific conditions. This approach allows to derive a number of features of the political agency problem endogenously and to clarify when political terms are optimal and when they are not (which is the case when potential candidates are sufficiently heterogeneous, when myopic policies are relatively harmless, when contractibility is high or when there is symmetric information on candidates' outside options).

Gersbach (2000, 2004) proposes to give politicians monetary incentives in order to take long term outcomes into account. However, there are good reasons why monetary incentive schemes for politicians are not observed in reality. As will be argued below, many if not most political outcomes are not contractible anyway, so contingent payments can not be made. Moreover, for those outcomes which are contractible, multitasking problems are likely to destroy the potential benefits that incentive contracts may have. This problem is particularly severe if some political outcomes are not observable to the public. This chapter therefore seeks for an optimal incentive mechanism *given that contractibility is limited.*

3.3 The Model

Consider a principal who wants to hire an agent in order to perform some task for him. For instance, the principal could be the owner and the agent the manager of a firm. Alternatively, the principal could be an electorate that appoints a politician as an agent.[5] Agents are drawn from a large population and can be either of two types $\theta \in \{\theta_b, \theta_g\}$, where θ_g denotes a good type and θ_b a bad type. The probability of drawing either type is identical. It is assumed that ex-ante, neither the principal nor potential agents know the agents' types as it is unclear how they are suited to the specific task.

The game lasts two periods $t = 1, 2$, where second period outcomes are discounted with a common discount factor δ, which is normalized to

[5] As is common in the literature on political agency, it is assumed that there is no conflict of interest between voters so the common agency problem effectively becomes a standard one-principal-problem.

one. In each period t, the agent is supposed to generate some unspecified outcome X_t (e.g., profit or political success). The outcome consists of a contractible component $x_t \in \{0, x\}$ and a non-contractible component $\hat{x}_t \in \{0, x\}$, where $x > 0$. The overall outcome $X_t = \mu x_t + (1-\mu)\hat{x}_t$ is a weighted average of the two components, so $\mu \in (0,1)$ describes the importance of the contractible relative to the non-contractible component.

Our interpretation of the model will be that low contractibility (small μ) describes a problem of political agency while high contractibility (large μ) describes a managerial agency problem. The reason for this interpretation is that managers are typically expected to maximize profit—an outcome that is easily included into a contract and verified by a court. Politicians, on the other hand, usually have much more complex job descriptions: besides stimulating the creation of wealth they are supposed to guarantee "just" redistribution, to provide an "efficient" amount of public goods and to pursue a foreign policy that is "in the interest of the country". Many of these objectives are difficult to describe ex-ante even though ex-post voters recognize a good policy when they see one. Hence, the contractibility of political outcomes is limited even though observability is not.

For both components of X_t, the probability of reaching a good outcome is given by $p_g \in (0,1)$ for the good type and $p_b \in (0, p_g)$ for the bad type, that is $\Pr(x_t = x \mid \theta = \theta_g) = \Pr(\hat{x}_t = x \mid \theta = \theta_g) = p_g$ and $\Pr(x_t = x \mid \theta = \theta_b) = \Pr(\hat{x}_t = x \mid \theta = \theta_b) = p_b < p_g$ for $t = 1, 2$. After the first period, both principal and agent observe both outcomes and can use them to make inferences on the agent's type. If both outcomes are good, the belief on the agent's type improves as

$$\Pr(\theta = \theta_g \mid x_1 = x \wedge \hat{x}_1 = x) = \frac{p_g^2}{p_g^2 + p_b^2} > \frac{1}{2} \tag{3.1}$$

by Bayes' rule. If both outcomes are bad, on the other hand, the belief deteriorates as

$$\Pr(\theta = \theta_g \mid x_1 = 0 \wedge \hat{x}_1 = 0) = \frac{(1-p_g)^2}{(1-p_g)^2 + (1-p_b)^2} < \frac{1}{2}. \tag{3.2}$$

How mixed signals are interpreted depends on the parameter values.

$$\begin{aligned} \Pr(\theta &= \theta_g \mid x_1 = x \wedge \hat{x}_1 = 0) = \Pr(\theta = \theta_g \mid x_1 = 0 \wedge \hat{x}_1 = x) \\ &= \frac{p_g(1-p_g)}{p_g(1-p_g) + p_b(1-p_b)} > \frac{1}{2} \text{ if and only if } p_g + p_b < 1. \end{aligned} \tag{3.3}$$

For simplicity, it will be assumed that $p_g + p_b < 1$ in what follows (this is an inessential assumption). Therefore, the principal wants to keep the agent in period two if at least one outcome was positive. Otherwise, the principal wants to dismiss the agent. If that happens a new agent is drawn from the pool for period two.

Both in the political and in the managerial context, agents routinely have to take investment decisions that determine the emphasis that is placed on current performance relative to future performance. For instance, a politician may be tempted to postpone urgent labor market reforms because he expects them to lead to hardships in the short run. Similarly, a manager may be tempted to forgo appropriate R&D investments to boost current profits. To capture this investment problem in the model, the agent will be allowed to shift probability mass between the two time periods. Formally, the agent can choose at the beginning of period one to decrease $\Pr(x_2 = x)$ by $q \in (0, p_b)$ percentage points, which in turn increases $\Pr(x_1 = x)$ by $q' \in (0, q)$ percentage points (and likewise for shifts from x_1 to x_2, $\tilde{x}_2$ to $\tilde{x}_1$ and $\tilde{x}_1$ to $\tilde{x}_2$). The fact that $q' < q$ reflects that such probability shifts are inefficient and will not occur in the first best.

If the agent has shifted probability mass, the inference on the agent's type that can be drawn from the first period outcomes changes, so equations (3.1) to (3.3) have to be adjusted with the new probabilities of reaching a given outcome. To avoid having to go through a number of case distinctions (and with no qualitative consequences to the results) we will continue to assume that the probability that an agent is of a good type is larger than 1/2 whenever at least one outcome was good. More formally, it will be assumed that $(p_g + q') + (p_b + q') < 1$.

To make things interesting, it is assumed that the agent's investment choice is not observable by the principal. In order to induce efficient investments and to sort agents, the principal therefore designs an appropriate contract which he offers potential agents who can accept or reject it. A contract contains the wage that is paid (possibly depending on performance and whether or not the agent is dismissed after period one) and may contain a re-employment decision that specifies under which circumstances the contract will be extended to period two. Specifically, a contract is a tuple (w_1, w_2, d), where $w_1 : (x_1, d) \to \mathbb{R}$ denotes the first period wage, $w_2 : (x_1, x_2, d) \to \mathbb{R} \cup \varnothing$ denotes the second period wage and $d : x_1 \to \{0, 1\} \cup \varnothing$ denotes the re-employment decision.[6] $d = 1$ represents the case where the agent is employed for two periods, while $d = 0$ corresponds to the case where the agent is dismissed after period one.

It will be assumed that the principal is able to commit to employ the agent for two periods so that there will be no renegotiation of the contract duration when dismissal becomes attractive ex-post but was excluded ex-ante.[7] Because $\hat{x}_1$ is not contractible, the first period wage can only be made contingent on outcome x_1. Likewise, *if* the second period wage is

[6] Note that both wages map into the set of real numbers. That is, negative wage payments are in principle allowed. This assumption is made for simplicity only. The central equilibrium contract of this paper that is presented in Proposition 2.2 involves strictly positive wage payments in all states of the world. The other contracts could be easily adapted along the lines of Innes (1990).

