Aalto University
School of Business

Is more competition always desirable?
Evidence from public construction procurements in Finland

Finance

Master's thesis

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Abstract

RESEARCH PROBLEM

Researchers have found mixed evidence of how the level of competition affects bids in auctions. According to conventional economic theory, an increase in competition should make bids more competitive. However, the winner's curse phenomenon calls for less aggressive bids in common-value auctions. Bidders may become less aggressive also due to the entry effect, since an increase in the number of potential bidders decreases the likelihood of winning the contract, yet participation costs remain constant. Rational bidders should take this into account by bidding less aggressively. Which of the effect dominates differs between different types of auctions.

DATA AND METHODOLOGY

In this thesis, was empirically studied using Finnish data, how the level of competition affects bids in auctions for public construction projects. Moreover, the relation between bid prices and budget overruns was also studied. The data for studying the effect of competition on bid prices contained information of 496 auctions of various kinds of projects, whereas the data for studying budget overruns contained information of 183 auctions. The data was analyzed using statistical methods such as multivariate regression analysis. The competitiveness of bids was measured as the relation between the pre-bid cost estimation and the lowest bid. Budget overruns were measured as the difference between the final cost of the contract and the lowest bid relative to the lowest bid. If the final cost of the project was not available, the relative amount of change orders and extra works was used as a proxy for budget overruns.

FINDINGS

Per each additional bid received, the lowest bid decreases significantly when compared with the pre-bid cost estimation. However, the winner's curse and the entry effect significantly impact bids upward. Two solutions were provided: the release of information about the pre-bid cost estimation and the use of the second-price sealed-bid auction method. An economic downturn was found to be associated with the higher number of bids, lower bid volatility and more competitive bids. The timing of procurement is therefore important. Larger contracts were found to be associated with more accurate pre-bid cost estimations. The costs of small contracts are estimated roughly, but conservatively to avoid budget overruns. Bids were moreover found to be negatively correlated with budget overruns.

Keywords Common-Value Auction, Private-Value Auction, Affiliated-Value Auction, Winner's Curse, Entry effect, Budget Overrun, Public Procurement, Construction Project

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TUTKIMUSONGELMA
Tutkijat ovat löytäneet monenlaista todistusaineistoa kilpailun vaikutuksesta huutokaupoissa jätettyihin tarjouksiin. Perinteisen talousteorian mukaan kilpailun lisääntymisen tulisi tehdä tarjouksista kilpailukykyisempiä. Voittajan kirous -ilmiö sen sijaan kannustaa tarjoamaan vähemmän aggressiivisesti huutokaupoissa, joissa huutokaupattavan kohteen arvo sama kaikille ostajille, mutta osallistujat eivät tiedä kohteen arvoa. Tarjoajat voivat tulla vähemmän aggressiivisiksi myös, kun potentiaalisten tarjoajien määrä kasvaa. Tämä johtuu siitä, että tarjoajien määrän kasvu vähentää todennäköisyyttä voittaa kilpailu tarjouskustannusten pysyessä vakiona. Rationaalisesti käyttäytyvä tarjoaja ottaa tämän huomioon tarjoamalla vähemmän aggressiivisesti. Huutokaupat eroavat sen suhteen, kuinka voimakkaita edellä mainitut ilmiöt ovat.

AINEISTO JA MENETELMÄT
Tässä työssä tutkitaan empiirisesti, kuinka kilpailun taso vaikuttaa jätettyihin tarjouksiin huutokaupoissa, joiden kohteena ovat julkiset rakennushankkeet Suomessa. Tutkimuskohteena on myös tarjoushintojen ja budjetin ylitysten relaatio. Aineisto kilpailun vaikutuksesta tarjoushintoihin sisältää tiedot 496 huutokaupasta ja aineisto tarjoushintojen ja budjetin ylitysten tutkimiseksi tiedot 183 huutokaupasta. Aineiston analysointiin käytetään tilastotieteellisiä menetelmiä kuten monimuuttujaregressioanalyysia. Tarjousten kilpailukykyä mitataan vertaamalla alhaisinta tarjoushintaa urakasta tehtyyn kustannusarvioon. Budjetin ylitys määritetään urakan lopullisten kustannusten ja alhaisimman hinnan välisen erotuksen suhteena alhaisimpaan hintaan. Mikäli lopullista kustannusta ei ole saatavilla, käytetään budjetin ylityksen määrittämiseen lisä- ja muutostöiden määrää suhteessa alhaisimpaan tarjoushintaan.

TULOKSET
Tutkimuksen perusteella jokainen saatu lisätarjous laskee alinta tarjousta merkittävästi suhteessa urakan kustannusarvioon. Voittajan kirous ja potentiaalisten tarjoajien lisääntyminen nostaa kuitenkin tarjouksia merkittävästi. Ongelmaan esitetään kaksi ratkaisua: kustannusarvion ilmoittaminen tarjoajille etukäteen ja suljetun toisen hinnan huutokaupan käyttäminen. Talouden taantuman havaittiin olevan yhteydessä suurempaan määrään tarjouksia, matalampaan tarjoushajontaan sekä kilpailukykyisempiin tarjouksiin. Suurempien urakoiden kustannusarvioiden havaittiin olevan tarkempia kuin pienempien urakoiden. Pienempien urakoiden kustannukset arvioidaan karkeasti, mutta konservatiivisesti budjetin ylitysten välttämiseksi. Suhteellisten tarjousten havaittiin korreloivan negatiivisesti budjetin ylitysten kanssa.

Avainsanat Yhteisten arvostusten huutokauppa, Yksityisten arvostusten huutokauppa, Voittajan kirous, Budjetin ylitys, Julkinen rakennushanke

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1 INTRODUCTION

In Finland, public procurements accounted for about 15% of the gross domestic product; GDP, in 2014[1] and about one third of these procurements were construction projects.[2] Public construction procurements hence represented a major part of public spending, but at the same time were an important source of revenue and income to the companies and workers in the industry. Moreover, whenever there is a debate about public resuscitation to stimulate the economy, discussion often turns in to large infrastructure projects, which emphasizes the importance of public construction projects for the overall economy. Even though public construction projects have such a large impact on the economy and society, very little empirical research has been done regarding the topic in Finland. Most of the previous studies have concentrated mainly on the legislative aspects of public construction projects as well as the quantities of these projects, but not many if any studies have been made related to the nature of these projects. With this, I mean that no one has profoundly studied, how well public construction projects have stayed in the budget and schedule, how publicly funded projects have performed in comparison with privately funded projects, are there systematic patterns in terms of budget or schedule overruns, how bid prices have behaved during different economic times, what is the relationship between unexpectedly low bid prices and budget overruns, etc.

According to *Public Procurement Act*, public construction procurements have to be procured through competitive bidding, i.e. auctions, to ensure that tax payers' money is used efficiently. Researchers have however found miscellaneous evidence of how the number of bidders affects bids in auctions. According to conventional economic theory, competition should increase buying bids (decrease selling bids), since it is more difficult to win the competition when there are more bidders. See that I am referring to buying bids, when bidders are trying to buy something from an auctioning seller e.g. a piece of Picasso, and selling bids, when bidders are seeking to sell something to an auctioning buyer, say, a construction service. In a bidding contest, where continuous bids are allowed, a dominant strategy for a bidder is to keep bidding until the price reaches the bidder's opportunity cost. When the number of bidders' reaches infinity, the bid price should approach a perfectly competitive outcome. Afterwards in this study, I will call this phenomenon as the *competition effect*, the term I loosely borrowed from the study of Hong and Sum (2002). The competition effect seems plausible also in the light of empirical evidence (e.g.

[1] http://www.hankinnat.fi/en/Pages/default.aspx (31.1.2015) (Public Procurement Advisory Unit)
[2] http://www.hankintailmoitukset.fi/fi/docs/tilastot_2011 (HILMA - declaration system for public procurements)

Brannman et al. 1987; Giliberto and Varaiya 1989; Goeree and Offerman 2003; Paul and Carr 2005). However, it appears that competition leads to higher buying bids (lower selling bids) more likely in auctions, where each bidder knows how much he values the object, but his value is private information and unaffected by the information about other bidder's valuation i.e. *private-value auction* (see e.g. Hong and Sum 2002).

In auctions, where the value of the object is the same for all bidders, but bidders have different views of that value, i.e. *common-value auction*, the winner of the auction, might be the bidder with the most overly optimistic view and she is likely to end up paying too much for the object auctioned. This phenomenon was first called as the *winner's curse* by Capen et al. (1971), who claimed that oil companies had paid too much for the oil drilling rights in Outer Continental Shelf (OCS) oil lease auctions in the 1960s and 1970s.[3] However, in equilibrium rational bidders should take this into account by bidding less aggressively, which is in fact something that has been found in several studies since Capen et al. (see e.g. Kagel and Levin 1986, and Kagel et al. 1989). Hong and Shum (2002) studied a data set of construction procurement auctions run by the New Jersey Department of Transportation, NJDOT, in the years 1989-1997 and found that if the *winner's curse effect* is strong enough, it can outweigh the competition effect and prices could actually rise as the number of bidders increases. Thus competition might in some cases actually increase selling bids (decrease buying bids), which is the opposite of the common believe that competition is always good and desirable.

Most of the auctions are neither pure common-value nor pure private-value value auctions; instead, have elements from both of these extreme cases. Such auctions are generally called *affiliated-value auctions*. Construction project auctions are typically affiliated-value auctions; however some construction projects have more common value elements than others and vice versa. Participating in an auction incur real costs to a bidder. Li and Cheng (2006) argue that bidders may become less aggressive also in private-value auctions, when the number of potential bidders increases, due to the *entry effect*. This is because an increase in the number or bidders decreases the likelihood of winning the contract, but the participation cost, i.e. *entry cost*, remains the same. In equilibrium, rational bidders should take this into account by bidding less aggressively or by withdrawing from the competition. There are thus three simultaneous effects, all related to competition, affecting bids in auctions for construction projects. The competition effect affects bids downward, whereas the

[3] Since Capen et al. (1971) evidence of the winner's curse phenomenon have found e.g. Cassing and Douglas (1980), Lorenz and Dougherty (1983), Roll (1986)

winner's curse effect and the entry effect affect bids upward. Which of the effect dominates depends on the type of contract and the competitive environment.

In this thesis, I will study empirically whether the number of bidders affects the lowest bid in auctions for public construction projects in Finland. Moreover I will study whether this effect differs between different types of contracts. Hong and Shum (2002) have found evidence from the U.S. market that an increasing number of bidders affects the lowest bid upward in auctions for highway projects, but downward in auctions for bridge construction and repairing and paving contracts. These results suggest that the winner's curse effect and the entry effect are particularly strong in terms of general highway projects. According to Hong and Sum, public authorities should favor negotiations over auctions for works, where the winner's curse effect is particularly strong. In this thesis, I will widen the scope of Hong and Shum (2002) to include not only infrastructure projects, but also building construction.

I will also seek to find out, whether there are systematic patterns between budget overruns and certain types of projects. Furthermore, I will study if low bid prices, possibly caused by the winner's curse, are correlated with budget overruns. For example, if a contractor realizes that they have made a too generous bid due to the winner's curse, they may initiate a further *claim strategy* for seeking additional revenues through change orders and extra works. In turn, the contractor might has spotted inconsistencies in the tender documents, and decides to submit a very aggressive bid deliberately by simultaneously knowing that they can seek more profit afterwards through change orders and extra works. Also, if a contractor runs into financial problems due to a too low bid, it can afterwards lead to disputes, poor co-operation, delays, bad quality and so on. If the client is not able to negotiate proper contract terms that effectively transfer these costs to the contractor, the client may have to bear at least a share of them.

For the clarification, a budget overrun in this thesis is defined as the amount of final costs above the lowest bid relative to the lowest bid. Due to industrial reasons, the costs of construction are generally expected to be higher than the original contract price or the lowest bid.[4][5] This is true in almost all types of projects. Since cost overruns are expected, the term "budget overrun" does not accurately describe the matter being studied. The chosen proxy, however, captures the relative change in budget overruns very effectively. Since, I am interested in factors affecting budget

[4] It is more than a rule that changes will be made in original contract documents during the construction.
[5] The lowest bid does not always equal the original contract price due to contract negotiations

overruns not on absolute levels of budget overruns, the chosen variable suits well for the purpose. Similar approach was followed by Love et al. (2013) in their study.

1.1 Motivation and background

According to Organization for Economic Cooperation and Development, OECD, public procurements accounted for about 29% of total general government expenditures and 13% of the GDP in OECD member countries in 2011.[6] While these are astonishing figures, they were even higher for European Union, EU, countries. In 2011, total expenditure on works, goods and services in EU 27 countries was over €2,400 billion, accounting for approximately 19% of the GDP in the area.[7] Public procurements thus represented a large part of the total demand in EU countries and have certainly been one of the key economic drivers in the area in recent years. There is no reason to expect that the importance and magnitude of public procurements have dramatically changed since 2011.

In Finland, the annual value of public procurements was about €36 billion in 2011, see Table 1. In total, public procurements accounted for about 19.2% of the GDB in 2011, thus represented a considerable amount of the total demand. Moreover, the number and value of public procurements have been somewhat upward trending in past years.

Table 1

Public procurements in Finland

Year	2007	2008	2009	2010	2011
Number of contracts	2198	2746	2963	3193	3252
Total expenditure (billion €)	29.46	32.40	34.08	35.06	36.31
GDP (%)	16.4	17.5	19.8	19.6	19.2

The data is collected from the publication "Public Procurement Indicators 2011" published by the European Commission in 2012. About one third of the procurements are construction projects.

Although the value of public procurements has somewhat decreased since 2011, and accounts now about 15% of the GDP[8], it is obvious that public procurements still represent a major part of public spending and play an important role in the economy. Since public procurements are financed by tax

[6] http://www.oecd.org/corruption/ethics/integrityinpublicprocurement.htm
[7] Public Procurement Indicators 2011, published by the European Commission in 2012
[8] http://www.hankinnat.fi/en/Pages/default.aspx (31.1.2015) (Public Procurement Advisory Unit)

payers' money and have such a large impact on the economy, it is extremely important that procedures to allocate these procurements are as effective as possible. If the qualification criteria are set too high, it may restrict competition unnecessarily, which would be reflected in higher bids. In turn, if the qualification criteria are set too low, the entry cost and the winner's curse may cause bidders to bid less aggressively. In theory, there is an optimal level of competition for each project in a given competitive environment. In practice, it is not easy to reach the optimum. With more knowledge, it is though possible to get closer to the optimum. Even a slight improvement in auction arrangements for public construction procurements would be worth millions of euro.

Very often one hears that public construction projects are prone to budget overruns. Sweeney (2009) studied over 200 public construction projects in Australia and found a positive correlation between estimated costs and relative budget overruns. The average budget overrun for the projects of more than 100 million Australian dollars in value was as high as 20%, whilst for all projects 10.7%. In another Australian study called *"In pursuit of additional value. A benchmark study into alliancing in the Australian public sector."* performed by the Department of Treasury and Finance, Victoria, in 2009, the average budget overrun in traditional public construction projects was regarded to be something around 20%. In the light of these studies, the general belief that budget overruns are very common in public construction projects is not very surprising.

Risto Pennanen, a reporter in Taloussanomat, wrote about the issue in his column in 6/12/13.[9] Pennanen referred to quite recent budget overruns in Finland: Ring Rail Line from €300 million to €738 million, the House of Parlament from €100 million to €235 million and Western Metro from €450 million to €800 million. Pennanen rhetorically argued that public procurers should be put responsibly for bad purchasing. He moreover questioned the whole importance of competitive bidding in public procurements if the agreements never hold. Although Pennanen's argument may not hold if inspected more deeply, it reflects the opinion of the general public.

There are various reasons for budget overruns. One could also argue that many of these reasons are logical and perhaps even acceptable. For instance, public projects are often large and complex, as were those referred by the reporter Pennanen in Taloussanomat. The mere size and complexity of these projects make the estimation of the final costs very difficult. In many behavioral economics related studies, people are found to be inherently and massively overconfident and overoptimistic in various decision making situations. The following quote is from the paper of DeBondt and Thaler

[9] http://www.taloussanomat.fi/kolumnit/2013/06/12/holmoys-maksaa-julkisessa-rakentamisessa/20138292/145

(1995) *"Perhaps the most robust finding in the psychology of judgment is that people are overconfident."* Following the argument of DeBondt and Thaler, it is reasonable to assume that overconfidence and over optimism applies also to construction cost projections. This argument is furthermore supported by the findings of Sweeney (2009), mentioned earlier. Thus budget overruns might be due to human err of which we are all prone, not intentionally and deliberately made false forecasts motivated by dubious reasons. Moreover, a large size of a project creates room for continuing appeals performed by various external parties affected by the project. These appeals can delay the project significantly and increase the overall costs of the project. This type of cost is very difficult to model and to be included in initial cost projections. In addition, the production of a large project is frequently kicked off with unfinished drawings to speed up the schedule and it often follows that significant changes must be made in the plans and drawings during the construction, which can be very costly.

In addition to the aforementioned reasons, there are also more suspicious explanations for budget overruns. For example, a competing contractor might intentionally appeal for its competitor's project in order to deteriorate its rival's profits and reputation. In the worst case, the company hires a person or even a group of people to make continuing appeals purposely and professionally. Moreover, some public agents may have somewhat vague motives to deliberately underestimate construction costs in order to ensure the permission of starting the preparations of a certain project. It is also a well-justified question, whether public procurers have as high incentives to cooperate with the contractor as their private counterparts, since they are not using their own money. If problems arise, someone else pays the price. Moreover, since legislation, directives and norms that guide public procurements have various other objectives than just overall costs, the hands of the public officials working with projects are at times tied behind their back. For example, if a public official is found to be cutting corners, he might be prosecuted, even if he acted in noble reasons and his actions were in the interest of the tax payers and the general public. Thus officials might be unwilling to compromise even if it would be in everyone's interest. This kind of stiffness, inherent to public projects, can accelerate problems and cost overruns compared with privately funded projects.

Despite the various reasons for budget overruns, frequent and often large scale budget overruns ultimately raise concerns about an opportunistic behavior. It is possible that the market views complex projects associated with high uncertainty very lucrative in terms of further claims. Contractors may submit low bids in order to win the contract, but have a hidden agenda to adopt a

claim strategy after the agreement to increase profit, resulting in a high number of change orders and extra works. Dyer et al. (1989) studied experimentally in laboratory environment a group of construction firm managers, who had lots of experience in low bid auctions. They found that these highly experienced construction managers were as much subjected to the winner's curse as were college students in their previous studies. Construction companies would soon go bankrupt or stop bidding completely for contracts if they fell into the winner's curse over and over again. Contractors must have either learned through a trial and error process to avoid the winner's curse by bidding less aggressively when it comes to real projects not laboratory tests, or they have developed a strategy for renegotiating the contract afterwards, i.e. a claim strategy. Another explanation could be that when underpricing becomes evident, contractors try to raise their profits by lowering the quality of the work, saving in manpower, etc. These cost cuts may eventually prove to be very costly for the client in terms of delays, poor collaboration, repair works and so on. Moreover, contractors under limited liability might go bust, in which case the client must hire another contractor to finish the job, but also to pay the costs associated with the contractor's bankruptcy. This problem is tough usually minimized by setting the pre-qualification criteria high enough or trough contracts terms e.g. by requiring the contractor to set up collateral.

All in all, the main goal of the competitive bidding should be the finding of the most economically advantageous option, not the cheapest one. The most economically advantageous contractor may be left with nothing together with taxpayers if the contract is awarded to the contractor, who underestimates the costs the most or acts opportunistically.

1.2 Research problem

As mentioned before, not many if any studies have been made in Finland regarding the topic. Some minor studies might have been made by individual constructors or contractors, but to my knowledge, no one has profoundly studied the topic empirically and published it. There are however a somewhat rich literature around the topic in the U.S. and other foreign countries. These studies can be used to construct proper research questions and hypotheses, and to compare methods and findings to prior works. It is, though, worth mentioning that most of the academic studies are built on theoretic models, not on empirical research. There is thus a major need for empirical research, and not only in Finland.

It would certainly be good if public procurers had more empirical evidence to justify their decisions. I do not consider reasonable the suggestion by Hong and Sum (2002) that public

procurers should favor negotiations over auctions for certain type of projects, since it could lead to corruption and inefficiencies in the long run. Rather, I think that better equipped public procurers would make better decisions regarding the designing of auctions. With more knowledge, public procures would be better able to determine the level of pre-qualification requirements for the contractors, to optimize the number of bidder's asked to submit bids, time procurements more wisely and to choose the best contract form for the project, just to name a few.

Moreover, if the winner's curse effect and the entry effect were tackled away, at least to some extent, bids would be more accurate, since contractors would not need to add speculative risk contingencies in their bids in order to compensate the negative impact of the winner's curse and the entry effect. More accurate bids would furthermore increase the predictability of the construction costs and reduce budget overruns in general, which would make public budgets more stable and enhance the reputation of the whole construction industry. Efficient contractors would also benefit from more effective bidding competitions, as unjustifiably low bids submitted by opportunistic contractors or contractors under limited liability would be reduced. Finally, information about public construction procurements could also benefit the designing of private construction procurements or even for some other type of procurements such as IT system or health care procurements.

In this thesis I will primarily try to answer to the following questions:

1. How does the level of competition affect the lowest bid in auctions for public construction projects? Are there differences either in the sign or the magnitude of this effect between different types of contracts?
2. Do relatively low bids correlate with relative budget overruns? Are there differences in the magnitude of this effect between different types of contracts?
3. What are the characteristics that affect competitive behavior?

Research questions will be first studied by examining the existing literature and research findings. Based on these findings more sophisticated research hypotheses will be developed, which are then tested empirically by analyzing data using statistical methods such as multiple regression analysis. Data, for the empirical part of this thesis, will be collected by hand from multiple public sources as well as from the archives of various public procurers in Finland. Moreover, some of the data is provided by individual employees working in these public entities.

1.3 Main findings

The findings of the thesis are presented very roughly in this sections. For a more detailed description of the results see Chapter 7.

Each additional bid received seems to be associated with about 1.5% to 2.5% decrease in the lowest bid on average when compared to the pre-bid cost estimate. This is due to the competition effect. The client cannot benefit from seeking more bids sheer by asking for more, since per each additional bid sought, the lowest bid increases about 1.0% to 1.5%. This is due to the entry effect and the winner's curse effect. The number of bids sought is the most important determinant of how many bids will be received. Of the all bids sought, 48.2% will be received on average. Because, just about 50% of contractors asked to submit bid, eventually submit it, the two outcomes outweigh each other. Two possible solutions for the problem were provided: the releasing of information about the pre-bid cost estimation in advance and the use of the second-price sealed-bid auction type. Both of the methods decrease common uncertainty and therefore the negative impacts of the winner's curse effect and the entry effect. Provided solutions are most effective in projects where the common uncertainty is the greatest. Good candidates are large renovation projects mixed with a lump sum price or projects that are technically very challenging. Of the two solutions provided, the first one is easier to implement.

An economic downturn seems to be associated with higher number of bids received, lower bid volatility and more competitive bids. Clients received on average 0.777 more bids during an economic downturn in 2009 and 2010, and bids were about 3.2% less volatile during the crisis when compared with the years before the crisis. The average difference in the lowest bid between crisis and the years before the crisis was 6.7%, when compared to the pre-bid cost estimate. The difference between the crisis and the years after the crisis was 5.7%. The impact is similar in magnitude than getting about three additional bids. The difference between crisis times and normal times was almost negligible in the group of large contracts, but very strong in the groups of small contracts. A possible explanation is that competition between large contractors is fiercer in normal times than competition between smaller contractors. This is because larger companies have very effective procurement systems and can utilize the economies of scale. The margins of material suppliers and subcontractors may thus be at a very competitive level not only during crisis times.

Larger contracts seem to be associated with more accurate pre-bid cost estimation. Per each additional million in contract value, the accuracy of the pre-bid cost estimation improves by 0.3%. A likely explanation is that more effort is put on cost estimations when the contract size increases.

This is because an equal mistake in relative terms, incurs larger impact in absolute terms when the contract size increases. The cost estimations of small contracts and renovation contracts are calculated roughly, but conservatively to avoid budget overruns.

Budget overruns do not seem to be greater in larger projects or in renovation projects contrary to the expectations. However, the lower the lowest bid, the higher the relative budget overrun. One percent drop in the lowest bid, increases budget overruns by 0.162%. A likely explanation is that the contractor initiates a claim strategy for seeking additional profit through change orders and extra works when they noticed to have submitted a too low bid. An alternative though not mutually exclusive explanation is that contractors act opportunistically when the quality of the contract documents happens to be poor and the contractor knows they can seek additional revenue through change orders and extra works.

