CONSTRUCTING COSTS

-Risks in the Building Sector and Cost Increases during Construction-

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Summary
The economic analysis of building contracts is an unexplored field within Law and Economics. This paper makes an attempt to cast some light over the subject and encourage to more research within the field. The main purpose has been to describe why the actual price in a public construction project often turns out to be higher than the contract price and offer a way of handle that risk. In the paper a model is set up that shows an optimal contract given expectations on actual price and gaps in contracts. Four overarching questions are presented to guide the reader:

- Why does many construction projects end up more costly for the buyer than contracted?
- How can a contract allocate the risk in a construction process?
- How can the described risks be handled in an efficient way?
- What is the optimal form of a contract for a government that wants to minimise costs?

A contract can be designed to transfer all the risk on one party, but it can also only partially allocate the risk on the suitable risk bearer. This paper describes how the ground condition risk, legal and procedural risk and designing and construction risk can be handled. The risks are described and analysed by the help of incentive theories.

Cost increases for the buyer can mainly be explained by two situations. The first situation is when something unexpected occurs that forces costs to increase for the project as a whole and the risk is already allocated in advance. If the contract specifies that the buyer should bear the current risk it will not cause any procedural problems and the project will end up more expensive for the buyer. The second situation arises when a risk is realised and the contract has not specified how to deal with it. Bargaining power and anticipations on the other parts behaviour will be of significance for how to place the extra costs.

A more general discussion is also held about contract forms in the construction sector and the way that different contracts handle financial risk. One conclusion is that a fixed price contract without any gaps probably is the best way for the government to keep control of cost increases. Unfortunately, in the real world almost all contracts suffer from gaps. An experienced purchaser can however, avoid the largest gaps. Therefore this paper concludes, that experts, specialised in buying constructions, best can help the government to mitigate cost increases. The paper also concludes that cost plus contracts should be used very rarely mainly because of the low incentives it gives the contractor to keep costs down.
Index of Variables

α  - Contract Form
ΠC  - Contractor’s Profit
ΠT  - Contractor’s Target Profit
A  - Agent-Similar use as Contractor
C  - Cost
CA  - Actual Cost
CT  - Target Cost
G  - Governmental Outlay
P  - Price
Pr  - Principal-Similar use as Governmental Purchaser
Q  - Quality/Degree of Gaps in the Contract
t  - Time
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1 Introduction

This chapter contains an introduction and background to why cost increases and risks in public building projects is an important topic to study. Purpose, methods and delimitations will also be handled below.

1.1 Background to the Problem

Imagine a person who orders a brand new car from a car dealer. He signs a contract, which stipulates the price, relevant quality aspects, colour and date of delivery. On the day of delivery he can go to the car dealer and collect his new car with the specially ordered characteristics and pay the price in advance agreed upon. It is hard to imagine that any customer would accept to pay a higher price than agreed for the car when collecting it because of increased labour or material cost. This, however, happens frequently in the building sector.

One might then ask if there are any significant differences between the two sectors. It is of course possible to find differences, for example, the car industry is characterised by a higher degree of automatisation than the building sector. Surprisingly many features are though similar and the construction sector is impending methods used in the car industry by, for instance, building with ready-made blocks.

Returning to the first lines with the comparison of the automobile industry and the construction industry, there is still on unexplained question: How is it possible to raise the price in a construction project after the contract has been concluded? Especially governmental construction projects draw attention from the public when information about cost increases is revealed. One can often read headlines in newspapers saying that the construction of a hospital or a school has exceeded the planned costs. After a construction has been completed it is usually easy to recognise the fact that there has been a cost increase. Sometimes it is possible on an ex post basis to spot the reasons for the price increase. Ex ante it is, however, almost impossible to foresee the problems and include a solution to them in a contract. Unexpected cost increases in building projects might be very expensive. If it is possible to trace the source of the problem and understand why many building projects end up being more expensive than anticipated then, perhaps, it is also possible to do something about it. The problem is well known in accounting, but in Law and Economics it is new. It is, however, probable that Law and Economics can bring new insights to the problem mainly through the ability to combine behaviour and incentives with economics and law.
A public construction project can be divided into several phases, which can be more or less extended in time. It starts with a need for the building either by the community or by the governmental officials. In the second step a designer is consulted to make plans for the project. Generally, this is made under some kind of competition. When an appealing design is found the governmental agent publishes the project and let construction companies bid for the building project. Usually the lowest bid gets the contract. Of course there can be exceptions from taking the lowest bid if for example quality is more important than a low price. Then the government chooses the bid that is best suited for their demands. After the construction is finished the government has to run and maintain the building.

**Figure 1.1 Phases in a building project**

A building project demands a rather large amount of information. A contractor wants, for instance, to know what ground he is building on, which material to use, how big and high the house should be et cetera. It is sometimes rational for a contractor not to deal with all information before the project has started. If a contractor wants to be almost perfectly informed before starting an ordinary project a substantial time must be spent collecting data and trying to interpret it. Even if he can calculate the costs exactly it is still not guaranteed that he will attain the project because the competitors might miscalculate the costs and offer a lower bid. There is in other words a very large sunk cost connected to calculating the exact costs before the project.

In a large construction project there is always a risk that something unexpected occurs that the parties just plainly forgot to stipulate in a contract. Both parties may gain or lose on this uncertainty, but there are solutions offered by economic theories. This paper will therefore offer a way of dealing with risk and uncertainty in construction contracts.
1.2 Purpose

The main purpose of this thesis is to describe why the actual price in a public construction project often turns out to be higher than the contract price and offer a way of handle that risk. A model will also be set up to show an optimal contract given expectations on actual price and gaps in contracts.

This overarching purpose is formulated into four concrete questions that can guide readers through the whole paper:

• Why does many construction projects end up more costly for the buyer than contracted?
• How can a contract allocate the risk in a construction process?
• How can the described risks be handled in an efficient way?
• What is the optimal form of a contract for a government that wants to minimise costs?

1.3 Method

In most construction assignments a contract is concluded to stipulate date of completion, bearing of financial risks et cetera. Changes in clauses and contract types can lead to different outcomes of the contractual relation. The discipline Law and Economics has offered a way of analysing incentives and efficiency in contracts. This paper therefore uses that approach to explain actors behaviour and incentives in construction contracts.

Researchers have earlier focused on how technical problems might lead to higher costs in projects. This paper, however, has its emphasis on how contracts deal with the financial risk for the contractor or the government. It also identifies some important risks in construction projects and offer a way of dealing with them.

This problem with unexpected cost increases occurs all over the world, but this paper focuses on problems in Sweden¹ and how efficient risk conducting can deal with the problem. All theoretical work and the models are illustrated by empirical data collected in Sweden.

¹ The judicial frame is, however, similar in the whole European Union because of the fact that member states have common rules concerning public purchases which exceed a certain value. This means that if the estimated value of the contract is higher than EUR 5,000,000 the same regulation applies. Also if the construction contract is divided into subcontracts to a value of at least EUR 5,000,000 together, all subcontracts that exceed EUR 1,000,000 shall be treated on an EU level. (Directive 93/37/EEC).
1.4 Delimitation

In the paper, focus lies on contracting and building phase and not much attention is paid to the time before and after the project. The paper is concentrated on contracts where only one firm is contracted with the government. This is called a general contractor. In the building sector it is common that the main contractor uses one or more subcontractors, or that the government contracts with more than one firm, which then is called multiple contractor. This is, however, not what I want to focus on in the paper. Therefore the assumption that there is only one contractor is used throughout the whole paper. Projects containing rebuilding are of minor importance in the empirical part of the paper. The reason for this is mainly the increased complexity and uncertainty that rebuilding projects cause. They suffer therefore often from a higher cost increase, expressed in percentage, than new building.