[7] This could either be due to the fact that the principal has been able to build up a reputation of sticking to contracts with his agents. Or it could be that the principal is able to undertake measures that de facto commit the parties to stick to the contract. For instance, the job design could be made specific to the agent so that a later change of employment would induce substantial transaction costs. In the case of political agency, the commitment assumption seems particularly innocuous as constitutions are difficult to renege upon.

already written into the contract, it can only depend on the contractible outcomes x_1 and x_2. As a re-employment decision can (but must not) be included into the contract, the parties have the opportunity to regulate the contract duration flexibly. If the re-employment decision is left open in the original contract, the parties will have to come to a new agreement after period one. Negotiating the prolongation of the contract at that point has the advantage that the principal can make his offer contingent on the observed outcome of both output dimensions, that is, we then have $d : (x_1, \hat{x}_1) \rightarrow \{0, 1\}$. Note that both wages can in principle depend on the re-employment decision.

Of course, the agent will only accept a contract offer by the principal if it is better than his outside option. Agents have an outside opportunity which guarantees them a utility of u_1 in period one. If an agent was employed by the principal in the first period, his second period outside option $u_2(x_1, \hat{x}_1)$ depends on his first period performance, which is publicly observable by assumption and acts as a signal about the agent's type. Therefore, $u_2(x_1, \hat{x}_1)$ strictly increases in both arguments.[8] It will be assumed that the good outcome x is large relative to the agent's outside option. This assumption is merely for the sake of exposition and does not affect the qualitative nature of the results.

Both principal and agent are assumed to be risk-neutral. Therefore, the agent receives utility $U = w_1 + w_2$ (where w_2 is given by the agent's outside option whenever he is fired after period one). The principal's utility $V = X_1 - w_1 + X_2 - w_2$ is given by the summation of outcomes minus wage payments.

[8] In order to be precise, the second period outside option—if set optimally by alternative employers—also depends on the other parameter values of the model (e.g., p_g and p_b). Because depending on those, the principal designs the contract which influences the agent's investment behavior and hence the quality of the signals x_1 and $\hat{x}_1$. However, for our purposes it is sufficient to acknowledge that being successful in period one increases the agent's outside option in period two. Spelling out the precise magnitude by which the outside option changes is not relevant.

3.4 Implementation

When designing the contract he offers, the principal has three things in mind. He wants to address the sorting problem, he wants the agent to undertake efficient investments in both dimensions, and he wants to pay as little as necessary. With full information, therefore, the first best contract would specify that the agent is reemployed if and only if at least one outcome turns out to be good, that the agent may not shift probability mass from one period to another and that wages are such that the agent receives his outside option in each period.

We will now see the surprising result that this first best outcome is unconditionally attainable even under asymmetric information. With a slight abuse of terminology, the sequence of contracts that achieves this will be denoted as a Golden Handshake Contract.[9]

Proposition 3.1 *(Golden Handshake Contract) There exists a sequence of short term contracts that implements the first best. These contracts have the following characteristics. (i) The re-employment decision is left open in the first contract and the principal dismisses the agent if and only if both outcomes are bad. (ii) The agent's first period wage is not made contingent on outcomes but is larger if the agent is dismissed afterwards. In the second period the agent receives incentive pay.*

Proof. We will first specify further characteristics of the optimal sequence of contracts. The second period wage the principal is willing to pay will of course depend on the first period outcomes. If both outcomes were bad, the newly drawn agent will be offered a fixed wage of his outside option u_1 which will be accepted. If at least one outcome was good, the old agent will be offered a new contract that depends on the first period outcome in the contractible task. If $x_1 = x$, the proposed

[9] Here, and in what follows, it is assumed that the agent chooses the action that is most beneficial for the principal whenever his own payoff is unaffected by the choice of action.

second period wage is large if $x_2 = x$ and small if $x_2 = 0$. If, on the other hand, $x_1 = 0$, the proposed second period wage is small if $x_2 = x$ and large if $x_2 = 0$. In all cases, the expected value of w_2 is chosen such that it exactly matches the agent's outside option after first period outcomes have been revealed (taking the inferred values of (3.1) to (3.3) as the probabilities of contracting with a good type). What remains to be specified is the first period wage. In expectation, w_1 is chosen such that it exactly matches the agent's outside option u_1. The first period wage with dismissal is chosen to be larger than the first period wage without dismissal by an amount that exactly matches the expected benefit of attaining $\hat{x}_1 = x$ instead of $\hat{x}_1 = 0$ (which arises—before knowing the realization of x_1—due to the higher expected salary in period two).

After characterizing the sequence of contracts, it will now be shown that they indeed implement the first best. First observe that in both periods the agent's outside option is paid in expectation so that the expected wage payment is indeed the lowest offer that is still acceptable for the agent. Further, the sorting problem is addressed in the most efficient way by dismissing agents whenever the updated probability of contracting with a good type falls below one half. Finally, it has to be checked that in both the contractible and non-contractible dimension, the agent has no incentive to shift probability mass in either direction. Let us first consider probability shifts in the contractible dimension. Is there an incentive to increase the probability of achieving $x_1 = x$ at the expense of reducing the probability of $x_2 = x$? The simplest way of recognizing that this is not the case is by noting that the higher probability of being successful at x_1 creates expectations for period two that the agent will (on average) not be able to fulfill. If indeed the agent achieves $x_1 = x$, the principal will infer from this that the probability of being confronted with a good agent is given by (3.1) or (3.3), depending on the result in the non-contractible dimension. From this he induces a probability of reaching good outcomes in period two, which is used in setting the expected wage level w_2. The actual probability (after shifting probability mass downwards), however, is lower for two reasons. First, the agent's good results in the first period were positively influenced by the probability shift and so do not reflect in the same way that the agent is actually of a good type. Second, the probability shift reduces the second period probability of being successful. Therefore, increasing the second period wage spread (with a low payment for $x_2 = 0$ and a high payment for $x_2 = x$) can make the agent's expected second period wage arbitrarily small, rendering downward probability shifts useless if the agent stays with the principal.[10] A similar argument applies for upward shifts of probability mass that increase the probability of achieving $x_2 = x$ while reducing the probability of $x_2 = 0$. In this case, the principal infers a success probability for the second period which is lower than the actual probability. Therefore, paying a sufficiently low wage for $x_2 = x$ will make such a shift unattractive. Finally, note that by construction, probability shifts in the non-contractible dimension can never strictly increase the agent's expected income. In fact, the golden handshake he receives after being dismissed exactly compensates him for the losses that result from not having $\hat{x}_1 = 0$, so the agent is indifferent whether the probability of reaching $\hat{x}_1 = x$ changes. As he is also indifferent about the outcome of $\hat{x}_2$ because w_2 can not be made contingent on $\hat{x}_2$, shifting probability mass in the non-contractible dimension can never strictly increase the agent's expected payoff. ■

Golden handshake contracts have very natural features. The principal uses incentive pay to stop the agent from shifting probability mass in the contractible dimension. Trying to fool the principal by favoring short-term success over long-term perspectives is not advisable because

[10] In principle, the agent could nevertheless want to make the probability shift, planning to decline the principal's second period offer and making use of the better outside option that success brings about. Note, however, that declining the principal's offer is a signal that a probability shift was done and hence the agent's outside offer will be revised using the probability of being a good type that are inferred when taking into account that probability was shifted. If this is done, the agent can never gain from this move relative to what he could also achieve by not shifting probability mass.

the principal can make the agent's short-term performance the measure for long-term pay: as future failures are punished hard after present successes, probability shifting in that dimension is not a worry for the principal.[11] The non-contractible task should be expected to be more of a problem because direct incentive pay can not be used. Here, however, the principal employs the golden handshake. By compensating the agent for a bad outcome at $\hat{x}_1$ whenever this leads to dismissal, the agent can be prevented from trying to shine in period one at the expense of period two.

