

# Chapter 1

## Introduction to the Theory of the Firm

### 1.1 Overview

The aim of this chapter is to give a short introduction to what is called the theory of the firm. This strand of economic theory deals with the existence and size of firms. Why do firms exist at all? Instead of such an organizational framework, every transaction could be carried out via market mechanisms. On the other hand, if the market mechanism is not optimal, every transaction could be carried out within one single firm. In reality, something in between is observed. Instead of a pure market mechanism or one huge organization, there are numerous firms of different styles and sizes. What defines the boundaries of a firm, that is, what determines the firm size? In some settings, firms buy inputs from independent suppliers, while in other cases, the downstream firm vertically integrates the upstream firm (e.g. simply buys the supplier) so that the input is produced in-house. What determines the level of integration? How does an employment relationship differ from a contracting relationship of two independent firms? To answer these questions also requires to analyze the organizational structure of firms. In general, the results are not restricted to firms but also apply to other kinds of organizations like administrations.

The remaining chapter describes several approaches to model a firm: Section 1.2 shortly mentions the approach of general equilibrium theory. In Section 1.3, the theory of incentive contracts is reviewed, including a brief summary of the standard models. Section 1.4 extends this approach by incorporating transaction costs, resulting in contractual incompleteness. In Section 1.5, the use of incomplete contracts with respect to property rights and decision rights is discussed, including the optimal design of institutions. The last section provides an outline of the remaining thesis and its contribution.

## 1.2 General Equilibrium Theory

Neoclassical economics found on the manifold results of general equilibrium theory. This theory provides a deep understanding of price formation, market performance and outcomes in perfectly competitive environments.<sup>1</sup> Every transaction or interaction is carried out via markets, using a pure price mechanism to exchange commodities. Within this framework, an employment relationship is nothing but an exchange of money and working time. Knight (1921) raised the issue of risk allocation. To formalize the idea of risk, the concept of uncertainty was introduced by Arrow (1964) and Debreu (1959, ch. 7). When the future unfolds, a formerly uncertain *state of the world* or *state of nature* is realized. The *state space* consists of all possible states, that is, all possible future events that influence the individuals' utilities. A *state-contingent* commodity is redefined in every state. For example, an umbrella is viewed to be a different commodity if the weather is nice than if it is raining. As a potential difficulty, a complete description of the state space all involved parties can agree upon is necessary. If this is given, state contingency can incorporate risk considerations into the general equilibrium theory. The famous work of von Neumann and Morgenstern (1944) provides the tools for comprehensive models. Nevertheless, the theory has

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<sup>1</sup>Several textbooks give an exposition of general equilibrium theory, see for example Mas-Colell, Whinston, and Green (1995).

its shortcomings. A lot of papers, among them the famous *lemon problem* of Akerlof (1970), point to the fact that general equilibrium theory is not able to satisfactorily incorporate the issue of asymmetric information. Further, general equilibrium theory does not say much about the existence, the size and the inner life of firms. By mainly modeling the firm as a production set along with a cost function, the theory stresses the influence of technology. Inputs are transformed into output in a perfectly efficient manner, ignoring any possible conflict of interest between firm members. The internal organization of the firm like the decision-making process is not addressed, the firm remains a black box. While decreasing economies of scale can explain why overall production is not extended beyond a certain point, they do not shed light on the size of the firm. There is no substantial difference between intra-firm and inter-firm transactions. Coase (1937) raises the issue that the theory is consistent with the whole economy comprising one huge firm. Even worse, Williamson (1985, ch. 6) argues that merger or integration, in the setting of general equilibrium theory, should always be profitable. The new large firm can at least replicate the results of the disintegrated situation if the two departments of the integrated firm continue to act as if they were still independent. But whenever there is room for additional gains, intervention from the top can improve the results. This *selective intervention* is not always feasible and we observe disintegrated settings in reality. To explain this observation is beyond the scope of general equilibrium theory.

## 1.3 The Theory of Incentive Contracts

### 1.3.1 The Primitives of Contract Theory

One of the most important objectives of contract theory<sup>2</sup> is to open the black box general equilibrium theory declares to be a firm and to study the inner working of firms and other institutions. A firm is viewed as a nexus of contracts, for example between the firm owner and a board of managers or a

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<sup>2</sup>Bolton and Dewatripont (2005), Macho-Stadler and Perez-Castrillo (2001) as well as Salanié (1997) provide comprehensive introductions to contract theory.

manager and some workers. Contract theory mainly deals with the class of contracts probably the most relevant for economic theory, the incentive contracts.<sup>3</sup> Incentives play a role in numerous situations. For example, a monetary success premium might incentivize a worker to work hard or the fame an athlete gets from winning the olympic games can provide incentives to exercise a lot. On the other hand, dependent on the setting, a prize in a contest might incentivize the participants to sabotage the efforts of their opponents. Incentive contracts allow the parties to influence the behavior of their contractual partners even if they cannot force a certain action directly. The contract can help to align the objectives of parties with conflicting interests if there is some strategic interaction among them. For example, an employer who pays his employee a share of the firms' profit might induce the employee to take the employer's objective into account.

The use of incentive contracts requires some premises. One of the parties involved controls an activity which effects also the contractual partners, but there are conflicting objectives. If the interests were perfectly aligned, there would be no need for a contract. The incentives used in the contract can be monetary like success premiums or fines, but they might as well be the rejection of future cooperation or other kinds of punishment. The crucial aspect is that the controlling party is responsive to the incentives specified in the contract. The goal of the incentive contract is to influence this party to change its behavior. A contract basically specifies an incentive scheme. The parties must agree on a contract before the activity is exercised. This contracting stage might incorporate some difficulties which are addressed later. Further, an incentive contract needs to commit all parties to stick to the contract. If the contract suffers from deficient credibility, the intended effects will not arrive. For example, if it is known that a party cannot afford to pay the contracted success premium, the contractual partners anticipate that they will never see this money and the success premium does no longer influence their behavior.

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<sup>3</sup>The theory of incentive contracts is also known as agency theory.