1.4 Limitations

This study is limited to handle public construction procurements in Finland. The data is collected from the province of Uusimaa, and within the province of Uusimaa mainly from the metropolitan area of Finland, covering the area of municipalities Helsinki, Espoo and Vantaa. Limitation was done in the purpose of minimizing sample variation and the effect of unobserved factors caused by the geographical location that could have induced unnecessary noise in the results. Such noise could have been caused e.g. by differences in the competitive behavior in different geographical locations, different ground conditions, or cultural differences. Moreover, since Finland is a small country with a relatively low number of construction companies, focusing on the Metropolitan area better ensured enough bids for each of the auction included in the sample.

1.5 Structure of the study

This thesis is structured as follows. Chapter 2 provides a quick glance into the construction industry in general. The purpose of this chapter is to provide the reader the necessary background information for understanding the rest of the thesis in the right context. It should also ease the assessing of assumptions and limitations made in the thesis, but also the suitability of the chosen methods, and the interpretation of the results. After that, a broader look into the theoretical background of auctions and earlier findings is presented in Chapter 3. The purpose of this chapter is to clarify the assumptions and theoretical background behind the research hypotheses and to provide tools for further discussion. Chapter 4 presents the research hypotheses studied in the empirical part of this thesis, whereas Chapter 5 and 6 presents the data and the methodology used to

analyse the data, respectively. Chapter 7 provides the findings of the statistical analysis performed whilst Chapter 8 provides further discussion and concludes the study.

2 THE CONSTRUCTION INDUSTRY

The following chapter explains the overall framework of the construction industry. The chapter begins by the definition of different parties commonly involved in a construction project. After that, a typical construction process and the most used contract types are presented. The standard Finnish General Condition for Building Contract is covered thereafter, which is followed by the general definition of change orders and extra works. Public procurements and market characteristics are examined thereafter whilst the final section of the chapter explains the bidding process in more detail.

2.1 Key partners involved

A typical construction project involves a number of different parties, which can be either from the public sector or the private sector. The most influential parties are the client, constructor, contractors and consultants such as the architect and engineers. There are also other important parties such as end-users, the owner, authorities, and construction inspectors, but I will not cover their roles in this thesis, because it is not critical in the context of this thesis.

In some cases, the owner of the project might work simultaneously as the client, constructor and even the contractor. For example, major contractors in Finland construct hundreds of apartments by their own account every year, which they sell to interested buyers later. However, this thesis is about traditional design-bid-build projects, where an external contractor is selected through an auction to take care of the construction activities in accordance with pre-determined design documents. Therefore, I will focus on explaining the roles of different parties from the perspective of the traditional design-bid-build project.

2.1.1 Client

The client is naturally the most important party involved in a construction project. The client has something to be built, the vision and the need for certain functionalities, and she or he needs someone to fulfil those needs. The client decides what they want to build, when they need the final product to be finished, and how much they are willing to pay for it. Some clients have the ability to manage construction projects themselves, and some even have designing or contracting capability, but in many cases the client employs a construction consultant or a contractor to take care of the process in exchange of monetary compensation. (Kankainen & Junnonen 2001: 12) It is also

possible that the client is not the owner of the project, but due to simplicity, I will later on use only the term “client” to refer to the party, who initiates the project.

2.1.2 Constructor

The constructor is an organization, who is given the responsibility of managing the project. The constructor can be either the client himself or an external party contracted by the client to undertake the project on behalf of the client. In many cases, major clients such as municipalities have separate organizational departments for this purpose. The constructor represents the client and takes care of the client’s interests e.g. in the negotiations with the designers, contractors and other construction parties. The client is still responsible for the investment decisions and funding, but the constructor takes care of the project management on a more technical level. (Kankainen & Junnonen 2001: 13)

The typical tasks of a constructor include the defining of quality, scope, schedule and cost objectives as well as monitoring the realization of these objectives. Moreover, the constructor is responsible for selecting the designers, applying for building permits, selection of contractors, construction supervision, coordinating, acceptances, warranty period tasks, etc. Furthermore, the constructor produces the necessary project reports, financial statements, technical documents, and plans that fall within the responsibility of the client and are necessary for completing the project. (Kankainen & Junnonen 2001: 13)

Since the constructor works in favor of the client and in many cases is actually the same agent, I will later on use these words in parallel when referring to the agent, who sits on the opposite side of the table against the contractor, who is in charge of the actual construction work at the site.

2.1.3 Designers and other consultants

In most cases, clients or constructors do not have all the necessary skills needed for managing major construction projects successfully, thus they hire consultants, who are experts in particular fields, for example in designing or costing. Consultants are often employed quite early in the project life cycle to advice on design and cost matters. Commonly involved consultants are: architects, structural engineers, building services engineers and cost consultants or quantity surveyors. (Kankainen & Junnonen 2001: 13)

Architects are in charge of designing the appearance and the functionality of the building to meet the requirements of the client and the building permit. Moreover, the architect often leads and coordinates the overall design work including the activities of other designers such as structural engineers and building services engineers. Structural engineers are responsible for designing the

structures and foundations that support the various loads on a building, whereas building services engineers design the systems that control the internal environment of the building such as heating and ventilation system, water supply and drainage, lighting, power supplies and telecommunications. Cost consultants prepare the estimates of how much the project will cost to build and sometimes monitor the actual costs during the construction. (RT- ohjekortti 10-10387 Talonrakennushankkeen kulku 1989: 7)

2.1.4 **Contractor**

When sufficient design information is available, the constructor calls for tenders from contractors, who then submit bids for the actual construction work. How much is sufficient design information depends on the contract type, explained in more detail later in this chapter.

The main task of the contractor is to complete the project in accordance with the contract documents, in the allowed time frame and for the agreed price. Moreover, the project must meet the required quality level set for the project. Other responsibilities include taking care of the safety, health and welfare of the workforce and the public, the protection of the environment and minimising disruption. Contractors usually do not have all the necessary skills to build all the works by themselves with reasonable costs, thus they subcontracts some parts of the work to various subcontractors. Typical subcontract works include e.g. plumbing, heating, ventilation and electrical works. In many cases, subcontractors have specialist design knowledge of their area of work and are therefore given some design responsibility as well. (Kankainen & Junnonen 2001: 13-14)

The contractor, who is in charge of the overall construction work and is in a direct contractual relationship with the client, is called the *main contractor* also known as the prime contractor or the general contractor. It is also possible that there are several main contractors working side by side on an equal basis. In that case the client is responsible for coordinating the works. The client may also subordinate some or all of the other contractors to one contractor, who is then responsible for coordinating the overall work. (Kankainen & Junnonen 2001: 13-14) For the simplicity, subordinated contractors are later on in this thesis called side-contractors[10].

2.2 Construction process

It is quite difficult to describe a common process for construction projects, since there are no two alike projects. Moreover, different countries have slightly different practices and legislative

[10] Side-contractor is a direct translation from Finnish due to the absence of English equivalent for the term “sivu-urakoitsija”

requirements that somewhat guide the process. Figure 1and Figure 2 present one way of defining a typical life cycle of a traditional design-bid-build project. The example is from the U.S. perspective, but the process is, apart from some small details, very similar in Finland.

Figure 1

Typical life cycle of a traditional design-bid-build project (Mehta 2012: 3-19)

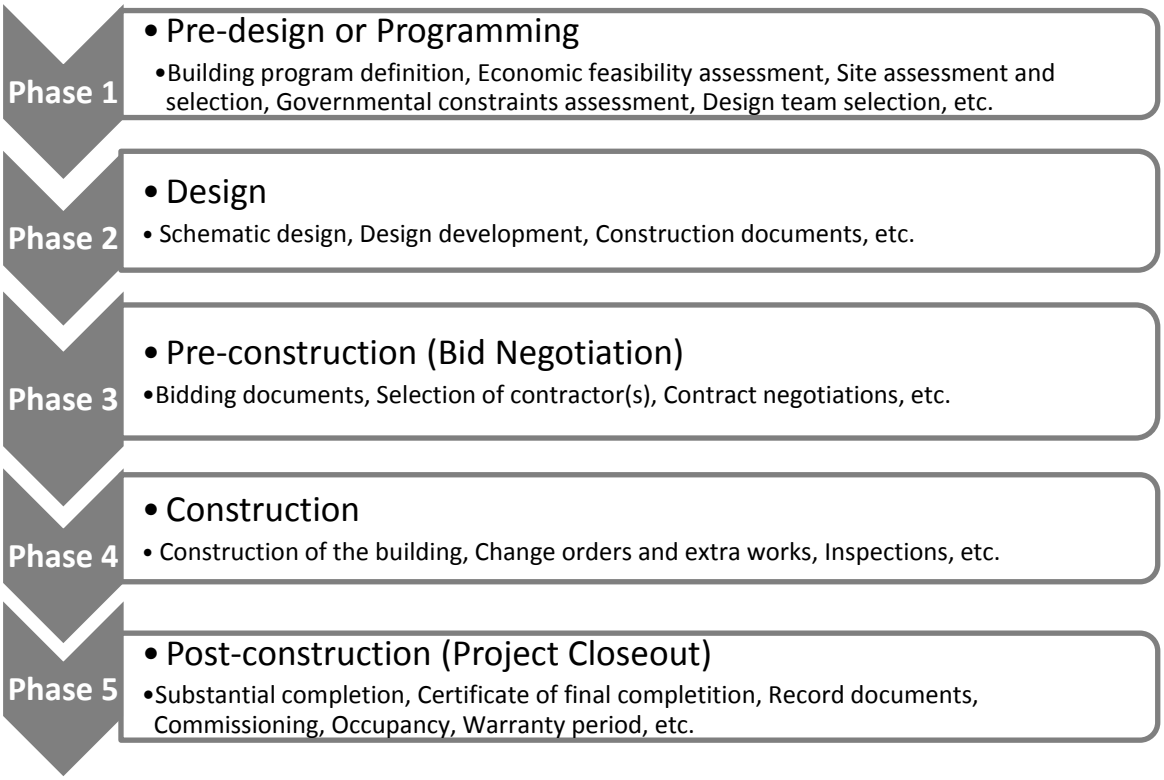
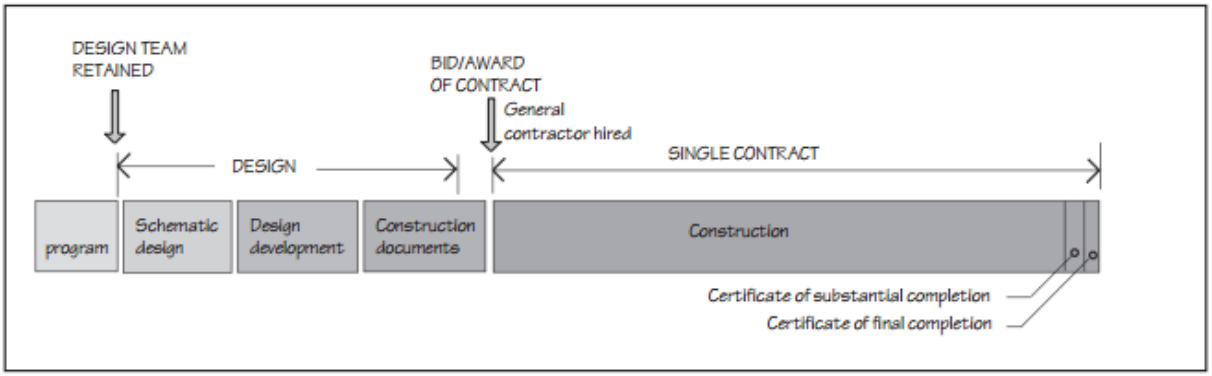


Figure 2

Sequence of operations in the traditional design-bid-build project (Mehta 2012: 20)



The process begins with the pre-design that includes tasks such as the building program definition, economic feasibility assessment, site assessment and selection, governmental constraints assessment and design team selection. At this phase, the client defines what they want to build and how much they are willing to pay for it. It is not unusual for the client to hire an architect and other consultants already at this phase, since developing a program for a large and complex project might be a very difficult task. (Mehta 2012: 4-5)

The pre-design phase is followed by the design phase, which can furthermore be divided into multiple stages including schematic design, design development, and the construction document stage. In short, the architect develops the graphical illustration of the client's program in the schematic design stage. Usually several revisions are needed, since the client rarely accepts the first proposal. Rough estimations of the likely cost and schedule are moreover produced at this stage. In the next stage, i.e. the design development stage, the architect involves other designers in the process for designing the building in greater detail. Decisions are made e.g. concerning products, materials, and equipment's. Alternative design proposals and more detailed estimations of the likely cost and schedule are also prepared. After the design development stage, the architect and other designers together prepare the construction documents required by the contractor to construct the building. These documents include detailed construction drawings and specifications. (Mehta 2012: 6-8)

The design phase is followed by the pre-construction i.e. the bid negotiation phase. There are a couple of methods that can be used in selecting the contractor(s). Most projects, especially publicly funded projects, are awarded to contractors through auctions. Furthermore, auctions can be open or restricted. In an open auction, all contractors interested in the project can submit bids, whereas in a restricted auction, the constructor calls for bids from a pre-determined group of contractors. The contractor(s) can also be selected through negotiations. In this method, the client negotiates with the contractor(s) for the contract price, schedule, and other details. (Mehta 2012: 12-14) The negotiation method is rarely used for public projects, but frequently for private projects.

The construction work usually starts right after the client have chosen the contractor(s) through a competitive bidding process or negotiations. The work is performed in accordance with the contract documents that are virtually the same as the bidding documents, especially in public projects. If changes are made in the original contract documents during the construction, these works are carried out as change orders and extra works. The constructor, designers and authorities furthermore

carry out various kinds of inspections during the construction to make sure that everything is built in accordance with the building permit and contract documents. (Mehta 2012: 15-18)

The construction phase is followed by the pre-construction or close-out phase. This phase includes two major milestones, which are the substantial completion inspection and the certificate of final completion. The substantial completion inspection is performed when the work is complete for the most parts so that the client can start using the facility. A list of incomplete works referred as the punch list is filled during the inspection. Punch list items will be completed until the final inspection of the project will be held. If the final inspection passes, the certificate of final completion will be issued and the contractor(s) is given the final payment. Responsibilities and the liability of running costs such as maintenance costs will be transferred to the client. The contractor(s) moreover prepares record drawings and specifications to the client. These documents include all the changes made during the construction. The warranty period will also begin. (Mehta 2012: 18-19)

2.3 Contract types

Construction projects differ significantly from each other in terms of how much risk is associated with the project, but also the expertise and experience level of different parties to respond to these risks varies. There are several different ways to cope with risks related to construction projects: initial preparations can be performed more thoroughly, drawings checked multiple times, ground conditions and existing structures inspected more deeply and so on. However, in many cases the most effective way to deal with these issues is to choose the right contract type for the project, so that the party, who has the best ability to bear the risk, bears it. Moreover, contract types differ not only in terms of how they transfer risks from one party to another, but also in terms of how they impact the overall project schedule and the quality of the work. The client must define the most important objectives for the project, and choose the contract type that serves those objectives the best.

A typical construction contract contains all kinds of issues from delay damages and insurances to the length of warranty periods, but the two most critical issues to ponder when determining the contract type are: how responsibilities are divided and the method of payment.

2.3.1 Division of responsibilities

There are various different ways how responsibilities can be divided in a construction project. In order to limit the overall length and scope of the thesis, I will, however, concentrate just on the most

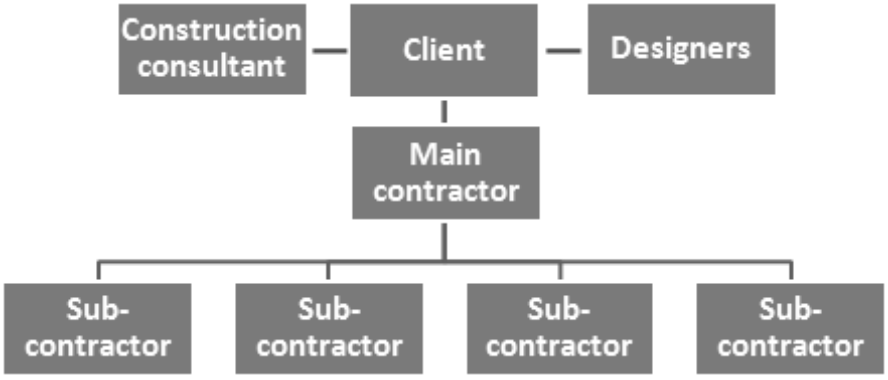
basic ones, which are the main contract, the multiple prime contract, the D&B contract, and multiple versions of project management contracts. There are also other contract types such as Public Private Partnership (PPP) or Integrated Project Delivery (IPD), but they are much rarer and furthermore excluded from the empirical part of this thesis, which is why there is no need to cover them here.

Main contract

In the main contract, the client prepares plans and drawings for the construction work beforehand, and contracts with just one contractor, i.e. the main contractor, to undertake the whole construction work usually with a lump sum price i.e. fixed price. The main contractor is allowed to use subcontractors, but these contractors are not in a contractual relationship with the client instead with the main contractor. Figure 3 presents the contractual hierarchy of a typical main contract. (Junnonen 2009: 17)

Figure 3

Contractual hierarchy of a typical main contract (Junnonen 2009: 17)



The main contract is very clear in terms of how responsibilities are divided. The client is responsible for the designing of the building, whereas the contractor has the overall responsibility of the implementation of the project in accordance with the drawings provided by the client. The contractor's responsibility moreover lasts until the end of the warranty period. Although the client is responsible for the design, the cost and schedule risks are bore by the contractor, which is why the main contract is often viewed as a relatively simple contract form for the client. The client's risks are related to the accuracy and the quality of the drawings and other documents, unforeseen items e.g. ground conditions and the efficiency of the competition in order to ensure a competitive price for the work. (Urakointiohje: Ohje rakennustöiden teettäjille. Liikenneviraston julkaisut 2009: 11)

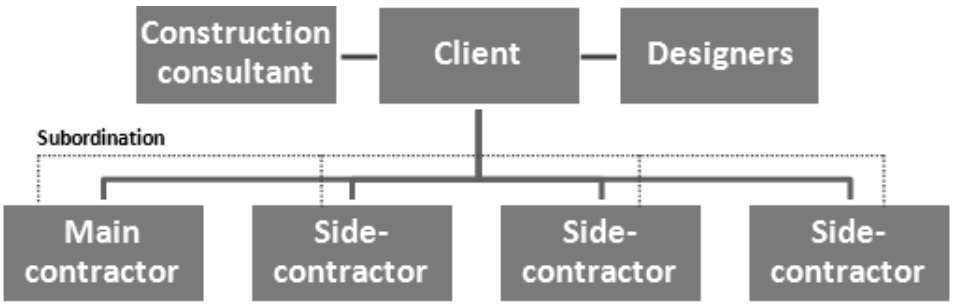
In an auction for a main contract, contractors compete with the price sufficient for them to be able to undertake the project the client has pre-determined. Contractors compete with the effectiveness of the implementation i.e. working methods, coordination and management skills, as well as procurements, but not with technical or functional solutions. The main contract is best suited for small and medium size projects, where the scope of the project and technical details are rather easy to determine. It does not suit so well for projects, where the scope of the contract is difficult to define e.g. due to insufficient mass data or incomplete plans. (Urakointiohje: Ohje rakennustöiden teettäjille. Liikenneviraston julkaisut 2009: 12)

Multiple prime contract

In a multiple prime contract, the client prepares plans and drawings for the construction work beforehand as in a main contract, but instead of contracting just one contractor, the client sings multiple agreements with many contractors to undertake different parts of the overall work usually against a lump sum price. The client often subordinates some or all the other contractors to one contractor, who is usually the contractor responsible for the structural works of the project. This contractor works then as the main contractor of the project and coordinates the works of other contractors, called side-contractors. Although side-contractors are subordinated to the main contractor, they are not in a contractual relationship with the main contractor, instead with the client. Each contractor can moreover use specialized subcontractors for works they desire under their scope of works. Figure 4 presents the contractual hierarchy of a typical multiple prime contract. (Junnonen 2009: 18)

Figure 4

Contractual hierarchy of a multiple prime contract (Junnonen 2009: 18)



The multiple prime contract can be viewed as an alternative for the main contract. This contract type however requires more expertise from the client. The client is responsible for the quality and accuracy of the construction documents provided for the contractors as in the main contract, but the

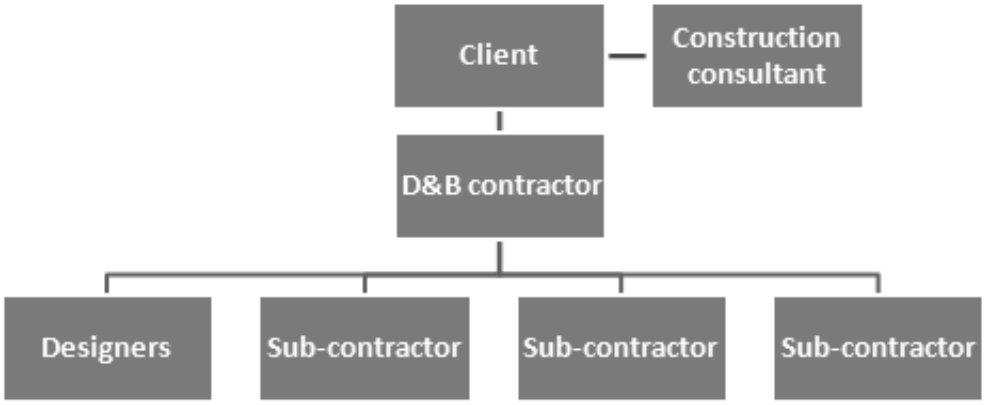
contract type is not so clear in terms of how responsibilities are divided. Unless other contractors are not subordinated to one of the contractors, the client is responsible for coordinating the works. The client must also manage multiple agreements and might easily fall into difficulties if the works of different contractors do not proceed as planned. The multiple prime contract however enables the use of different types of contracts for different parts of the work and the utilization of contractors' specialized expertise. It can also enhance competition. Furthermore, different parts of the work might be interleaved with each other, thereby shortening the duration of the project. The contract type suits the best for medium and large scale projects, which can be divided into clear and well defined subsystems. (Urakointiohje: Ohje rakennustöiden teettäjille. Liikenneviraston julkaisut 2009: 12-13)

Design and build contract

In the design and build contract, D&B, the main contractor is responsible for both the design and the construction work. The design may include not just detailed design, but also functional design. In most cases the client though provides the concept or the schematic designs and the contractor is responsible for preparing a more detailed design. The contractor usually hires specialized experts for the design work, but in some cases the designing can be made in-house. Figure 5 presents the contractual hierarchy of a typical D&B contract. (Junnonen 2009: 14-17)

Figure 5

Contractual hierarchy of a typical D&B contract (Junnonen 2009: 14)



There are a couple of advantages to a D&B contract compared with traditional contracts such as main contracts or multiple prime contracts. A team consisting of experts in both designing and implementing can find innovative ways to reduce construction costs, while at same maintaining the quality and the functionality of the final product. (Junnonen 2009: 14) Since bids can be asked from

contractors already in the schematic design phase, construction activities can proceed simultaneously with the design, contrary to traditional contracts. This shortens the duration of the overall project. (Peltonen & Kiiras 1998: 50) Moreover, since the contractor is responsible for the design, claims regarding inconsistencies in the drawings are eliminated. (Urakointiohje: Ohje rakennustöiden teettäjille. Liikenneviraston julkaisut 2009: 13-14) A close connection of the design and implementation can thus lead to overall economic gains and shorter duration of the project.

However, there are pitfalls as well. D&B contracts are inherent to conflict of interest, since the contractor may try to increase profit by cutting corners in the designing. Furthermore, the contractor may use products of lower quality than determined in the plans and drawings. In a traditional contract, the designer contracted by the client, monitors and oversees the contractor's work, which reduces opportunistic behavior. Comparison of D&B tenders and design alternatives also require more expertise from the client. Contractors also take into account in their bids, the overall cost, quantity and schedule risks they bear, which is why D&B contract is not always the most economical option for the client. (Urakointiohje: Ohje rakennustöiden teettäjille. Liikenneviraston julkaisut 2009:13-14)

In a D&B contract, contractors compete not only in terms of price, but also with the functionality and quality of the overall product. That is to say that efficiency is not the only thing that matters, technical, functional and even esthetical solutions are of interest as well. D&B contract is best suited for large projects, where it is possible to find time or cost advantages by combining the designing and construction. It is also useful if the client wants for some reason to avoid a separate planning process. (Urakointiohje: Ohje rakennustöiden teettäjille. Liikenneviraston julkaisut 2009: 13-14)

Project management contracts

Project management contracts are fee-based procurement forms in which the client buys construction services or construction management services from an external party. The construction manager contracted by the client acts in the favor of the client and gives his or her expertise in certain areas such as costs directing, scheduling or site operations in the use of the client. Project management contracts can be roughly divided into two categories: Construction Management (CM) and Management Contracting (MC). Categories differ in terms of how much responsibilities are transferred from the client to the construction manager, and how contractual agreements are arranged with other parties involved in the project. In the construction management contract, CM, subcontractors are in a contractual relationship with the construction manager, whereas in the

management contracting, MC, they are in a contractual relationship with the client. (Peltonen & Kiiras 1998: 17-18) The contractual hierarchies of these two contract types are presented in Figure 6 and Figure 7, respectively.