Similar payments, usually called golden parachutes, are frequently made after takeovers to the incumbent top management when it loses its job due to the change of ownership. Often, these payments are explicitly written into the original employment contracts. Arguments for golden parachutes that have been brought forward are that they constitute deferred payments which would be lost after a takeover (Knoeber, 1986) and that they may be part of an optimal incentive scheme that increases relationship-specific investments of managers (Schnitzer, 1995).[12] To this literature this chapter adds the benefit that golden parachutes may be an efficient way to prevent agents from focusing on short-term success at the expense of long-term profitability.[13]

Note that the prospect of a golden handshake makes it necessary to decrease the first period wage of successful agents below their first period outside option in order to maintain $E[w_1] = u_1$. This means that the payment schedule increases even more strongly over time than information revelation on a successful agent's ability would justify anyhow. Again, this is reminiscent of deferred compensation theories which suggest that

[11] This discussion of Proposition 3.1 only highlights the problem of shifting probability mass from the second to the first period, but similar arguments can be made in the other direction.

[12] For a critical view see Bebchuk and Fried (2003).

[13] Gersbach (2004) also proposes golden parachute clauses in the context of political agency. However, in his model golden parachutes fulfill the purpose of protecting the agent from ex-post expropriation of deferred payments, which corresponds to the motivation the literature on takeovers provides.

initial salaries are low compared to productivity, but then increase disproportionately, a phenomenon that can be observed in many industries (see Prendergast, 1999, for an overview of this literature). Note, however, that in our model, low first period wages for successful agents do *not* arise because payments are deferred to the future as agents in expectation receive no more than their outside option as a second period wage. Rather, low first period wages to successful agents are the counterpart to the golden handshake payments that must be made to agents that are dismissed after bad results.

Contracts in this model are essentially short-term in nature: there is no need to hold on to agents if they turn out to be unsuccessful. While one may feel happy for the principal, the question remains open why one would give politicians unconditional long-term contracts. As the exercise has shown, the danger that politicians may act myopically as such is not sufficient to warrant any restrictions—even in the presence of a sorting problem. The question then is what ingredients a model would need to generate results that match with the real world prevalence of political terms—at least if one contains that one of the constitutional cornerstones of liberal democracies which has emerged over the centuries is not an inefficient artefact.

Maybe the most obvious way to argue that the Golden Handshake Contract from Proposition 3.1 is an implausible first best solution is to criticize that it potentially contains punishments for good results and rewards for bad results. And indeed if one would introduce a standard moral hazard component into the model this would bring about low effort provision by the agent in period two in some states of the world. This does not change anything in the way of making long term commitments more attractive, however, and a discussion of moral hazard will therefore be postponed to Section 3.5.

The critical feature of the model turns out to be the agent's outside option, which we have assumed to be known not only by the agent but also by the principal. Yet, in reality a principal will never be fully aware of the idiosyncratic value an agent attaches to a particular job and other alternatives he may have. Thus, a desirable property of a derived mechanism would certainly be that it is immune at least against small perturbations of the agent's outside options. Alas, the Golden Handshake Contract of Proposition 3.1 is not robust at all towards such an innocent alteration of the model.

Before proving this in Lemma 1, we will first define the way uncertainty enters. Assume that each outside option $u_i(\cdot)$ is now given by $u_i(\cdot) = u + \varphi$, where u represents the original value of $u_i(\cdot)$ and φ is drawn from a probability distribution with atomless probability density function $f(\varphi)$ on the support $[-\epsilon, \epsilon]$ and with expected value zero. In what follows, if ϵ is infinitesimally small, we will speak of an "arbitrarily small degree of uncertainty". Naturally, it will be assumed that the agent is aware of the precise value of his outside options while the principal only knows their distribution.

Lemma 1 *With an arbitrarily small degree of uncertainty on the size of the agent's outside options, there exists no contractual structure that implements the first best.*

Proof. Suppose there exists a sequence of contracts that implements the first best. Then the reemployment decision must be $d = 0$ if and only if $x_1 = 0$ and $\hat{x}_1 = 0$. Assume first that the principal does not make w_1 contingent on d. As the agent's outside option for period 2 must be fulfilled and since $u_2(x_1, \hat{x}_1)$ is strictly increasing in $\hat{x}_1$, we must then have $w_2(x_1, \hat{x}_1 = 1) \geq u_2(x_1, \hat{x}_1 = 1) > u_2(x_1, \hat{x}_1 = 0)$. As w_2 can not be made contingent on $\hat{x}_2$ the latter implies that the agent has an incentive to shift probability mass from $\hat{x}_2$ to $\hat{x}_1$: $\hat{x}_2$ does not affect the agent's payoff, while a higher probability of achieving good results in period one increases both the probability of being hired for period two and the expected future wage. Hence, we have a contradiction.

To complete the proof, note that making w_1 contingent on d does not help to improve the situation. While in the environment of Proposition

3.1 the principal could increase the spread between $w_1(d = 0)$ and $w_1(d = 1)$ up to the point where the agent is indifferent about the outcome of $\hat{x}_1$, this is not possible here as the probability of guessing the outside option exactly right is zero as f has a probability mass of zero on each possible realization. As the agent's outside option bears a slight amount of uncertainty, the agent would hence either prefer to shift probability mass to $\hat{x}_2$ or to $\hat{x}_1$. ■

The reason why already a small degree of asymmetric information concerning the agent's outside option destroys the feasibility of the Golden Handshake Contract is that its central component to implement efficient investments in the non-contractible task is a payment that makes the agent indifferent about the outcome of $\hat{x}_1$. But since the utility the agent expects under different circumstances depends on his outside options (which are stochastic from the point of view of the principal) the chance of paying an amount that achieves exact indifference has zero probability. As the proof of Lemma 1 shows, the principal has no hope of efficiently sorting agents and implementing the optimal long-term investment in the non-contractible dimension at the same time. As a consequence he must decide which of the two is more important to him. Proposition 2 presents a contract that induces the agent not to shift probability mass between periods in both dimensions (at the expense of achieving efficient sorting).

Proposition 3.2 *(Commitment Contract) There exists a long term contract that prevents the agent from shifting probability mass in both tasks and in expectation pays no more than the agent's expected outside option. This contract has the following characteristics. (i) The principal commits not to dismiss the agent. (ii) The agent receives a flat wage in both periods.*

Proof. Consider the following two period contract. The first period wage is $w_1 = u_1$,[14] the second period wage is $w_2 = E[u_2(x_1, \hat{x}_1) \mid \Pr(\theta = \theta_g) = 1/2]$, where the expectation is taken under the assumption that the agent does not shift probability mass. By construction, the principal's expected payment is equal to the agent's expected outside option. As the agent's wage is unaffected by performance, he has no incentive to shift probability mass. ■

In a next step, we have to show which contractual structure efficiently implements correct sorting (while foregoing efficient investments in the non-contractible task). This is done by Proposition 3.3.

Proposition 3.3 *(Incentive Contract) There exists a series of short term contracts that efficiently sorts agents, induces efficient investments in the contractible task and in expectation pays no more than the agent's expected outside option. These contracts have the following characteristics. (i) The re-employment decision is left open in the first contract and the principal dismisses the agent if and only if both outcomes are bad. (ii) The agent receives a flat wage in period one, but incentive pay in period two.*

Proof. Consider the following two-period contract. The agent is dismissed if and only if both outcomes are bad. The first period wage is $w_1 = u_1$, the second period wage is exactly as in the Golden Handshake Contract: In case $x_1 = x$, w_2 is high if $x_2 = x$ and low if $x_2 = 0$, in expectation paying the agent's outside option. In case $x_1 = 0$, w_2 is low if $x_2 = x$ and high if $x_2 = 0$, again paying the agent's outside option in expectation. Obviously, sorting is handled efficiently. By construction, the agent also receives no more than his outside option. With the same logic as in Proposition 3.1, the agent does not have an incentive to shift probability mass from or to x_2. ■

[14] More precisely, the principal must set $w_1 = u_1 + \epsilon$ to be sure to match the agent's outside option. But as ϵ is infinitesimally small by assumption, we refrain from explicitly noting it here (and likewise in what follows).