This paper examines the relation between a government, which also is called buyer and a private contractor. The reason for choosing a government as a buyer is because they act as a risk neutral buyer without any credit risk. That has made the analyses a bit easier, but a private large buyer will probably give the same result.

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2 Recent research has also showed that projects with multiple contractors are less efficient than projects with only one contractor. They usually cost more and takes longer time to finish. Both empirical and theoretical works has showed that to write and supervise contracts is usually harder the more contracts that have been included in a project and therefore the cost increases and the quality will be lower with more contractors. (Ashenfelter et al)
2 Empirical Cases

This section will illustrate problems and risks in the construction sector. All examples are real public building projects in Sweden.

2.1 About the Empirical Research

In this section a number of projects will be presented in order to illustrate the main ideas of the paper. Public constructions are chosen after certain criteria. They are general in the sense that the public sector usually is responsible for the erection of the construction in a country. The intention has been to span over a lot of different public building projects just to show that the problem is similar in a variety of projects. Projects are only collected from Sweden since it has been easy to collect data there. These problems are probably generally occurring all over Europe. The data is only collected from general contracts with one single contractor. After the project presentation some remarks explaining the cost increase from the point of view of this paper are given.

2.2 The Hospital of Sunderby

The hospital of Sunderby, situated between Luleå and Boden in the north of Sweden, is the most modern hospital in Europe and covers today an area of 88,000 m². It is a hospital containing 416 treatment places, 16 rooms for surgery, 13 dialysis places, 9 places for intensive care, 9 places for heart intensive care and 7 childbirth rooms. The final building decision was settled and reconsidered many times before January 1995 when the responsible principal at last could throw up the first sod. On the first of February 1999 the building was ready and the final inspection was made. A lot of smart technical solutions, bright rooms and cosiness characterise the hospital. During the whole project an environmental plan has guided the construction company. This means, for instance, that all material used in the project has been documented and allergy tested. Natural material such as bricks, wood and stone was used to fullest possible extent. Recycled material has also been used during the construction. Old cellular plastic is, for example, used as floor isolation. Freons as refrigerant was forbidden in the project. Instead the cold water from the river of Luleå is used to cool down equipment and rooms. Energy is saved by letting the buildings be oriented towards the sun and by recycling the ventilation heat.

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1. The material is collected from information brochures printed by the building firm PEAB and through telephone interview with the responsible purchaser Arne Johansson, 1999-08-04.
Building and projecting has been done parallel, which means that when one part of the hospital was completed, the constructing firm moved on to another part, which then was fully planned and ready to be built. The contract form is a kind of cost plus fluctuating fee. In this case it means that the construction company has their actual costs covered and the fee is based on some form of sliding scale. This implies that the more costs and time the company saves, the higher the lump sum payment will be in the end. The contract sum was SEK810 million, but at the end of the project the costs had raised to SEK1100 million, which meant an increase of over 35 per cent. The cost increase was mainly due to the form of project management. During the construction project the purchaser realised that they needed more space and rooms in the hospital and this was the main cause to cost increase. They also realised that they needed sprinklers and additional technical equipment that was not contracted.

2.3 Eksjö Library

The new library in Eksjö was opened in 1998 and includes an area of 2 300 square metres. It is situated about five minutes walk from the centre of Eksjö. One reason for constructing a new library was that the old could not expand any more. Also, the upper secondary school needed a new library because their old library was too small. The municipal therefore decided to integrate the two old libraries into one new.

At completion the project ended up with a total cost of around SEK24 million. That sum included the construction work, interior decoration, ground purchase, consultation fee et cetera. Only the construction work counted for SEK19.4 million of the total sum. The purchasing municipality of Eksjö used a fixed fee contract and at the signing of the construction contract that sum was 17.3 million. This means that the construction was approximately 12 per cent more expensive than originally anticipated although the price was settled in advance. One big cost entry was due to the fact that the new library was placed on a rock. This caused additional work for the construction company and therefore the purchaser had to pay a bit more. The biggest cost increase is recorded as unforeseen costs and is about SEK1.2 million. During the project the purchaser had to change their specifications a bit, for instance was there a realised need for a canopy that cost additionally SEK200,000.

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4 The information is received through a telephone interview with Lars Ljung, the chief of culture in the municipal of Eksjö.
The need for a new library was a rather old question in the municipality of Eksjö. A couple of years before the decision to build the present library was set, a draft for the library had been sketched. This drawing presented a bit bigger library to a calculated cost of SEK30 million. The city council could not afford such a big investment and therefore had to remove some parts from the plan until the calculated cost were almost SEK10 million less than the original draft. During the development of the draft the responsible purchaser also calculated with a very positive development of construction cost. They expected the low prices for construction work to remain throughout the whole project.

2.4 Vallsundsbron

The bridge of Vallsund was a major bridge project in the north of Sweden completed on the 16th of September in 1998. The bridge replaces a 350 years old ferry line in Storsjön and offers the possibility to travel much faster between Östersund and the south of Jämtland. There are actually two bridges, one is 130 metres long and the other is 1500 metres long. The bridge is constructed of steel and concrete with its highest part about 18 metres above see-level. A general contractor named PEAB managed the whole project. The principal organisation was Vägverket, a governmental agency that manages all public roads in Sweden.

After the completion the bridge won a famous design price in 1998 called the construction of the year. The motivation was: *Through an ambitious planning and projecting and a well thought methodology have the bridge constructors at Frösön managed a series of hard demands considering for example logistics, environment and a sometimes hard winter climate. The connection, realised by two bridges and an artificial island, is also aesthetically appealing by the sensitive adaptation to the existing landscape.*

The idea of a bridge project is over 60 years old and finally in 1978 the idea was also raised in the city council of Östersund, but it took additional ten years more before they could decide on the final building plan. The Swedish government also approved the plan in 1991. The delay of four years was due to a time consuming appealing process against the project. In 1992 the Norwegian architect firm Knut Selberg won the design competition and finally decided the blueprint of the bridge. Shortly after the design phase, but before the building

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5 I have collected the facts of this part by internet, local newspapers and correspondence with the responsible manager.
phase new calculations showed that the cost of the bridge would be SEK40 million more than planned. After negotiations the government lent additional money under the condition that repayment must be done when the bridge came into use. The idea was to pay back with the money saved on the closed down ferry line.

The building phase started on the 8th of February in 1996. PEAB had then won the contract at a sum of SEK261 million. It was a kind of incentive contract that the parties used. When the project finished in 1998 the final sum was SEK270 million. The increased price was partly due to changed factor prices, but the main reason was a connection road that the contract did not cover.

As can be seen the price increases after the design phase are not very large and a small part of the increase was contracted ex ante. The major outlay seems to be due to a contracting and planning mistake.

2.5 Co-ordinated Location of the Garrison in Eksjö

Eksjö has a long tradition as a garrison city and today four military units are located in the city. The whole garrison employs 400 officers and 200 civilians and has a capacity for training about 1400 conscripts. Before 1994 the four units were split in two separate parts of the town with their own supply systems such as gas stations, garages and dining rooms. This imposed, of course, double costs for the government that financed both places. In 1992 the government therefore decided to co-ordinate the location of the separate units into one garrison area. Neither of the two old units had room for all conscripts, but the cheapest seemed to be that one unit moved into the other unit’s area and to build two new barracks and a new office house. The whole construction project had a contract price of SEK45 million and the contract form was similar to a fixed price contract. The whole project ended up around SEK3-5 million more expensive than the contract concluded. The main reason was that during the initial phase of the project solid ground was found and made the construction about SEK1-2 million more expensive. Minor specification mistakes were also made, such as the number of toilets each floor should have.