Figure 6

Contractual hierarchy of a typical construction management contract (Peltonen & Kiiras 1998: 18)

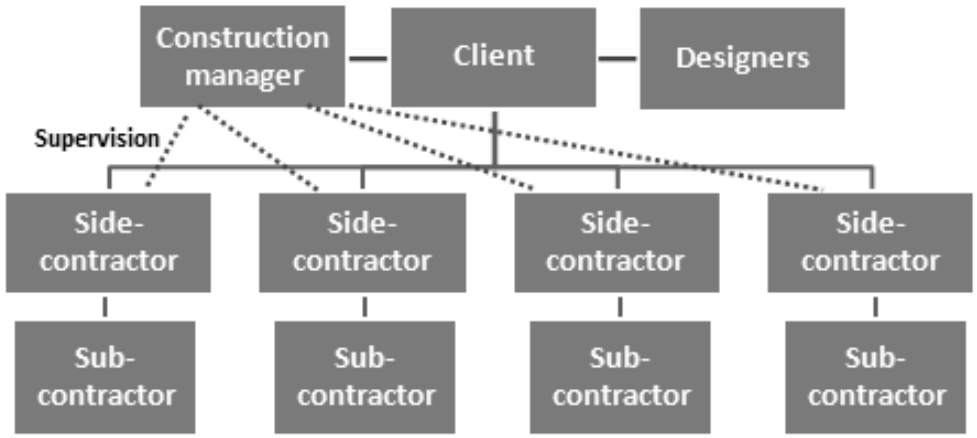
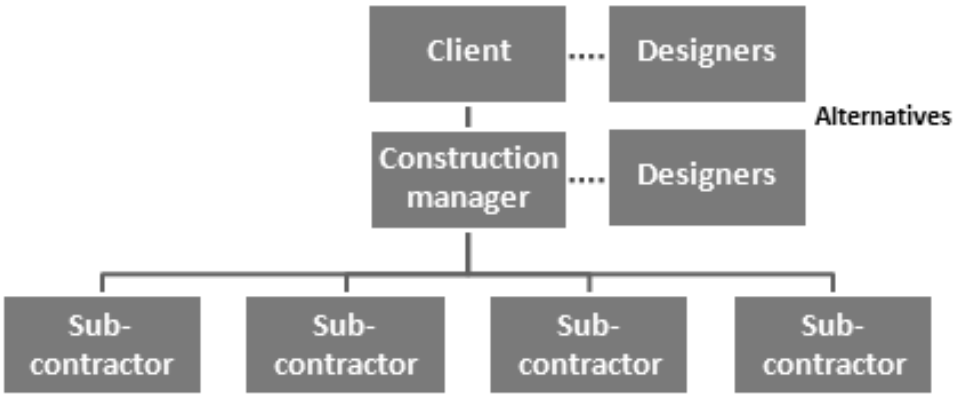


Figure 7

Contractual hierarchy of a typical management contracting (Junnonen 2009: 23)



Common to both contract types is that the client pays the actual cost of the construction work, which includes direct costs plus a compensation for the construction manager's overheads and a fixed fee. In a construction management contract, the client pays directly to the contractors on the basis of invoices, whereas in a management contracting, the construction manager pays the subcontractors after they have finished their work, and the client later compensates these costs to the construction manager in exchange of receipts and other documents. (Aaltonen 2009: 8-9)

Project management contracts are used especially in projects that require special expertise or strong guidance from the client during the construction. The aim of using project management contracts is usually to save costs and shortening the duration of the project. The client also retains a great deal of decision power with regard to procurements. All procurements must be accepted by the client, which distinguishes project management contracts from traditional contracts such as main contract. Usually the interest of the construction manager and the client are aligned by using a target price as an incentive mechanism in the contract. If the total cost remains under or exceeds the target price, the construction manager and the client share these saving or losses in accordance with pre-agreed proportions. (Aaltonen 2009: 8-12)

2.3.2 **Method of payment**

The client can choose the method of payment for the contract freely, regardless of how responsibilities are divided in the contract. Choosing the right method of payment for the contract is a very important task in the process of defining the right contract type for the project. There are four basic methods used in the industry, in which I focused in the following section.

Guaranteed maximum price contract

A guaranteed maximum price contract, GMP, is a form of agreement in which the contractor guarantees that the contract costs will not exceed a specified maximum. A contractor is compensated for the actual costs incurred plus a fixed or a cost based percentage fee subjected to GMP. If the actual cost of the works is higher than the guaranteed maximum price, the contractor is responsible for the cost overrun, unless the GMP has been increased due to changes in the content or the scope of the work. (Winch 2002: 129) For example, suppose a contractor agrees to build an office building in exchange for actual costs and €2,000,000 flat fee with a GMP of €10,000,000. If the contractor's actual costs are €9,000,000, the contractor is not paid €11,000,000 (€9,000,000 + €2,000,000), instead, €10,000,000. Again, if actual costs are €7,000,000, contractor will be paid €9,000,000.

GMP contract effectively transfers risks from the client to the contractor, since the client can cap his costs, whilst the contractor cannot. As a consequence, the contractor is likely to bid a higher price by adding a risk contingency into the bid. However, if the client has e.g. a fixed budget that cannot be exceeded, a higher price might be acceptable. GMP moreover allows the client to benefit from any cost savings founded during the construction. However, if savings are not split with the contractor, there is not much of an incentive for the contractor to seek them in absolute terms. The contractor can though lever gross margin by reducing costs.

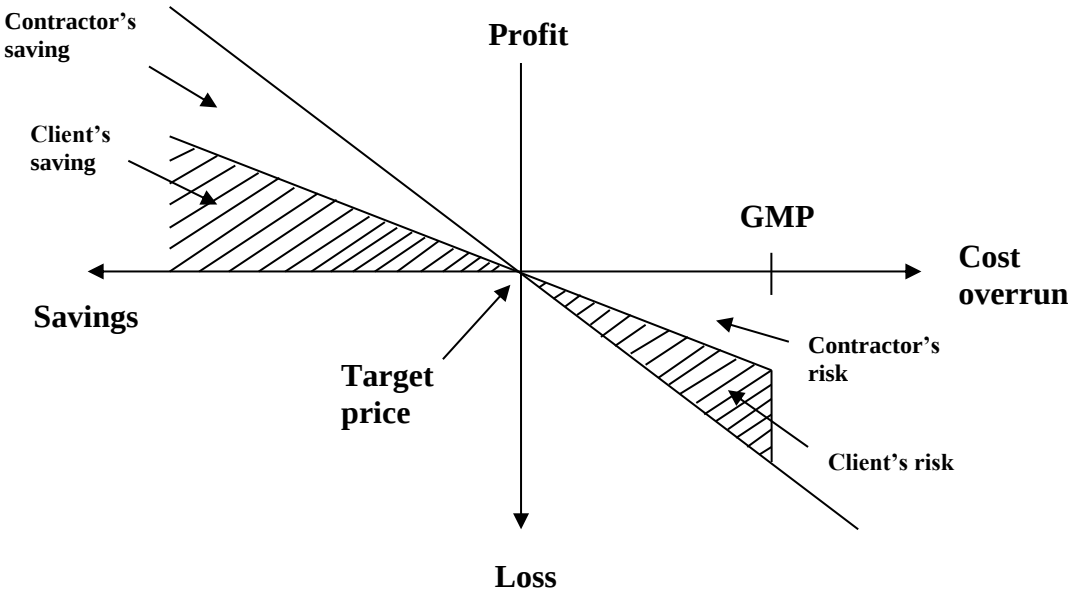
Target cost contract

The target cost contract is a contract form, where the contractor and the client agree on a specific target cost for the work. If total costs, i.e. the combined sum of direct costs plus a fixed or a cost based percentage fee, incurred to be lower than the target price, the contractor would get a share of these savings. Again, if total costs incurred to be higher than the target price, the client and the contractor would split these costs. (Urakointiohje: Ohje rakennustöiden teettäjille. Liikenneviraston julkaisut 2009: 17) Savings under or cost over the target price can be shared e.g. in 50/50 basis.

The target cost contract is usually mixed with GMP. In this contract form, the contractor guarantees that the contract sum will not exceed a specified maximum, but there is also a specific target price to create incentives for the contractor to look for savings. For instance, suppose a contractor agrees to build an office building with a GMP of €10,000,000 and a target price of €8,000,000. Moreover, costs under or over the target price are agreed to be split in 50/50 basis. If the actual cost happens to be €9,000,000, the contractor is not paid €9,000,000, instead, €8,500,000. Again, if the actual cost is €7,000,000, contractor will be paid €7,500,000, not €7,000,000. There is thus a pain and gain mechanism in the contract. The logic of a target cost contract mixed with GMP is presented graphically in Figure 8.

Figure 8

Risk structure of a target cost contract mixed with GMP. (Winch 2002: 140)



The principal benefit of the target cost contract is its ability to align the objectives of the client and the contractor. Both can benefit from cost savings founded during the project. However, there is a risk that expectations about the quality of the work are conflicting, since the contractor's incentive is to find savings, whereas the client desires as high quality as possible with minimum costs. Moreover, since the contractor is compensated based on actual costs, they have to give the client access to their accounts and other records on an "open book" basis, which requires a high level of trust between the parties. During the construction, the target and the maximum costs are adjusted with change orders and extra works to respond the changed situation (Junnonen 2009: 26).

The target cost contract is often used for large or complex projects, usually combined with D&B or Construction Management responsibilities. Competitive bidding is usually arranged so that the client sets the target and maximum costs for the contract, and contractors compete by offering their own target cost for the project. Also the fee matters. (Urakointiohje: Ohje rakennustöiden teettäjille. Liikenneviraston julkaisut 2009: 17) The client may also evaluate some other criteria e.g. reference works or team work ability.

Lump sum

In a traditional lump sum contract, the contractor promises to complete the job with a lump sum price. Payments are received usually in advance and in stages during the construction. The contractor bears the risk with regard to quantities, subcontract prices, material procurements, etc. However, it can be agreed, and practically always is, that the client bears certain type of risks, even if the contractor promises to do the work with a lump sum price. For example, the contractor is usually compensated for costs caused by force major events such as natural catastrophic or strikes. The contractor must also be able to trust the information provided by the client in a timely manner. Hence, the client bears the risk of errors in the construction documents, not the contractor. Changes in the scope or the content of the project during the construction are taken into account as change orders and extra works. The better the work is defined in the tender phase, the less likely it is that the contract sum will change during the construction. (Peltonen & Kiiras 1998: 20)

Lump sum contracts are often used for projects, where the scope and schedule can be defined clearly so that the contractor can fully estimate project costs. The lump sum contract transfers more risks to the contractor than other types of contracts. The client can be quite certain about the likely cost of the works if the project is well defined and the construction documents are accurate. However, the defining of tender documents requires a great deal of time and effort. Moreover, a lump sum contract can easily lead to disputes about the quality of the work, since the aim of the

client is to have as high quality as possible with the agreed price, while the contractor bears the risks of implementation costs. (Urakointiohje: Ohje rakennustöiden teettäjille. Liikenneviraston julkaisut 2009: 16)

Unit price

In a unit price contract, the client promises to pay the contractor a fixed unit price for each unit of some item constructed by the contractor. The final price of the project is therefore dependent on the quantities needed to carry out the work, but also the unit price for one item. The client bears the quantity risk whilst the contractor bears the price risk. In order to estimate the final costs of the project, the client must estimate quantities and multiply quantities with unit prices. (Ahokas et. al. 2009: 39) Some parts of the works can though be carried out with a lump sum price.

The unit price contract is suitable for projects, where the different types of items can be reasonably well identified, but there is a major uncertainty about the number of these items. Unit price contracts are often used for infrastructure works such as ground works or paving, where the amounts can change significantly during the construction. The unit price contract also requires careful preparation and comprehensive determination of how items are measured to prevent future disputes. The benefit of this payment method is its flexibility for changes in plans during the construction. Moreover, competitive unit prices are used to price change orders and extra works. (Urakointiohje: Ohje rakennustöiden teettäjille. Liikenneviraston julkaisut 2009: 16-17)

Cost plus

In a cost plus contract, the client agrees to pay all the costs of the work, including direct costs plus a compensation for the contractor's overheads and profit margin. The client effectively bears all the risks related to the project. A cost plus contract is often used for renovation projects, where the scope of the work cannot be determined, or in emergency situation, where the works must be started as quick as possible. (Ahokas et. al. 2009, 39-40) Sometimes not even the kinds of labor, material, or equipment needed for the work is known before starting the construction. If a lump sum contract were used for such a project, the contractor would need to add significant risk contingencies in their bid, which would raise the price unnecessarily. The cost plus contract also eliminates conflicting views about the quality of the work. The contractor though does not have much incentive to find savings in this contract form.

2.3.3 Comparison of different contract types

Contracts are commonly viewed from the perspective of how much they transfer risks and responsibilities from the client to the contractor. Two representations of this approach are shown in Figure 9 and Figure 10, where the contractor's risk increases as a function of responsibilities.

Figure 9

Risk balances of different contract types (Lowe & Whithworth 1996: 895)

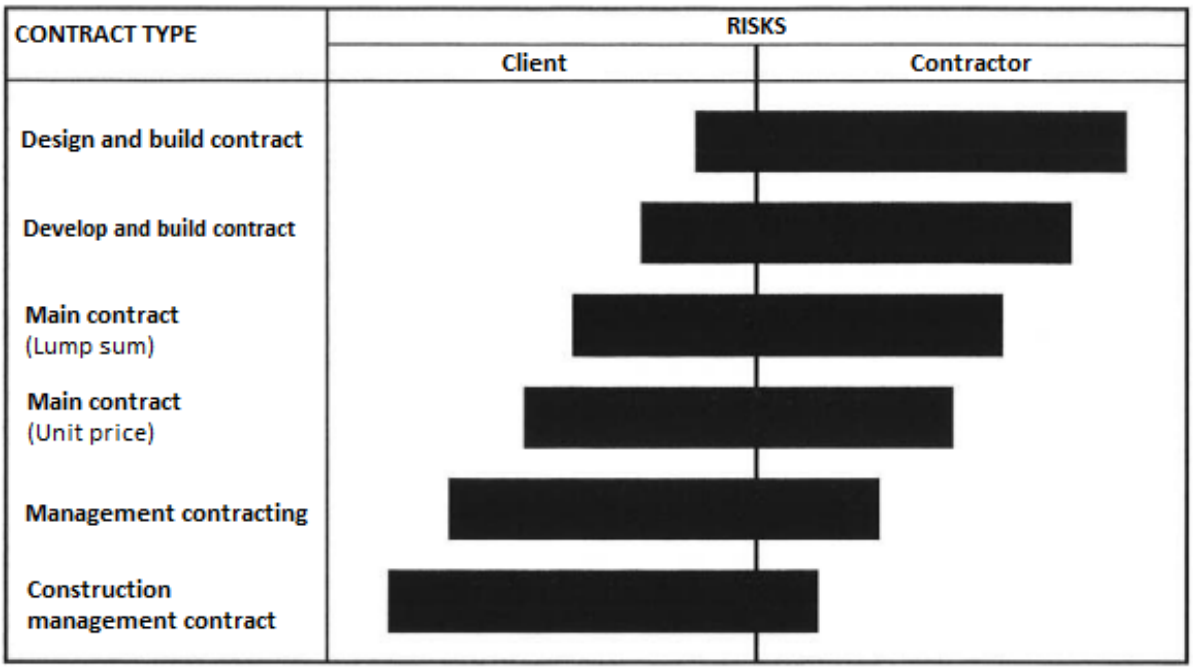


Figure 10

The relation of risk and responsibilities in different contract types (An owner's guide to project delivery methods 2012: 7[11])

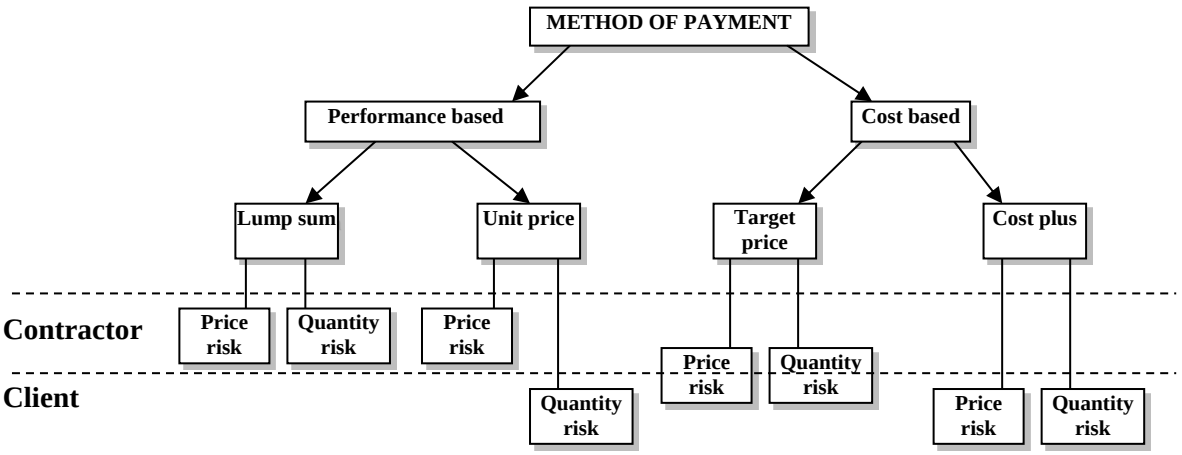
PROJECT DELIVERY METHODS					
D&B	Develop and build contract	Main contract (Lump sum)	Main contract (Unit price)	Management contracting	Construction management
Least	Client's risk				Greatest
Greatest	Contractor's risk				Least
Least	Client's responsibility				Greatest
Greatest	Contractor's responsibility				Least

[11] https://cmaanet.org/files/Owners%20Guide%20to%20Project%20Delivery%20Methods%20Final.pdf (5/7/2015)

Contract types can also be seen from the point of view how different methods of payments divide quantity and price risks between the client and the contractor. The firmer the contract sum, the more risks the contractor bears. Representation of this approach is shown in Figure 11.

Figure 11

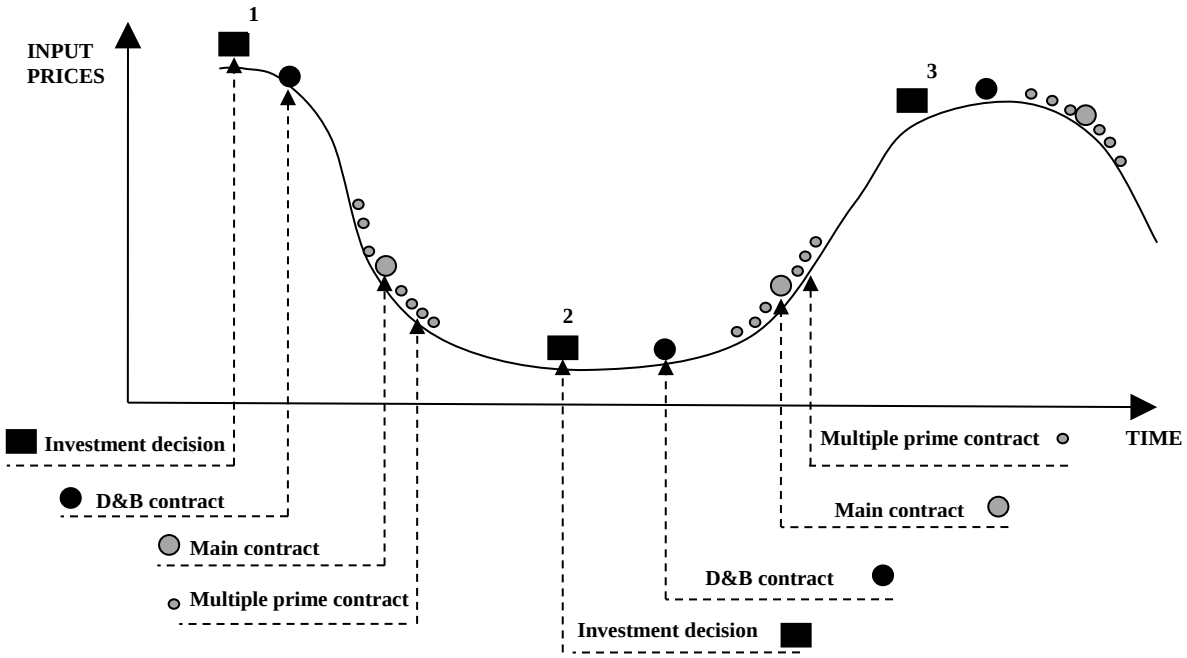
Method of payments and risk balances (Peltonen & Kiiras 1998: 21)



How certain risks are divided between parties is however not the only thing to consider, when choosing the right contract type for a project. There is usually other than monetary objectives as well. Other objectives might be related e.g. to the quality, functionality, or schedule. Moreover, economic cycle or location may affect input prices in a way that further influence the selection of the contract type. For example, during an economic upturn, the client might want to slow down the process by choosing a contract type that effectively separates the design and the construction processes from each other. This way the client may benefit from a possible decrease in input prices i.e. lower bids in the coming years, when the economy eventually turns to a downturn. In turn, the client might want to speed up the schedule in a recession when input prices are low by choosing a contract type that allows the design and the construction to proceed simultaneously. In Figure 12 is shown how economic cycle affects the costs of different contract types.

Figure 12

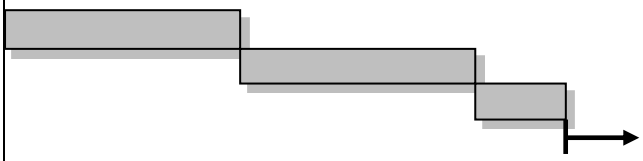
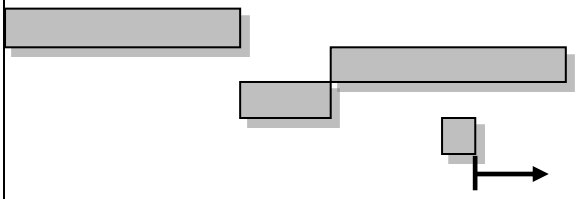
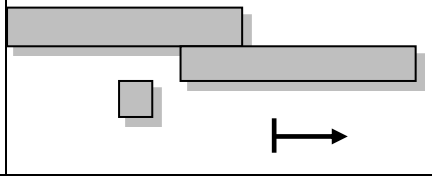
The impact of economic cycle on the costs of different contract types (Peltonen & Kiiras 1998: 72)



The more risk the contractor bears in terms of method of payment, the longer the schedule. This is because tender documents must be prepared carefully to ensure that the contractor is able to price the contract effectively and to avoid future disputes. The impacts of the different methods of payments on the overall schedule of the project are shown in Figure 13.

Figure 13

The impact of contract type on the overall schedule (Peltonen & Kiiras 1998: 52)

METHOD OF PAYMENT	SCHEDULE
Lump sum Schematic design Detail design Tender procedures Construction	
Target price Schematic design Detail design Tender procedures Construction contract Construction	
Cost plus Schematic design Detail design Tender procedures Construction	

Contract types differ also in terms of how much they align the incentives of the client and the contractor. For example, in the target cost contract, the monetary incentives of the client and contractor are well in line, but expectations about the quality of the final product may conflict. The client desires to have as high quality as possible with minimum costs whilst the contractor gains only through cost cuts. In the cost plus contract, instead, quality objectives are not conflicting, but the contractor does not have much incentive to cut costs. In the main contract, in turn, monetary incentives are very much contradicting, which can lead to serious quality problems. However, the client can be pretty sure about the costs of the project given that the construction documents are well defined.

As evident, different contract types serve for different objectives, and the client must decide, which objectives he or she values the most and choose the contract type that best serves those objectives. Moreover, the special features of the project and the overall economic cycle must be considered and taken into account when determining the right contract type. Furthermore, contractors naturally add risk contingencies in their bid, depending on how much risks they have to bear. The client must therefore evaluate whether or not the contractors are uncertain about their ability to avoid or bear

these risks, which would be reflected as higher bids. Risks are not worth to be transferred to a party, who does not have sufficient capabilities or resources to manage those risks.

Risks arising from divergent views are typically minimized through contract negotiations before signing the actual contract agreement. In the contract negotiations, any ambiguities about the content of the work or conditions for the selection of the contractor are reviewed. At this point, it is also checked if the contractor has understood the tender documents right.