Both the Commitment Contract and the Incentive Contract have very natural analogons in the real world. The Commitment Contract very much looks like the form of contract that is dominant in many public sector positions, involving maximal job security and flat incentives. The Incentive Contract on the other hand resembles the contractual norm in many private sector employments. Dismissal is easy (and will take place after bad performance) and monetary incentives are used to induce the agent to act in the interest of the principal. Proposition 3.4 now compares the two contracts and shows under which circumstances which contractual structure will be chosen.

Proposition 3.4 *With an arbitrarily small degree of uncertainty on the size of the agent's outside options, the principal will either offer an Incentive Contract (if the degree of contractibility is sufficiently large or if the sorting problem is sufficiently important relative to the investment problem) or a Commitment Contract (if the degree of contractibility is sufficiently small and if the investment problem is sufficiently important relative to the sorting problem).*

Proof. Taking into account that the wage payments are small relative to x as they correspond to the agent's respective outside option, offering the Commitment Contract gives the principal an expected utility of

$$V_{CC} = (p_g + p_b)x \tag{3.4}$$

since the agent reaches the good outcome with a probability of $(p_g + p_b)/2$ at all instances. If the principal offers the Incentive Contract, his expected payoff can be shown to be

$$\begin{aligned} V_{IC} \quad = \quad & \frac{p_g + p_b}{2}x + (1-\mu)(q' - q)x + \frac{1}{2}\frac{p_g + p_b}{2}x \\ & + \frac{1}{2}\frac{(1-p_b-q')(1-p_b)p_g + (1-p_g-q')(1-p_g)p_b}{(1-p_b-q')(1-p_b) + (1-p_g-q')(1-p_g)}x. \end{aligned} \tag{3.5}$$

Comparing (3.4) and (3.5) one finds that $V_{CC} \geq V_{IC}$ if and only if

$$\begin{aligned} \frac{1}{2}\frac{p_g + p_b}{2}x \;\geq\; & (1-\mu)(q'-q)x \qquad (3.6) \\ & +\frac{1}{2}\frac{(1-p_b-q')(1-p_b)p_g + (1-p_g-q')(1-p_g)p_b}{(1-p_b-q')(1-p_b) + (1-p_g-q')(1-p_g)}x. \end{aligned}$$

This inequality is more likely to hold, the smaller $q' - q$ (i.e., the larger the investment problem), the smaller $p_g - p_b$ (i.e., the smaller the sorting problem) and the smaller μ (i.e., the lower contractibility). If $\mu \to 1$, (3.6) can not hold and if $\mu \to 0$ and $p_g \to p_b$, it always holds. This establishes the proposition. ■

Proposition 3.4 shows that it may be optimal for a principal to commit to a long-term contract whenever contractibility is low. In such a situation, giving explicit incentives to implement efficient investments is not feasible and hence the principal has to redress to other means of preventing shifts in probability mass. He would certainly like to make the agent believe that he will be patient with him, in order not to push him to focus too much on short-term successes. But the agent knows well enough that this would not be in the interest of the principal ex-post as bad results will also be interpreted as a sign that the agent is of low ability. Hence, the principal must actually commit not to dismiss the agent. This of course has the disadvantage that efficient sorting does not take place and so the principal will choose the Commitment Contract only if the investment problem is sufficiently pronounced compared to the sorting problem, even if contractibility is low.

When contractibility is high, the Commitment Contract does not do much good. In this case the damage that can be done by shifting probability mass in the non-contractible dimension is low, as this task is of minor relevance to the principal, so the Incentive Contract is more attractive. Indeed, if contractibility goes to one, the downside of the Incentive Contract (inefficient investments in the non-contractible dimension) disappears completely, as is recorded in Corollary 1. This is the result that one would expect under complete contractibility with a risk-neutral agent.

Corollary 1 *If contractibility is high ($\mu \to 1$), an Incentive Contract can approximate the first best.*

One feature of optimal contracts for politicians that all potentially optimal contracts share is that pay increases over time if the politician is successful. While this seems to be at odds with the typical bureaucratic salary regulation which provides no explicit pay raises after re-election, I would still argue that this is something that can be observed in reality. First, success in the form of good economic conditions puts the government in a better position when it bargains over salaries for politicians. This argument has been empirically verified by Di Tella and Fisman (2004) who show that gubernatorial wages in US states are heavily influenced by past successes and failures of the respective governors, suggesting an implicit pay for performance scheme. Second, successful politicians can count on significant non-wage increases in pay, deriving from later consulting activity, media presence and follow-up jobs.

3.5 Extensions

In this section we will consider two possible extensions of the basic model that was explored in the previous section. First it seems worthwhile to investigate how effort provision in the sense of the canonical moral hazard model would affect the optimal contract choice. As noted earlier, moral hazard obstructs the provision of incentives for efficient investment decisions of the agent, as explicit incentives in some instances require that the agent be punished after good results in period two. Maybe not surprisingly, this may invalidate the conclusion from Corollary 1 that the first best can be approximated when contractibility goes to one. More importantly, however, moral hazard acts as an additional constraint on the use of the Commitment Contract. As the Commitment Contract is characterized by fixed payments and unconditional employment, incentives to shirk are maximal. Therefore, adding moral hazard to the model reinforces the downside of committing to long-term contracts in much the same way as a more pronounced heterogeneity of agents (i.e., a bigger sorting problem) does.

Given that there are two tasks, a further natural extension of the model is to incorporate multitasking problems. If the agent can shift probability mass from one task to another, this has different effects on the two optimal contracts. For the commitment contract obviously nothing changes. As wage payments do not respond to outcomes, there would be no reason for the agent to engage in multitasking. Things are different for the Incentive Contract. As second period outcomes in the noncontractible dimension can not be incentivized, there will be a temptation to shift attention to or away from the contractible second period task whenever its outcome generates a wage spread. As a result, there is an antagonism between preventing multitasking (which calls for flat wages) and preventing inefficient investment decisions (which calls for incentive pay).

Note that multitasking is particularly harmful when contractibility is low. In that case, focusing on the (relatively unimportant) contractible task to the detriment of the (relatively important) non-contractible task can do most damage (see Holmstrom and Milgrom, 1991). As a consequence, the principal will never want to use an Incentive Contract when μ is low, even if sorting is very important, which also makes the Commitment Contract unattractive. In that case the optimal contract, which we will denote as the No Commitment Contract has the following characteristics. First, a sequence of short-term contracts will be chosen which leave the reemployment decision open to tackle the sorting problem (which we have assumed to be substantial). Second, there will be a flat wage corresponding to the size of the agent's outside option in both periods to avoid multitasking.

Choosing between the Commitment Contract and the No Commitment Contract in case of low contractibility brings about nicely the general features of payments for politicians. As in reality, neither contract involves contingent payments. And there is a trade-off the designer of a constitution faces when he makes his choice: if the sorting problem is relatively big, one should opt for short political terms (represented by the No Commitment Contract). If, on the other hand, the provision of long-term investment incentives is relatively more important, political terms should be long (represented by the Commitment Contract).

3.6 Conclusion

This chapter answers three questions concerning the use of electoral terms, which are unconditional long-term contracts, in politics. (1) What use can it have to commit to a long-term contract even if it may later turn out that breaking up the principal-agent relationship would be efficient? (2) Why is this commitment observed to provide incentives for politicians but less so to provide incentives for managers? (3) Given that commitment may be optimal, what factors influence the optimal length of a political term?

It has been shown that commitment to long-term contracts may be useful to curb opportunistic behavior of politicians, preventing that short-term results are overemphasized at the detriment of sustainable achievements. In doing so, an imperfect instrument (unconditional reemployment) is used because political outcomes are typically of low contractibility, while explicit incentives can be used to induce efficient investments when contractibility is high (as in many managerial constellations). Given that there are political terms, there is a trade-off between inducing efficient investments (which calls for long terms) and the desire to oust incompetent politicians (which calls for short terms).