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6 The increase was about 3.5 percent and a small part was due to changed factor prices.
7 The information is acquired through talks with the chief of the Garrison, Wilhelm af Donner, a telephone interview 1999-08-06 with the responsible building engineer, Jan Olofsson and through information brochures.
8 The increase was about 5-10 per cent of the contract price.
2.6 Zenithuset\(^9\)

Zenithuset is the latest building on the Campus of the University of Linköping and was taken into use in August 1998. The building is used by the administration for grades, certificate and application errands. The university doctor, the psychologist and the minister also use it. In the ground floor a restaurant, a travel agency, a bank and a bookstore also rents room. The reason for the new building was the continuous growth of the university. New stores wanted to establish and the administration needed more space.

The calculated cost of the project was SEK26.5 million and the company Akademiska Hus was responsible for the construction of the building. The final price for the building was about one million more than planned.\(^{10}\) Reasons for the price increase were some small contracting mistakes, but the main increase was due to an unexpected rock under the building area.

2.7 The South Highway Entrance to Helsingborg\(^{11}\)

The South Highway Entrance to Helsingborg was a pilot project in the area of Swedish traffic environment. The whole project started as an idea in 1994 and on the first of September 1995 the construction firm NCC could start building the road. The whole project was completed at the end of June 1996 and then the city of Helsingborg had a new five kilometres long entrance after a total of 10,800 working hours.

Old traditional signal controls have been replaced by a roundabout, which makes the traffic running smoother. A lot of technical solutions has been used to solve very common asphalt problems. The building firm tried, for instance, the new powder Uintaite, which makes the asphalt stronger and prevents ditches from wheels, especially in the circulation place. The illumination of the road is very unique. All lampposts contain energy saving lamps and every slip road has one-meter high lampposts, which only lights up the roadway. The reflex posts, usually seen on the verge, are replaced by 90 centimetres high position lights. The low lampposts and position lights are totally new in Europe.

\(^{9}\) I have acquired the information for this part through information brochures from the University of Linköping and through a telephone interview with the responsible property manager.

\(^{10}\) The price increase was about 4-5 percent of the contract price.

\(^{11}\) The material is collected through a telephone interview 1999-08-06 with Folke Svantesson, chief of the project at Vägverket. Additional materials are brochures collected from the building firm, NCC.
The contract used during the project was a fixed price contract and at the date of conclusion the parties agreed on a price of SEK32 million. During the project the purchaser realised that the road needed to be extended and the price of the extra parts of the road where SEK4 million. New specially designed road signs was also an additional expense of SEK2 million. The project ended up at about SEK40 million when all additional expenses were counted.  

2.8 Moderna Museet  

Moderna museet is a museum for modern art and it was built in 1957 on the island of Skeppsholmen in Stockholm. Today their collection covers 5000 paintings, sculptures and installations; 30 000 paper works and 12 000 photos. Their old exhibition halls could only show 15 per cent of all pieces at the museum. It was therefore the decision to build new premises was taken. Jose Rafael Moneo, who is a world-famous award-winning architect, designed the new museum. The construction work started in August 1995 and was finished in August 1997. The new building was that year also elected the most beautiful construction in Stockholm. In February 1998 the new museum was opened by King Carl Gustaf. The whole new building covers a gross floor area of 19.500 m$^2$, out of this area 4.500 m$^2$ is for public exhibitions. It means that the museum can show at least 40 per cent of their art. The construction also includes one auditorium with capacity for receiving 350 persons and one motion-picture theatre with 100 seats.

The new museum was built to a fixed price under a fixed price contract. It was a rather large general contract and the responsible firm had to contract a lot of subcontractors. Negotiated price was SEK129.1 million, but the whole project cost about SEK30 million more for the client. The reason was that more than 500 additional changes were made after the contract had been concluded. The management of the museum had ordered specialised equipment that the principal of the building contract did not know. This equipment could not be used if the plans of the construction were not changed. Also other fundamental changes were made such as a modification of the windows.

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12 It is a cost increase on about 25 per cent.
13 The information is collected through interview January 11th 2000 whit Helena Lennartsson, who was a member of the management team of Statens fastighetsverk and through public material offered by the construction company NCC.
2.9 Concluding Remarks on the Empirical Research

When the government decides to put money on a new construction project it compares the price and utility between different projects. It is important to invest the money where they can give the society the highest utility. Every social sector has at least one principal that wants the government to invest money in their projects. The government often finds the project to be socially valuable, but in some cases also too costly to invest in. Governmental rejection of a proposal from a principal might lead to two outcomes, either the principal drops the whole project or he tries to cut the costs until he thinks the government can accept his project. If the government approves the plan the principal can start building. The new calculations are probably not as exact as the ones made at the first time. They also might be a bit too optimistic about the costs. As soon as a project has started it is hard to stop because the state will lose its invested money without getting anything if it decides to abort the project. It is even hard for a state to consider the invested money as a sunk cost. A minor cost increase in the project might therefore pass without any actions from the principal.

In most of the empirical research this tendency is possible to spot. It is of course hard to get a responsible principal to confess that his calculations were a bit too optimistic and that this was because the government needed to realise the importance of the project. A lot of projects in the empirical part have a long consideration time with major cuts in the planned costs. It might be possible that some of the cost increases are results of the bargaining between the governmental decision maker and the responsible principal.

Table 2.1 Summary of the Empirical Research

<table>
<thead>
<tr>
<th>Name of the Project</th>
<th>Type of Construction</th>
<th>Cost Increase</th>
<th>Type of Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunderby sjukhus</td>
<td>Hospital</td>
<td>35%</td>
<td>Cost Plus Fluctuating fee</td>
</tr>
<tr>
<td>Eksjö bibliotek</td>
<td>Library</td>
<td>12%</td>
<td>Fixed Price Contract</td>
</tr>
<tr>
<td>Vallsundbron</td>
<td>Bridge</td>
<td>4%</td>
<td>Incentive Contract</td>
</tr>
<tr>
<td>I12 Regiment</td>
<td></td>
<td>7%</td>
<td>Fixed Price Contract</td>
</tr>
<tr>
<td>Zenit</td>
<td>University building</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Highway Entrance to</td>
<td>Road</td>
<td>12.5%</td>
<td>Fixed Price Contract</td>
</tr>
<tr>
<td>Helsingborg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderna museet</td>
<td>Museum</td>
<td>23%</td>
<td>Fixed Price Contract</td>
</tr>
</tbody>
</table>
Constructing Costs

It might seem a bit strange that even a fixed price contract can end up more expensive than originally thought. In some cases the cost increases arise because the principal has not specified his will enough or he has just plainly forgot to specify. Probably some of the cost increases could have been avoided if the purchaser knew in advance what he needed and could specify this in a contract. The empirical evidence also shows that the reason in most of the cases is due to unforeseen costs. This can for instance be that the constructing company finds rocks in the ground where the construction is supposed to be placed or that the construction prices suddenly rises on the market. It is strange that the ordering part accepts a contract with a clause that if market prices rise the risk will not lie on the construction company who professionally builds, but on the ordering part.
3 The Construction Sector and the Risks

This part identifies different risks connected to a construction project and describes the origin of the risk with the help of law and economics. It also analyse ways of allocate the risk and reasons to why a construction often end up more expensive for the buyer.