The enforcement of the contract can happen explicitly or implicitly. A contract that can be enforced explicitly is called enforceable. This requires the existence of a third party that can impose sufficient penalties if the contract is breached. This third party is usually called a court since it can be seen as a stylized version of a real-life court under some simplifying assumptions. For example, contract theory usually requires that there is no corruption. Obviously, an enforceable contract can condition only on variables that are verifiable to outsiders. Otherwise, the court cannot recognize if the contract was breached. Contract theory usually does not specify the court in detail. Since the contractual partners perfectly anticipate the penalties they incur in case of breaching the contract, nobody will ever do so. The pure existence of the court suffices and no trial is ever carried out. In the absence of a court, there might be implicit ways to enforce a contract. Rosen (1994) provides a comprehensive collection of articles about implicit contracts. Such contracts are self-enforcing. This is the case if an opportunistic party is better off by sticking to the contract than by breaching it. For example, a firm might give up some short-term profit by sticking to the contract in order to build up a long-term reputation ensuring higher profits in the future. In case of repeated interaction among the contractual partners, it might be optimal to fulfill a contract if otherwise the contractual partners refuse any future cooperation. Unfortunately, the theory of repeated games has shown that those mechanisms work in case of an infinite time horizon only. Nevertheless, if the contractual partners can credibly threaten to punish a breaching party sufficiently severe, the contract can be enforced implicitly without the existence of a court.

### **1.3.2 Asymmetric Information**

As long as information is symmetric and public, any incentive problem is trivial. Symmetry of information implies the activity under consideration to be observable. The contractual partners can specify it in the contract. Such a contract is enforceable, any deviation from the contract is detected. Especially, it is possible to realize the maximum feasible overall surplus.

Along with the activity, the contract can contain compensational transfer payments in order to induce a certain distribution of the generated surplus. In summary, a Pareto efficient outcome is reached. This is also referred to as the first best efficient outcome. The case of symmetric information usually serves as a benchmark in contract theory. The inefficiency caused by an informational asymmetry is measured with respect to the symmetric setting. To increase efficiency it is necessary to resolve, at least partially, the informational asymmetry. Eliciting the private information from the informed party often requires to offer this party a positive informational rent. The uninformed party, even if it has all bargaining power, may be unable to extract the whole surplus but has to share it with the informed party. The uninformed party faces a trade off between surplus maximization and rent extraction.

The standard models<sup>4</sup> of contract theory may be classified according to the kind of informational asymmetry they address. In a *moral hazard* model, a hidden action is taken after the contract is signed. The information is symmetric ex ante at the contracting stage but the action taken ex post is not publicly observable. In *adverse selection* models, the informational asymmetry is already present ex ante.<sup>5</sup> In moral hazard and adverse selection models, a variable is observable to some but not to all contracting parties so that the informational asymmetry lies between them. If instead a variable is observable to all contracting parties but *unverifiable* to a third party, the asymmetry lies between the contracting parties and the court.

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<sup>4</sup>The models discussed here mainly involve static spot contracts. For dynamic contracting, see for example Bolton and Dewatripont (2005, part III).

<sup>5</sup>If informational asymmetries reduce efficiency, there may be incentives to acquire information in order to reduce the asymmetry even if acquisition is costly. *Monitoring* a hidden action and ex post *auditing* are the two main acquisition procedures, see for example Strausz (1997, ch. 1.4.3).

### 1.3.3 The Contracting Stage

At the contracting stage, the contractual partners have to agree upon a contract. In the simplest setting, there are only two parties involved.<sup>6</sup> The most prevalent way to model the contracting stage is the principal agent model as broadly covered in Laffont and Martimort (2002). In principal agent models, all the bargaining power lies with the principal, who is usually the uninformed party. She makes a take-it-or-leave-it offer to the agent. From a game theoretic perspective, the contracting stage of a principal agent model is a Stackelberg game<sup>7</sup> with the principal as a leader and the agent as a follower. The principal has a first mover advantage, while the agent has an informational advantage. If the agent rejects the offer, no contract is signed neither now nor in the future. The agent accepts the offer if and only if his outside option does not leave him better off than signing the contract. This is called the agent's participation constraint or individual rationality constraint. The principal takes this constraint into account when making the offer. Further, she anticipates any future behavior of the agent. If the agent has to undertake an action or report private information once the contract is signed, he behaves opportunistically and chooses an action or report which maximizes his own payoff. This is described by the agent's incentive constraint. Mathematically, the principal decides which contract to offer by maximizing her own payoff subject to the participation constraint and the incentive constraint. If the environment is more complex so that several parties act after signing the contract, there is strategic interaction among them. They play a game in the sense of game theory. The principal designs the game by designing the contract. Instead of a simple incentive constraint, she has to take into account the equilibrium conditions of the game.

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<sup>6</sup>There is also a vast amount of literature about multilateral contracting as, for example, auction theory or contest theory. Collusion and side-contracting are important issues in multilateral settings. These are beyond the scope of this chapter.

<sup>7</sup>To be precise, it is a subgame since some settings require to model actions or events that take place before the contracting starts. To calculate the payoffs of this Stackelberg game, it is necessary to take future events and actions into account so that it often looks more natural to think of the contracting as a stage of a larger game.

The principal agent model requires the principal to have full commitment power. The principal must credibly commit to his offer being a take-it-or-leave-it offer excluding any further negotiations. It is her commitment power which gives her all the bargaining power. If the contractual partners have partial instead of full commitment power, the parties have at least some bargaining power. Binmore, Osborne, and Rubinstein (1992) provide an overview of several bargaining models. Bargaining models often lead to a multiplicity of equilibria. If the focus is on their common features but not on a specific equilibrium, the use of a principal agent model is justified, see Salanié (1997). A common bargaining concept is generalized Nash bargaining. Nash (1950) introduced an axiomatic approach to bargaining. Binmore, Rubinstein, and Wolinsky (1986) show that the Nash bargaining solution can be reached as an equilibrium in an alternating offer bargaining game. While Nash (1950) assumes parties with equal bargaining power, the generalized Nash bargaining allows for parties with different bargaining power and contains the principal agent model as a special case where one party has all the bargaining power.

So far, we have considered commitment with respect to negotiations, resulting in bargaining power. But there might as well be other limitations of commitment power which impose constraints on the set of enforceable contracts. For example, consider a setting where some uncertainty about the state of the world is resolved ex post after the contract is signed. If a party is contractually obliged to conduct a net payment in some states of the world, this party has an incentive to break up the contract and walk away instead of paying if such a state of the world is realized. An enforcement problem exists if the party cannot credibly commit to occasionally pay in ex post. This is obviously the case if there are wealth constraints but it might as well be an effect of lawful protection. The resulting limited liability is anticipated so that the set of feasible contracts is restricted to those fulfilling limited liability constraints. The effects of limited liability are comprehensively analyzed in Sappington (1983). Similarly, a budget balance constraint might be incorporated. If a contract requires, for example, to destroy part of the



output in certain states of the world, the contracting parties might have an incentive to break up the contract and renegotiate as soon as this state of the world is realized. This is the case if the respective party cannot credibly commit to destroy the output. Again, this is perfectly anticipated and a budget balance constraint is imposed.