2.4 The Finnish General Conditions for Building Contracts (YSE 1998)

The Finnish General Conditions for Building Contracts (Rakennusalan yleiset sopimusehdot, YSE 1998) form the basis of the Finnish contract jurisprudence. YSE 1998 concerns issues such as how to deal with changes to building plans during the construction, liabilities and obligations of different parties, damages, warranties, etc. The YSE terms have been prepared in cooperation between constructors and contractors, thus they take more or less equally into account the various and often opposing interests of different parties involved in the project. The use of standardized and widely recognized terms speeds up the agreement process, as counterparties can focus on more important issues in the process of determining the contract for the project. YSE 1998 terms are usually attached to contract documents and they form the core of the most construction contracts in Finland. Even though YSE 1998 terms are widely used, contracting parties can agree not to use YSE 1998 as a basis of their contract, since YSE 1998 is not a compulsory law. Contracting parties may also agree to deviate from YSE 1998 terms in some individual matters.

2.5 Change orders and extra works

It is almost impossible to agree the content of a construction work so that there would not occur needs for changes in plans during the construction. Changes in the original design and plans or the scope of the work are more the rule than the exception. Changes may arise e.g. due to errors or inconsistencies in contract documents such as drawings, changes in government regulations, changes proposed by the contractor or client, or due to incomplete plans that must be completed during the construction process. These changes are carried out as change orders and extra works. Laine (2005: 30) Complementary designs such as installation drawings are though not seen as change orders or extra works. Moreover, a diligent contractor is expected to follow good construction methods, thus some works can be required, even if they are not explicitly mentioned in the contract documents (Laine 2005: 16).

YSE 1998 defines extra work as follows:

- The work is not included in the original contract documents
- The work does not change the content of the contract, but it is done in addition to the agreed work
- The work is not subjected to any agreed work performances. (Ahokas et al. 2009: 198)

In other words, an extra work is a building block or an obligation of the contractor to do something, which is not mentioned or included in the original contract documents, and is made in addition to the agreed work. Thus, if a street is agreed to be paved, but later on the client wants an adjacent street to be painted as well, this work will be carried out as an extra work.

Change orders are works that are caused by changes in the content of the agreed contract. YSE 1998 defines change orders as follows:

- The work is not included in the original contract documents
- The work changes the content of the contract or is subjected to the agreed work, but does not change the content of the work. (Ahokas et al. 2009: 198)

Thus, if a street is agreed to be paved with regular asphalt, but later on the client wants it to be paved with acid-proof asphalt, this work will be carried out as change order. (Laine 2005: 15)

According to YSE 1998, the contractor is obliged to carry out change orders, clearly indicated by the client, unless these works significantly alter the nature of the work (Ahokas et. al. 2009: 199). This obligation ensures that the contractor cannot refuse to carry out change orders necessary or essential for the completion of the project (Ahokas et. al. 2009: 197). Since the client has been given such a unilateral right, YSE 1998 furthermore defines that the contractor is entitled to additional time and compensation for carrying out change orders if these orders increase costs or extend the schedule. In turn, the client is entitled to compensation if change orders lead to lower costs. The contractor must submit a tender for the change work, which must be further approved by the client, until actual construction works can be started. The work must be priced in accordance with the contract documents or other agreements between the parties. Ultimately, if the price cannot be derived from contract documents or equivalent, nor a consensus about the price can be reached, the contractor must carry out change orders, at the client's request, based on actual costs plus 12 percent compensation for overheads and profit margin. The contractor is also entitled to a reasonable extension in the construction schedule due to changes. The client may alternatively hire another contractor to carry out the change order. (Ahokas et. al. 2009: 207-212)

The contractor must carry out required works, even if parties cannot agree whether the works are included in the original contract or are change orders unless these changes alter the nature of the work significantly. Open issues and disputes will be solved later, either in the final inspection or the economic clearance of the project, or ultimately in the district court. (Ahokas et. al. 2009: 199) According to YSE 1998, the contractor is not however obliged to implement any extra works. The client and the contractor can freely agree on the price, the time of completion and the impact of extra works on the overall project schedule and other liabilities. Extra works must also be agreed, before the works can start. (Ahokas et. al. 2009: 215-217)

2.6 Public procurement

Countries have commonly enacted laws to regulate public procurements. In Finland, public procurements are subjected to national procurement legislation, *Public Procurement Act*, which is conducted from the European Community directives on public procurement. According to the legislation, public sector procurements must follow transparent and open procedures. Moreover, fair and non-discriminatory conditions of competition must be ensured. The primary objective of the legislation is to ensure that tax payers' money is used efficiently, and secondly, to enhance competition in the market and competitiveness of the companies. In the legislation, public procurement units are forced to utilize existing market structures and to improve the functioning of markets whenever possible, when procuring goods, services or works.[12] The law however applies only for construction contracts above €150,000 in value in Finland.

Although *Public Procurement Act* provides minimum requirements for public procurements in terms of openness, transparency, efficiency and non-discriminatory treatment, the law leaves room for ad hoc discretion. In terms of construction contracts, public procurers can set, and practically always do, certain minimum pre-qualification requirements for the contractors to ensure that companies considered for the work, really have adequate resources and skills for the job. Thus, public procurers have the right and possibility to restrict competition by pre-qualifying companies that can submit bids. [13] Whether this right to restrict competition is good or bad, is not so clear. As mentioned earlier, academic research is mixed though not inconsistent when it comes to the effect of competition on bid prices. At least, the expertise and knowledge levels of the officials, who make

[12] http://www.hankinnat.fi/en/Pages/default.aspx (31.1.2015) (Public Procurement Advisory Unit)
[13] http://www.hankinnat.fi/fi/hankintaprosessi/ehdokkaiden-ja-tarjoajien-soveltuvuus/Sivut/default.aspx (31.1.2015) (Public Procurement Advisory Unit)

these decisions, should be very high. Otherwise, there is a risk that competition is restricted too heavily or that companies without sufficient resources or skills are not blocked away efficiently.

There are several options of how public procurements can be acquired. These options are: open procedure, restricted procedure, competitive dialogue procedure, and negotiated procedure. The nature of the project defines which of the options is the most appropriate.[14] The contract must be awarded based on either the most economically advantageous tender or the lowest price. If the contract is awarded based on the most economically advantageous tender, tenders must be evaluated against pre-announced criteria.[15] Criteria can consist of measures for the overall schedule, quality, experience level, references or even for balance sheet structures.

In the open procedure, the public procurement unit announces a notice of contract and all interested contractors can submit a tender. In Finland, the notice of contract must be announced in HILMA declaration system for public procurements. Whether or not contractors are qualified for the work is checked afterwards. [16] Qualification criteria must be attached in the notice of contract. The open procedure is suitable for simple and well defined procurements.

The restricted procedure has two steps. First the procurer announces the notice of contract in HILMA, and contractors will then send a letter of interests to the procurer based on this information. The procurer then selects among interested contractors those whom it will send invitations to tender. The procurer must, however, ask bids from at least five companies. Yet, if there are not enough qualified companies, the procurer can continue the process with the qualified candidates. The procurer must specify the qualification requirements in the notice of contract. Moreover, if the procurer wants to limit the number of contractors, selection criteria as well as the selected number of bidders must be specified in the notice of contract. [17] The restricted procedure is suitable for large procurements, which can though be defined rather well, so that bidders can deliver a fully priced bid.

In the competitive dialogue procedure, the procurer negotiates with qualified candidates about the content of the project in order to find out one or more solutions that meet the requirements of the

[14] http://www.hankinnat.fi/fi/hankintaprosessi/hankintamenettelyt/Sivut/default.aspx (31.1.2015) (Public Procurement Advisory Unit)
[15] https://www.tem.fi/en/consumers_and_the_market/public_procurement (31.1.2015) (Ministry of Employment and the Economy)
[16] http://www.hankinnat.fi/fi/hankintaprosessi/hankintamenettelyt/avoin-menettely/Sivut/default.aspx (Public Procurement Advisory Unit)
[17] http://www.hankinnat.fi/fi/hankintaprosessi/hankintamenettelyt/Sivut/default.aspx (31.1.2015) (Public Procurement Advisory Unit)

client. Contractors are then asked to submit bids for that particular solution. The competitive dialogue procedure is used for particularly complex projects, where the defining of the project in advance is very difficult.[18]

The negotiated procedure is rarely used for public procurements, since its usage requires a specific justification that can be derived from the *Public Procurement Act*. In this procedure, the procurer announces the notice of contract in HILMA, and chooses among interested contractors those, who it will start negotiations with about the contract terms.[19]

2.7 Competitive environment and bidding strategy

The competitive environment of the construction industry contains all kinds of factors affecting the bidding decisions of individual contractors. These factors include general issues such as legislation and economic cycles, which are applicable to all contractors, but also individual issues such as financial constraints, managerial capabilities, resources availability, differing technologies, which are unique to each contractor. The market has low entry and exit barriers with low capital requirements, which is why the industry is highly fragmented and characterized by small contractors. Most contractors cannot operate in all sectors of the market, thus they define a strategic domain in which they operate. The strategic domain can be defined broadly to contain certain market areas such as civil engineering, building construction, or renovation, but it can be defined also more specifically. (Drew and Skitmore 1997) Some small company may e.g. decide to focus on infrastructure works, which are worth between €100,000 and €500,000, and located in eastern Finland. In contrast, major construction companies frequently operate in all of the market segments, but generally stick to larger contracts in which they have competitive advantage against smaller rivals.

According to Drew and Skitmore (1997), bidding is a two stage strategic decisions process. First, the contractor must choose whether or not to bid. At this stage, the contractor has to consider their current and future workloads, but also the likelihood of being the lowest bidder, since preparing the bid requires time and effort, and ties up resources. Moreover, the contractor must assess whether the given contract is in line with the chosen strategy. Second, the contractor must decide the mark up

[18] http://www.hankinnat.fi/fi/hankintaprosessi/hankintamenettelyt/Sivut/default.aspx (31.1.2015) (Public Procurement Advisory Unit)
[19] http://www.hankinnat.fi/fi/hankintaprosessi/hankintamenettelyt/Sivut/default.aspx (31.1.2015) (Public Procurement Advisory Unit)

level, which is high enough to cover overheads and risks, and to yield a profit, but low enough to win the competition.

Several studies about the factors affecting the bidding decision have been conducted in the past decades (e.g. Shash 1993 and Wanous et al. 2000). Based on these studies, there seems to be a few recurring factors that influence the bidding decision. According to Flanagan and Norman (1982) these factors are:

1. Contract size and complexity
2. Regional market conditions
3. Current and future workload
4. Type of client
5. Type of project

Hillebrandt and Cannon (1990) moreover identified that managerial capacity and capability are very important determinants in the bidding decision process. According to Hillebrandt and Cannon, contractors do not give much importance to the availability of resources, because they can easily overcome such resource constraints by subcontracting, leasing or hiring, whereas managerial skills and resources are more limited.

The pricing of the bid starts with a baseline estimate, which is conducted at the operational business level. Johnson and Scholes (1993) have identified four sources of cost efficiency: the economies of scale, supply costs, product process design, and experience. When the baseline estimate is ready, the process is fed back to the business strategy level, where the senior management decides the mark up level which is expected to maximize the company's expected payoff. Male (1991), however, argues that bidder may from time to time attempt to fulfill other objectives such as minimizing the profits of competitors, or obtaining a contract even at a loss in order to maintain production. The senior management may also be more concerned with acquiring greater resource control than with optimally allocating resources, i.e. empire building.

According to Drew and Skitmore (1997), contractors seem to require less risk premium if they have experience in undertaking similar types of contracts. Moreover, Hillebrandt and Cannon (1990) state that companies undertaking a large number of smaller projects are likely to require lower risk premiums than companies with just a few large contracts, since the former has more diversified project portfolios than the latter.

It is not an easy task for a contractor to know, whether they have an efficiency advantage with regard to some particular project. The company's management might have a sophisticated view of the strength of each player in the industry or the company might have got certain information, say, about prices indirectly from the market, but the company still cannot be a hundred percent sure about its putative efficiency advantage. Thus even though the company might have a strong perception about its own and its rivals' strengths, the company has to take into account the possibility that they have made an error, and finally end up giving a too low bid. Moreover, what makes construction project auctions even more complicated for bidders is that these auctions are usually first-price sealed-bid auctions i.e. each contractor gives its price in a sealed letter of which the lowest bidder will be chosen for the job at the price they bid. Thus contractors are not able to see other players' bids at any point in time and are not able to adjust their bids or change their strategy during the auction. This is different from a typical auction for merchandise and goods, where bidders can see other bidders' bids and are allowed to make continuous bids.

3 THEORETICAL BACKGROUND

The following chapter begins with a quick look in to the most used auction methods. The history of the auction theory and the game theoretic models of auctions are presented thereafter. After that, the main findings and theories with regard to the competition effect, winner's curse and the entry effect are explored. Finally, the main findings with regard to the construction industry are presented.

For a more detailed description of auctions see e.g. Klemperer (1999) or Easley & Kleinberg (2010). In turn, a very good game theoretic approach to auctions is provided by Chatterjee & Samuelson (2001).

3.1 The standard auction methods

The two most commonly used auction methods and perhaps the most familiar to laymen are the ascending auction and the first-price sealed-bid auction. Other important auction methods are the descending auction and the second-price sealed-bid auction. Although the descending and the second-price sealed-bid auctions are less known than the first mentioned, they are very important in terms of auction theory, and form the body of the auction theory together with the ascending and the first-price sealed-bid auctions. There are also other auction methods such as "all pay" and the Japanese auction, but since these methods are rarely used and furthermore conducted from the four basic auction methods, I will not handle them in this study. Due to simplicity, auction methods

described in the coming sections are moreover presented mainly from the buying perspective, but could equally well be explained from the selling perspective.

3.1.1 The ascending auction (English auction)

Perhaps the best known auction method in use is the ascending auction, also known as the English auction. In this auction method, the bidding starts with a low price, and is raised gradually as higher bids are submitted until only one bidder remains. The highest bidder gets the object at the final price she bid. The English auction is commonly used to sell merchandise and goods e.g. antique. (Easley & Kleinberg 2010: 250)

3.1.2 The descending auction (Dutch auction)

In the ascending auction, also called Dutch auction, the bidding starts with a high price, and is decreased gradually until someone expresses her willingness to pay the price. The bidder gets the object at the current price. The auction is called Dutch auction since tulips have long been sold in the Netherlands using this method. However, the method is rarely used for other type of products. (Easley & Kleinberg 2010: 250)

3.1.3 The first-price sealed-bid auction

In the first-price sealed-bid auction bidders submit sealed bids individually without seeing other bidders' bids. The object is awarded to the bidder, who submits the highest bid with the price he bid. The first-price sealed-bid auction is commonly used by public procurers to buy products or services from private companies. Of course, the pricing logic then goes the other way around. The prize is awarded to the lowest bidder, not the highest bidder. (Easley & Kleinberg 2010: 250)

3.1.4 The second-price sealed-bid auction (Vickrey auction)

In the second-price sealed-bid auction, also known as Vickrey auction, bidders submit sealed bids individually without seeing other bidders' bids as in the first-price sealed auction. However, the bidder who submits the highest bid gets the object at the price of the second highest bid. The auction is called Vickrey auction in the honor of William Vickrey, who was the first researcher analyzing auctions from a game-theoretic point of view. Vickrey won the Nobel Prize for his work in 1996. (Easley & Kleinberg 2010: 250)

3.2 Different characteristics of auctions

Auctions can roughly be divided into three classes based on the characteristics of the object auctioned. These classes are private-value, common-value and affiliated-value auctions.

3.2.1 Private-value auction

Private-value auction is a term used to describe an auction, where each bidder knows his own valuation of the object auctioned, but not the valuations of other bidders. Moreover, the value of the object for each bidder is different and unaffected by the information about other bidders' valuation. It is not easy to come up with the examples of a pure private-value auction, but an auction for some consumption item could be pretty close to pure a private-value auction. The buyers' values reflect how much they each would enjoy consuming the item. (Easley & Kleinberg 2010: 252)

An example from a corporate world could be a corporate takeover. In a business auction, the value of the business for sale is usually different for each bidder due to differences in possible synergies or strategic reasons. A business auction is, though, not a very good example, since one bidder's valuation is usually somewhat valuably to another bidder and vice versa. Nevertheless, it gives some grasp to the idea of private-value auctions.

In a pure private-value auction, where continuous bids are allowed, a bidder's optimal strategy is simple. The bidder does not have to worry about other bidders' bids, rather, she just keeps bidding until she either wins the object, or the price of the object rises above or falls below her personal valuation, in which case she stops bidding.

3.2.2 Common-value auction

In the common-value auction, the value of the object is the same for all bidders in the, but bidders know just their own valuations, not the valuations of other bidders. Thus variance in bids can arise only due to differences in opinions about the real value of the object. The valuation of each bidder is also affected by the information about other bidder's valuation. (Easley & Kleinberg 2010: 252)

An artificial example of a pure common-value auction is a jar full of €1 coins. The value of the jar is the same for all bidders, but each bidder has its own opinion about how many coins the jar contains. A more real life example, close to a common-value auction, is an auction for oil drilling rights. The price of such a right depends on geological surveys, future oil prices, future technology, etc. All the bidders have different views of these influential factors, thus different valuations for the oil drilling right, although the actual price is about the same for each bidder.

In the common-value auction, a bidder's optimal strategy is not as clear as it was in the private-value auction. The bidder must take into account the fact that if he ultimately wins the object, he might be paying too much for it, since the value of the object for sale is the same for each bidder, but no one else was willing the pay as high a price for it.

3.2.3 Affiliated-value auction

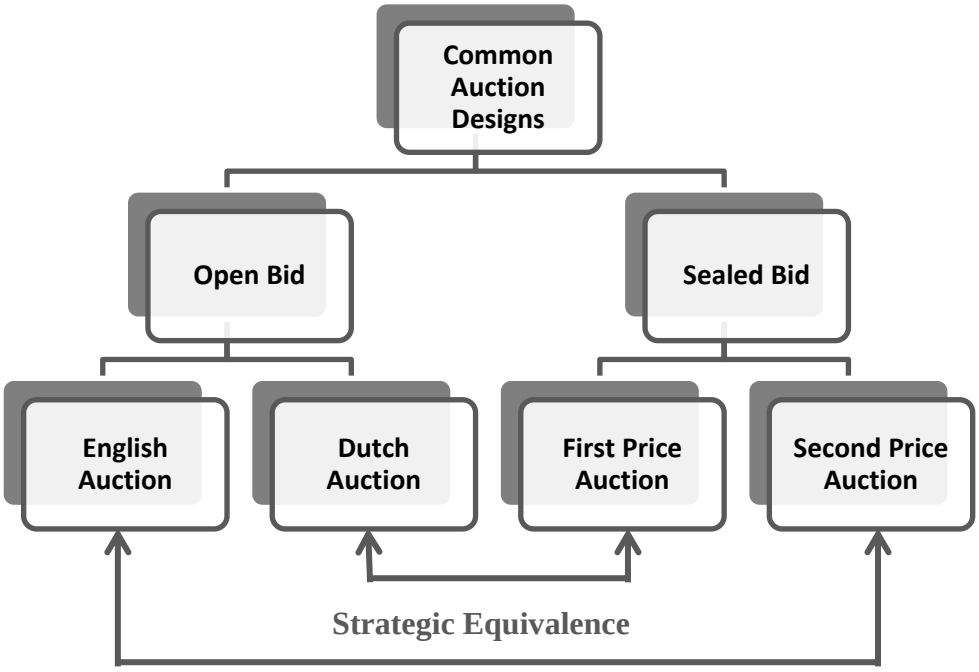
Most of the auctions are something between pure private-value and common-value auction. These auctions are generally called as affiliated-value auctions in auction literature. Like in the private-value auction, the value of the object for sale is different for each bidder; however, these valuations are positively correlated with each other. The valuation of one bidder is valuable to another bidder and affects his valuation of the object. For example, a painting may have some private value for a bidder, but other bidders' valuations affect his valuation as well, since they reveal information about the resale value of the painting i.e. common value element.

3.3 Auction theory

Auction theory is concerned with how the design of auctions affects people's behavior. Since auctions can be designed in several ways, researchers are typically interested in studying the efficiencies of different auction types. Other typical issues studied include optimal and equilibrium bidding strategies and revenue comparisons. Vickrey's study *"Counterspeculation, auctions and competitive sealed tenders"*, 1961, can be seen as a pioneer work of theoretical auction modeling. Vickrey used a game theory to explain the dynamics of auctions and provided the early results of the revenue equivalence theorem, RET. According to RET, if all bidders are risk neutral and their valuations are distributed independently and identically across bidders, then any such mechanism, where the object is always allocated to the bidder with the highest value or bid, and bidder with the lowest value expects zero utility, has the same expected revenue (Klemperer 1999). Under these conditions, both, the auctioneer and the bidders are indifferent between the auction mechanisms used. Vikrey noted that Dutch auction was strategically equivalent to the standard first-price sealed-bid auction. He also proposed a new auction model, the second-price sealed-bid auction, in which the highest bidder wins the object with the price determined by the amount of the second highest bid. According to Vickrey, the second-price sealed-bid auction should produce equivalent results to the traditional English auction.

Figure 14

Strategic equivalence of different auction types



The revenue equivalence theorem (RET) remains to be the centerpiece of modern auction theory and much of auction theory can be understood by the means of the theorem. RET however applies only if certain conditions are fulfilled. For example, consider a common-value auction with three bidders where each bidder can bid a random amount between 0 and 1. Moreover, suppose that every value between 0 and 1 is equally likely, such that the expected value of the object on sale is .50. Without additional information, risk neutral bidders will bid .50, whilst risk averse bidders will bid less than .50. The risk aversion thus affects the valuation of an object on sale. RET will no longer holds; because bids will not only be a function of expected value, they are also affected by the information revealed during bidding.

Myerson (1981), Milgrom and Weber (1982), and Maskin and Riley (1984) provided further analysis of RET when one or more of these conditions are relaxed. Myerson analyzed what is the optimal auction type when the assumption of symmetry fails, whereas Milgrom and Weber showed that if the assumption of independent valuations does not hold i.e. valuations are somewhat correlated, the most profitable standard auction is the ascending auction. Maskin and Riley, instead, reasoned that if bidders are risk-averse, the optimal auction to maximize the seller's expected revenue is the first-price sealed-bid auction.

RET is very sensible to the assumption of the private-value auction, however, virtually every auction violates these assumptions. A bidder is often uncertain about the value of the asset and valuations of individual bidders are usually correlated with each other i.e. one bidder's valuation is valuable to another bidder. These aspects gave rise to the development of the common-value auction model. (*Harstad and Pekec 2008)* The studies of Wilson (1967, 1969) and Rothkopf (1969) are pioneer works of common-value auction modeling.

3.4 Walrasian auction

In 1877, Léon Walras, a French mathematical economist, published a study called "Elements of Pure Economics", in which he constructed his basic theory of general equilibrium. This study is often viewed as the first theoretical work considering the general equilibrium theory, a center piece of modern economics. In his work, Walras presented a model of an auction, where there is perfect information and no transaction costs, i.e. the features of perfect competition. Each agent in this setting submits their demand at every possible price to an auctioneer, who then sets the clearing price so that the total demand equals the total amount of the object auctioned. The clearing price in a Walrasian auction thus perfectly matches the supply and the demand and produces a perfectly efficient outcome.

A Walrasian auction assumes perfect competition and information, a finite number of identical items offered for sale, and that bidders are price takers, which is however rarely the case in the real world. Even though the Walrasian mechanism might work in private-value auctions, in which a bidder's valuation is affected only by his own perceptions and not by the perceptions of others, it does not necessarily work in common-value auctions where bidders are differentially informed about the value of the auctioned item. (Hong and Shum, 2002) This is due to the winner's curse problem discussed in more detail in the next section.

3.5 Winner's curse

In 1971, three petroleum engineers, Capen, Clapp, and Campbell (1971) claimed that oil companies had paid too much for the oil drilling rights in Outer Continental Shelf (OCS) oil lease auctions in the 1960s and 1970s, and had suffered unexpectedly low rates of returns due to that. Capen et al. reasoned that overpaying was caused by the winner's curse affiliated with the common-value auctions. In a common-value auction, the real value of the project is the same to all bidders, but all the bidders have different views of that value. Thus the highest bidder i.e. the winner of the auction tends to be the bidder with the most overly optimistic view. In other words, although your valuation

might be correct on average, you win the auction only when your estimate is the highest and ultimately find yourself overpaying. Similar findings to those of Capen et al. have been found in many studies. The field evidence of the winner's curse phenomenon has been found e.g. in auctions for baseball players (Cassing and Douglas 1980); publishing rights (Dessauer 1981); offshore oil leases (Lorenz and Dougherty 1983); corporate takeovers (Roll 1986).