3.1 General

It is astonishing how many things that can go wrong during a construction project. Imagine a simple construction of a school building and think of how it is constructed. Every thing has been specified exactly. Floor plan, construction material, style of carpets, size of windows, colour of walls are only some examples of elaborated planning. The former examples are mainly risks within the control of the parties, but construction risks can also be beyond their control. Examples might be the price of material, ground conditions and collective strikes that affects outcome of a project. The help of knowledge and experience might in some cases reduce risks, but some risks cannot be eliminated. They can, however, ex ante be allocated between concerned parties. It is important to point out that risk allocation is not the same as risk reducing. It is more a way of letting the most suitable party bear the risk. (Cooter and Ulen, 1997) In most cases the risk can be allocated in four different ways:

1. The risk is born by the purchaser.
2. The risk is divided between the parties.
3. The risk is born by the construction company.
4. The parties can conclude an insurance contract.¹⁴

A lot of strategies and models about risk conducting have been developed in the field of economics. Many are contradictory and no one has so far been able to fully cover this complex area. Economic literature has discussed criteria for an optimal risk bearer. One criterion is that the party, who has the best possibility to anticipate the risk and minimise the damage if it is realised, should also bear the risk. Another criterion is that the risk shall not be assigned to a party that does not have the practical or financial ability to bear it. A third criteria is that the chosen way of managing the risk shall create incentive for monitoring. Both parties shall have incentives to minimise the loss if a risk is being realised even if the whole

¹⁴ This thesis does not deal with insurance although it is rather common to insure for some potential risks in a construction project. The aim is to examine how parties can allocate risks within an ordinary contract and not by shifting the risk to a third party. It might, however, also be hard to insure against all possible contingencies because the difficulty of monitoring the parties.
risk is assigned to one party. A choice of contract form is also a decision for how the risk will be handled. The following sections describe some examples of risk and how economic theory handles them.

### 3.2 Contract Forms in Construction Sector and the Financial Risk

A contract is a binding agreement between two or more parties. It shall specify actions that the considered persons are supposed to undertake and the conditions that will be valid during the contract period. Construction contracts usually comprise actions about date of completion, payment, type of installations and performance of service. The condition is for instance management of uncertain contingencies, warranty time et cetera.

In theory a contract can be complete. This means that all possible contingencies that can affect the parties will be included in the contract. In practice most of the contracts are incomplete, which means that not all possible conditions and actions are specified. The incompleteness can be either intentional or unintentional. An unintentional incompleteness might be due to the fact that the parties forgot to deal with a certain condition for an action or that they specified the contract too vaguely. This makes it impossible for the parties to reinterpret the contract after the unspecified event has occurred. Intentional incompleteness occurs when one party in the contractual relation is aware of the incomplete fact. It is possible that a party deliberately left out important contingencies in order to get an advantage in the contractual relationship. (Kaplow and Shavell, 1999)

The reason for trading is usually to raise the utility for the involved parties. These thoughts also yield for contracts, because they are means of exchange. Consequently the reason of a contract is to raise the expected utility of the parties involved. If a contract is impossible to modify in a manner that raise the expected utility for both of the parties, it is said to be Pareto efficient. It is important that contracts are enforced, otherwise the parties can gain by cheating on each other and thereby not result in a Pareto efficient position. It will also be hard to make future plans if there is a risk that someone might breach the contract. A tribunal therefore enforces most contracts. That can for instance be a state-authorised court, but it might also be an arbitrator. It is especially important that contracts about financial issues are enforced. Otherwise it would be rather difficult to run virtually any kind of lending operations if a borrower can refrain from repaying a loan without any kind of punishment. It is also necessary that contracts dealing with supply of customised or specialised goods and/or service...
are enforced. This is because no customised goods would be distributed otherwise. The simple
explanation is that a buyer will not pay the manufacturer in advance because he can simply
walk away after receiving the money. A manufacturer will not produce a single specialised
good to a customer who, after completion, can refuse to buy the good at the agreed price. The
nature of a specialised good makes it impossible for the manufacturer to sell it to other
customers and he has to agree on a price decided by the buyer. This is called hold up problem
and will be discussed further in section 3.3. (Kaplow and Shavell, 1999)

Financial risk is mostly associated with uncertainty of payments. The danger of not getting
paid is the most important issue to settle in a contractual relation for the constructor. A
contractor allocates resources to the project with the highest alternative use. All tender offers
must therefore be weighed against the returns from the production factors in another project.
If he finds a new project with a higher return during a construction in progress it is very
tempting to breach the old contract and sign a new. This is, however, rather difficult because
contracts usually control this kind of behaviour and often only permits efficient breach.

There are a lot of possible contract forms in the construction sector. They span from one
extreme when the contractor works on cost plus pricing to the other with a lump sum payment
when the performance is done. The main differences between the two extremes devolves upon
which party who has to bear the risk and the incentives the contract gives the contractor to
provide an efficient service to the client. There are mainly five different contract forms and
they are briefly discussed below.

3.2.1 Cost Plus Contracts

This type is usually called cost reimbursement contracts or prime cost contracts. Cost plus
contracts can be divided into three sub groups. The first is the so-called cost plus percentage
contracts. This means exactly what the name says, that the constructor’s costs will be covered
and he will be paid a certain agreed upon percentage of the actual or allowable cost to cover
overheads, profit, et cetera. The contract form is sometimes used when projects need to be
started quickly and there is no time for detailed schemes. All the time the principal gain in the
beginning can, though, be lost during the project. This is because a contractor might increase

15 The part 4.2.1 to 4.2.5 builds mainly on Seeley, pp. 11-13.
his profit by delaying the project or at least keep the workers occupied until another project emerge. There are no incentives for the constructor to work quickly and to minimise cost.

The second form is called \textit{cost plus fixed fee contracts}. This means that the contractor will have his costs covered and when the project is finished he will get a lump sum payment. The amount is usually decided before the start of the project. This contract is very similar to the first, but gives a somewhat better incentive to finish projects so the payment can be collected and the work force can be used in other projects.

The last form is \textit{cost plus fluctuating fee contracts}. The building company will have their actual costs covered and get a fee after completion of the contract. This fee is based on some form of a sliding scale so the more costs the constructor saves the greater will the lump sum value be. An incentive to finish as quickly and cheap as possible is created for the contractor. Usually, this is the best form of cost plus pricing contracts, but it requires that the principal can monitor the quality of the work.

\subsection*{3.2.2 Target Cost Contracts}

This type of contracts is constructed to give the building firm incentive to work efficient and cheap. A basic fee is generally quoted as a percentage of an agreed target estimate often obtained from a priced bill of quantities. Adjustments of the target are sometimes possible for cost of labour, materials et cetera. The actual amount paid to the contractor is obtained by increasing or reducing the basic fee by an agreed percentage of the saving or excess between the actual cost and the adjusted target estimate. If the project is completed quickly a bonus can be the reward for the contractor, but if the project is delaying a penalty may be the cost for the constructor. The main problem of this contracting form is to set an accurate target.

To illustrate target contracts, assume the contractors share is a constant of 20 per cent and actual audited costs turn out to be SEK1 million less than the target cost. SEK200,000 is then added to the contractor’s target profit, the remaining SEK800,000 reverting to the government. Conversely, if actual costs prove to be higher than the target cost, the contractor’s profit is reduced by 20 per cent of the excess, the government reimbursing the balance. (Scherer, 1964)
3.2.3 Measure and Value Contracts

Measure and value contracts include those based on schedules rates, approximate quantities and bill of quantities. An advantage of this form is that it is easy to financially control because of the precontractual agreed rates. The risk of making a profit or loss is borne by the contractor.