### 1.3.4 Moral Hazard

In a moral hazard model, sometimes called an agency problem, the information is symmetric *ex ante* when the contract is signed. The informational asymmetry arises from an action undertaken *ex post* which is only privately observable. For example, consider a firm owner who hires an employee. When contracting, both share the same information. Once the contract is signed, the employee starts to work, but the employer cannot observe how much effort the employee exerts. If effort is costly for the employee, for example due to disutility from work, an employee who receives a fixed wage is best off by shirking, while the employer would benefit from a hard-working employee. If there is some information available which is correlated to the employee's effort, the employer can reduce the informational asymmetry by tying the employee's wage to this information, which serves as a signal of the effort. Holmstrom (1979) analyzes the optimal use of such signals. If the signal is perfectly correlated to the hidden action, the uninformed party can deduce the hidden action from the signal and there is effectively no asymmetric information at all. On the other hand, conditioning payments on some piece of information which is uncorrelated to the hidden action does not have any incentive effect. In our example, the employer could condition the employee's wage on the firm's output if this is correlated with the employee's effort. The employee, at least partially, then internalizes the objective of the employer. As an extreme case, the employer could give the whole output to the employee who compensates the employer with an unconditional upfront payment. We can interpret this as the employer selling the whole project to the employee. With such a sell-out contract, the employee fully internalizes the employer's objective.

Clearly, such a sell-out contract is not necessarily optimal. If the informed party who is choosing the action is risk averse while the uninformed party is not, a trade off occurs. A contract which provides incentives for the informed party to undertake a more efficient action might increase this party's risk burden at the same time. While a sell-out contract provides the most effective incentives, it leads to an inefficient allocation of risk. Allocating risk perfectly efficient so that the uninformed but risk neutral party bears all the risk in turn does not provide incentives that improve the alignment of the parties' objectives. A comprehensive analysis of risk sharing and moral hazard in a principal agent model is given in Grossman and Hart (1983). Even if risk considerations play no role because all parties are risk neutral, a sell-out contract may not be feasible. This is especially the case if the informed party is protected by limited liability, which is described in Sappington (1983). A principal who incentivizes the agent to choose a surplus-maximizing action may be unable to extract a large share of this surplus since upfront payments of the agent are impossible. The principal faces a trade off between surplus maximization and rent extraction. She might be better off with a contract that implements an action different from the surplus-maximizing one, if it leaves her with a larger share of the (smaller) surplus.

In a setting with several agents who choose their efforts noncooperatively, a moral hazard problem can occur even if there is no uncertainty about output. If the output reveals that an agent has deviated from a stipulated choice of action, the principal cannot infer *who* has deviated. There is still an informational asymmetry, free riding occurs. Alchian and Demsetz (1972) restore the inefficiency with the help of a principal who, at some costs, can monitor the agents' actions. Holmstrom (1982) shows that the additional costs of monitoring can be avoided if the principal can break the budget balance condition and impose penalties that waste output or bonus payments which exceed the output.

If the informational asymmetry does not concern an action chosen by one of the parties but an information privately revealed after the contract is signed, results similar to moral hazard are obtained. For example, see Harris and Raviv (1979) for such an *ex post hidden information* model.

### 1.3.5 Adverse Selection

Adverse selection models deal with *ex ante* asymmetric information so that, in contrast to moral hazard, the details of the timing are crucial. In a *signaling* model, it is the informed party who moves first. The informed party acts in a way that provides a signal about the asymmetric information. The uninformed party extracts information from the signal so that the informational asymmetry is reduced or even solved completely. For example, Spence (1973) analyzes a job market with jobseekers who know their own abilities and employers who are uninformed. The uninformed employers have to offer uniform wages, which in turn might be so small that jobseekers of high ability leave the market. But a jobseeker who knows his ability may choose an elaborate higher education in order to signal his ability to an uninformed employer. The employer can use the signal to identify the jobseekers of high ability and hire them for higher wages, increasing the efficiency of the outcome. Of course, the existence of such a separating equilibrium depends on the details of the setting. Most important, incentive compatibility has to ensure that jobseekers of low ability cannot gain from imitating those of high ability. The costs of the signal play a major role for incentive compatibility. If jobseekers of high ability can easily graduate in higher education while those of low ability need to put a lot of work and therefore costs into it, the latter cannot gain from imitating the former. But even if signaling does not cause any costs at all, information might be extracted. This is shown in the *cheap talk* models of Crawford and Sobel (1982) and others. The informed party anticipates the uninformed party's reaction to the signal, which might lead an opportunistic informed party to signal at least some information truthfully.

In *screening* models, it is the uninformed party who moves first. The uninformed party can offer a menu of contracts to the informed party in order to induce self-selection. For example, Stiglitz (1977) analyzes an insurance company facing customers of different risk. While each customer is informed about his own accident probability, the insurer is not. The insurer can offer a menu of different rates combining high deductibles with low premiums and vice versa. While low-risk customers do not mind a high deductible but high-risk customers do, the customers self-select and choose the contract designed for their risk, therefore resolving the informational asymmetry. Again, incentive compatibility is required to avoid that a high-risk customer pretends to be a low-risk one by choosing the respective contract.

The foundation of adverse selection models is the broader framework of *mechanism design*. The most powerful result of this theory is the *revelation principle*. This principle is shown to hold in different settings, see for example Myerson (1979). Whenever applicable, it implies the existence of optimal mechanisms which require the uninformed party to announce their private information directly and induce them to report the information truthfully. To offer an incentive compatible menu of contracts as in the above insurance example is such a *direct* and *truthful* mechanism.

### 1.3.6 Unverifiability

So far, we have considered situations in which one of the contracting parties has an informational advantage over the contractual partners. It might as well be the case that the contracting parties share information symmetrically, but this information is unverifiable to a third party, especially a court. This kind of informational asymmetry is very different from the literature on incentive contracts. As discussed in 1.4.1 below, unverifiability is an important concept in the literature on incomplete contracts and transaction costs. While Laffont and Martimort (2002) see unverifiability as part of the theory of incentive contracts, several authors like Macho-Stadler and Perez-Castrillo (2001) or Salanié (1997) do not follow this classification and exclude unver-

ifiability from the analysis of incentive contracts or explicitly view it to be part of transaction cost theory only. This is further discussed in Section 1.4.1.