The winner's curse has been a somewhat controversial topic among scholars since Capen et al. (1971), as it implies that bidders do not learn from their mistakes, which severely violates the idea of rationality, the very basic assumption of many economic theories. For example Cox and Isaac (1984) argue that if all the bidders are rational, winner's curse cannot occur. In equilibrium, rational bidders should take the winner's curse into account by bidding less aggressively i.e. bid sufficiently less than one's estimate. Moreover, because it is quite difficult to dismiss alternative explanations for overbidding when using field data, some researchers have presented alternative explanations for the winner's curse. For instance, Hendricks et al. (1987) found that average profits in early OLS leases were negative in auctions with seven or more bidders, but they argued that this was more likely to be caused by the uncertainty of bidders' about the number of bidders attending the competition rather than the winner's curse. According to Hendricks et al. most auctions in the sample received less than six bids, thus bidders might have fully accounted for the winner's curse effect of less than six bidders, but not for the auctions with seven or more bidders. Furthermore, it has been argued that the findings of Capen et al. (1971) could be explained by an attempt of oil companies to collude for lower prices. However, this argument does not exclude the possibility that oil companies really suffered from the winner's curse. If Capen et al. have not published their findings; instead, had utilized the information against their competitors, their company would not have won any auctions, because in order to avoid losses, they would have had to reduce their bids whilst their competitors would not have. A more rational solution is, to publish your findings, and hope that your competitors also reduce their bids, and this is exactly what Capen et al. did.

In order to solve the problem of unreliable data and alternative explanations for findings supporting the winner's curse, researchers have studied the topic experimentally in laboratory environment. Bazerman and Samuelson (1983) showed that inexperienced bidders are susceptible to the winner's curse in a corporate takeover game. Moreover, Kagel and Levin (1986) found that bidding is more aggressive in auctions with large numbers of bidders (6-7) than with small numbers (3-4), causing negative profits. According to Kagel and Levin, bidders do adjust their bids to the winner's curse problem in auctions with large numbers on bidders (6-7), but the adjustment is not large enough to

fully compensate the negative effects of the winner's curse. They reasoned that bidders have learned to avoid the winner's curse in small groups through trial and error, but have not fully understand the mechanics of the winner's curse, thus are not able to avoid it when the situation changes i.e. the competition intensifies. In addition, Kagel et al. (1989) found that experimental auction markets are associated with a strong winner's curse phenomenon, and that bidders learn through experience to adjust their bids in order to mitigate the winner's curse, but do not sufficiently adjust their bids to reach the Nash equilibrium. Similar findings have found Dyer, Kagel, & Levin (1989); Garvin and Kagel (1994); Kagel & Richard (2001). A significant amount of evidence thus indicates that bidders are in fact susceptible to the winner's curse, but continuous exposure to common-value auctions seems to reduce the impact of it.

Rational bidding can be very difficult. The bidder must estimate the value of the object on sale, but also the expected value conditioned on winning the auction and the magnitude of the winner's curse adjustment. Hence, it should not be so strange that bidders do make mistakes. In fact, it seems that the winner's curse is a rather common phenomenon in common-value auctions. Or as Richard Thaler (1988) neatly put it *"I think it is important to keep in mind that rationality is an assumption in economics, not a demonstrated fact. Given the results of the experimental studies, isn't it possible that some bidders make mistakes in these auctions? It is also interesting to note a peculiar tendency among many economic theorists. A theorist will sweat long and hard on a problem, finally achieving a new insight previously unknown to economists. The theorist then assumes that the agents in a theoretical model act as if they also understood this new insight."* Today, it is a widely accepted fact that people do not always act rationally. A whole new field of study, behavioral economics, has emerged to explain how and why people sometimes make irrational decisions.

As a side note, a book called "Common Value Auctions and the Winner's Curse" written by Kagel and Levin, 2002, is a very good piece to the topic.

3.6 Entry effect

Participating in an auction incur real costs to the bidders. These costs are generally called entry costs in the auction literature. Li and Zheng (2006) argue that bidders may become less aggressive also in private value auctions, when the number of potential bidders increases, due to the entry effect caused by the entry cost, which is always positive and may dominate the negative competition effect. This is because the likelihood of winning the contract decreases when the number of potential bidders increase, yet the participation cost, i.e. the entry cost, remains the same.

In equilibrium, rational bidders should take this into account by bidding less aggressively, or deciding not to bid at all. Only bidders with sufficiently favorable signals will actually participate. Similar arguments have provided e.g. Xu (2013) and Roberts and Sweeting (2010).

Xu (2013) argues that clients should make the entry costlier in order to intensify competition. According to Xu, discouraging actual participation makes the marginal participant in the auction of a better type. Xu's argument is based on the assumption that the entry decision is made after the bidders know their valuations. In such a setting, discouraging actual participation can be optimal for the government. Making entry costlier screen less favorable bidders and increase competition among participants. Most of the papers dealing with the entry effect employ however the model of Levin and Smith (1994) to describe bidders' entry decisions. In this model bidders make entry decisions before knowing their own valuations. In such a setting an increase in the entry cost reduces both the probability of entry and the expected number of actual bidders. In turn, the actual bidders face less competition and bid less aggressively. It is thus not clear whether the client should reduce the entry cost or make it costlier. The auctioneer can reduce the impact of the entry effect also by restricting the number of qualified bidders, who can submit bids.

3.7 Findings in the construction industry

3.7.1 Affiliated value actions

Auctions for construction projects usually consist of both private and common value elements. Based on academic research, there are three different factors related to competition affecting bids simultaneously in such an auction. On the one hand, the Walrasian view of the market suggests that the bid price should approach a more competitive outcome when the competition intensifies, i.e. competition effect. On the other hand, the more competitors there are, the stronger the winner's curse effect. Rational bidders should take this into account by bidding less aggressively. Finally, there is also the entry effect affecting the bid price upward. If the winner's curse effect and the entry effect are strong enough, they can ultimately outweigh the competition effect and prices could actually rise when the competition intensifies. (see e.g. Pinkse and Tan, 2000, 2005, Hong and Sum 2002, Menicucci 2009)

According to Brannman et al. (1987) optimal bids in an affiliate-value auction depend on both the number of bidders and the accuracy of the cost estimations. More bidders or greater uncertainty in cost estimations calls for more conservative bids in order to avoid the winner's curse. Goeree and Offerman (1999) moreover argues that in an affiliated-value auction, a bidder with a moderate

private value and an overly optimistic estimate of the common value may outbid a rival with a superior private value, but a more realistic estimate of the common value. Inefficiencies are thus be expected to occur in construction project auctions.

Paul and Carr (2005) studied the impact of reduced competition on bid prices. They controlled model variance by selecting a single building type, designed by a single firm, with pre-bid estimates prepared from the same estimating database, over a limited time period. The data consisted of 19 major public educational facilities projects in New York State. The final sample contained 438 bids and over $158 million in construction value. Researchers found evidence of a strong nonlinear relationship between the number of contractors attending the bidding competition and the lowest bid price. According to the researchers, there will be a 3.79% increase in project costs, on average, for each bidder lost. This finding was statistically significant at .003 level, suggesting a very strong relationship. The effect diminishes when more and more contractors take part in the competition and is almost negligible after the ninth contractor.

Paul and Carr (2005) however did not find evidence of statistically significant correlation between the number of bids and the average bid price. They neither provided an explanation for this finding. Perhaps their highly controlled sample was strongly characterized by common value auctions, whose value bidders had, on average, evaluated correctly, but the winners of the auctions failed to take the negative impact of the winner's curse into account in their bidding.

Hong and Shum (2002) studied the topic using a complex simulation model, which they constructed by utilizing bid data from construction procurement auctions run by the New Jersey Department of Transportation, NJDOT, in the years 1989-1997. The data consisted of 767 auctions of which 423 were general highway projects, 194 bridge construction and repairing projects, and 150 grading and paving projects. Based on simulations, the number of bidders is positively correlated with the lowest bid in terms general highway projects. According to Hong and Sum, the optimal number of bidders in these auctions would be three. Hong and Sum moreover argued that the government could lower the expected procurement costs of general highway projects by about 15% by reducing the number of bidders from 6 to 3. However, Hong and Sum found opposite results for other types of projects in their sample. In terms of bridge construction and repairing projects, and grading and paving projects, the number of bidders was negatively correlated with the lowest bid.

Many academic papers have argued that the release of information regarding the seller's valuation of the object in sale may cause bidders to bid more aggressively in common value auctions (see

Milgrom and Weber 1982, Harstad 1990, and Campbell and Levin 2000). De Silva et al. (2008) tested this theory empirically buy examining the impact of a policy change by the Oklahoma Department of Transportation to the release the state's internal cost estimations of highway projects. De Silva et al. performed a differences-in-differences analysis comparing bidding in Texas, in which the cost information was released throughout the entire period, to bidding in Oklahoma, where the policy was changed during the period. The data contained over 13,000 bids in Oklahoma and Texas over the period 1998-2003. De Silva et al. found evidence that the average level of bids was lower after the release of additional information as suggested by the theory. Researchers also found that the standard deviation of bids fell after the change in policy, but they did not find evidence that releasing the information would result in statistically significant lower winning bids.

De Silva et al. split their sample in two groups, of which they argue to differ significantly in the level of common cost uncertainty. These project types were asphalt paving projects and bridge construction/repair works. According to researchers, bridgework projects contain more uncertainty, common to all bidders, whereas asphalt paving projects possess more private value characteristics. They find that both, the average level of bids and the standard deviation of bids, fell more strongly for bridgework projects. The average bid for bridgeworks fell by about 9.6% after the policy change in Oklahoma. Moreover, the lowest bid fell about 9.0%, but this finding was statistically significant only at 10% level. The effect on paving projects was statistically insignificant, suggesting that the releasing of cost estimation did not have any impact on the average bid price for paving projects. The number of bidders seems to reduce the average bid and the lowest bid for all projects in their sample.

3.7.2 **Budget overruns**

Ganuza (2007) developed a model where cost overruns, i.e., the difference between the final price and the price announced when the project is initially awarded, arise as a consequence of renegotiation of the initial contract. Ganuza argue that low investment by the client in the specification of the initial design is the main reason for cost overruns, since it increases the likelihood of significant changes in the design after the contract is signed. According to Ganuza it can though be in the interest of the client to under invest in the initial design, since it intensifies competition and lowers rents by making contractors more homogenous. In other words, although a more accurate initial design increases the likelihood of awarding the project to the most efficient

contractor, it also increases the rents of that contractor. Under perfect competition, under investment in the design specification does not occur since rents are eliminated.

Ganuza however did not take into account in his reasoning, the negative impact of the winner's curse. Rational bidders should take the under investment in the initial design into account by bidding less aggressively. One could also argue that if the bid is too generous due to the winner's curse effect, the company chosen for the work may run into financial difficulties or lack of resources during the construction, which instead can lead to disputing with the client, poor co-operation, delays in the schedule, bad quality, etc. If the client has not been able to take these problems into account properly, for example in the form of efficient contract terms, a very low bid price that looked good at first glance, may prove to be very costly at the end of the project. Even if the client is able to manage these problems properly and to receive the project with the original bid price, there might be indirect costs in form of bad relations, lost brand value, exhausted personnel, bad press, lost revenue, and so on.

Bajari and Tadelis (2001) studied the contractual arrangements used in the construction industry. According to them, there is a tradeoff between transaction costs caused by changes and incentives to reduce costs. Bajari and Tadelis developed a model, which they used to show that although a cost-plus contract does not create incentives for cost reduction, it is superior to a lump sum contract when a project is more complex. This is because the cost of renegotiating a lump sum contract is very high if the initial design is incomplete.

As mentioned earlier Sweeney (2009) studied 234 public construction projects in Australia and found that the average budget overrun for the projects of more than 100 million Australian dollars in value was as high as 20%, whilst the average of all projects was 10.7%. Moreover, just 12% percent of the projects in Sweeney's sample were delivered on budget.

In a study called "Analysis of WSDOT Construction Cost Overruns", the Washington State Department of Transportation studied a total of 433 unit price contracts completed between 1985 and 1989. Researchers found evidence that construction cost overruns are associated with project complexity and a large number of bidders. Complex projects were moreover strongly characterized by large projects. Researchers argued that since the competition forces contractors to lower their rents, some contractors may initiate a claim strategy, i.e. an aggressive pursuit of change orders and extra works, after signing the contract. Moreover, researchers claimed that formal claims, strongly associated with large projects, were one of the reasons for cost overruns. All in all, these findings

suggest that cost overruns are associated with common value auctions. However, it seems that bidders were not able to take into account the negative impact of the winner's curse effect by bidding less aggressively, instead, initiated a claim strategy when the underpricing became evident.

Love et at. (2013) provide an analysis of cost overruns of 276 Australian construction and engineering projects. Construction projects, 161 units in their sample, ranged from banks to hospitals and hotels. Civil engineering projects, 115 units, ranged from tunneling to road construction and sewer treatment plants. Love et al. used the contract award as the reference point for budget overruns and found a mean cost overrun of 12.22%. No significant differences for cost overruns were found among procurement method, project type, and contract size

Odeck (2004) investigated the relationship between actual and estimated costs of road construction in Norway over the years 1992-1995 and found a mean cost overrun of 7.9% ranging from -59% to +183%. Interestingly, cost overruns appeared to be more predominant among smaller projects. According to Odeck, the greatest potential for cost savings lies in exerting pressure on smaller projects to control their costs. The completion time of the projects and the regions where projects are situated were also found to affect the size of cost overruns. However, Odeck did not find that the project type would influence the level of cost overrun.

3.7.3 **Other findings**

Calveras et al. (2004) argue that limited liability may cause firms in a bad financial situation to bid more aggressively than financially healthy firms, thus there might be a high probability of bankruptcy of the company submitting the lowest bid. Similar findings have found e.g. Waehrer (1995), Zheng (2001), Parlane (2003), Engel and Wambach (2006) and Board (2007). Bankruptcy would instead lead to cost overruns eventually, since the client has to hire another contractor to do finish the work, but also to bear bankruptcy related costs such as delays, litigation, and new procurement process. According to the researchers, this fear is realistic, especially for smaller projects, where there are more unknown and small contractors submitting bids. However, I do not regard this fear realistic, at least not in Finland, since public procurers are allowed to set pre-qualification requirements for the contractor to ensure the quality of the participating companies. According to YSE 1998, contractors are moreover required to provide a collateral worth of 10% of the contract amount, which mitigates the problem further.

4 RESEARCH HYPOTHESES

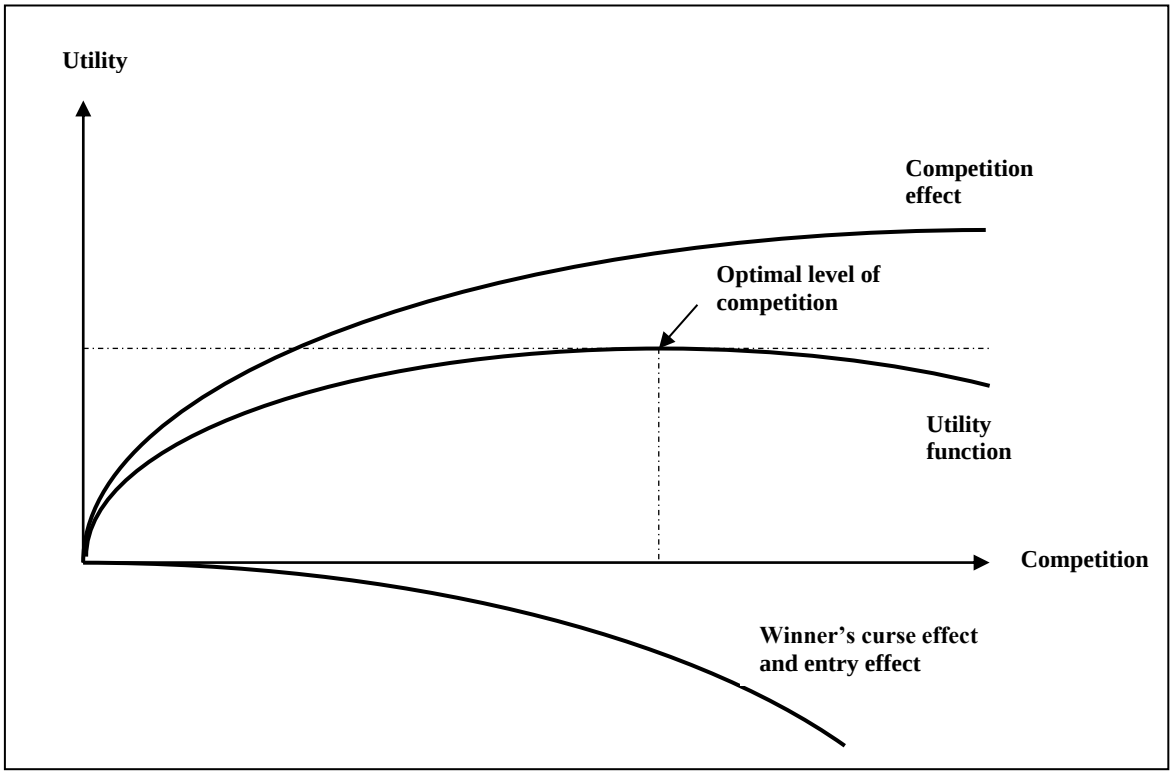
The research hypotheses of the thesis are presented in this chapter. The chapter begins with a short recap to the research problem, which is followed by the actual research hypotheses.

4.1 Recap

Construction projects differ significantly from each other in various different ways. Some types of projects are technically more difficult to carry out than others. For instance, constructing a power plant or a dam requires a lot more technical expertise than constructing a children's daycare center or an apartment building. Projects differ not only in terms of technical expertise required, but also in how much uncertainty the project contains. To recap, when the competition intensifies the competition effect affects the bids downward. However, the stronger the competition the stronger the winner's curse effect affecting bid prices upward. Moreover, the entry effect affects the bid price upward depending on the number of potential bidders. In theory, there is an optimal level of competition for each project. The optimal level lies at the point, where the gain from an increase in competition caused by the competition effect equals the loss from an increase in competition caused by the winner's curse effect and the entry effect. In other words, the optimal level of competition lies at the point, where the derivative of the utility function is zero. A graphical visualization of the research problem is shown in Figure 15.

Figure 15

The optimal level of competition



4.2 Hypothesis 1

Renovation projects are in general viewed to be riskier than new construction projects, since it is impossible to be a hundred percent sure of what the existing structures will contain. Drawings of the existing structures might not be available at all or the structures might not have been made in accordance with the original drawings. Moreover, providing that there are damages in the existing structures, the scale of these damages might be difficult to observe. In contrast, new construction starts from an empty plot and structures are usually based on well-prepared drawings and other documents. Naturally, also new construction projects contain risks related e.g. to unforeseen factors such as ground conditions, but the probability and the magnitude of these risks are usually not as high as in renovation projects.

According to Brannman et al. (1987) uncertainty in cost estimations strengthens the winner's curse and calls for more conservative bids in order to avoid it. Auctions for renovation projects are thus expected to be closer to a common-value auction than auctions for new construction projects. One could though argue that renovation projects may require special expertise that can create efficiency advantage i.e. private-value element. Although this can be true to some extent, the general use of

cost plus contracts indicates that renovation projects are in fact characterized more by common value elements. My first research hypothesis is therefore as follows.

H1: The level of competition affects the winning bid downward more strongly in auctions for new construction projects than for renovation projects.

4.3 Hypothesis 2

Researchers in the study of Washington State Department of Transportation (1991) argue that larger projects, measured as the value of the lowest bid, are on average more complex than smaller ones. This is true, because complexity increases the cost of the construction work i.e. the baseline estimate, and therefore increases the lowest bid. The value of the project thus serves as proxy for the complexity of the project. Moreover, when projects are increased merely in size, complexity is added simply because the administration of a larger project becomes more complex. According to the researchers, the increase in staffing overweighs the increase in size in many cases. Complexity moreover increases the uncertainty in cost estimations, which in equilibrium, should be taken into account by bidders in the form of less aggressive bids in order to avoid the negative impact of the winner's curse. Moreover, the entry cost is expected to be, on average, higher for larger and complex projects than for smaller and simpler ones. Thus my second hypothesis is as follows.

H2: The level of competition affects the winning bid downward more strongly in auctions for small projects than for large projects.

4.4 Hypothesis 3

It is reasonable to assume that the client puts more effort in pre-bid cost estimations, when the project size is large. This is because the "cost" of being wrong in relative terms has greater impact in absolute terms when the project size increases. Following this reasoning, larger project should be associated with more accurate pre-bid estimates. Thus, my third hypothesis is as follows.

H3: The larger the project, the more accurate the pre-bid cost estimate.

4.5 Hypothesis 4

It is quite difficult to estimate the number of potential bidders. However, in some cases the procurer announces in the notice of contract, the number of contractors, who will be send the tender documents. In that case, contractors know the level of competition in advance. Moreover, the

number of bids sought reflects the competitive environment. [20] That is to say that if there are a vast number of companies operating in a certain market segment, the procurer usually seeks to receive bids from more contractors than if there were just a few. Contractors are aware of the competitive situation in the market situation, thus can anticipate the level of competition. The number of bids sought thus serves as a proxy for the level of potential competition. The higher the number of potential contractors, the stronger the *entry effect*, which instead should be reflected by a relatively lower number of bids, received. In other words, the more bids you seek, the less you get in relative terms. Moreover, the entry effect should be associated with less competitive bids. Hence, my fourth hypothesis is as follows.

H4: The number of potential bidders is negatively correlated with the relative bid price and the relative number of bids received.

4.6 Hypothesis 5, 6 and 7

According to Peltonen & Kiiras (1998: 71), contractors' own production increases in an economic upturn, which decreases their willingness to submit tenders for public contracts. Bids become less competitive and the variance in bids becomes greater. In turn, contractor's willingness to submit tenders for public contracts increases in an economic downturn, since there are less of other works available. Following the above reasoning, hypotheses five, six and seven are as follows.

H5: The number of bids received is lower in an economic upturn.

H6: Bids become less competitive in an economic upturn.

H7: Volatility in bids becomes greater in an economic upturn.

4.7 Hypothesis 8

A contractor may seek additional profits by initiating a claim strategy if they notice to be exposed to the winner's curse. Since the winner's curse effect is expected to be stronger in larger projects, budget overruns are expected to be more common and greater in magnitude in larger projects than in smaller ones. This reasoning is also in line with the findings of earlier studies (e.g. Sweeney 2009; Hinze and Selstead 1991). One could though argue that, in equilibrium, negative profits due to the winner's curse should not occur. However, a significant amount of evidence indicates that bidders are in fact susceptible to the winner's curse; yet, continuous exposure to common-value

[20] The number of bids sought equals the number of contractors who were sent the tender documents in this thesis.

auctions seems to reduce the impact of it (e.g. Kagel et al. 1989; Kagel and Richard 2001). Thus it is reasonable to assume that although bidders may be able to take the winner's into account in their bidding, they do not adjust their bids enough to reach the equilibrium. Moreover, there might be some novel players that have not yet accrued sufficient amount of knowledge to avoid the winner's curse. Thus my eighth hypothesis is as follows.

H8: Budget overruns are in relative terms greater in larger contracts than in smaller ones.

4.8 Hypothesis 9

It is an industrial fact that renovation projects are characterized by higher amount of change orders and extra works than new construction projects. This is because, it is very difficult to define accurate construction documents for these projects in advance, which is why a cost plus is often used as the method of payment in renovation contracts. Renovation projects are also more prone to the winner's curse effect due to higher uncertainty, which might strengthen the contractor's endeavors of pursuing additional profits through change orders and extra works. Thus my ninth hypothesis is as follows.

H9: Budget overruns are in relative terms greater in renovation projects than in new construction projects.

4.9 Hypothesis 10

Based on many academic studies, we can expect that the average of all bids in a pure common-value auction is pretty close to the real value of the object in sale. Major deviations from the average bid though occur and the reasons for this are diverse. Some bidders might have made miscalculations, or have underestimated the costs of construction in general. Moreover, companies under limited liability bid more aggressively than financially sound companies and might, in some circumstances, succeed in submitting bids. Since it is likely that a company, who has submitted an unexpectedly low bid, initiates a claim strategy or goes bankrupt during the construction, different countries and working groups have developed procedures to spot abnormally low tenders, which are then supposed to be rejected.[21] Although all of these methods are more or less artificial, and cannot detect all the abnormally low bids, it is interesting to test whether relatively low bids are in fact

[21] See e.g. "Prevention, Detection and Elimination of Abnormally Low Tenders in the European Construction Industry", DG III Working Group, 1999

negatively correlated with budget overruns. Following the above reasoning, my tenth hypothesis is as follows:

H10: Relative bids are negatively associated with relative budget overruns.