3.2.4 Contracts Based on Drawings and Specification

Contracts based on drawings and specifications are used when the works are uncertain in character and extent. The principal pays a fixed sum for the works, regardless of the actual cost. By entering into a fixed price contract the employer hopes to place all the risk on the constructor. The contractor has then the responsibility to cover any additional costs, which could not be foreseen before the works were commenced.

3.2.5 Package Deal Contracts

Package deal contracts contain both the responsibilities for design and construction. This contract form has led to deeper integration between architects and construction companies. The work for principals is easier when they only need to make one contract and one purchase. It is though important to keep in mind that the less developed the design is, the less detailed the specification and hence the less precise must the calculation of the price be.

3.2.6 Comparison Between the Contracts in Construction Sector

As earlier mentioned the main difference between construction contracts is the way they handle financial risks. The risk of bearing cost increases can be pictured by a line with the Cost Plus Contracts at one extreme where the government bears all extra costs and Package Deal Contract on the other extreme where the architect and constructor together bear the risk of the whole project. Contracts Based on Drawings and Specification, where a lump sum is paid, places all financial risks on the contractor, but only for building mistakes. (Rosen, 1995)

**Figure 3.1 Financial Risk-Bearer in Building Contracts**

![Financial Risk-Bearer in Building Contracts Diagram]
3.3 Ground Condition Risk

Misperception about the fundamental condition of the building site is a common source of production disturbance and cost increases. Construction disturbances connected to the physical field of work are often discovered after the work has been initiated. The reasons can be a very large rock or findings from an ancient habitation. Even a very close examination of the ground conditions cannot guarantee full information about the construction place.

It is common that the client cover the expenses of a ground condition examination and provides all interested contractors with this information. Problems arise when the information about the conditions is not in accordance with reality. The contractor has made his tender and written a contract on the basis of the provided information. Corrections for the new situation will naturally call for extra payment. On the contrary, if the client provides no information, all contractors need to seek for the information by them selves. The whole situation can be handled in four different ways. The first is to let the principal bear the whole ground condition risk. It will force him to do a thorough ground condition survey just to diminish the risk of future extra costs. In a lot of situations the examinations will be very costly and not give all relevant information. It might therefore be possible that through this way of managing risks the principal will invest too much in ground research, which is not optimal. A second way of handling risk is to let the bidding firms do a ground condition examination. It will naturally lead all firms to do investigations on their own and the risk of having to pay extra during the construction phase will lead them to do a close investigation. This might not be optimal because too many are doing the same research at a too high cost. A third way of handling the risk is to let both parties share the same proportion of the risk. The principal has then no incentive of doing an investigation because he has to bear half of the cost anyway. All constructors will at least examine the ground carefully enough to see that they will make a profit from the construction. The fourth way of managing the risk is to put up standards for ground condition examination. A principal might for example be obligated to present a soil report according to some standards and if this is done correctly the constructor will bear the whole risk. Provided that the standards are set to an optimal level the ground condition risk will also be handled optimally.

3.4 Legal and Procedural Risk

Most contracts are incomplete in the way that they remain silent about a risk, the contract has then in other words a “gap”. Gaps may be unintentional if the parties plainly forgot to write
the clause or deliberately try to create an advantage in the relation. Deliberate gaps may have a rational nature if the cost of allocating risk is too high. Negotiating the allocation of risk imposes transaction costs with certainty when the contract is made. Leaving a gap in the contract will require the parties to allocate a loss if it materialises. In other words there is a trade-off between allocating ex ante risks and allocating ex post losses. (Cooter and Ulen, 1997)

**Equation 3.1 Minimising Transaction Costs of Contracts**

\[
\text{Cost of allocating a risk} > \text{cost of allocating a loss} \times \text{probability of a loss} \quad \Rightarrow \quad \text{leave gap}
\]

\[
\text{Cost of allocating a risk} < \text{cost of allocating a loss} \times \text{probability of a loss} \quad \Rightarrow \quad \text{fill gap}
\]

*Source: Cooter and Ulen, p.181.*

The legal risk arises from the fact that the parties are uncertain about how a court or arbitrator will interpret the law and the contract when there is a difference of opinion about how the contract will be interpreted. As earlier mentioned hardly any contracts can be fully specified and even if they are, there might still be alternative ways of interpreting the contract. In the construction sector there is a fear of file for a lawsuits because of the uncertain outcome. The contractor fears the risk of losing money and the principal is afraid that the construction will not be ready in time if they go to a tribunal. (Samuelsson, 1998)

A procedural risk is grounded in the parties’ unwillingness to use legal methods as a mean of solving disputes. Even if a contract is set up with the best intentions, the realisation often mean a balancing between completing the contract in time and making a profit. Arbitration can violate both parties’ goals and therefore it occurs rarely. It was earlier pointed out that virtually all contracts are incomplete to their nature. In a contractual relation wealth maximising parties might therefore take advantage of the incompleteness by renegotiating on the terms. Transactors usually have the ability and also the incentive to renege on the transaction by holding up the other party. This will yield an advantage of unspecified or unenforceable elements of the contractual relation. (Klein, 1980) The fear of arbitration and the high specificity a building contract creates, will alter the risk of opportunistic behaviour in a pronouncing way.

There are mainly four different kinds of specificity:

1. Site Specificity
2. Physical Asset Specificity
3. Human Asset Specificity
4. Dedicated Asset Specificity
The first kind of specificity concerns the location of the asset. One example can be a steel company that locates its plant near a mine to cut down on transportation costs. When the plant is built the steel company will be very much dependent on how the mine sets the price. The second form of specificity concerns physical assets that have been made to fit certain activities. It can for instance be a specialised tool in the production industry. The third type of specificity is called human asset specificity and it concerns special qualifications or skills a person may posses. The last form is dedicated asset specificity and that is usually when a general asset has been dedicated to a specific purpose. (Williamson, 1975)

The consequence when a building contract creates a contract specific asset is the risk of getting restrained. Even if there are a lot of potential contractors in the auction phase, the winner of the contract will get a cost advantage when he has started with the project. That is because if the principal wants to replace him with another contractor it might take some time and extra cost. The opposite yields also for the contractor. If a contract is terminated he cannot just walk away without any efficiency losses. When the contract specific assets reach a certain level it is simply rational to continue the contractual relation despite the fact that the contractor does not fulfil the principals expectations. This might also be an explanation to why cancellation of contracts is so uncommon in the building sector. (Samuelsson, 1998)

Problems of hold-up can be solved in a contractual relation if the magnitude of the potential hold-up can be anticipated. The party with a risk of being cheated on can merely decrease the initial price he will pay by the amount he expects to be cheated on. If for instance an employer knows that an employee will cheat a certain amount each period, it will be reflected in the employee’s wage. A secretary, for example, may miss work one day a week on average. If secretary time is highly substitutable, the employer can cut the secretary’s weekly wage 20 per cent, hire 20 per cent more secretaries, and be indifferent. The secretary, on the other hand, presumably values the leisure more than the additional income and therefore is better off. (Klein, 1980) These thoughts can probably be applied in the building industry if the public purchaser by experience knows that the price usually ends up a bit higher than originally agreed. If the purchaser for instance expect a cost increase of 10 per cent after a contract conclusion and his lowest tender is SEK100 million. He can then accept the lower offer only if he originally has calculated on a cost of SEK110 million.
3.5 Designing and Construction Risk

A very well documented source of construction disturbance is defective documents. Correction of the documents will often lead the purchaser to make continuous adjustments. The financial risk of the client will then increase to the same extent as the corrections. Designing and construction risk appears when drawings and basic documents are unprecise. According to an American survey more than 60 per cent of all conflicts in the construction sector were due to faulty drawings. (Kellog, 1993)

The problems might be due to incomplete documents, misinterpretation of the assignment of responsibilities, vague specification of requirements and changes during the construction phase. These risks will increase whenever a construction work is initiated before the architects and technicians have had an opportunity to analyse the client’s need. In some cases the principal lacks the ability to interpret essential information and therefore makes wrong specifications. This kind of dilemma is also a contracting problem and the contractor might find “gaps” in the contract where it is possible to charge extra money. To correct these contracting mistakes might be very expensive. A profit maximising contractor might deliberately leave some gaps in order to recoup some of the expected losses from the bidding phase. In the bilateral relation between contractor and building-principal it is easy to charge a price above competitive level for the extra service needed to fill the gap. The principal cannot monitor the needed work and it is difficult to hire a new contractor to do the work.