To resolve the informational asymmetry caused by unverifiability, the contract can offer mechanisms which allow the court to extract the information from the contracting parties. These mechanisms rely on the concept of Nash implementation analyzed in Maskin (1977).<sup>8</sup> Nash implementation and its refinements may be applied to unverifiability, see Laffont and Martimort (2002, ch. 6). To extract the unverifiable information, a contract usually specifies the rules of a message game. The contracting parties are required to send a message about the unverifiable information to the court. Conditional on the messages it receives, the court imposes rewards or penalties given in the contract. If only one party is required to send a message, this party usually has an incentive to lie and the information is not extracted. Requiring several parties to report the information induces strategic interaction among them. The incentives provided by the contract determine the equilibrium outcome, potentially solving the informational asymmetry. The results depend on the equilibrium concept used. While Nash implementation requires a Nash equilibrium only, it seems more reasonable at least in some settings to use sequential reports and subgame perfection. A very simple message game is a shoot-them-all mechanism in which the contracting parties incur a sufficiently severe penalty in case they do not report the same messages so that the information can be extracted. This points directly to the disadvantages of message games. If the contracting parties are wealth constrained, it might be impossible to impose sufficiently severe penalties. Further, the parties have incentives to renegotiate the contract if the penalties are ex post inefficient. A multiplicity of equilibria is also a common source of difficulties. Despite their theoretical power, message games are rarely seen in reality.

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<sup>8</sup>Maskin (1977) is a previous version of Maskin (1999).

### 1.3.7 Summary

Asymmetric information is the center of the theory of incentive contracts. If the objectives of the contracting parties are not perfectly aligned, the informational asymmetry creates distortions. Incentive contracts can help to elicit private information and to decrease inefficiency. These contracts mainly consist of outcome contingent compensation schemes. The inner life of a firm clearly incorporates asymmetric information and conflicting interests of the firm members so that contract theoretical models are useful instruments to analyze the forces at work inside a firm. Unfortunately, the theory of incentive contracts is not capable to explain the size of a firm or even its existence. One might argue that informational asymmetries are smaller inside a firm than outside, but the theory does not explain why this should be the case. There is no substantial difference between inter- and intra-firm transactions. This is mainly due to the fact that the theory allows for informational costs only, while transactions are assumed to be costless. Introducing transaction costs into the theory can help to distinguish inter- and intra-firm transactions and results in contractual incompleteness, which is analyzed in the following section.

## 1.4 Transaction Cost Theory

### 1.4.1 Incomplete Contracts

So far, we have considered complete contracts which condition on every available verifiable variable. Obviously, a variable that does not improve the outcome can be omitted. Such a contract is not complete in a literal sense but cannot be improved by completion so that it might be viewed as *sufficiently complete* or *comprehensive*. The set of enforceable contracts, also called the contracting space, is restricted by the informational structure only.<sup>9</sup> Comprehensive contracts specify the obligations of the contracting parties for every possible future state of the world. This assumption is no longer reasonable if

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<sup>9</sup>This perspective takes the commitment power and its implications like limited liability as given.

writing a contract and verifying the variables are costly transactions. Coase (1937) identifies transaction costs as a possible reason for the existence of firms, providing the starting point for the transaction cost economics developed by Williamson (1975).<sup>10</sup>

If a variable is in principle verifiable to outsiders but the verification is sufficiently costly, these costs prevent the contracting parties from including the variable into the contract and the resulting contract remains incomplete.<sup>11</sup> The concept of incomplete contracts is therefore closely related to the concept of unverifiability, which might be viewed as a special case with infinitely high verification costs. To specify the contractual obligations for every possible future state of the world requires to describe these states of the world. This might involve a lot of details, leading to prohibitively high costs of writing a complete contract. An additional source of contractual incompleteness is bounded rationality.<sup>12</sup> Individuals may be unable or unwilling to think very far ahead or to take every detail into account, especially if a certain state of the world is unlikely to occur. This can also be interpreted as a kind of transaction costs where thinking ahead before writing the contract is costly. As a result, unforeseen contingencies not covered in the contract may occur.

Contractual incompleteness is a restriction on the contracting space which is not based on the informational structure. To model these restrictions, ad hoc assumptions are used. For example, the contracting space may be restricted to linear contracts. Ad hoc assumptions are unsatisfactory from a theoretical viewpoint but can help to keep the analysis tractable. If, for example, the contracting parties are protected by limited liability, message games that induce truthful reports may not be feasible since no sufficiently severe punishments are available. Instead of modeling limited liability explicitly, the ad hoc assumption to exclude message games looks reasonable.

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<sup>10</sup>A review of transaction costs economics is given in Williamson (1989).

<sup>11</sup>A recent introduction to incomplete contracts is given in Bolton and Dewatripont (2005, part IV).

<sup>12</sup>A formal model that shows contractual incompleteness to be an endogenous outcome of bounded rationality is discussed in Anderlini and Felli (2004).

The classification of the different theories of the firm is currently not consistent. If a contract is comprehensive as soon as it conditions on every verifiable variable, unverifiability can be seen as part of the theory of complete incentive contracts, as in Laffont and Martimort (2002). In transaction cost theory, an unverifiable variable is not impossible to verify but too costly to verify, which justifies the view of unverifiability as a contractual incompleteness instead of an informational asymmetry. From this point of view, unverifiability does not belong to the theory of complete incentive contracts but to the theory of incomplete contracts. Unverifiability is often combined with further ad hoc assumptions like no message games, also stressing its role for transaction cost theory. Brousseau and Glachant (2002) distinguish explicitly between the theory of incomplete contracts and the transaction cost theory. In their classification, incomplete contracts are the result of unverifiability and deal with information symmetrically shared by the contracting parties. In difference, they define transaction cost theory to investigate private information in a setting where transaction costs originate from bounded rationality. While the court is considered to be imperfect in case of contractual incompleteness because it cannot verify an observable variable, transaction cost theory is viewed to incorporate much more severe institutional failure where, for example, the court resp. the judge who represents it is of bounded rationality. This detailed distinction is not very common in the literature and does not provide further insights for the purpose of this thesis so that, following Hart (1995), Salanié (1997), and Bolton and Dewatripont (2005), it is neglected here. The foundations of incomplete contracts have received some criticism. Since this discussion is related to property rights, it is deferred to Section 1.5.