These results will allow researchers that analyze policy formation in different fields of political economy to restrict attention to a particularly simple class of mechanisms when they incorporate agency problems into their models: the class of simple reelection schemes that do without contingent payments.

Chapter 4

Solvency Regulation in Insurance Markets with Rational Consumers*

*This chapter is based on joint work with Ray Rees.

4.1 Introduction

Virtually all developed insurance markets are subject to intense regulation by government authorities. One of the main focuses of supervision is the solvency of insurance firms. Currently, the European Union is working on Solvency II, a new capital adequacy framework for European insurance companies. Solvency II is supposed to do for the insurance industry what Basel II has done for banking, namely a change towards a regulation that takes specific firm characteristics into account. Although negotiations are still underway, it seems to be clear that the new rules will increase the requirements from insurance firms both in terms of the provision of capital and information.[2] At a global level, the International Association of Insurance Supervisors seeks to harmonize national regulations by proposing core principles of insurance regulation. Given the pervasiveness of solvency regulations, it is natural to ask what benefits they may bring about and how an optimal regulatory policy should look like.

In the Property and Casualty sector, policyholders hand over a premium to insurers in order to receive a reimbursement in case specified losses occur in the future. Insurers of course will only be able to meet their obligation if they have sufficient reserves to cover the claims of their clients. A widespread view holds that solvency regulation—e.g., the imposition of minimum reserve levels—then has the task to ensure that insurance companies do not evade their contractual obligations by failing to put up appropriate levels of reserves. According to this view, regulation acts as a contract enforcement device that guarantees property rights and, hence, efficient trade.

This idea has been formalized by the early literature on insurance regulation (see in particular Borch, 1981, Munch and Smallwood, 1981, and Finsinger and Pauly, 1984). Its main implication is that minimum

[2] See, for instance, the January 2005 special issue on insurance regulation and risk management of *The Geneva Papers on Risk and Insurance: Issues and Practice.*

reserve levels may be beneficial for consumers as they help to prevent firms from cashing out reserves before claims occur. This result holds despite the fact that insurers risk to forgo future profits when they increase insolvency risk by reducing capital reserves.

One aspect of the insurance business that is entirely neglected by this approach is rational consumer choice. In the above models it is typically assumed that the demand for insurance is exogenously given and independent of the financial health of an insurance firm. However, an insurance company that holds low levels of reserves offers only limited protection against possible future losses. Therefore, consumers will have a lower willingness to pay for its service. That is, consumers make their demand for insurance contingent on the soundness of an insurance company.[3]

Rees, Gravelle and Wambach (1999) make this point in a model of insurance supply. They show that, if consumers are well informed about an insurer's level of capital, the insurer will always put up enough reserves to ensure solvency. Similarly, it is shown that a regulatory restriction on the insurer's asset portfolio can only do harm. This chapter is a first step in the direction of a more realistic model of insurance markets with solvency risk.[4]

However, it is restrictive in two respects. First of all, it assumes perfect capital markets so that the cost of capital exactly equals the expected return of reinvesting. This allows the insurer to build reserves that cover *all potential losses* of its clients without cost, which seems unrealistic. In reality, raising new capital has positive and increasing

[3] Besides inspecting its level of reserves directly, the solvency of an insurance firm can be assessed by observing its credit ratings, its stock market performance, reports by consumer associations and recommendations by brokers and the financial press. Cummins and Doherty (2006) show how brokers help consumers make an informed choice regarding the characteristics of different insurance firms. Doherty and Schlesinger (1990) demonstrate the impact of potential insolvency on insurance demand.

[4] Other authors that have pleaded for a deregulation of insurance markets are Eisen, Müller and Zweifel (1993), Rees and Kessner (1999) and Harrington (2002).

capital costs because of the scarcity of capital and because investors want to reduce agency problems by limiting free cash flow. Second of all, the authors assume that consumers are identical which is essential for the no-regulation result, as will be shown below.

This chapter builds a new model of insurance supply with rational consumer choice, incorporating imperfect capital markets and heterogeneous policyholders. Increasing capital costs invalidate the earlier literature's finding that an insurance firm either holds no capital reserves at all or such high levels that the risk of bankruptcy is zero. Heterogeneity among consumers then implies that the amount of reserves that different consumers deem as appropriate are not the same.

The main result of the chapter is that—although demand is negatively affected by capital reductions—the insurer provides a level of capital that is too low compared with the socially optimal level and invests too much into risky assets. It is shown that a minimum reserve regulation combined with price regulation and a restriction on risky investments can implement the first best outcome. However, in the more realistic case where price regulation is not feasible, solvency regulation may actually worsen the outcome because it may increase the extent to which an insurance firm makes use of market power. We conclude that solvency regulation with rational consumers can only be successful if regulators possess very precise information about risks and consumer preferences.

The chapter is organized as follows. Section 4.2 presents a new model of insurance supply with increasing capital costs and rational consumers. Section 4.3 then goes on to show the optimal pricing, capital and investment strategies by a monopoly insurer. Section 4.4 compares these to the socially optimal levels. Section 4.5 shows what this implies for regulation. And, finally, Section 4.6 concludes.

4.2 The Model

Consider a risk neutral monopoly insurer who offers full insurance against some exogenous risk which consumers are faced with. To abstract from issues of adverse selection, we assume that risks are identical, that is, the distribution of losses is the same across agents. There is some positive measure of risk-averse consumers who may be heterogeneous (for instance with respect to their degree of risk aversion and their wealth). Since there is a continuum of consumers, any demand of strictly positive measure has the property that all idiosyncratic risk is diversified away. Hence, the distribution of average claims costs c (i.e., costs per client) has converged to some cumulative distribution function $G(c)$ which is assumed to be continuously differentiable with appropriate density $g(c)$.[5] Total claims cost are then given by $C(q, c) = qc$, where q denotes the quantity of policies sold.

Before offering its insurance contract, the insurer commits to raising some capital k per contract it sells. This gives rise to the cost $\xi(k)$ per policy. Due to free cash flow concerns, we assume that $\xi'(k) > 0$ and $\xi''(k) > 0$.[6] The insurance firm can invest its capital endowment into either of two assets, a riskless asset with fixed return $r_0 \geq 0$ and a risky asset with stochastic return r, which is uncorrelated to claims cost and which is distributed according to the continuously differentiable distribution function $F(r)$ with corresponding density $f(r)$ on the interval $[\underline{r}, \bar{r}]$. For instance, the risky asset could be the market portfolio from a capital asset pricing model. It is natural to assume that $\underline{r}< r_0$ and

[5] See Wooldridge (1986) for this (and other) asymptotic results. Note that in the unrealistic case where *every* individual risk is uncorrelated to *any* other risk, the law of large numbers would imply that the distribution of average losses has converged to a distribution that has all probability mass on the expected value of individual losses. In this situation, the challange of capital and investment regulation would stem from the uncertainty of an insurer's assets alone and there would be no aggregate uncertainty deriving from the claims distribution.

[6] Jensen (1986), among others, has argued that it is desirable to give managers a hard budget constraint in order to reduce agency costs. This seems particularly desirable in firms with large free cash flows—such as insurance companies.