5 DATA

The following chapter begins with a short description of the data sources and the sample selection procedures. After that the data is presented in more detail.

5.1 Sources of data

The primary sources of data for this study were the archives of the Centre for Economic Development, Transport and the Environment in Uusimaa (ELY centre), the Public Works Department of Helsinki, and several housing production entities: VAV Asunnot Oy, Espoon Asunnot Oy, The Helsinki Housing Production Department and Asuntosäätiö.

The Centre for Economic Development, Transport and the Environment in Uusimaa is responsible for the regional implementation and development tasks of the central government. The department takes care of the roads and bridges and the maintenance of associated equipment's and facilities in the province of Uusimaa.[22] The Public Works Department of Helsinki instead takes care of the planning, construction and maintenance of streets, green areas and city premises in the city of Helsinki. The department is also responsible for parking control.[23]

VAV Asunnot Oy and Espoon Asunnot Oy are public companies owned by the cities of Vantaa and Espoo, respectively.[24][25] The principal task of these companies is to provide high quality apartments and houses for the people in the area at a reasonable price. The Helsinki Housing Production Department is responsible for housing production in accordance of the objectives set by the city of Helsinki.[26] Asuntosäätiö is a non-profit organization founded by six major non-governmental organizations in 1951. The aim of this organization is to provide good quality apartments for the people in the area.[27]

[22] https://www.ely-keskus.fi/web/ely-en
[23] http://www.hel.fi/www/hkr/en/
[24] http://www.vav.fi/front_page
[25] http://www.espoonasunnot.fi/
[26] http://www.att.hel.fi/en/att
[27] http://www.asuntosaatio.fi/main.php

Secondary sources of data were HILMA -declaration system for public procurements, Credita and various other internet sources.[28] Secondary sources of data were used primarily to confirm certain information and to supplement missing parts of data.

5.2 Sample selection

The data of this study contains various kind of information about public construction projects and associated contracts and auctions. The sample includes information about infrastructure projects such as road and bridge works, residential projects, and public building projects such as schools, hospitals and fire stations. The following information was gathered from all of the projects included in the sample: the name and description of the project, the date the auction was held, and the type of contract. Depending on the availability of data, information about the number of bids sought, the number of bids received, the value of the lowest bid, the values of all bids, the pre-bid cost estimate, and the final costs of the projects or the amount of change orders and extra works were collected.

5.2.1 **Residential**

Information about residential projects was collected from the aforementioned housing production departments. If a multiple prime contract was used as the contract type, each of the contract was included in the sample separately. Contracts with design responsibility or other than a lump sum price were not included in the sample.

Multiple prime contracts were commonly used for residential projects in the original data. However, due to the absence of pre-bid cost estimations for individual side-contracts, a large part of the multiple prime contracts could not be included in the final sample.[29] Since most of the contracts within the group of residential projects were thus main contracts, the average contract size in the sample was relatively large.

5.2.2 **Public building**

Information about public building projects was collected from the archives of the Public Works Department of Helsinki. The sample contained projects of day care centers, schools, hospitals, fire stations, offices, etc. Parking facilities were also regarded as public buildings. Projects in this group were rather large on average, but since Public Works Department of Helsinki uses multiple prime contracts regularly in their projects and individual pre-bid cost estimations were available also for

[28]Credita is a private company that stores declarations of public procurements announced in HILMA. Credita's "storage" contains public procurements notices from the beginning of 2003.
[29]Pre-bid cost estimation is necessary information fort the most hypothesis being studied

side-contracts, the average contract size in the sample remained relatively small. Contracts with design responsibility or other than a lump sum price were not included in the sample.

5.2.1 Infrastructure

The data regarding infrastructure projects was collected from the archives of the Centre for Economic Development, Transport and the Environment in Uusimaa, and the Public Works Department of Helsinki. Infrastructure projects contained all kinds of works from pedestrian light installations to road construction and bridge repairing. Due to the heterogeneous project base, statistical results regarding this group were expected to be somewhat noisy. However, adding of infra works increased the full sample size significantly and was therefore a justified course of action.

Statistical noise with regard to infrastructure projects may arise also due to the use of unit price and D&B contracts within the sample. To recall, the client bears more risk in a unit price contract than in a lump sum contract. This is because the client has to bear the risk with regard to the number of items performed. In turn, the contractor bears more risk in terms of D&B contract compared with traditional contracts, since the contractor is liable also for the designing of the structures. However, due to the relatively rare use of other than lump sum price within the sample, the method of payment was not chosen to be controlled in the regression analysis. Moreover, dummy variables of different types of projects are included in the regression primarily in controlling means, in which case there would not be as much need for the type of controlling. When interpretations of the results are made, one just has to remember that dummy variable for infrastructure works captures all uncontrolled effects within the group. Therefore, results might be somewhat noise for project dummies explained in more detail in Chapter 6.

A typical infrastructure project in the sample was rather small. This is because the Finnish Transport Agency is responsible for major road, railway and waterway projects in Finland, whereas ELY centres take care of smaller projects. Projects of the Finnish Transport Agency were not included in the sample, because they would have differed significantly by nature from the rest of the projects within the sample. A typical highway project takes several years, even decades, to be completed. Moreover, the contracts of these projects usually consist of special features that would have impacted the results in a way that could not have been controlled properly. Furthermore, there are a very limited number of companies than can undertake major highway projects in Finland.

5.3 Sample characteristics

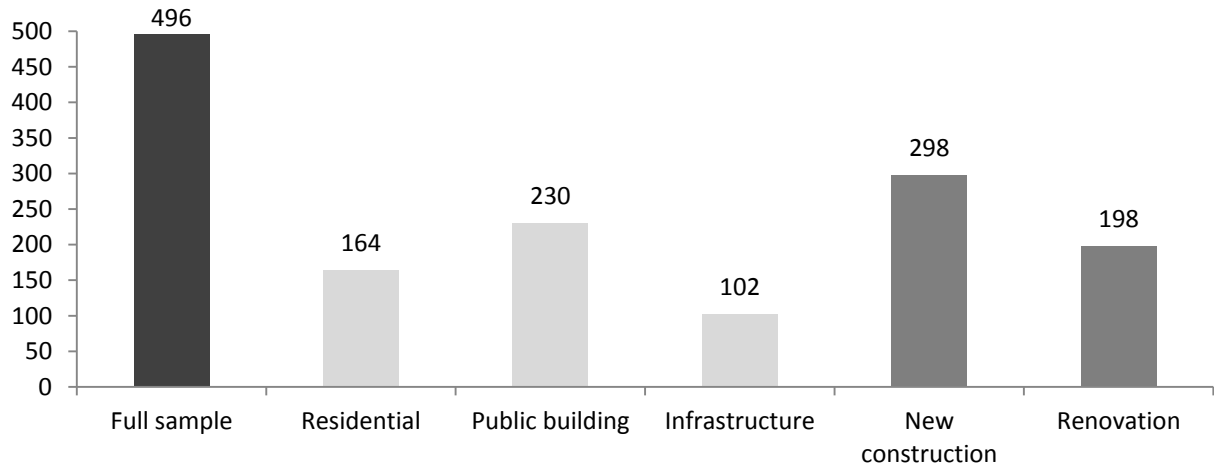
5.3.1 Sample for hypotheses 1 to 6

A construction auction does not always lead to a construction contracts and even if it does, the final contract price might not equal the lowest bid. However, due to simplicity, I will later use the term "contract" to refer the data points in the sample.

Figure 16 presents the sample for studying hypotheses 1 to 6.

Figure 16

The distribution of the sample contracts with regards to different types of projects

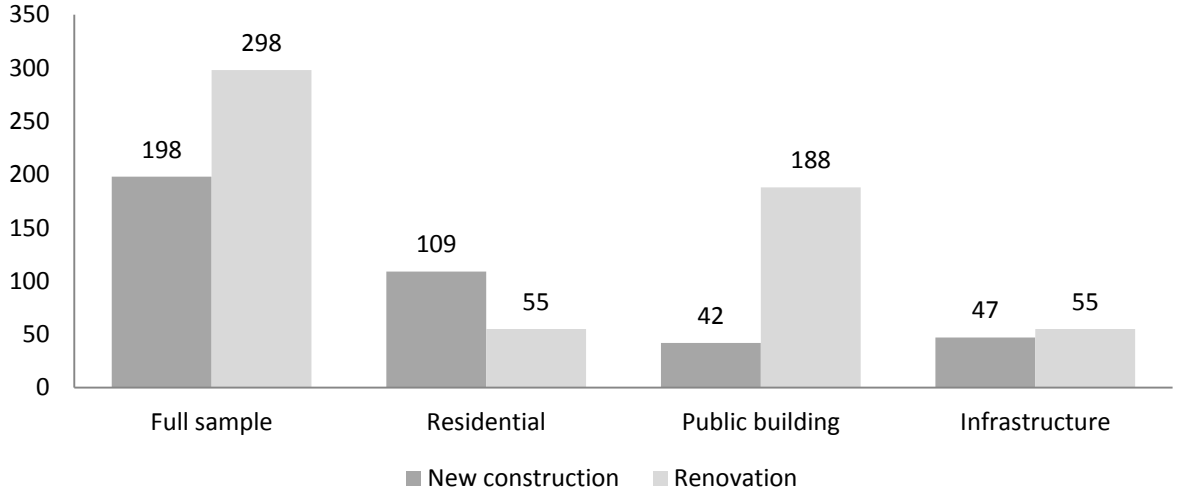


The original sample for studying hypotheses 1 to 6 contained 504 contracts. Since outliers of more than three standard deviations apart from the mean relative bid value were removed, the sample reduced to 496 contracts. What is meant by the mean relative bid value is explained in Chapter 6. As evident from Figure 16, building construction dominates the sample quite heavily. About 80% of the contracts within the sample were related to residential or public building projects. The relatively high number of contracts for public buildings is however somewhat misleading, since multiple prime contracts were commonly used for these projects. Several contracts were thus received for individual projects within this group.

Figure 17 shows how contracts were divided between renovation and new construction.

Figure 17

The division of contracts between renovation and new construction



The vast majority of the contracts for public buildings were related to renovation projects, whereas two third of the contracts for apartment projects were related to new construction projects. Contracts of infrastructure works divided more evenly. Many of the projects contain both renovation and new construction works. The criteria for the division of contracts between renovation and new construction are provided in Chapter 6.

Figure 18 and Figure 19 show the time distribution of the sample contracts.

Figure 18

The distribution of contracts over time

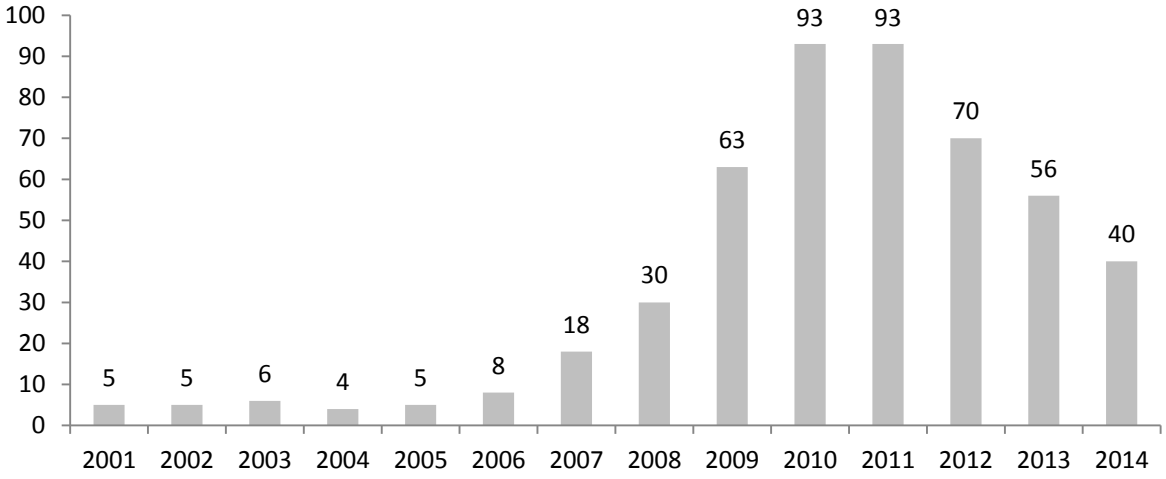
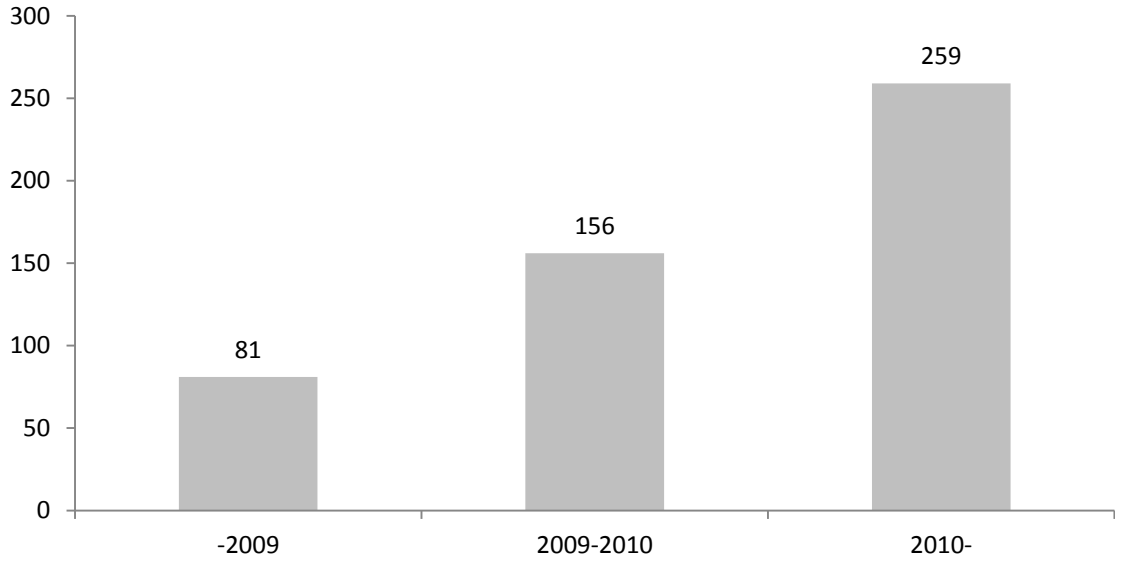


Figure 19

The distribution of the sample contracts around the financial crisis in 2009 and 2010

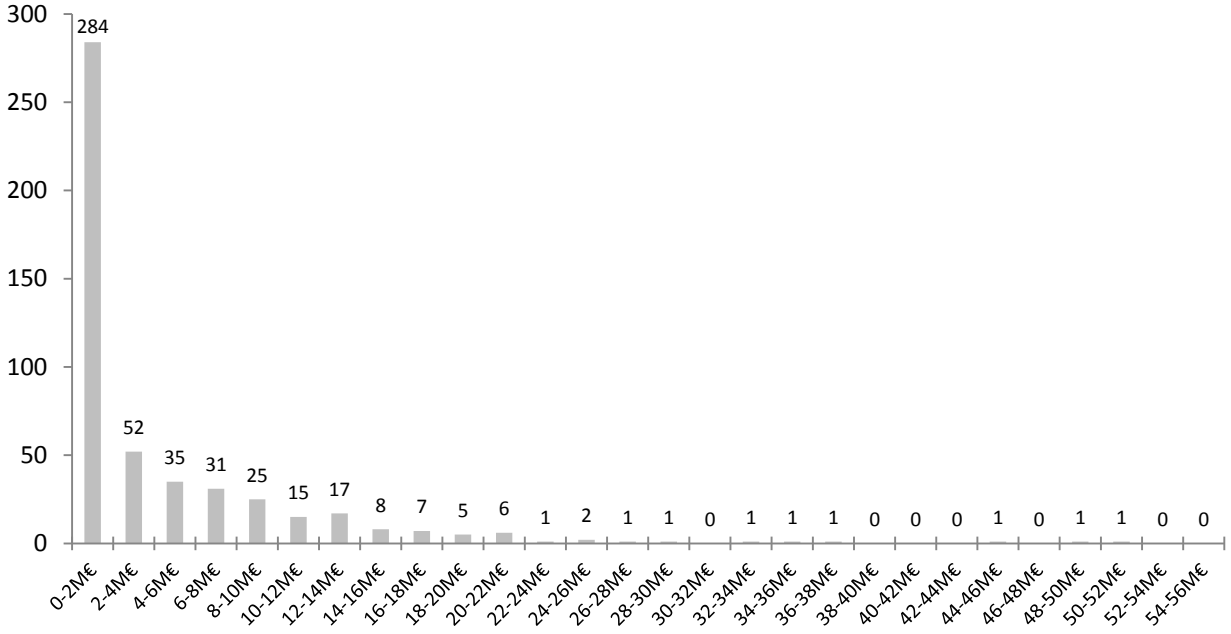


Due to a small amount of data available before the financial crisis, the sample had to be collected over a relatively long time period from 2001 to 2014. A long time period was necessary to ensure sufficient amount contracts before the financial crisis in 2009 and 2010. A long time period is hardly a problem, because the pre-bid cost estimation provided by the client is used as the denominator of the dependent variable in most of the regressions. Therefore, if there were e.g. some legislative changes during the chosen time period, the dependent variable would capture the impact of these changes. This is because it is reasonable to assume that cost consultants or any other expert who is preparing cost estimations, is able to include in their cost estimations the impact of changes in the legislative environment.

Figure 20 shows the distribution of the sample contracts with regard to the amount of the lowest bid in millions of euro.

Figure 20

The distribution of the sample contracts with regards to the amount of the lowest bid



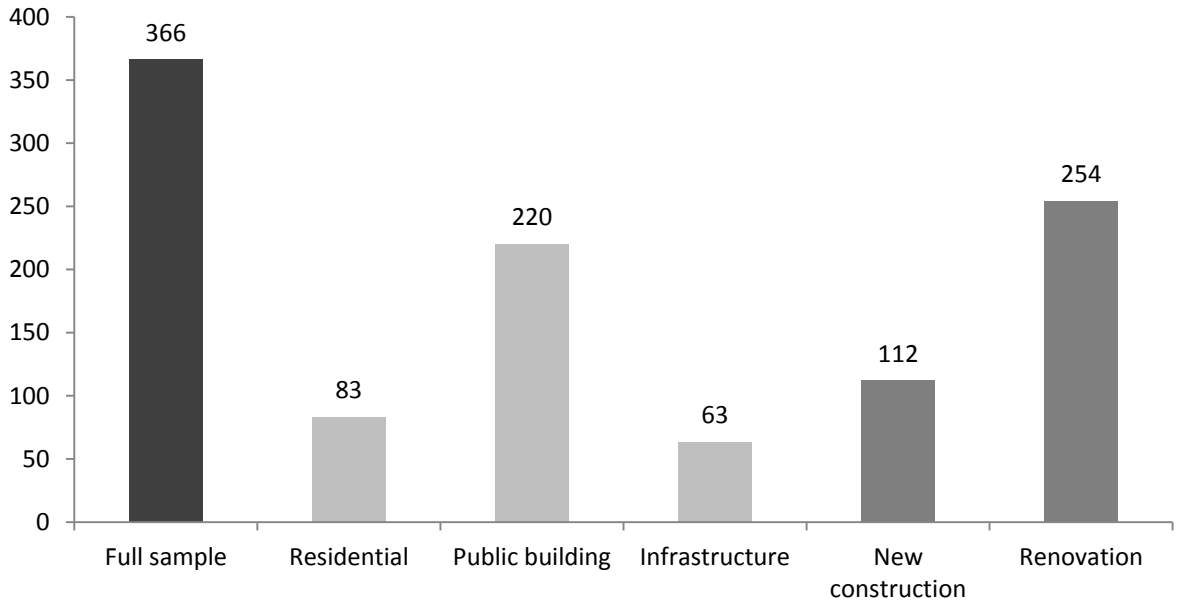
Obviously, the sample is strongly skewed towards smaller contracts. About 57% of the contracts were worth less than 2 million euro, and about 86% of the contracts less than 10 million euro. In turn, 17 contracts were worth more than 20 million euro, whilst the largest contract was worth over 50 million euro. The large number of small contracts in the sample is partly explained by the fact that projects of public buildings in the sample were often divided into multiple pieces, instead of awarding the whole project to just one contractor. Typically these projects were divided into five separate contracts: structural work, electricity, plumbing, heating and ventilation, and automation. Roughly speaking, structural works represented about 60-80% of the total construction costs whilst electricity works were worth about 7-15%. Plumbing and heating and ventilation contracts represented both about 5-10%, whereas an automation work was worth about 1% of the total construction costs.

5.3.1 Sample for hypothesis 7

In order to study bid variance, all individual bids per each of the contract were collected. Figure 21 shows the sample divided into different types of projects.

Figure 21

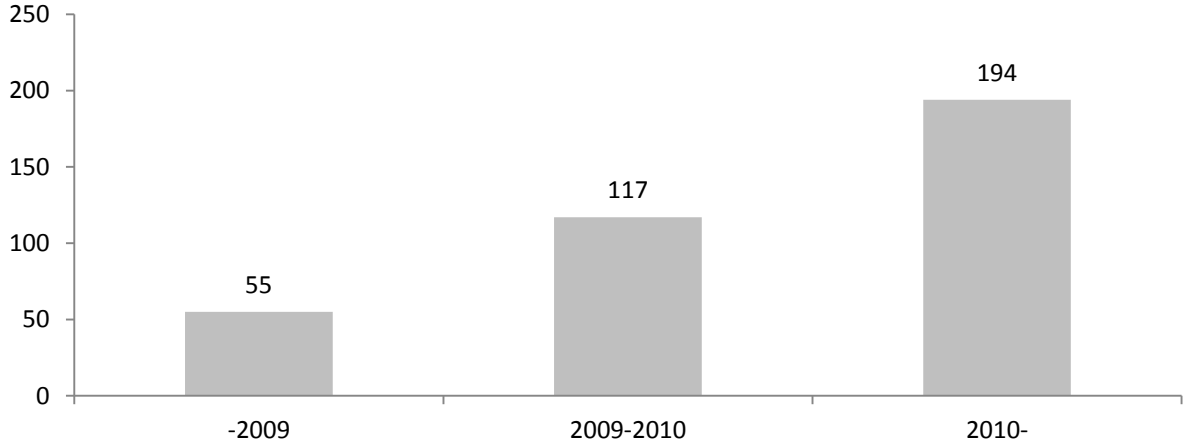
Contracts for studying bid variance



As evident, contracts for public buildings dominate the sample quite heavily. This must be taken into account when interpreting the results with regards to bid variance. Figure 22 shows the time distribution of the sample contracts for studying bid variance.

Figure 22

The time distribution of the sample contracts for bid variance

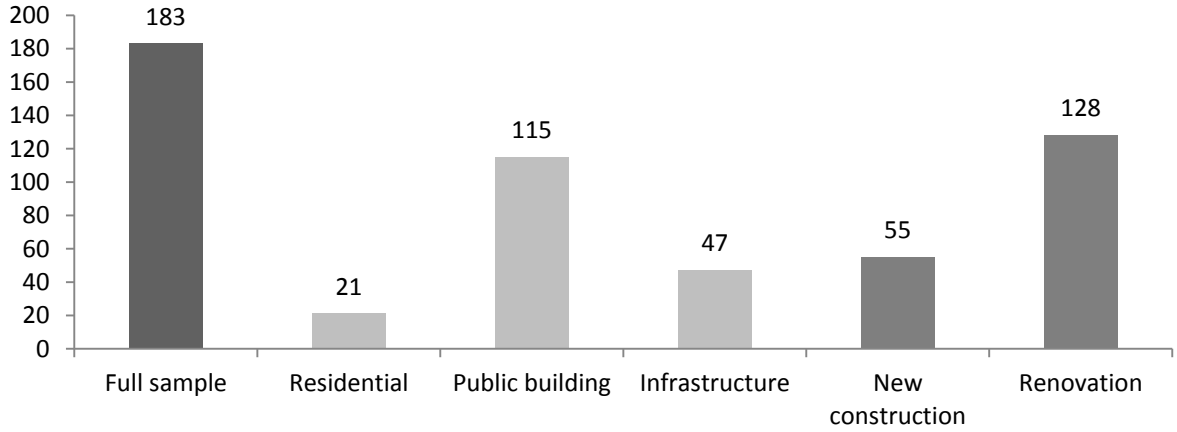


5.3.2 Sample for hypotheses 8 to 10

Figure 23 shows the sample for studying budget overrun hypotheses.

Figure 23

The sample for studying budget overruns



The sample for studying budget overruns was relatively scarce due to limited amount of data available. Moreover, contracts for public buildings and renovation projects form the majority of the sample. This must be taken into account when interpreting the results.