### 1.4.2 Renegotiation

Renegotiation is an issue not only for incomplete but also for comprehensive contracts. The models in Section 1.3 implicitly assume that the contracts are not renegotiated. Dewatripont (1989) shows that the possibility to renego-



tiate can decrease efficiency. For example, consider a principal agent model with moral hazard where a risk averse agent chooses an effort level unobservable to the principal. If renegotiation is impossible, the optimal contract solves the trade off between allocating risk efficiently and incentivizing the agent to exert effort. Now assume that the contracting parties can renegotiate the contract after the agent has chosen his effort but before the uncertainty is resolved, that is, before the output is observed. There is no need for incentives anymore so that shifting risk away from the agent could generate gains from trade. On the other hand, both parties anticipate the outcome of the renegotiation. If, for example, the agent expects a fixed payment independent of the output to be the result of renegotiation, the agent has no incentive to exert any effort *ex ante*. According to Fudenberg and Tirole (1990), efficiency is decreased due to the possibility of renegotiation in such a setting. In turn, efficiency might be increased if the renegotiation can be used to elicit information from the better informed party.

If the renegotiation stage does not reveal information, the anticipation of its outcome can be incorporated into the original contract. The resulting contract is *renegotiation proof* since the contracting parties do not renegotiate even though renegotiation is possible. The *renegotiation proofness principle* allows us to restrict the contracting space to renegotiation proof contracts. The relationship between renegotiation proof contracts and renegotiated contracts is further analyzed in, for example, Laffont and Tirole (1990) and Hart and Tirole (1988).

Even though renegotiation is efficient *ex post*, it might be inefficient *ex ante*. From an *ex ante* point of view, some *ex post* inefficiency might be worthwhile if, for example, it implies more effective incentives *ex ante*. Efficiency would increase if the parties could commit not to renegotiate. This lack of commitment might be viewed as a contractual incompleteness, but this is not very common since the "incompleteness" is not related to transaction costs, bounded rationality or unverifiability. It is mainly taken as a simple constraint on the *ex ante* optimization problem like wealth constraints.

If contracts are incomplete, renegotiation plays a different role. If, for example, the contract does not specify what to do in a certain state of the world, a realization of this state implies that the contracting parties have to figure out what to do, they renegotiate. Renegotiation, like *ex ante* contracting, is a costly transaction since, for example, haggling is time consuming. Further, the parties may fail to reach an efficient agreement if information is asymmetric. Hart (1995, p. 25) describes a downstream firm which does not know the production costs of its supplier, while the supplier has learned these costs before renegotiation starts. Offering a high price ensures that the supplier delivers, but implies overpaying in low-cost states of the world. Offering a lower price reduces overpaying, but the supplier refuses to deliver in high-cost states so that trade may not occur even though it were efficient *ex post*.

A central challenge of the contract is to provide a framework for the renegotiation in order to reduce renegotiation costs and to improve the renegotiation outcomes. Renegotiation might even resolve the contractual incompleteness. Hermalin and Katz (1991) analyze a principal agent moral hazard model with observable but unverifiable effort where message games are excluded by assumption. Their results are different from Fudenberg and Tirole (1990): Due to the observability of effort, renegotiation can increase efficiency.

### 1.4.3 The Hold-Up Problem

Some of the costs of renegotiation described in the previous section occur *ex ante* since the agents anticipate the renegotiation outcome and adapt their *ex ante* behavior. Instead, the transaction costs of renegotiation itself or the costs of a renegotiation breakdown accrue *ex post*. If the contracting parties can costlessly start again with a new, identical contractual partner, they can avoid these *ex post* costs by simply switching to a new partner. If this is costly instead, the parties may prefer to stick to the original contractual partner.

An obvious reason to do so are ex ante relationship specific investments as in Klein, Crawford, and Alchian (1978). Such an investment is costly for the one who invests, it creates value if the relationship continues but is less valuable outside this relationship so that the investment creates a *quasi-rent*. For example, an upstream firm might invest in order to adopt the needs of a specific downstream firm. The investing party anticipates the outcome of the renegotiation stage. If this party fears to be *held up* by a contractual partner who appropriates a large share of the quasi-rent, the investment level chosen ex ante is inefficiently low. Hart and Moore (1988) show that the hold up problem, in general, leads to underinvestment. The hold up problem brings about an additional source of inefficiency due to renegotiation which can occur even if renegotiation itself is costless and there are no ex post inefficiencies. Aghion, Dewatripont, and Rey (1994) show that underinvestment can be avoided if the original contract is used to design the renegotiation game. The allocation of bargaining power and the default option in case renegotiation breaks down are the two main features. To implement the renegotiation game, contractual provisions like penalties for delay are incorporated in standard Rubinstein<sup>13</sup> bargaining games. Similar results are obtained if there are no relationship specific investments but the purpose of the contract is to implement risk sharing.

#### 1.4.4 Summary

If contracting itself generates transaction costs, for example due to bounded rationality, contracts remain incomplete. While the theory of complete contracts focuses on compensation schemes used to elicit asymmetric information, the incomplete contracts literature focuses on renegotiation about the distribution of quasi-rents created throughout the relationship. Different from complete contracts, renegotiation of an incomplete contract may help to increase efficiency. An important role of the original contract is to provide an institutional framework for renegotiation. To account for the size resp. the boundaries of a firm, one might argue that the costs are different for

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<sup>13</sup>For Rubinstein bargaining games, see Rubinstein (1982).

intra-firm and inter-firm transactions. As Bolton and Dewatripont (2005, ch.11) summarize, transaction cost theory views the firm as a long-term *governance structure* that limits opportunistic behavior which would imply large costs in a pure market setting, for example due to extensive haggling. While vertical integration reduces the costs of renegotiation, it increases bureaucracy. This is still a vague explanation for the size of a firm, Demsetz (1989) provides a discussion of the difficulty to distinguish transaction costs (occurring for intra-firm transactions) and management costs (occurring for market transactions). Grossman and Hart (1986) emphasize that transaction cost theory mainly shows that a disintegrated setting with incomplete contracts might be more efficient than complete contracting. To derive results about the boundaries of the firm, it is implicitly assumed that integration yields the same results as complete contracts, without justifying this assumption. To improve the theory, it is required to model property rights and decision structures explicitly in order to be able to compare different allocations of ownership, for example integration and disintegration.

## 1.5 Property Rights and Decision Structures

### 1.5.1 Ownership

To understand the idea of ownership, consider a simple vertical structure with an upstream firm  $B$  providing input for a downstream firm  $A$ . As long as  $B$  is an independent firm, the two firms interact via prices in a market. In case of vertical integration, firm  $A$  acquires firm  $B$  and therefore becomes the owner of it.<sup>14</sup> To interact,  $A$  and  $B$  do not use prices anymore but the head of firm  $A$  simply orders firm  $B$  what to do, esp. which quantity to produce. The disintegrated situation is sometimes referred to as the *price mode* or *negotiation mode* while the integrated setting is known as the *quantity mode*. A formal model of the two modes is analyzed in Simon (1951) who compares a sales contract and an employment contract.