Concerning the designing risk it is hard to find another risk bearer than the responsible principal. He is often the only party who knows what needs his organisation has and how to specify them for an architect. Hopefully the principal also has the financial ability to bear some extra cost. It is important though that the designer works in direction to minimise the risk. One way of doing this is to make him responsible for that his blueprint is in accordance with standards and building norms for the appropriate purpose.

Increased building costs due to unexpected price increases of labour or material is a common source to a higher final cost. According to the former argumentation about an optimal risk bearer the constructor should bear this risk. He should probably have the best possibility to anticipate the risk and include it in the price when he is giving his tender.
4 The Model

This chapter tries to show how the contractor can maximise profit and the purchaser can minimise outlays given different contracts, uncertain actual cost and default rules. First there is a discussion about the contractor’s role and thereafter the role of the governmental purchaser will be treated. Both actors’ interactions will be illustrated later on. The chapter ends with an example on how risk averse behaviour might influence the outcome.

4.1 The Model in General

A building process starts when the government decides to build a new construction. The next step is to find an architect that can supply a suitable design. By using the drawings of the building and other relevant factors interested building companies are supposed to send in tenders for the project. The criterion for choosing a constructor is usually that there is a good quality to a low price. Most common way of doing this is by a kind of bidding process, often by sealed tender.

I use a model that is based on two parties, namely, the private building firm and the government. The latter is usually represented by a bureaucrat, whom I assume, acts to minimise the governmental outlays. The building entrepreneur tries to maximise his own profit. It is an interesting relation because additional outlays of the government are, often, also partly an increased profit for the constructor. In an attempt to simplify my model I assume that the government already has chosen a construction company to contract with and now has to write a contract. In the beginning I assume risk neutrality from both parties, but in the last part I will drop this restriction.

Figure 4.1 Financial Risk in Building Contracts

I have earlier mentioned that I will not discuss the design phase in this analyse, I will therefore exclude Package Deal Contracts, which is a cooperation between the architect and the constructor. That leaves two extremes to analyse. It is on one side the cost plus pricing contracts and on the other side the fixed price contracts. To fill the gap between the two
extremes, the so-called incentive contracts have been devised and are represented by the
target cost contracts.

4.2 Contractor’s Profit

The contractors profit \[ \Pi_C \] from incentive contracts can be formulated algebraically, where
\[ \Pi_T \] is the negotiated target profit amount, \[ \alpha \] the contractor’s constant sharing proportion,
\[ C_T \] the negotiated target cost and \[ C_A \] the actual cost charged to the contract. (Scherer, 1964)

**Equation 4.1 Contractor’s Profit**

\[ \Pi_C = \Pi_T + \alpha(C_T - C_A) \]

*Source: Scherer, p. 258.*

The difference between a cost plus pricing contract and a fixed price contract lies in the value
of the contractors sharing proportion \[ \alpha \]. With a cost plus pricing contract \[ \alpha = 0 \] and only the
fixed fee \[ \Pi_T \] can be achieved. In a lump sum agreement the sharing proportion is \[ \alpha = 1.0 \]
and with a target contract \[ \alpha \] takes a value between 0 and 1.0. \[ C_T \] is set by negotiation before
any work is done and the value ex ante is also the same as ex post value. Depending on
anticipated competition the value may be set tight or loose. The ex post value of \[ C_A \] depends
on the decision the contractor makes as to how vigorously and how far to extend its cost
reduction effort. The outcome of various initially uncertain contingencies also affect actual
costs. In this model the contractor is supposed to deal with uncertainty through decisions
based on expected value.

To illustrate the equation, assume the contractor’s target profit \[ \Pi_T \] is set to SEK2 million
and the target cost \[ C_T \] is set to SEK10 million. The actual audited costs \[ C_A \] turn out to be
SEK9 million and that is SEK1 million less than the target cost.

**Equation 4.2 Numerical Example of Contractors Profit**

\[ \Pi_C = \Pi_T + \alpha(C_T - C_A) = 2 + \alpha(10 - 9) \]

Depending on the contractors sharing proportion \[ \alpha \] the profit will differ, considering other
things being equal. If for instance the contractor signed a fixed price contract \[ \alpha = 1 \] his profit
will be SEK3 million and if he instead signed a cost plus contract \[ \alpha = 0 \] his profit will only be
SEK2 million. In the last case the government saves SEK1 million on the contract. The target
contracts stretches in the area between the two extremes \[ 0 < \alpha < 1 \] and also the profit from it.
Constructing Costs

A target contract with the contractor’s sharing proportion set to 20 per cent ($\alpha=0.2$) will in the example yield a profit of SEK2.2 million. SEK200,000 is added to the contractor’s target profit and the remaining SEK800,000 reverting to the government. Conversely, if actual costs prove to be higher than the target cost, the contractor’s profit is reduced by 20 per cent of the excess, the government reimbursing the balance. In a fixed price contract the contractor must bear the whole excess over the estimated target. The opposite yields for a cost plus contract where the contractor has no responsibility for cost increases.

Differentiating with respect to $[\alpha]$ gives the point where the contractor is indifferent whether to opt for a fixed price contract or a cost plus pricing contract. Naturally this point is found where the target cost $[C_T]$ is equal to the actual cost $[C_A]$.

**Equation 4.3 Differentiating Contractor’s Profit with Respect to $[\alpha]$**

$$\frac{d(\Pi C)}{d\alpha} = C_T - C_A = 0$$

This tells that a risk neutral contractor that expects costs to overrun will try to make a cost plus contract and that a contractor expecting an actual cost below the target cost gladly signs a fixed price contract.

The government has already before the start of the project estimated the social benefit of the building, which is dependent on different quality variables $[Q]$. The service a building can create is very much dependent on the quality $[Q]$ of the building project. Real quality depends on if the governmental purchaser is able to communicate all quality variables to the contractor. If the constructor builds exactly according to the purchaser’s intention the social utility will not be affected by the quality. It is when the building company lowers the quality from the originally planned that the social benefit of the project will be lower. In the model it is only possible to lower the quality of the parts that the contract has left unspecified. By specifying the contract fully, the social benefit the government intended is reached without any changes in costs. The model assumes that the government builds according to the ex ante estimated quality and thereby will compensate for gaps $[1-Q]$ in the contract. It is also assumed that a contractor’s bargaining position will differ depending on what contract the parties originally concluded.
Equation 4.4 The Contractor’s Profit Depending on Gaps in the Contract
\[ \Pi_C = \Pi_T + \alpha(1-Q)C_A + \alpha(C_T-C_A) \]

Using the old earlier considering that the contract is specified to 90 per cent \([Q=0.9]\). The cost plus pricing contract will give the lowest profit of SEK2 million while the fixed price contract will give the highest profit. Even here the target contract with a sharing proportion of 20 per cent \([\alpha=0.2]\) places it self in a middle position generating a profit of 2.38.