6 METHODOLOGY

The following chapter explains the research methods used in this study. First, the means of controlling statistical noise arising from extraneous factors are presented. After that the dependent and independent variables of the regressions are presented.

6.1 Controlling

As mentioned earlier, there seems to be a few recurring factors that influence the bidding decision of contractors. According to Flanagan and Norman (1982) these factors are:

1. Contract size and complexity
2. Regional market conditions
3. Current and future workload
4. Type of client
5. Type of project

In addition to the above list, researchers have found evidence that managerial capacity and capability as well as competition affect the bidding behavior. The following two factors are thus of interest in this study as well:

6. Managerial capacity and capability
7. Competitive environment

To recall, the data for this study was collected from the province of Uusimaa and mainly from the metropolitan area. The limitation was done in the purpose of minimizing sample variation caused by the geographical location or the regional market conditions that could induce unnecessary noise in the results. Moreover, the data was gathered from highly prominent and well-known public procurers, which are more or less similar with each other. Thus, statistical noise arising from the variation in factor 2 and 4 in the list above was minimized already through sample selection. The rest of the factors are of interest in this study and captured using direct measures or proxies. Moreover, regressions of sub samples of data work also as a kind of controlling tool since variance is expected to be lower in a more homogeneous group of projects.

6.2 Regression variables

6.2.1 Dependent variables

Relative bid price

The dependent variable in the regressions (1-12) in Table 7 and Table 8 is the relative bid price, measured as the lowest bid divided by the pre-bid cost estimation provided by the client. To clarify this, if the pre-bid cost estimation was €10,000,000 and the lowest bid was €11,500,000 then the value of the variable would be 1.15 or 115%. Likewise if the lowest bid was €9,000,000 the value would be 0.90. The pre-bid cost estimates were prepared either by independent estimating firms regularly used by the constructors in the sample, or internally within the constructors' organizations. If the cost estimation was given as a range, the mean of the range was used as the cost estimation.

The time of the project preparation process when the cost estimation is made naturally affects the accuracy of the estimation. If cost estimations were prepared at different stages of the project preparation process, the latest was chosen for the sample. It is important to notice that even if cost estimations were inaccurate, it is not a problem for the matters being studied. This is because what we are interested here is the relative change in bids, not the absolute value of the pre-bid cost estimation. The pre-bid cost estimation works primarily as a bench mark value, enabling the studying of changes in bids. Inaccuracy is though a problem if cost estimations prepared at different stages of the project preparation process are systematically unbiased. For example, if cost

estimations are always more conservative at earlier stages of the process this may cause some bias in the results. This is actually true according to my discussion with the constructors. When the project development phase proceeds, the risk contingency in pre-bid cost estimation is gradually reduced. However, since a vast majority of the cost estimations in the sample are prepared more or less at the same stage, heteroscedasticity in this perspective is hardly a problem.

Hypothesis 3 states that the larger the project, the more accurate the pre-bid cost estimate. The data is hence expected to be heteroscedastic at least between the value of the contract and the relative bid price. This can lead to a situation where a certain variable does not appear to be statistically significant even though it actually is. This problem is reduced by running regressions also for subsets of data. Regressions are run e.g. for groups with values close to each other, which should mitigate the heteroscedastic problem between the value of the contract and the relative bid price.

Relative number of bids received

The dependent variable in the regressions (13-18) in Table 9 is the relative number of bids received, measured as the number of bids received divided by the number of bids sought. The number of bids sought equals the number of contractors, who were sent the tender documents. To clarify this, if the number of bids sought was 10 and the number of bids received was 8, then the relative number of bids received would be 0.8.

Bid variance

The dependent variable in the regression (19) in Table 10 is the standard deviation of all bids per each of the contract. Standard deviation should be lower in an economic downturn.

Accuracy of the pre-bid cost estimation

The dependent variable in the regression (20) in Table 10 is the absolute value of the relative deviation of the lowest bid from the pre-bid cost estimation. To clarify this, if the pre-bid cost estimation was €10,000,000 and the lowest bid was €11,000,000 then the value of the variable would be 0.10 or 10%. Likewise if the lowest bid was €9,000,000 the value would be 0.10. As the variable always gets a positive value, a negative regression coefficient stands for better accuracy and a positive regression coefficient lower accuracy.

Relative budget overrun

The dependent variable in the regression (21) in Table 10 is the relative budget overrun, measured as the difference between the final cost of the project and the lowest bid divided by the lowest bid.

To clarify this, if the lowest bid was €10,000,000 and the final cost was €11,000,000 then the relative budget overrun would be 0.1 or 10%.

If the final cost of the project is not available, the relative amount of change orders and extra works, measured as a percentage of the lowest bid, is used as proxy for budget overruns. To clarify this, if the lowest bid was €10,000,000 and the amount of change orders and extra works was €1,000,000, the relative budget overrun would be 0.1 or 10%.

The using of change orders and extra works as a proxy for budget overruns, may cause some upward bias in the results, since it does not take into account e.g. damages paid to the client due to delays in the construction schedule. However, in most cases the amount of change orders and extra works forms the majority of the variance between the initial contract price and the final cost of the project, thus this upward bias is likely to be small in magnitude.

Change orders and extra works are expected to occur in almost all construction projects, where the method of payment is a lump sum. This is general knowledge in the industry. Since budget overruns usually refer to unexpected cost overruns, the term does not accurately describe the situation studied. However, due to simplicity the difference between the final cost of the project and the value of the lowest bid is called budget overrun in this thesis.

Number of bids received
The number of bids received on each of the contracts forms the dependent variable of the regression (22) in Table 10Table 10.

6.2.2 **Independent variables**

Number of bids sought
The number of contractors, who were sent the tender documents, i.e. the number of bids sought, is used as a proxy for the number of potential bidders. This is because the number of bids sought reflects the competitive environment. Typically more bids are asked if more contractors are operating in a certain market sector.

Number of bids received
The number of bids received on each of the contracts forms perhaps the most interesting variable of this study.

The number of bids sought and the number of bids received reflect both the level of competition in this study. This is a different compared with the previous studies that have used only the number of bids received as a proxy for the competition. The chosen approach takes more completely into account the effects of competition on bid prices. This is because, in order to receive more bids, the client has to seek more, which is expected to increase the entry cost and therefore bids.

Value of the lowest bid

The value of the lowest bid captures the effect of complexity of the project as well as size. This is because complexity and size increases the cost of the construction work and therefore increases the lowest bid. The value of the lowest bid is measured in millions of euro. To clarify this if the value of the lowest bid is €10,500,000 the value of the variable would be 10.5.

6.2.2.1 Dummy variables

The impact of categorical factors such as the type of contract is captured using dummy variables. Dummy variables take the value 0 or 1 to indicate the absence or presence of some categorical effect. The variable shows the impact of the effect when presence.

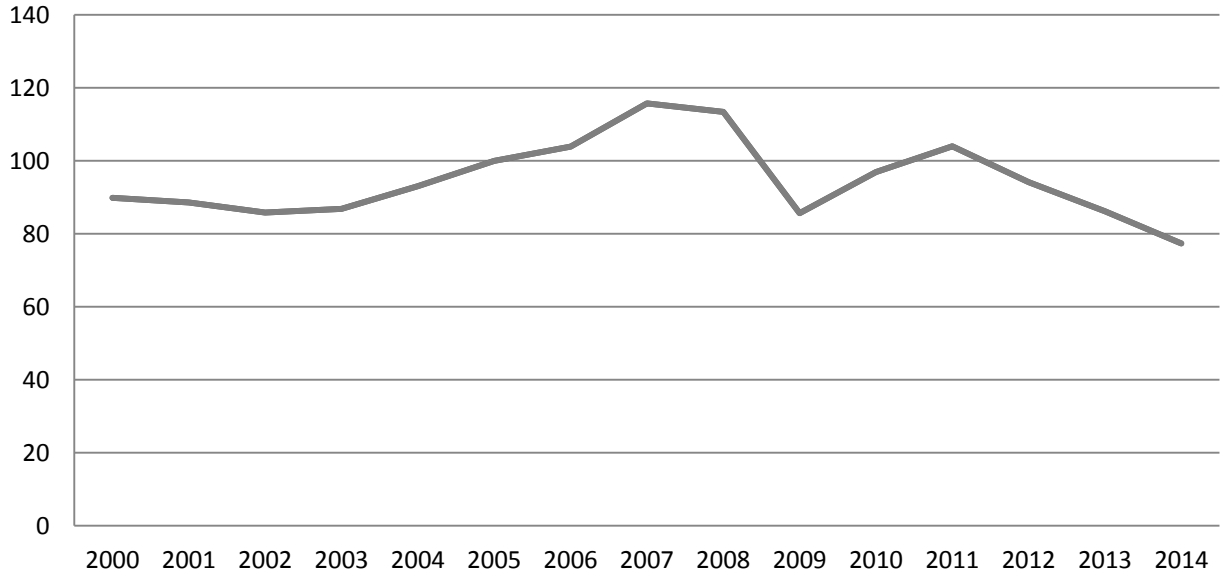
Pre crisis

Construction volume reflects the managerial capacity and capability of the companies, since current work load affects the availability of resources. When the construction volume is at high level, there are less and less skilled people available. On contrary, if the construction volume is at low level, there is an ample amount of skilled people without work. In Figure 24 is shown the yearly average of the new construction volume index in the past years.

Figure 24

The yearly average of the new construction volume index in Finland in 2000-2014 (2005=100)

Source: Statistics Finland



The construction industry is a late-cycle business, in which the impacts of the general macroeconomic events are shown with a delay, usually within one to two years. This is why the construction volume plummeted until in 2009 and 2010, due to the financial crisis in 2008 and 2009. In order to capture the impact of the financial crisis compared with the time before the crisis, a pre-crisis dummy is put in place. The variable gets a value of 1 if the bid was received before 2009 and 0 otherwise.

After crisis

In order to capture the impact of the financial crisis compared with the time after the crisis, an after-crisis dummy is put in place. The variable gets a value of 1 if the bid was received after 2010, and 0 otherwise.

Renovation

The division of projects between renovation and new construction is made by interpreting the descriptions of the projects. If the project is considered as a renovation project, the variable gets a value of 1 and 0 otherwise. Projects regularly contain both renovation and new construction works. Due to simplicity, projects that contain both renovation and new construction works are considered as renovation projects. However, if the renovation part is trivial compared with the totality, the project is considered as a new construction project. Demolition works are considered as renovation works. Since, the division of projects between renovation and new construction is made by

interpreting the descriptions of the projects; there is a slight room for error. Yet, due to a relatively large sample size, possible errors have at most a minor effect on the overall results.

Multiple prime contract

If the contract type is a multiple prime contract, the variable gets a value of 1 and 0 otherwise.

Side-contract

If the contract is not a main contract nor for the structural works of a multiple prime contract, the variable gets a value of 1 and 0 otherwise. Multiple contracts are thus handled as they would all be subordinated to the contractor, who is responsible for structural works of the project. This approach enables the studying of different types of works within a larger totality. As mentioned earlier, the structural part of the work usually causes the majority of the construction costs. Moreover, it an industrial custom to subordinate other contracts to the contractor, who is in charge of the structural works and has the best ability to coordinate the works of other contractors i.e. side-contractors.

In order to avoid multicollinearity caused by the high correlation between multiple prime contract and side-contract variables, side-contract variable is included only in the regression of the full sample. Correlation between the variables is then 0.681, which is low enough figure to avoid problems of multicollinearity.

Residential

If the project is considered as a residential building, the variable gets a value of 1 and 0 otherwise.

Public building

If the project is considered as a public building, the variable gets a value of 1 and 0 otherwise. As a side note, infrastructure projects do not have an own dummy variable. The values of the residential and public building dummies are relative to the infrastructure group. For example, suppose that the relative bid price for the residential dummy gets a value of 0.05. This would mean that the relative bid price is on average 0.05 higher for the group of residential buildings than for the group of infrastructure projects.

6.3 Limitations

One could argue that the variables chosen for the study are not sufficient to capture all the influential factors affecting bids during the chosen time period. This is a reasonable concern, especially; because the time span of the study is long and significant economic and legislative

turbulent have occurred during that time. For instance, the legislation that governs the construction industry might have changed in a way that has impacted bid prices. However, since the denominator of the dependent variable in most of regressions is the pre-bid cost estimation provided by the client, the impact of changes that are not captured by the independent variables are captured by the dependent variable. This is because it is reasonable to assume that the pre-bid cost estimation incorporates the impact of changes either in the legislative or the competitive environment. Thus the dependent variable itself works also as a control variable, reducing statistical noise in the results.

Although the relative bid price is a useful variable to measure the price competitiveness of bids, it has pitfalls as well. A major concern of using it as a benchmark value is its non-standard nature. Since the properties of the projects are expected to affect bids, they may also affect the pre-bid cost estimation. For example, if the client expects the level of competition to be lower for some reason, this information is probably incorporated in the pre-bid cost estimation. Such a mechanism will decrease the statistical significance of the regression coefficients and increase the likelihood of type II error i.e. failing to detect an effect that is present, but would decrease the likelihood of type I error i.e. detecting an effect that is not present. Some findings may thus appear to be statistically insignificant even though they actually are. In the absence of better measures for the price competitiveness of bids, the pre-bid cost estimation though remains to be the best tool for this purpose. One just has to be cautious, when making interpretations about the results.

A construction auction does not always lead to a construction contracts and even if it does, the final contract price might not equal the lowest bid. In many cases, the price is not the only criteria for awarding the contract. Due to simplicity, it was however assumed that a contract was agreed with the price of lowest bid. This might somewhat exaggerate budget overruns, but since the contract is awarded to the lowest bidder in vast majority of contracts, this is just minor bias in the data. Moreover, there is no need to assume that the bias would systematic by nature, thus the impact is likely to vanish when large amount of data is analyzed together.

7 RESULTS

7.1 Descriptive statistics

Table 2 shows the descriptive statistics of the samples for studying hypotheses 1 to 7.

Table 2

Descriptive statistics of the sample for studying hypothesis 1 to 7

Sample	Total low bids (M€)	Total pre-bid estimates (M€)	Mean relative bid	Number of contracts	Mean value of the lowest bid (M€)	Total number of bids sought[1]	Total number of bids received	Mean number of bids sought	Mean number of bids received
Full	2179	2273	0.88 (0.90)	496	4.39 (1.28)	4687	2656	9.45	5.35
Renovation	580	644	0.83 (0.83)	298	1.95 (0.79)	3163	1806	10.61	6.06
New construction	1599	1629	0.95 (0.97)	198	8.07 (5.58)	1524	850	7.70	4.29
Residential	1702	1708	1.01 (1.01)	164	10.38 (8.27)	1205	609	7.35	3.71
Public building	318	383	0.79 (0.78)	230	0.79 (0.78)	2569	1513	11.17	6.58
Infrastructure	159	181	0.89 (0.88)	102	1.56 (0.99)	913	534	8.95	5.24

Note: Median in parentheses

The full sample of the study contained 496 contracts, which received 2656 bids in total. The total value of the contracts was about €2,179 million whilst the smallest contract was worth €15,100 and the largest €50.420 million. The average contract size was €4.39 million, and the median €1.28 million.

As can be seen from Table 2, the average relative bid of the full sample was 0.88. This means that the lowest bid was on average 12% lower than the pre-bid cost estimation prepared by the client. There are however major deviations between different types of projects. As expected, pre-bid cost estimations were more accurate for new construction projects than for renovation projects. Respective figures were 0.95 and 0.83. More interestingly, pre-bid cost estimations for residential projects seem to be much more accurate than estimations for other types of projects. The mean relative bid price of contracts for residential projects was 1.01 whilst the respective figures for public buildings and infrastructure projects were 0.79 and 0.89. Better accuracy might be explained by the fact that 66% of the contracts for residential projects were new construction projects, whereas comparable figures for public buildings and infrastructure projects were 18.3% and 46.1%.

Interestingly, the total amount of low bids, €2,179 million, is actually pretty close to the estimated amount of low bids, €2,273 million. The difference is just 4.1% whilst the difference between arithmetic averages was 12%. This finding suggests that pre-bid cost estimations become more accurate when the project size increases. A possible explanation is that more effort is put on estimation when the contract size becomes larger. Figure 25 and Figure 26 show the relation between the value of the lowest bid and the relative bid price.

Figure 25

The relation between the value of the lowest bid and the relative bid price

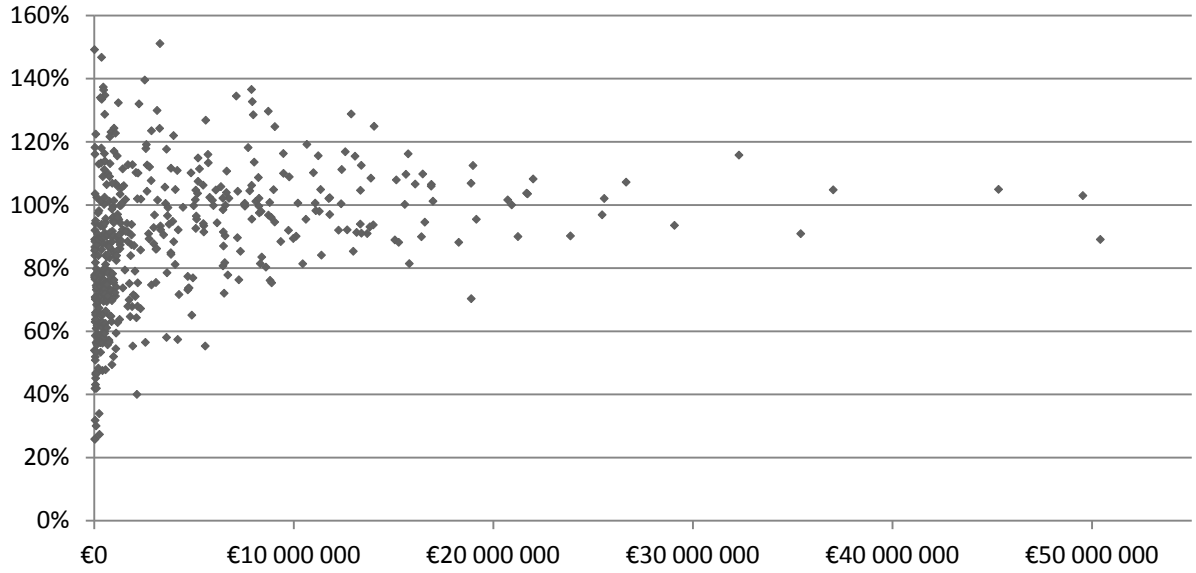
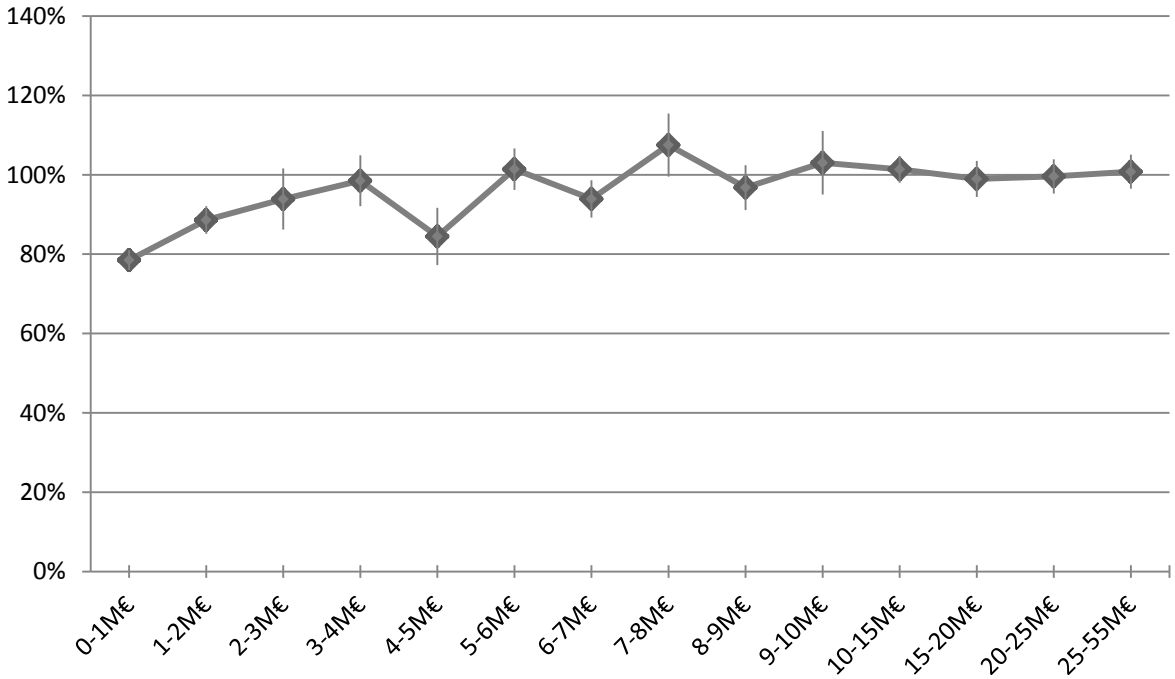


Figure 26

The relation between the value of the lowest bid and the mean relative bid price

Note: Vertical line shows the 90% confidence interval of the mean.



It seems that pre-bid estimates become more accurate and less volatile when the contract size increases. We cannot though be sure about this causality, since 76.8% of the contracts above 3

million euro in the sample were for residential projects. The relation between the relative bid price and the value of the contract may thus be explained by the higher accuracy of the cost estimations within the group of contracts for residential projects. Nonetheless, it seems that the accuracy of the pre-bid cost estimations becomes better also within a group of contracts with a value higher than 3 million euro. This finding suggests that pre-bid cost estimations really become more accurate when the contract size increases. This is supporting evidence of Hypothesis 3. Multiple regression analysis is though needed to confirm the finding.

Contracts for residential projects are on average much larger in the sample than contracts for other types of projects. The mean contract size for residential projects was €10.38 million, whereas it was just €0.79 million for public buildings and €1.56 million for infrastructure projects as shown in Table 2. A part of the difference in the accuracy of pre-bid cost estimations may thus be explained by the sheer difference in contract sizes. The sample of contracts for public buildings contains a lot of small contracts such as automation, heating and ventilation, electricity and plumbing works. Since, the majority of the total construction costs come from the structural part of the work, pre-bid cost estimation efforts might have been divided unevenly between the contracts. The largest contract might have acquired most of the pre-bid cost estimation efforts, with the expense of other contracts. Smaller contracts may be estimated roughly, but conservatively to avoid budget overruns. This kind of behaviour would distort the arithmetic mean of the relative bid price downward, although the cost estimation for the whole project would be rather accurate in euro terms. This argument is supported by the fact that the weighted average of the relative bid price for public buildings is 0.86 whilst the arithmetic average was just 0.79.

The sample of contracts for infrastructure projects is very heterogeneous including projects from bridge construction to pedestrian light installations. Due to a very mixed project base, reasonable interpretations of the results are difficult to be made. However, rather low accuracy of the pre-bid cost estimations within the group of infrastructure projects might be explained by the aforementioned arguments: small average contract size and a high number of renovation projects within the sample.

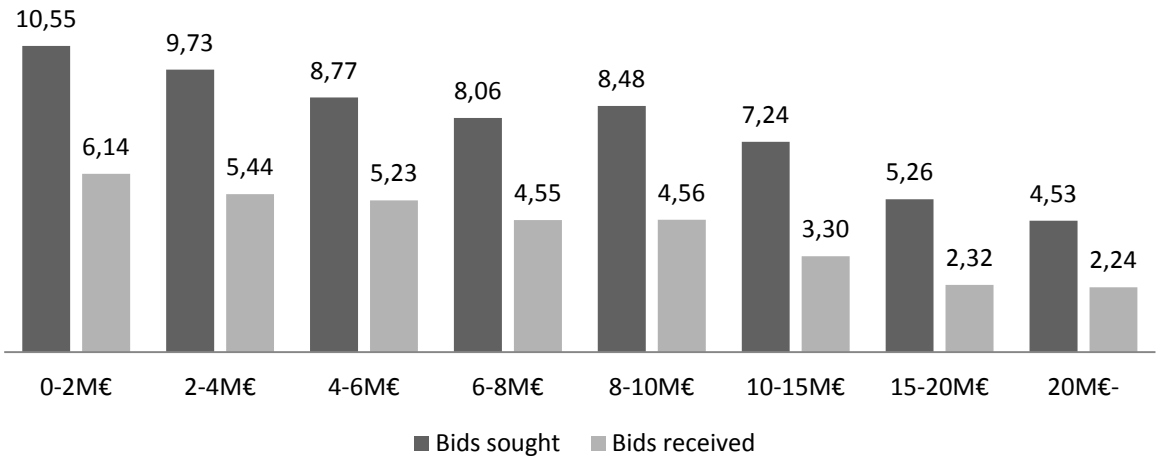
All in all, it seems that pre-bid cost estimations of public buildings and infrastructure works are very much on the safe-side. This might be a deliberated decision. Different institutions have dissimilar budget constraints that call for different level of certainty from pre-bid cost estimations. For instance, if the budget is very flexible, there is less need for very accurate cost estimations. In turn, if the budget is very tight, accurate cost estimations are important. In

addition, there might be differences in the budget approval processes. For instance, the budgets of projects owned by the city of Helsinki must be approved by the city council until the procurement can begin. This may call for more conservative cost estimation so that the budget would not be exceeded later. The housing production entities do not have similar budget approval processes. Nevertheless, there is not much reason to compare different types of projects together. What is of interest in this study is how bids behave and how bids affect budget overruns. The accuracy of pre-bid cost estimates is of course an interesting by-product.