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<sup>14</sup>Of course, firm  $B$  could as well acquire firm  $A$ .

Coase (1937) argues that, in some situations, the quantity mode is more efficient than the price mode, which could explain the level of integration and therefore the size of firms. Instead, Alchian and Demsetz (1972) point out that integration may not be necessary to implement the quantity mode. If the key feature of integration is that  $A$  can fire and replace the manager of  $B$ , there is no difference to the disintegrated setting where  $A$  can stop trading with  $B$  and switch to a different supplier. In case of complete contracts, ownership does not influence efficiency. As Hart (1989) points out, any privileges conferred to ownership can be contracted away. In case of integration,  $A$  could contractually commit not to give any orders to  $B$ , which leads to the outcome of the disintegrated setting. In case of disintegration, the independent supplier  $B$  could contractually guarantee to follow  $A$ 's orders, leading to the outcome of integration.

As soon as transactions are costly so that contracts remain incomplete, it is impossible to describe the rights conferred to ownership completely. Hence, they can not necessarily be contracted away and ownership matters. Hart (1995, ch. 2) describes a change of ownership as a change of the status quo point resp. default option in renegotiation. That is, ownership changes what happens in case renegotiation breaks down and, since the parties anticipate this, influences the renegotiation outcome, the ex ante activities, and overall efficiency. Still, this does not define the rights which distinguish the owner of an asset from a manager who works with the asset.

### 1.5.2 Residual Decision Rights

A contract may contain *specific decision rights* for the use of an asset, that is, the contract confers the right to undertake a specific decision to one of the contracting parties. If contracts are incomplete, an unforeseen contingency may require a decision not specified in the contract. According to the anglo-saxon legal tradition as described in Salanié (1997, p. 180), the *owner* of the asset has the right to undertake such a decision. He has *residual decision rights*. Starting with the famous paper of Grossman and Hart (1986),

contract theorists model property rights as *residual control rights* or *residual decision rights*. This is also according with common sense, as Hart (1995) demonstrates with the simple example of renting a car for a few month. If the renter comes up with the idea to build in a new CD player and the contract is silent about that, it is obvious that the renter has to ask for the owner's permission. The main effect of the allocation of residual decision rights is to change the parties' role in ex post renegotiation, which of course impacts ex ante behavior.

Earlier concepts of property rights stick to the concept of complete incentive contracts and, as in Alchian and Demsetz (1972) and Jensen and Meckling (1976), argue that ownership is the right to claim *residual income* or *residual returns* created by the use of an asset. Hart (1995, ch. 3.4) provides a short discussion of this concept. If the contracting parties sign a profit-sharing contract which determines how to split up the profit between them, it is unclear who is the claimant of residual income. They both claim a share of it. If residual income determines ownership, a profit sharing contract leads to a kind of joint ownership. Since residual control can hardly be shared, these difficulties are not an issue if residual control determines ownership. From a theoretical point of view, residual income and residual control may be separately owned. This implies further difficulties. For example, a hold-up problem may appear. In practice, residual control and residual income are often bundled together, for example through a one share - one vote policy.

Incomplete contracts and decision rights also provide a perspective on the financial structure of firms.<sup>15</sup> If, for example, an entrepreneur cannot afford to purchase an asset, a financial contract with a wealthy investor may be signed. If the debtor is not able to accomplish the contracted payments, the creditor usually has the right to decide about the future use of the debtor's assets. In case of complete contracts, this decision is already anticipated in the original contract. If contracts are incomplete, the creditor's decision

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<sup>15</sup>Hart (1995, part II) provides a comprehensive overview of financial contracting.

right plays a role, it may even be a residual decision right in some states of the world. The contractual incompleteness gives rise to financial structures like debt, equity or even bankruptcy procedures. In fact, these structures represent state-contingent allocations of control resp. decision rights. As Williamson (1988) points out, the corporate finance decision is therefore very closely related to the vertical integration decision. Zingales (2000) investigates more closely the relationship between corporate finance and the theory of the firm.

### 1.5.3 Ex Ante vs. Ex Post Inefficiency

There are two important strands of literature on incomplete contracts and decision rights. The main difference is the kind of inefficiency they address. The *property rights approach* deals with actions or decisions undecidable ex ante at the contracting stage but verifiable ex post. Hence, renegotiation is efficient ex post. The allocation of decision rights, esp. property rights, influences the renegotiation and therefore also influences ex ante activities. Any inefficiency results from the ex ante unverifiability. The property rights approach is based on Grossman and Hart (1986). In this paper, noncontractible<sup>16</sup> ex ante investments are undertaken by both contracting parties while some production decisions are made ex post. These decisions are verifiable and therefore efficient ex post (for given ex ante investments), but they are undecidable ex ante so that they are made by the owner of the residual decision rights, which is the owner of the respective assets. A firm is identified with the assets it owns so that the allocation of property rights determines the level of integration. In the disintegrated setting, both contracting parties invest moderately since the ex post surplus is divided comparatively evenly. In case of integration, the integrating firm extracts a large share of the surplus and therefore overinvests, while the integrated firm underinvests. As a result, integration is optimal if one party's investment is much more important than the other one's. Hart and Moore (1990) extend this idea in order

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<sup>16</sup>If investments were contractible, ownership resp. integration would not play a role since, according to the Coase (1960) theorem, the inefficiency would be resolved anyway.

to incorporate changes in the incentive structure. In case of disintegration, a firm owner can stop contracting with the independent contractee firm as a whole, including workers and physical assets. In case of integration, the owner of the integrating firm can fire the workers of the integrated firm but continue to use its assets. This broader framework provides more general control structures than ownership alone. One particular important result is that, in terms of efficiency, complementary assets should be owned together.

A different approach of incomplete contracting focuses on *ex post inefficiencies*. If these inefficiencies are the result of limitations on the possible transfers, the financial structure of firms seems to be a natural application. Aghion and Bolton (1992) analyze a model where a wealth constrained entrepreneur raises funds from an investor in order to finance a project. There are no relationship specific investments and no hold up problem. The financial structure is determined by the allocation of decision rights. An unverifiable action is taken *ex post*. While *ex ante* participation constraints may foreclose to give full control to the entrepreneur, the wealth constraint leads to inefficiencies if the investor is in control. The optimal allocation of control depends on the *ex ante* uncertain state of the world. Besides wealth constraints, there may be other sources of *ex post* inefficiency. For example, in Aghion and Tirole (1997) and Bester (2005), the inefficiency arises because monetary incentives are not feasible.