$E[r] > r_0$. Let $\alpha \in \mathbb{R}$ denote the proportion of reserves that is invested into the risky asset.[7]

Denoting the premium the insurer demands for insurance by π, an insurance contract offer is a tuple (π, k, α). As the distribution of average claims costs is independent of the precise magnitude of demand and since the insurer raises capital on a per capita basis, individual demand is independent of expected aggregate demand, that is, there are no network externalities and hence no issue of consumer coordination. Aggregate demand is then given by some function $D(\pi, k, \alpha)$ with inverse demand $\pi(q, k, \alpha)$. It turns out to be more convenient to work with inverse demand. The insurer's choice variables in that setting are q, k and α. We make the following assumption on insurance demand.[8]

Assumption *Inverse demand $\pi(q, k, \alpha)$ is such that (i) $\pi_q(\cdot) < 0$, (ii) $\pi_k(\cdot) > 0$, (iii) $\pi_{kq}(\cdot) < 0$, and (iv) $\pi_{\alpha q}(\cdot) > 0$.*

Assumptions (i) and (ii) simply say that consumers prefer cheaper premiums and more capital (which reduces the risk of insurance default). Assumption (iii) states that the agents who have a higher willingness to pay for insurance also have a higher willingness to pay for decreased insolvency risk of the insurer (in the form of a higher k). This follows naturally from the fact that those are the more risk-averse consumers. Finally, Assumption (iv) says that consumers with a higher willingness to pay for insurance are relatively less interested in risky investments of the insurance capital, again because of the higher degree of risk aversion they have.[9]

The insurance company's end of period assets (net of liabilities) are

[7] We do not restrict α to lie in the interval $[0, 1]$, which means that short sales of risky assets are in principle allowed.

[8] Subscripts denote derivatives.

[9] Note that we do not make any assumptions on the sign of π_α. This implies that the investment policy α not necessarily affects consumer utility in a monotonous way (like the capital level). For example, customers may find more risky investments desirable at low levels of α, while they may want to reduce them when α is large.

given by the random variable

$$A(q,k,\alpha,r) = q[\pi(q,k,\alpha)+k][1+\alpha r+(1-\alpha)r_0] - q\xi(k).$$

This is simply premium income plus investment income minus the costs of capital. End of period assets per policyholder are then given by $a(q,k,\alpha,r) = A(q,k,\alpha,r)/q$.

Due to limited liability, the insurer's end of period profit is $\Pi = \max\{A(q,k,\alpha,r) - C(q,c), 0\}$. The expected end of period profit is therefore

$$\bar{\Pi} = \int_{\underline{r}}^{\bar{r}} \int_{0}^{a(\cdot)} [A(q,k,\alpha,r) - C(q,c)]dG(c)dF(r).$$

Integrating by parts and rearranging yields

$$\bar{\Pi} = \int_{\underline{r}}^{\bar{r}} \int_{0}^{a(\cdot)} qG(c)dcdF(r). \tag{4.1}$$

4.3 Profit Maximization

Since the insurance company is assumed to be risk-neutral, it maximizes expected profit.

$$\max_{q,k,\alpha} \int_{\underline{r}}^{\bar{r}} \int_{0}^{a(\cdot)} qG(c)dcdF(r)$$

The first order condition of this optimization problem with respect to q is[10]

$$\int_{\underline{r}}^{\bar{r}}\int_{0}^{a(\cdot)} G(c)dcdF(r) + q\pi_q \int_{\underline{r}}^{\bar{r}} [1+\alpha r + (1-\alpha)r_0]G(a)dF(r) = 0. \qquad (4.2)$$

The interpretation of this equation is straightforward: the first term reflects the expected profit an additional consumer generates for the insurance company (which is simply the expected average profit). The second term shows the expected cost of lowering the premium in such a way that one more consumer demands insurance: this is the reduction in premium income $q\pi_q$ multiplied by the expected probability of staying solvent.

The first order condition with respect to k is

$$\int_{\underline{r}}^{\bar{r}} G(a(\cdot))\left\{(1+\pi_k)[1+\alpha r + (1-\alpha)r_0] - \xi'(k)\right\} dF(r) = 0. \qquad (4.3)$$

This condition equates the expected marginal gain from raising capital (given by stronger demand and increased expected investment returns) with the corresponding marginal cost of capital on the capital market. Note that this first order condition—as the one before—is weighed with $G(a)$, the probability of staying solvent, since the insurer has a certain profit of zero in the event of bankruptcy.

Finally, the first order condition with respect to α is

$$\int_{\underline{r}}^{\bar{r}} G(a(\cdot))\{\pi_\alpha[1+\alpha r + (1-\alpha)r_0] + (\pi + k)(r - r_0)\}dF(r) = 0. \qquad (4.4)$$

In order to interpret this condition, first note that an investment in risky assets has both an advantageous and a disadvantageous effect for the

[10] In what follows we assume that the monopolist's program is well behaved, having interior solutions that fulfill the appropriate second order conditions.

consumer. On the one hand it increases the expected value of the insurer's end of period wealth (which decreases the risk of insolvency). On the other hand it increases the variance of the insurer's asset portfolio (which increases the risk of insolvency). Note that as long as $\pi_\alpha \geq 0$, the left hand side of (4.4) is strictly positive. That is, the insurer will increase risk exposure beyond the point where premium income is maximized, so $\pi_\alpha < 0$ in equilibrium. The reason for this is that, being risk neutral, the firm benefits from a higher α through the expected returns on its investment. Hence, marginal losses in premium income are equilibrated with marginal expected asset returns.

4.4 Welfare

Jointly, equations (4.2) to (4.4) determine the monopolist's contract offer (π^m, k^m, α^m), where $\pi^m = \pi(q^m, k^m, \alpha^m)$. In order to determine the socially optimal levels of capital and risk exposure, we set up the following welfare function.

$$W(\alpha, k) = \int_{\underline{r}}^{\bar{r}} \int_0^{a(\cdot)} qG(c)dcdF(r) + \int_0^q \pi(\hat{q}, k, \alpha)d\hat{q} - q\pi(q, k, \alpha) \qquad (4.5)$$

This is simply the summation of producer and consumer surplus. The first term is the monopolist's expected profit, the second term is the total rent that accrues to consumers (as measured by the area below the demand curve), and, finally, the last term is given by the total premium payments which have to be subtracted in order to determine net consumer surplus.

This formulation implicitly assumes that what policyholders *perceive* to be their surplus is an accurate measure for actual consumer surplus. This will be the case whenever policyholders have an idea of how differing levels of capital and degrees of risk exposure translate into insolvency probabilities for the insurance firm. As noted in the introduction, we assume here that consumers understand the product they purchase (say, because they are informed about the ratings of the insurance firm). If consumers instead underestimated the solvency risk of insurance companies (as the early literature on insurance regulation assumes), this would actually strengthen the results we derive below.

Proposition 4.1 *Given its output and investment strategy, the insurance company provides less than the socially optimal level of capital.*

Proof. Maximizing (4.5), the first order condition with respect to k is[11]

$$\int_{\underline{r}}^{\bar{r}} G(a(\cdot))\left\{(1+\pi_k)[1+\alpha r+(1-\alpha)r_0]-\xi'(k)\right\}dF(r) \tag{4.6}$$

$$= \pi_k - \int_0^q \frac{\pi_k(\hat{q},k,\alpha)}{q}d\hat{q}.$$

Comparing (4.3) and (4.6) we see that the left-hand-sides are identical, while the right-hand-side of (4.6) is not equal to zero. From Assumption (iii) it immediately follows that $\pi_k(q,k,\alpha) < \pi_k(\hat{q},k,\alpha)$ for all $\hat{q} < q$. Therefore, the right-hand-side of (4.6) is strictly smaller than zero which proves the result. ■

Proposition 4.1 does not say that the insurance firm disregards consumers' desire for sufficient reserves. In fact the insurer knows that putting up capital is an asset that makes the product insurance more attractive and therefore increases consumers' willingness to pay for it. However, at the equilibrium, the monopolist is concerned how a marginal alteration of its level of reserves affects the *marginal* consumer's willingness to pay (the term π_k in equation (4.6)). A social planner, on the other hand, worries how changes in capital affect the *average*

[11] Again, second order conditions are assumed to hold.

consumer's willingness to pay (the term $\int_0^q \frac{\pi_k(\hat{q},k,\alpha)}{q} d\hat{q}$ in equation (4.6)). Since intramarginal policyholders are more risk-averse, the monopolist puts up too little reserves.