Equation 4.5 Numerical Example of Profit Depending on Gaps in the Contract
\[ \Pi_C = \Pi_T + \alpha(1-Q)C_A + \alpha(C_T-C_A) = 2 + \alpha(1-0.9)9 + \alpha(10-9) \]

The first derivative of the model shows that when the contract is fully specified and target cost is equal to actual cost the contractor is indifferent which contract to choose. If the actual cost is higher than the target cost the contractor must find a gap in the contract to make a cost plus contract and a fixed price contract equal. Otherwise the contractor will prefer a cost plus pricing contract.

Equation 4.6 Differentiating Contractor’s Profit given gaps with Respect to \([\alpha]\)
\[ \frac{d(\Pi_C)}{d\alpha} = C_A - QC_A + C_T - C_A = 0 \]
\[ C_T = QC_A \]

Given all possible contracts except the cost plus contract the contractor will maximise his profit when either he has no actual cost or the contract is totally unspecified. This is of course impossible in reality, but a reasonable assumption may be that the contractor at least strive to lower actual costs and find gaps in the contract.

Equation 4.7 Differentiating Contractor’s Profit given gaps with Respect to \([Q]\)
\[ \frac{d(\Pi_C)}{dQ} = -QC_A = 0 \]

4.3 Government’s Outlay

The government’s contract outlays are defined as the estimated target cost \([C_T]\) plus the target profit \([\Pi_T]\) paid to the contractor. Depending on what contract the parties have concluded the outlay would differ. In a cost plus pricing relation \([\alpha=0]\) the government has to cover all cost
overruns \([C_T-C_A]\), but in a fixed price contract \([\alpha=1]\) the government only has to pay what the parties originally concluded.

**Equation 4.8 Governmental Outlays Considering Different Contracts**

\[
G = C_T + \Pi_T + \alpha(C_T-C_A)-(C_T-C_A)
\]

To illustrate the equation, the same assumption as in the section about the contractor’s profit will apply, which means that the target profit is set to SEK2 million and the target cost is set to SEK10 million. The actual audited costs turn out to be SEK9 million. Also the same assumption about the contractors sharing proportion is made. In a fixed price contract, governmental outlays will be SEK12 million and in a cost plus pricing contract the outlays will be SEK11 million. Considering the target cost contract with a sharing proportion on 20 per cent the outlays will be SEK11.2 million.

**Equation 4.9 Example of Governmental Outlays Considering Different Contracts**

\[
G = C_T + \Pi_T + \alpha(C_T-C_A)-(C_T-C_A)=10+2+\alpha(10-9)-(10-9)
\]

From the simple example above it is easy to see that the government prefers a cost plus contract when they expect the actual cost to be lower than the target cost. This is also what a differentiating with respect to \([\alpha]\) shows.

**Equation 4.10 Differentiating Governmental Outlays with Respect to \([\alpha]\)**

\[
\frac{d(G)}{d\alpha} = C_T-C_A=0
\]

Equation 4.10 gives the point where the government is indifferent whether to opt for a fixed price contract or a cost plus pricing contract. This point is found where the target cost \([C_T]\) is equal to the actual cost \([C_A]\).

Leaving gaps in the contract might, as mentioned earlier lower the quality of the construction. This model assumes that the government wants the construction as originally planned. An adjustment for lower quality is of course also associated with a higher cost for the government. The extent of costs is linked to what contract the parties have. If they concluded a cost plus contract the profit for the contractor is usually decided ex ante as a lump sum and the government covers all costs. This leaves very little scope for bargaining. In an ordinary
lump sum agreement the contractor has a much stronger bargaining position because his contract stipulates all the work. The contractor has no obligation to do work that is not stipulated in the contract and can therefore extract a higher profit share on extra work due to his bargaining position.

**Equation 4.11 Governmental Outlays Depending on Gaps in the Contract**

\[ G = C_T + \Pi_T + \alpha(1-Q)C_A + \alpha(C_T-C_A) - (C_T-C_A) \]

### 4.4 The Interaction Between Government and Contractor

As described earlier, the contractor’s and the governmental official’s relationship has some remarkable features. The first thing worth mentioning is that all extra profit a contractor earns is an extra cost for the government. A second observation is that usually only the contractor can gain on unspecified issues in the contract. Thirdly, the government has an advantage in choosing contract as a monopsonistic buyer.

The presentation of this model has contained a lot of numerical examples. It is sometimes difficult to picture a clear image of how the model works. Therefore a summary of all examples is presented in table 4.1. The summary also contains new data. It is the two last rows that demonstrates how an actual cost overrun by SEK2 million affects the profit for the contractor and the government’s outlay.

**Table 4.1 Summary of the Examples given in Chapter 4**

<table>
<thead>
<tr>
<th>Equation</th>
<th>Contractor’s Profit</th>
<th>Government’s Outlay</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Pi_C = \Pi_T + \alpha(1-Q)C_A + \alpha(C_T-C_A) )</td>
<td>( G = C_T + \Pi_T + \alpha(1-Q)C_A + \alpha(C_T-C_A) - (C_T-C_A) )</td>
<td></td>
</tr>
</tbody>
</table>

| Example formula | \( \Pi_C = 2 + \alpha(1-Q)9 + \alpha(10-9) \) | \( G = 10 + 2 + \alpha(10-9) - (10-9) \) |

<table>
<thead>
<tr>
<th>Contract form</th>
<th>Cost Plus ( \alpha=0 )</th>
<th>Target ( \alpha=0.2 )</th>
<th>Fixed price ( \alpha=1 )</th>
<th>Cost Plus ( \alpha=0 )</th>
<th>Target ( \alpha=0.2 )</th>
<th>Fixed price ( \alpha=1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha ) changes</td>
<td>( \Pi_C = 2 )</td>
<td>( \Pi_C = 2.2 )</td>
<td>( \Pi_C = 3 )</td>
<td>( G = 11 )</td>
<td>( G = 11.2 )</td>
<td>( G = 12 )</td>
</tr>
<tr>
<td>( \alpha ) changes ( Q=1 )</td>
<td>( \Pi_C = 2.38 )</td>
<td>( \Pi_C = 3.9 )</td>
<td></td>
<td>( G = 11 )</td>
<td>( G = 11.38 )</td>
<td>( G = 12.9 )</td>
</tr>
<tr>
<td>( \alpha ) changes ( Q=0.9 )</td>
<td>( \Pi_C = 1.6 )</td>
<td>( \Pi_C = 0 )</td>
<td></td>
<td>( G = 14 )</td>
<td>( G = 11.38 )</td>
<td>( G = 12 )</td>
</tr>
<tr>
<td>( \alpha ) changes ( \alpha ) changes ( Q=1 ) and ( C_A=12 )</td>
<td>( \Pi_C = 1.84 )</td>
<td>( \Pi_C = 1.2 )</td>
<td></td>
<td>( G = 14 )</td>
<td>( G = 13.84 )</td>
<td>( G = 13.2 )</td>
</tr>
<tr>
<td>( \alpha ) changes ( Q=0.9 ) and ( C_A=12 )</td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
The decision of contract form is made on basis of the parties’ expectations of the actual cost \([C_A]\). If both parties expect the actual cost to be higher than the target cost \([C_T]\) the contractor will try to get a cost plus contract and the government a fixed price contract. The opposite condition yields if both parties anticipate the target cost to be higher than the actual cost. Their contracting opportunities can be pictured in a graph where the 45-degree line represents points where both are indifferent about contract form.