#### 1.5.4 Authority and Delegation

The property rights approach defines a firm as a set of assets. Hart (1995, ch. 3) stresses that this definition makes sense only if there are at least some significant nonhuman assets. These might be physical assets like machines, but also patents or client lists. In the absence of nonhuman assets, there is nothing that keeps the firm together. If it is acquired by another firm, the employees can leave instead of working for their new employer. They may found a new firm costlessly, they simply have to announce it. If nonhuman assets are involved, these assets become the property of the integrating



firm. The employees cannot simply form a new firm in order to continue their business independently since they had to leave the nonhuman assets behind. The asset owner has the *right to exclude* others from the use of the asset. This is also answering the question raised in Section 1.5.1 about the difference between an employment relationship and a sales relationship. The employer controls the nonhuman assets, which also gives her power over the employees. The property rights on the nonhuman assets are the source of the employer's authority. Holmstrom (1999) argues that the property rights approach alone does not provide a sufficient explanation for the boundaries of a firm. While the property rights approach describes why individuals own assets, it is somewhat vague why firms own assets. In this spirit, papers like Hart and Holmstrom (2002) extend the approach to incorporate, for example, externalities. Rajan and Zingales (1998) introduce the concept of *access*. In their model, the asset owner does not transfer residual control rights but guarantees the employee access to the asset, e.g. the possibility to use a machine. This enables the employee to specialize, giving him control over a critical resource, his specialized human capital. From this point of view, the firm is more than a collection of physical assets since the employees have some power within the firm.

More general, the literature on property rights views *authority* as the right to make a decision. While the decision itself is noncontractible, the right to make it can be contractually assigned. The contract provides an allocation of authority. If one of the contracting parties originally owns the decision right, for example due to property rights, the contract may transfer the decision right to a different party. If the contract transfers some but not all decision rights, *delegation* takes place. This might be viewed as an intermediate ownership structure where, for example, the firm owner delegates some power to a board of directors.

An obvious way to enforce an allocation of authority is via asset ownership. In this case, the transfer of decision rights is in fact a transfer of property rights. Access is also an allocation of decision rights. In Baker,

Gibbons, and Murphy (1999), the allocation of authority is enforced implicitly via repeated interaction. In case of ex post unverifiable decisions, a different concept of authority may be applied as well. Bolton and Rajan (2001) model authority as the right to give orders. Instead of spot contracting with ex post renegotiation, the parties can also sign a long-term employment contract. The employee can only choose to follow the orders of the employer or to quit.

The literature about the allocation of authority addresses the optimal design of institutions, e.g. firms or administrations, under numerous aspects. The optimal level of integration and the boundaries of the firm have already been discussed in the previous sections. The inner life of firms is also an issue in the literature. The allocation of authority designs the hierarchical structure of the firm. For example, Hart and Moore (2005) discuss the design of hierarchies as a trade off between coordination and specialization. Rajan and Zingales (2001) compare the hierarchical structures of firms in physical-capital-intensive and human-capital-intensive industries. Aghion and Tirole (1997) distinguish between formal and real authority. A better informed party who does not have formal decision rights has real authority if the owner of the formal decision rights is better off by following his recommendation. The allocation of formal authority impacts the incentives to acquire information. The relationship between incentives and decision rights is further investigated in, for example, Athey and Roberts (2001) as well as Bester and Krähmer (2007). Dessein, Garicano, and Gertner (2007) analyze a trade off between coordination and incentives. How decision rights interact with communication inside an organization is discussed in Bester (2005) and Dessein (2002). The previous description of the literature should give the reader a rough idea of the questions discussed but is far from being a complete review since there is a huge and constantly increasing amount of literature in the field.

### 1.5.5 Foundations of Incomplete Contracts

The foundations of incomplete contracts and esp. the property rights approach have been discussed extensively in the literature, Tirole (1999) provides a comprehensive overview. In fact, the unverifiability assumption in the incomplete contracts literature is stronger than it appears on first sight. It is usually implicitly assumed that the parties cannot contract around the unverifiability by message games or mechanisms as described in Section 1.3.6. This ad hoc assumption clearly asks for rigorous foundations.

Maskin and Tirole (1999b) derive an *irrelevance theorem* which states that ex ante undescribability does not prevent the parties from reaching optimal outcomes so that, in fact, transaction costs are irrelevant. Ex post message games can circumvent ex ante noncontractibility so that the parties receive the same payoffs as if contracts were complete. The main assumptions for the irrelevance theorem to hold are the absence of renegotiation and the ability of the parties to perform dynamic programming. Maskin and Tirole (1999b) suggest how rational parties can commit themselves not to renegotiate. Dynamic programming is assumed in most of the incomplete contracting models anyway. As Tirole (1999) emphasizes, there are conflicting views of rationality in the theory of incomplete contracts: On the one hand, parties are rational enough to make use of dynamic programming, while on the other hand, bounded rationality is used to explain contractual incompleteness. Further, Maskin and Tirole (1999b) and Tirole (1999) provide some ideas how ownership and control allocations may be explained in a setting of complete contracts.

As a response to Maskin and Tirole (1999b), Segal (1999) adds complexity considerations to the theory of contracts. If renegotiation cannot be prevented and the complexity increases, the optimal complete (message contingent) contract approximates the results of incomplete contracting. Building on Segal (1999), Hart and Moore (1999) show that undescribability plays a crucial role in some circumstances. These models do not justify the use of

property rights explicitly. Finally, Maskin and Tirole (1999a) give assumptions under which foundations for property rights models are given.

While the discussion reviewed so far focuses on the property rights approach with decisions undecidable *ex ante* but verifiable *ex post*, Aghion and Rey (2002) investigate a setting of *ex post* inefficiency occurring due to a decision that remains unverifiable *ex post*. Their model focuses on the robustness of control allocations to the introduction of implementation mechanisms like message games. They show that *ex post* unverifiability combined with wealth constraints considerably limits the capability of those mechanisms so that the restriction to contracts that simply allocate decision rights seems justified in these settings.