This result is akin to Spence's (1975) classic finding that a product market monopolist will provide the level of product quality desired by the marginal consumer, while a social planner would choose the level desired by the average consumer (see also Sheshinski, 1976). However, the result differs in two important respects. First of all, neither the marginal nor the average policyholder's preferred level of capital is chosen in the insurance setting. Second, an insurance monopolist will *always* provide too little capital, while the quality distortion in product markets can go either way. That is, the insurance framework generates a far more structured result although the environment is in principle more complex.[12]

Let us now turn to the composition of the insurer's asset portfolio. Here, we have the following proposition.

Proposition 4.2 *Given its output and investment strategy, the insurance company invests more into risky assets than is socially optimal.*

Proof. Maximizing (4.5), the first order condition with respect to α is

$$\int_{\underline{r}}^{\bar{r}} G(a(\cdot))\{\pi_\alpha[1+\alpha r+(1-\alpha)r_0]+(\pi+k)(r-r_0)\}dF(r) \tag{4.7}$$

$$= \pi_\alpha - \int_0^q \frac{\pi_\alpha(\hat{q},k,\alpha)}{q} d\hat{q}.$$

Comparing (4.4) and (4.7) we see that the left-hand-sides are identical, while the right-hand-side of (4.7) is not equal to zero. From Assumption

[12] In insurance markets, a slight increase in capital reserves starting from the market equilibrium will always be welfare enhancing. In product markets, on the other hand, a small increase in product quality could be either beneficial or detrimental to welfare, depending on the demand function at hand.

(iv) it immediately follows that $\pi_\alpha(q,k,\alpha) > \pi_\alpha(\hat{q},k,\alpha)$ for all $\hat{q} < q$. Therefore, the right-hand-side of (4.7) is strictly larger than zero. Hence, the result. ■

Proposition 4.2 has the same straightforward intuition as Proposition 4.1. The insurer's preoccupation with the marginal consumer brings about some degree of ignorance towards intramarginal policyholders who would prefer a more secure investment strategy but still want to purchase insurance.

4.5 Implications for Regulation

Propositions 4.1 and 4.2 state that an insurance firm with market power will provide too little capital and make investments that are too risky given its clients' preferences. It is tempting to conclude from this that the optimal regulatory policy should set a minimum reserve level and restrict investments in risky assets in such a way that equations (4.6) and (4.7) are fulfilled for the given q. This, however, would mean that two important points are overseen:

1. Absent restrictions on premium choice, the insurer will try to circumvent solvency regulation by altering q (that is, by changing the price of its product).
2. Even if this were not a concern, the socially optimal levels of k and α depend on the *optimal* q, not the one chosen by an unregulated monopolist.

In order to find the socially optimal regulation, let us first maximize (4.5) with respect to q. This gives the first order condition

$$\int_{\underline{r}}^{\bar{r}}\int_{0}^{a(\cdot)} G(c)dc dF(r) + q\pi_q \int_{\underline{r}}^{\bar{r}} [1+\alpha r+(1-\alpha)r_0]G(a)dF(r) - q\pi_q = 0. \quad (4.8)$$

A comparison of (4.2) and (4.8) immediately conveys that—given k and α—the insurer underwrites too few policies (i.e., demands too high a premium). This is simply a consequence of the assumption that it is a monopolist. Equation (4.8), together with equations (4.6) and (4.7), determines the welfare maximizing insurance contract (π^*, k^*, α^*), where $\pi^* = \pi(q^*, k^*, \alpha^*)$. The optimal regulatory policy is characterized by the following proposition.

Proposition 4.3 *The socially optimal insurance contract (π^*, k^*, α^*) can be implemented by a regulation that sets a price cap ($\pi \leq \pi^*$), a minimum reserve requirement ($k \geq k^*$), and restricts investments in risky assets ($\alpha \leq \alpha^*$).*

Proof. It must be shown that at (π^*, k^*, α^*) the monopolist does not have an incentive to decrease π, increase k, or decrease α. From inspection of (4.2) and (4.8) we find that $W_q = \bar{\Pi}_q - q\pi_q$. Hence, $W_q > \bar{\Pi}_q$ so that at (π^*, k^*, α^*), where $W_q = 0$, we must have $\bar{\Pi}_q < 0$. Thus, the insurance firm has no incentive to decrease π (which would be equivalent to increasing q).

Inspecting (4.3) and (4.6) yields that $W_k = \bar{\Pi}_k + \int_0^q \pi_k(\hat{q}, k, \alpha)/q d\hat{q} - \pi_k$. From the proof of Proposition 4.1 we know the last two terms to be positive together. Hence, $W_k > \bar{\Pi}_k$ so that at (π^*, k^*, α^*), where $W_k = 0$, we must have $\bar{\Pi}_k < 0$. Thus, the insurance firm has no incentive to increase k.

Finally, inspecting (4.4) and (4.7) yields that $W_\alpha = \bar{\Pi}_\alpha + \int_0^q \pi_\alpha(\hat{q}, k, \alpha)/q d\hat{q} - \pi_\alpha$. From the proof of Proposition 4.2 we know the last two terms to be negative together. Hence, $W_\alpha < \bar{\Pi}_\alpha$, so that at (π^*, k^*, α^*), where $W_\alpha = 0$, we must have $\bar{\Pi}_\alpha > 0$. Thus, the insurance firm has no incentive to decrease α. Therefore, the proposed regulation indeed implements (π^*, k^*, α^*). ■

Proposition 4.3 shows that an optimal regulation consists of two elements: monopoly regulation ($\pi \leq \pi^*$) and solvency regulation ($k \geq k^*$

and $\alpha \leq \alpha^*$). Therefore, it gives a theoretical foundation for the type of solvency regulation that is observed in practice. In the model, the solvency part is necessary for two distinct reasons. First of all it restrains the insurer's desire to cater to the marginal consumer's preferences (as argued in Section 4.4). Second of all, it is instrumental in preventing the insurer from evading price regulation. Without it, the insurer would lower costly reserves and increase its asset portfolio's risk exposure in order to make profits.

Many real world insurance markets are regulated in as strict a way as proposed by Proposition 4.3, including both solvency and price regulation. However, quite often, price regulation is either not feasible or not desirable. In particular, governments are often reluctant to intervene into the price mechanism (and rightly so) because the prospect of profits is what drives firms to provide desirable products in the first place. The question then is what the optimal solvency regulation looks like absent price restrictions.

The second best outcome $(\pi^{**}, k^{**}, \alpha^{**})$ is determined by a two-stage game where at stage one the regulator chooses k and α (equations (4.3) and (4.4)), taking into account that the firm chooses π at stage two (equation (4.8)). It turns out that in this setting a minimum reserve regulation (and a restriction on investments) still has its merits by providing an insurance product to consumers which is closer to their desires. As was already pointed out above, however, this also leads the insurer to raise prices. To some extent this is not objectionable. After all, higher capital requirements are costly for the firm. If prices are increased in such a mild way that there are still more policies sold than before the regulation, we even have the positive side-effect of a reduced output distortion and hence a clear case for minimum capital requirements. If, however, the premium increases so much that the firm sells less policies than before, the positive impact of better solvency has to be weighed against the negative impact of a stronger monopoly distortion. Proposition 4 demonstrates that this second effect may be so pronounced that the typical solvency regulation can only do harm.

Proposition 4.4 *Depending on demand characteristics,* any *binding minimum reserve regulation and restriction on risky assets may be detrimental to welfare in the absence of premium regulation.*

Proof. We will prove the statement for a minimum reserve regulation (assuming that α is fixed). The proof for a restriction on the asset portfolio is analogous. In order to verify the statement, we will have to show that $dW(q(k^m), k^m)/dk < 0$ is possible. In order to do so, we will show that the optimal second best level of capital k^{**} may be below k^m.