**Figure 4.2 Both Parties Optimal Contract**

![Graph showing the optimal contract choices based on expected cost](image)

The contracting phase must be made on expectations of the other party’s behaviour. It is difficult to predict the actual cost in reality because it is dependent on a variety of variables such as price for material, labour et cetera. An earlier discussion mentioned the degree of gaps in the contract as an additional uncertainty. It is very hard for a contractor to anticipate the degree of specification the contract will contain, at least in reality. By experience he can learn about frequently recurring gaps in a contract, but this will of course differ depending on the experience of the governmental principal. In the model the contractor is supposed to choose the optimal contract depending on expected actual cost and possible opportunistic opportunities or gaps in the contract.

**Figure 4.3 Both Parties Optimal Contract Considering Gap**

![Graph showing the optimal contract choices considering gap](image)
4.5 The Impact of Risk Aversion in the Model

In a bilateral relation one of the two is usually more risk averse than the other. It is commonly the financially weaker part that takes a more risk averse attitude. It may not be a very venturesome statement to assume that in the building industry the contractor is the more risk averse part when contracting with the government. In small projects it might be hard to spot the risk averseness, but in contracts with a high target cost the construction company will be afraid of doing mistakes.

Figure 4.4 Both Parties Optimal Contract Considering Gap and Risk Preferences

Figure 4.4 probably shows a more realistic curve than earlier presented, where the contractor’s fear of actual cost overrun gives the governmental principal a statistically slight advantage in choosing contract form provided that he makes correct estimates.

Equation 4.12 Contractors Expected Profit with Respect to Risk Averse Behaviour

\[ \Pi_C = \Pi_T + \alpha (C_T - C_A)^X \]

The risk assumption may be introduced during the contracting phase, but should not have any impact after concluding a contract. Figure 4.4 may give a hint that a variable indicating risks should be an exponent and possibly an exponent on actual cost for the contractor \([C_A^X]\). The exponent should be a value higher than one \([X>1]\), but should probably not be higher than two if the contractor is assumed to be risk averse.\(^{16}\) An exponent with the value one \([X=1]\) indicates a risk neutral contractor, while an exponent below one \([X<1]\) indicates a risk loving behaviour.

\(^{16}\) Using \([C_A^{1.1}]\) in the contractors expected profit function is one example of handling the risk assumption.
5 Conclusions

This chapter summarises important arguments from this paper. The problems that were presented in the first chapter will here be discussed to see whether they can be solved through the arguments found in the paper.

5.1 Concluding Remarks

The aim of this paper has been to answer why construction projects often end up more expensive for the buyer than contracted. This paper has shown that a construction project is associated with a lot of potential risks. The involved parties seem though to have a slight tendency to misevaluate the risk in a more positive way than it is in reality. It is therefore not surprising when the cost increases during a project. Contracts can transform most of the extra costs from the buyer to the constructor or the other way around. The paper shows which incentives different contracts can impose on the involved parties. A fixed price contract will, for example, give better incentives to the contractor to lower costs than a cost plus contract. This is an obvious conclusion because the saved costs in a fixed price contract will directly result in a higher profit for the contractor. In a cost plus contract the incentives to save costs are weaker because the contractor will get his agreed profit anyway.

Even a fixed price contract cannot fully protect the buyer from unexpected cost increases during the construction phase. It is common that these kinds of contracts also end up more costly for the buyer than originally agreed. Contract specification and gaps can explain the origin of the situation whole situation. It is possible to spot two different situations that can increase the costs for the buyer. The first situation is when something unexpected occurs that forces costs to increase for the project as a whole and the risk is already allocated in advance. If the contract specifies that the buyer should bear the current risk it will not cause any procedural problems and the project will end up more expensive for the buyer. The second situation arises when a risk is realised and the contract has not specified how to deal with it. Now bargaining power and expectations on the other parts behaviour is important. A building construction creates a very specific negotiation position between the involved parties. In the beginning of a project there are many potential constructors that competes about the construction contract. The buyer has a very strong bargaining position, but when a contract is written between a contractor and buyer the whole situation transforms into a bilateral
The constructor’s situation is strengthened even more after project initiation. Conflicts between both parties can result in delays for the project and in worst case a change of constructor. Depending on how the parties interpret the situation about unspecified risks, they will form a bargaining strategy. An experienced buyer that knows the potential risk of renegotiations can also keep an extra buffer in the budget for unexpected costs after contract formation.

An important guideline has also been to analyse what kind of incentive different risk assignments will yield. The party that has the best possibility to anticipate the risk and minimise damage, if a risk is realised, is the best bearer. It has been important to create incentives for both parties to minimise losses if a risk is realised. In this paper different risky situations has been described and analysed.

Concerning the ground condition risk this paper argues that the principal should be responsible for a basic soil report that fulfils a certain level of standard. If this is done he will escape liability when problems arise after initiation of the construction. A standard that is set to an efficient level will also result in an optimal outcome.

A principal is often the only person that knows what needs his organisation has and how to specify them for an architect, therefore he seems to be the best bearer of the design risk. It is though important that the designer works with a focus on minimising the risk. One way of doing this is to make him responsible for that his blueprint is in accordance with standards and building norms and appropriate for the purpose of the construction.

Increased building costs due to unexpected price increases of labour or material is a common source to a higher final cost. According to the former argumentation regarding an optimal risk bearer the constructor should bear this risk. He should probably have the best possibility to anticipate and control the risk and include it in the price when he gives the tender.

The legal and procedural risk can best be managed by a well-formulated contract that specifies what to do when a difference of opinion arises between the two parties. An arbitrator does not necessary have to be a court. For example, using the architect as an arbitrator

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17 This is called a fundamental transformation in the litterature by Williamson.
between the principal and constructor can sometimes best solve designing problems at a low cost.

Different types of contract will result in different risk bearing between the two parties. The model in this paper shows how it is possible to transform some of the risk between the parties. A fixed price contract without any gaps is probably the best way for the principal to keep control of cost increases. Unfortunately, in a real world almost all contracts suffer from gaps and this gives the contractor an opportunity to charge extra costs. An experienced purchaser can however, avoid the largest gaps. Therefore I believe that public purchasing by the government would be best handled by experts, specialised in buying constructions. My conviction after dealing with this subject is also that cost plus contracts should be used very rarely mainly because of the incentives it gives to save money for the contractor. It can, however, be hard to find constructors for high-risk projects without the use of such contracts.

5.2 Final Remarks

The aim of this paper has not only been to create a mere academic exercise, but also to help understanding and perhaps improve real-world situations. I do not think that the theories in this paper are isolated to analyses of the construction sector. I have noticed that the same types of problems may arise when a company orders a new computer system. Very often is the final price higher than originally agreed and the system is delivered late. The theories may probably, by some small adjustments, also be extended to cover private purchasing of construction projects. I believe that the results of this paper can be expanded by a survey of the total amount of money a public sector in a country loses due to cost increases after contract conclusion in building projects. That is, of course, a major task, but I think the result will astonish many decision-makers.

Law and Economics theory has proven to be a new powerful tool when analysing the building sector. I think the most important thing to remember from this paper is that price increases in public constructions are more than accounting figures on a balance sheet. It is also, among other things, incentives, mistakes and opportunistic behaviour. I believe this approach to the building sector needs much more research and attention. Hopefully will that occur in a near future.


**Literature**