### 1.5.6 Summary

While the discussion about the theoretical foundations clearly points to some shortcomings, the theory of incomplete contracts nevertheless provides interesting insights to the theory of the firm. Previous approaches to the boundaries of the firm usually suffer from the fact that they need different theories to explain the costs and benefits of integration. For example, integration might be viewed to bring about the benefits of economies of scale in production but the costs of a larger bureaucracy. The property rights approach is capable to incorporate the advantages and drawbacks of integration into one consistent theory. Integration weakens the *ex ante* incentives of the integrated firm, disintegration weakens the incentives of the integrating firm. While transaction cost theory describes the firm as a device to limit opportunistic behavior, this is not the case within the framework of property rights. A transfer of property rights shifts the incentives for opportunistic behavior without removing them. Different from transaction cost theory, complete contracts are not viewed as a benchmark. Instead, different allocations of decision rights are compared. Ownership and property rights mainly change the parties' position in *ex post* renegotiation, which protects the owner's *ex*

ante investment.<sup>17</sup> Besides the firm boundaries, Section 1.5.4 has shown how the optimal design of firms and institutions is easily and extensively analyzed within the framework of the allocation of decision rights.

## 1.6 The Contribution of this Thesis

Three different topics in the optimal design of organizations and firms are addressed in the following chapters of this thesis. The chapters may be read independently.

Chapter 2 describes a model that compares process based and function based organizational forms. For example, consider a multiproduct firm that produces two products. For each product, several tasks like manufacturing and marketing have to be done. In a multidivisional form (*M*-form), a firm is structured along processes. Each department is in charge of one specific product which it has to market and manufacture. In contrast, a unitary form (*U*-form) firm is structured along functions. Each department is in charge of one specific function, carrying out this function for every product. The marketing department has to market both products, the manufacturing department has to manufacture both products. Chapter 2 analyzes the organizational form within the framework of a simple task assignment model. The principal, e.g. the firm owner, contractually assigns the tasks to the two agents she hires. The task assignment is the only difference between the two organizational forms. Once the contract is signed, the agents choose their effort levels for the tasks they are in charge of. Effort is costly to the agents and the effort levels are private information so that moral hazard occurs. The principal provides monetary incentives to induce the agents to exert effort. Limited liability of the agents prevents the principal from extracting the whole surplus, leading to distortion in both organizational forms. The

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<sup>17</sup>In an extension to a multilateral setting, Bolton and Whinston (1993) show that if the parties' ex ante investments are substitutes so that firms compete ex post, integration both strengthens market power and limits ex post opportunism so that inefficient ownership allocations may occur.

outcome of a process is contractible, but there is no measure for the outcome of a function. The idea is that it is easily measurable which share of a firm's profit is attributed to a certain product, but hardly measurable which share of the profit is generated by, for example, the marketing department. As a result, the *M*-form enables more effective incentives. On the other hand, the *U*-form is assumed to provide some savings on effort costs due to specialization or economies of scale. Different from the existing literature on task assignment and organizational structure, chapter 2 models explicitly the interaction among the different functions. If there is strong substitutability or complementarity present, this helps the principal to induce her preferred effort levels. The comparative advantage of the *M*-form is not relevant in this case and the *U*-form is optimal. If the functions are neither too complementary nor too substitutable, the principal may be better off if she abandons the cost savings of the *U*-form in order to enable more effective incentives by the implementation of the *M*-form.

In chapter 3, the allocation of authority in a joint project of two agents is analyzed. If several persons or institutions undertake a joint project, decisions that influence all parties have to be made. For example, consider two departments of a firm working on a new product. Decisions about the quality of this product concern the marketing department as well as the production department, no matter who has made the decision. In chapter 3, the noncontractible decision under consideration affects the project outcome as well as both agents' costs independent of who has made the decision. The decision-maker exerts an externality on the other agent. The decision right is contractually assigned to one of the agents, while the decision itself remains unverifiable ex post. Generalized Nash bargaining is used to share the available surplus. Different from the existing literature, our model allows to address directly the interaction of bargaining power and cost structure with respect to the allocation of authority and the efficiency of the outcome. It is not only bargaining power and cost structure that determine the outcome, it is also crucial to what extent bargaining power reflects cost structure. The agents are protected by limited liability so that a trade off between surplus

maximization and rent extraction occurs. In general, first best efficiency is not reached. There are two decisive effects. First, the externality the decision-maker exerts on the other agent is determined by the differences between the agents' cost functions. Second, the severity of the trade off is described by the relationship between the decision-maker's cost function and her bargaining power. If bargaining power perfectly reflects the cost functions, the trade off vanishes. If the decision-maker's marginal costs increase faster than the other agent's marginal costs, this allocation of decision rights creates a larger surplus than the alternative allocation. But bargaining may allocate authority to the agent with the flatter marginal cost function if her bargaining power is large and the differences in cost parameters are small.

Chapter 4 considers the optimal decision-making hierarchy of an organization. In reality, we observe both flat hierarchies with decentralized decision-making as well as steep hierarchies with a small number of decision-makers who are superior to a large number of subordinates. Chapter 4 provides a model that explains the optimal hierarchical structure of a firm as a result of the alignment of the firm members' preferences and the (dis)similarity of the decisions. Comparable to chapter 3, each decision influences all firm members, no matter who has made the decision. Each decision-maker exerts an externality on the other parties. The decisions are noncontractible and remain unverifiable ex post. The principal, e.g. the firm owner, contractually assigns the decision rights to the agents. In a horizontal (or flat) hierarchy, each decision is made by a different agent. In a vertical (or steep) hierarchy, one agent is in charge of all decisions. The agents have preferences that conflict with the organization's objective. As a matter of taste, they prefer to work on certain tasks or in certain projects. The principal provides monetary incentives to influence the agents' decision behavior. The potential decision-makers prefer decisions different from the principal's preferred one's and incur private costs if their preferred decisions are not implemented. They are diverse in the sense that their cost functions differ. Since the agents are of limited liability, distortion is created in any hierarchy. The advantage of a vertical hierarchy is that the principal has to incentivize only a single

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decision-maker. This advantage might be outweighed if the agents are very diverse, that is, they have very different preferences. If one of the agents has larger marginal costs for decision 1 than for decision 2 while for the other agent it is the other way around, the principal may prefer a horizontal hierarchy. A switch from the vertical to the horizontal hierarchy reduces the expected wage payment of the former decision-making superior but increases the expected wage payment of the former subordinate. The principal is better off with a horizontal hierarchy if, for every agent, the agent's marginal costs for the two decisions are sufficiently different. We interpret this as a result of the decisions being very dissimilar. To summarize, the horizontal hierarchy is optimal if the agents are very diverse and the decisions are very dissimilar. Section 4.1 provides some examples for the different situations.