The most convenient comparison of k^m and k^{**} is by way of graphic representation in a (k, q) plane. k^m is determined by the intersection of the curves $\bar{\Pi}_q = 0$ and $\bar{\Pi}_k = 0$ which are given by equations (4.2) and (4.3). Applying the implicit function theorem we find $dk/dq|_{\bar{\Pi}_q=0} = -\bar{\Pi}_{qq}/\bar{\Pi}_{qk}$ and $dk/dq|_{\bar{\Pi}_k=0} = -\bar{\Pi}_{qk}/\bar{\Pi}_{kk}$. By the second order conditions of the firm's profit maximization problem both $dk/dq|_{\bar{\Pi}_q=0}$ and $dk/dq|_{\bar{\Pi}_k=0}$ have the same sign as $\bar{\Pi}_{qk}$, which is undetermined in general. From now on, consider the case where $\bar{\Pi}_{qk} < 0$, which turns out to be the relevant one.

We will first determine the slope of the two curves. Simple algebra yields that $dk/dq|_{\bar{\Pi}_q=0} > dk/dq|_{\bar{\Pi}_k=0}$ is equivalent to $\bar{\Pi}_{qq}\bar{\Pi}_{kk} - (\bar{\Pi}_{qk})^2 < 0$ if $\bar{\Pi}_{qk} < 0$. As $\bar{\Pi}_{qq}\bar{\Pi}_{kk} - (\bar{\Pi}_{qk})^2 > 0$ by the second order conditions of the monopolist, we can therefore conclude that $dk/dq|_{\bar{\Pi}_q=0} < dk/dq|_{\bar{\Pi}_k=0}$ around (q^m, k^m). The two curves are depicted in Figure 4.1. Their intersection determines the level of k^m.

The level of k^{**} is determined by the intersection of the curves $\bar{\Pi}_q = 0$ and $dW(q(k), k)/dk = 0$ which are given by equations (4.2) and (4.9). In order to plot $dW(q(k), k)/dk = 0$ it turns out to be helpful to derive the curve $W_k = 0$ first, which is defined by (4.6). Comparing (4.3) and (4.6) we find

$$W_k = \bar{\Pi}_k + \int_0^q \frac{\pi_k(\hat{q}, k, \alpha)}{q} d\hat{q} - \pi_k.$$

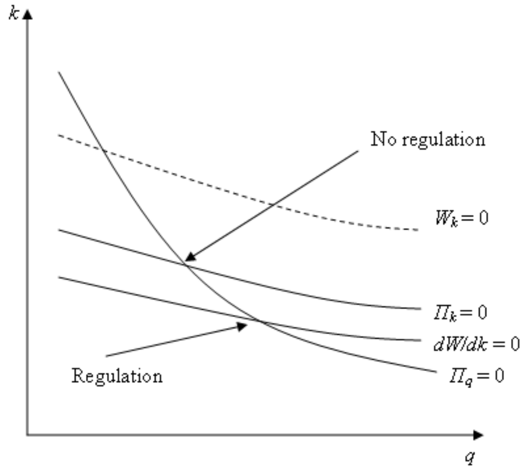

Figure 4.1: A case where $k^{**} < k^m$

As already derived in the proof of Proposition 4.1, the last two terms together are positive, that is $W_k > \bar{\Pi}_k$. Hence, at any (k, q) satisfying $W_k = 0$ we must have $\bar{\Pi}_k < 0$. Since $\bar{\Pi}_{qk} < 0$ by assumption, q must be decreased given k in order to reach $\bar{\Pi}_k = 0$. That is, the curve $\bar{\Pi}_k = 0$ lies everywhere below the curve $W_k = 0$ as depicted in Figure 4.1.

The position of the curve $dW(q(k), k)/dk = 0$ will now be located relative to the curve $W_k = 0$. We have $dW(q(k), k)/dk = W_q \cdot dq/dk + W_k = -W_q \times \bar{\Pi}_{qk}/\bar{\Pi}_{qq} + W_k$ where we have plugged in dq/dk from above. Noting that $W_q = \bar{\Pi}_q - q\pi_q$ we therefore conclude that

$$\frac{dW(q(k), k)}{dk} = q\pi_q \frac{\bar{\Pi}_{qk}}{\bar{\Pi}_{qq}} + W_k.$$

The first term of the right-hand side expression is negative as $\bar{\Pi}_{qk}$, $\bar{\Pi}_{qq}$ and π_q are all negative. Therefore, at any (k, q) satisfying $dW/dk = 0$ we must have $W_k > 0$. Since $W_{kk} < 0$ by the second order conditions for a welfare maximum, k must be increased to reach $W_k = 0$. That is, the curve $dW/dk = 0$ lies below the curve $W_k = 0$. By *how much* it lies below clearly depends on the size of the parameters (in particular $\bar{\Pi}_{qk}$).

The optimal second best level of capital k^{**} is depicted in Figure 4.1 as the intersection of the curves $dW/dk = 0$ and $\bar{\Pi}_k = 0$. The figure represents the situation where $\bar{\Pi}_{qk}$ is so negative that the optimal k^{**} is below k^m. Hence, in such a situation any binding minimum capital requirement $\tilde{k} > k^m$ would only push capital in the wrong direction. ■

The discouraging result of Proposition 4.4 is that an insurance regulator will need a tremendous amount of information in order to be successful since not even the general direction of an optimal intervention is certain. For some set of demand and risk characteristics, measures that increase capital and decrease the riskiness of the investment policy may be desirable. But for another set of characteristics, increasing capital and reducing risky investments may only lead to a more intense exploitation of market power. Absent very precise information concerning an insurer's risk management, regulation can easily lead astray.

4.6 Discussion

This chapter has shown in a simple model of insurance supply that insurance companies with market power have a tendency to build insufficient reserves and to employ too risky investment strategies. This was shown to be the case despite the fact that consumers are rational and reduce their demand for insurance if the insurer runs a high risk of being unable to meet claims. To our knowledge, this model is the first to justify solvency regulation in a setting of rational consumer choice.

Note that the main results of the chapter critically hinge on the assumption that consumers are heterogeneous with respect to their degree of risk aversion (which is implicitly stated in Assumptions (iii) and (iv)). If consumers had identical degrees of risk-aversion (e.g., because they have identical von Neumann-Morgenstern utility functions *and* identical wealth levels), we would have $\pi_{kq}(\cdot) = \pi_{\alpha q}(\cdot) = 0$. Going through the proofs of Proposition 1 and 2, one immediately finds that the welfare planner's first order conditions in this case collapse to the monopolist's. I.e., in the unrealistic case of identical consumers we would again have Rees, Gravelle and Wambach's (1999) no-regulation result.

Another point worth discussing is whether the assumption of market power (here in the form of a monopoly firm) is the appropriate setting to describe real world insurance markets. Clearly, in most insurance markets several competing firms are active. Note, however, that insurance markets are characterized by substantial search and switching costs due to the complexity of the product and the necessity to assess the practice of claims settlement (see Klemperer, 1995, for a general overview of the literature on switching costs and Schlesinger and Schulenburg, 1991, for an application to insurance markets). This gives insurers substantial market power with respect to captive consumers, suggesting that—in order to moderate the distortions exposed by this chapter—regulatory authorities should look for measures that lower search and switching costs and enhance transparency and disclosure in order to promote competition in insurance markets.

Finally, a word on the informational requirements for successful insurance regulation is in order. Clearly, an insurance regulator will have a hard time obtaining the precise information required to determine the optimal regulation. Indeed, even an insurance firm will only have imprecise knowledge of many of the variables involved. Given that the European Union is determined to intensify solvency regulation via Solvency II, the accompanying step of intensifying reporting needs concerning insurers' risk management appears to be a consistent requirement.

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Ich versichere hiermit eidesstattlich, dass ich die vorliegende Arbeit selbständig und ohne fremde Hilfe verfasst habe. Die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sowie mir gegebenen Anregungen sind als solche kenntlich gemacht. Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht.

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