The average amount of bids received for a contract in the sample was 5.35 whilst the amount of bids sought was 9.45. There is not much difference between different types of projects with regard to how many bids are received as a percent of the bids sought. Of the all bids sought, about 55% were received among all types of projects. The number of bids sought and received is however negatively correlated with the size of the contract. Figure 27 shows the relations between the value of the lowest bid and the number of bids.

Figure 27

The relation between the value of the lowest bid and the number of bids

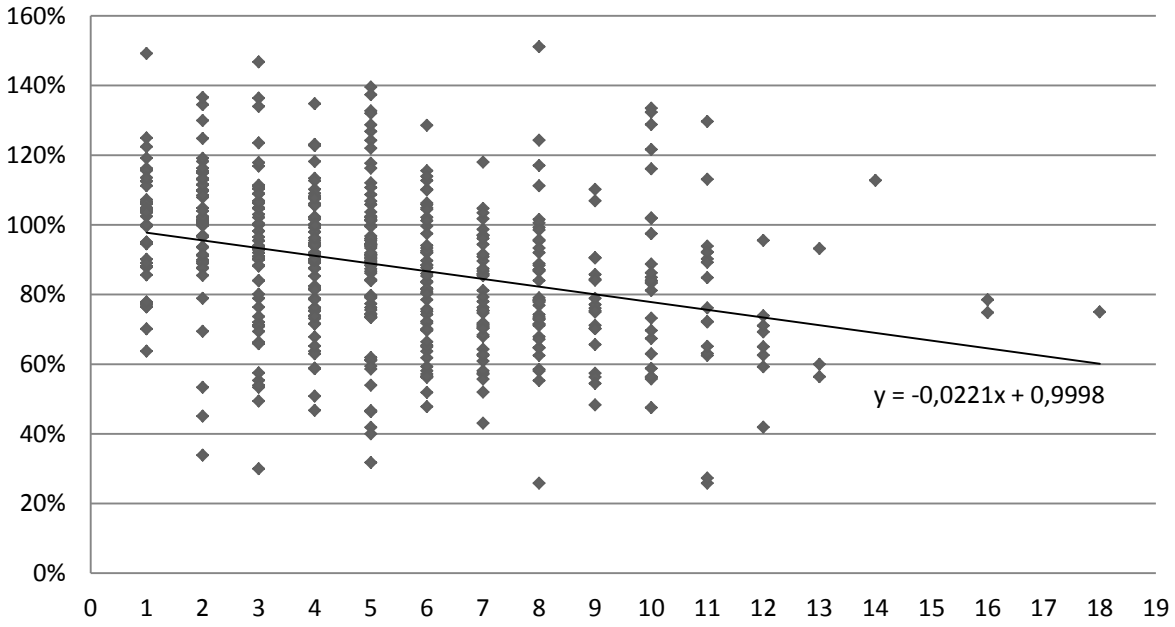


It seems that there is a decent amount of competition around small contracts, but very little around large ones. The client received on average just 2.24 bids for contracts above 20 million euro in value. The figure is so low that it is reasonable to question whether we have a functional market at the moment. Since the level of competition seems to be very much correlated with the value of the contract, I will expect to find causality between the value of the contract and the relative bid price.

Figure 28 and Figure 29 show the relation between the number of bids received and the relative bid price. As expected, the relative bid price is negatively correlated with the number of bids received. Bids seem to become about 2.2% more competitive per each additional bid received, when compared with the pre-bid cost estimation. Although there seems to be a strong negative correlation between the variables, we cannot however confirm this finding until multiple regression analysis is performed.

Figure 28

The relation between the number of bids received and the relative bid price



Regression analysis used in this study assumes that the relation between the variables studied is linear. This is perhaps not the case as depicted in Figure 15. For example Paul and Carr (2005), who found that there will be 3.79% increase in project costs, on average, for each bidder lost, had R-square value of just 10.2% for the linear regression and 38% for the curvilinear regression. However, based on Figure 28 the assumption of linearity is justified. The relation seems to be linear at least between the number of bids received and the relative bid price.

Figure 29

The relation between the number of bids received and the mean relative bid price

Note: Vertical line shows the 90% confidence interval of the mean. Projects with more than 13 bids were removed due to an insufficient number of data points.

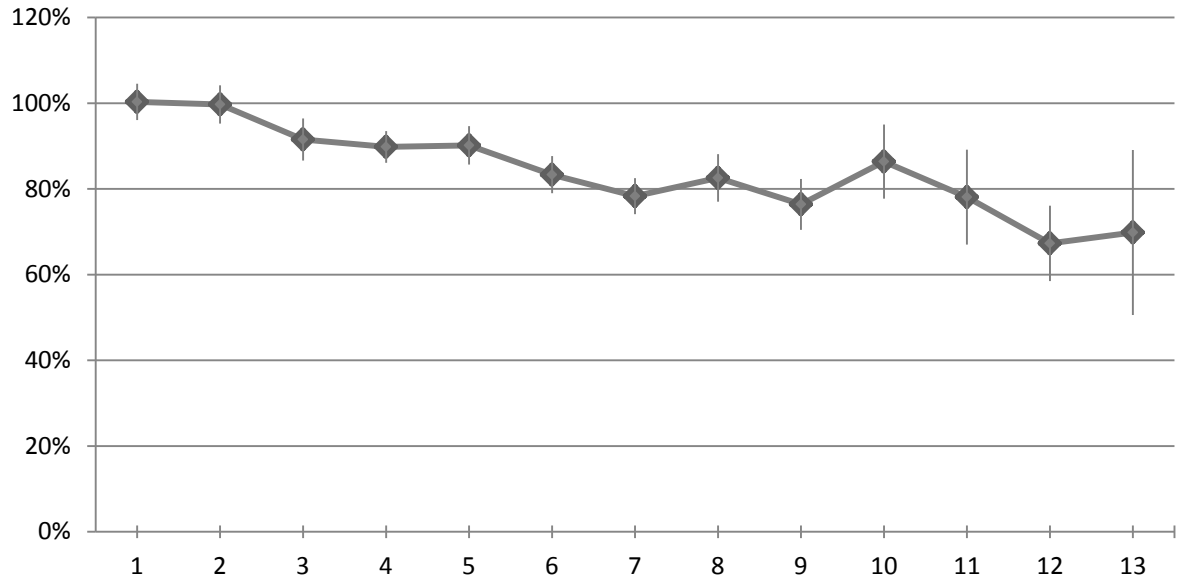


Table 3 shows the results of the correlation analysis between the relative bid price and the variables: the number of bids received, the number of bids sought and the value of the lowest bid.

Table 3

Pearson correlations - Deviation from the pre-bid cost estimate versus the number of bids received, the number of bids sought and the value of the lowest bid

		Number of bids received	Number of bids sought	Value of the lowest bid
Relative bid price	Pearson correlation	-0.311[1]	-0.182[2]	0.307[3]
	Sig. (2-tailed)	—	—	—
	N	496	496	496

[1]Correlation is significant at the 0.000000000002 level (2-tailed)
[2]Correlation is significant at the 0.00005 level (2-tailed)
[3]Correlation is significant at the 0.000000000003 level (2-tailed)

Correlation results indicate that there is a statistically significant relation between all of the explanatory variables and the relative bid price. Of the 496 bids examined, there is practically a hundred percent probability that these relations did not occur by chance alone.

Correlation between the number of bids received and the relative bid price was -0.311. This finding strongly suggest that the higher the number of bidders participating, the lower the bid price. The correlation is very close to the correlation -0.320 found by Paul and Carr (2005). The number of bid sought and the relative bid price are also negatively and statistically significantly correlated with each other, which furthermore support the theory that competition decreases bids. The value of the lowest bid is positively and statistically significantly correlated with the relative bid price. This would indicate that the larger the contract, the less competitive the bid, when measured against pre-bid cost estimation. Again, multiple regression analysis is still needed to confirm the findings.

Figure 30 and Figure 31 show the relation between the number of bids received and the mean relative bid price with regard to renovation and new construction projects.

Figure 30

The relation between the number of bids received for renovation projects and the mean relative bid price

Note: Vertical line shows the 90% confidence interval of the mean. Projects with more than 12 bids were removed due to an insufficient number of data points.

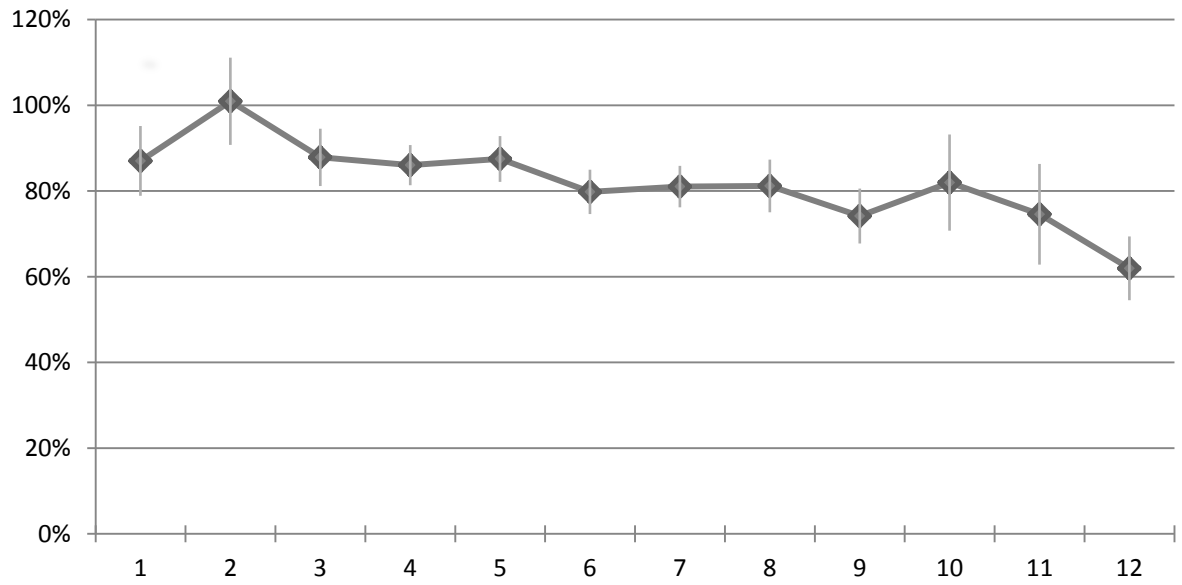
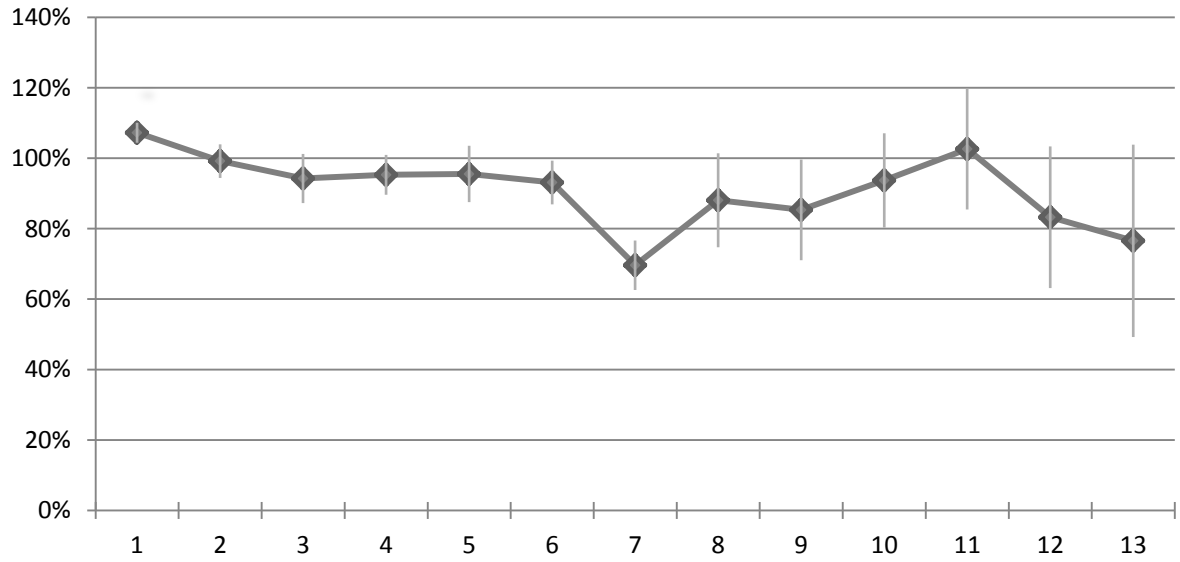


Figure 31

The relation between the number of bids received for new construction projects and the average relative bid price

Note: Vertical line shows the 90% confidence interval of the mean. Projects with more than 13 bids were removed due to an insufficient of number data points.



Correlation seems to be slightly stronger for renovation projects than for new construction projects based on Figure 30 and Figure 31. The lowest bid price becomes more competitive for both type of projects, when the number of bids received increase. The effect is however stronger for renovation projects than for new construction projects. This would indicate that auctions for new construction projects have more common value elements than auction for renovation projects. This is in contrast with Hypothesis 1 that states that the number of bids received affects the winning bid downward more strongly in auctions for new construction projects than for renovation projects.

Table 4 shows the descriptive statistics of the samples for studying hypotheses 8 to 10.

Table 4

Descriptive statistics of the sample for studying hypothesis 8 to 10

Sample	Number of projects	Total low bids (M€)	Total costs (M€)	Mean budget overrun (%)[1]
Full	183	570	650	18.3 (15.7)
Renovation	128	245	295	19.8 (17.4)
New construction	55	325	355	14.8 (6.6)
Residential	21	202	205	1.1 (0.6)
Public building	115	297	363	22.3 (18.2)
Infrastructure	47	71	81	16.1 (10.5)

Note: Median in parentheses
[1] Costs above the lowest bid measured directly or using the amount of change orders and extra works as a proxy

The average budget overrun in the sample was 18.3% above the lowest bid. However, the difference between the total costs of the contracts, €650 million, and the total amount of the lowest bids, €570 million, is just 14.0%. This would suggest that budget overruns are smaller in magnitude in larger contracts. This is in contrast with the earlier findings of Sweeney (2009) and with Hypothesis 8 that states that budget overruns are in relative terms greater in larger contracts. A possible explanation might be that projects studied in this thesis were on average much smaller than projects in the previous studies. The relation may change upside down when the scale of the projects increases significantly.

Renovation projects seem to be associated with higher budget overruns than new construction projects. Respective figures were 19.8% and 14.8%. This finding is in line with Hypothesis 9 that states that budget overruns are in relative terms greater in renovation projects than in new construction projects. This is because it much more difficult to define accurate contract documents for renovation projects than for new construction projects. Moreover it seems that a few very large budget overruns raised the arithmetic average of the new construction projects, because the median budget overrun within the group is just 6.6%.

Budget overruns seem to be very small in contracts for residential projects, but rather large in contracts for public buildings and infrastructure works. The average budget overruns was just 1.1% for residential projects, but 22.3% for public buildings and 16.1% for infrastructure projects. A part of this difference between the groups is probably explained by the fact that

contracts for residential projects in the sample are large and often for new construction projects. Contracts for public buildings and infrastructure project, instead, are smaller and frequently for renovation projects.

To recall, relative bids were much lower for public buildings and infrastructure works than for residential buildings, see Table 2. Therefore, it is interesting to see the ratio between the total cost of the project and the pre-bid cost estimation. Table 5 shows the relation between the pre-bid cost estimations and the total costs of the projects.

Table 5

The relation between pre-bid cost estimations and total costs of the projects

Sample	Mean relative bid	Mean budget overrun	Mean relative bid + mean budget overrun
Full	0.88 (0.90)	0.183 (0.157)	1.063 (1.057)
Renovation	0.83 (0.83)	0.198 (0.174)	1.028 (1.004)
New construction	0.95 (0.97)	0.148 (0.066)	1.098 (1.036)
Residential	1.01 (1.01)	0.011 (0.006)	1.021 (1.016)
Public building	0.79 (0.78)	0.223 (0.182)	1.013 (0.962)
Infrastructure	0.89 (0.88)	0.161 (0.105)	1.051 (0.985)

Figures in Table 5 are calculated somewhat artificially by summing up the mean figures from Table 2 and Table 4. It should nevertheless give some grasp of the real phenomenon. It appears that pre-bid cost estimations are rather accurate for all types of projects when costs above the lowest bid price, mostly caused by change orders and extra works, are taken into account. Moreover, figures in the fourth column in Table 5 meet the real meaning of the term "budget overrun" better. However, the fact that this figure is not used as the measure for budget overrun in this study, is not a problem. This is because; we are not that much interested in the absolute levels of budget overruns, instead, the relative change in budget overruns. It does not matter, which of the figures is used for this purpose, but due to practical reasons it was easier to use the chosen one.

Although the figure in column 4, in Table 5, seems rather accurate for public buildings, this is not the whole truth. Public Works Department of Helsinki adds provisions for change orders and extra works on top of their pre-bid cost estimations. These provisions are not included in

the figures of this study. A typical provision for change orders and extra works is about 10%. This means that although it seems that the total costs are just 1.3% above the pre-bid cost estimation, the real figure is somewhere around 8.7% less than the pre-bid cost estimation. Figure 32 shows a graphical illustration of the situation.

Figure 32

Pre-bid cost estimation versus actual costs - public buildings

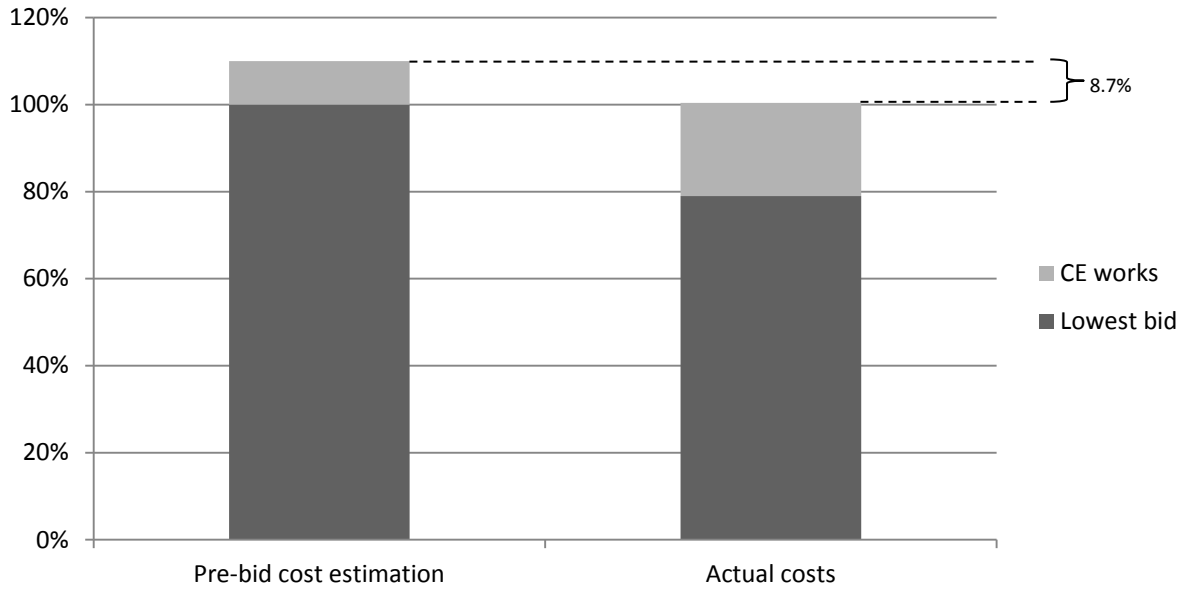


Table 6 shows the results of the correlation analysis between budget overrun versus the relative bid price and the value of the lowest bid.

Table 6

Pearson correlations – Budget overrun versus the relative bid price and the value of the lowest bid

		Relative bid price	Value of the lowest bid
Budget overrun	Pearson correlation	-0.197[1]	-0.184[2]
	Sig. (2-tailed)	—	—
	N	183	183

[1]Correlation is significant at the 0.0075 level (2-tailed)
[2]Correlation is significant at the 0.0127 level (2-tailed)

Correlation results indicate that there is a statistically significant relation between the explanatory variables and budget overruns. Correlation between the relative bid price and budget overrun was -0.197 being statistically significant at .00075 level. This finding suggests

that the lower the bid, the higher the budget overrun, measured as costs above the bid. This is strong evidence of Hypothesis 10, which states that relative bids are negatively correlated with relative budget overruns. The value of the lowest bid and budget overruns are also negatively and statistically significantly correlated with each other. This would indicate that the larger the contract, the lower the budget overrun measured as cost above the bid. This finding is in contrast with the earlier findings e.g. Sweeney (2009) and with Hypothesis 8, which states that budget overruns are in relative terms greater in larger contracts than in smaller ones.

7.2 Regression analysis

The results of the regression analysis are presented in a row of four tables without any discussion between the tables. Although the chosen way to present the results is not perhaps the most visually stimulating, it is easiest for the reader. This is because due to a high number of regressions, I refer to multiple tables in the discussion part of the results. It is better if the tables are close to each other so that the reader has to jump between the pages as little as possible.

Table 7 and Table 8 show the regression results of factors affecting the relative bid price, whereas Table 9 shows the regressions of factors affecting the relative number of bids received. Finally, Table 10 shows the results of factors affecting bid variance, bid accuracy, budget overruns and the number of bids received.

Table 7

Regression analysis on factors affecting the relative bid level

		Dependent variable: Relative bid price					
Regression		(1)	(2)	(3)	(4)	(5)	(6)
Independent variable	Exp. sign	Full sample	Renovation	New construction	Residential	Public building	Infrastructure
Number of bids sought	(+)	0.011*** (3.40)	0.011*** (3.08)	0.016*** (2.63)	0.013*** (3.18)	0.012*** (2.82)	0.011 (0.94)
Number of bids received	(-)	-0.021*** (-4.36)	-0.024*** (-4.20)	-0.022*** (-2.72)	-0.018*** (-2.89)	-0.027*** (-3.87)	-0.015 (-1.09)
Value of the lowest bid	(+)	0.000 (0.09)	0.015*** (3.02)	0.001 (0.39)	0.000 (-0.01)	0.018*** (3.21)	0.009 (1.09)
Pre crisis	(+)	0.067** (2.54)	0.002 (0.06)	0.108*** (2.78)	-0.024 (-0.76)	0.102 (1.57)	0.150** (2.46)
After crisis	(+)	0.057*** (2.90)	0.046* (1.90)	0.047 (1.40)	0.007 (0.24)	0.042 (1.50)	0.134** (2.34)
Renovation	(+/-)	-0.046** (-2.28)			-0.005 (-0.18)	-0.066* (-1.94)	-0.046 (-0.94)
Multiple prime contract	(-)	-0.025 (-0.91)	-0.084** (-2.27)	-0.035 (-0.86)	-0.006 (-0.20)	-0.104** (-2.20)	0.016 (0.19)
Side-contract	(-)	-0.077*** (-2.72)					
Residential	(+/-)	0.086*** (3.15)	0.088** (2.09)	0.093** (2.15)			
Public building	(+/-)	-0.011 (-0.33)	-0.020 (-0.50)	-0.007 (-0.09)			
Intercept		0.895*** (27.90)	0.868*** (22.14)	0.845*** (16.39)	0.988*** (22.27)	0.925*** (12.71)	0.793*** (9.38)
N		496	298	198	164	230	102
Adjusted R2		0.277	0.269	0.159	0.034	0.137	0.046
Significance F		0.000	0.000	0.000	0.087	0.000	0.134

Note: OLS regressions, t-statistics in parentheses: *,**, and *** indicate statistical significance at the 10% (p<0.1), 5% (p<0.05), and 1% (p<0.01) levels, respectively.

Table 8

Regression analysis on factors affecting the relative bid level

		Dependent variable: Relative bid price					
Regression		(7)	(8)	(9)	(10)	(11)	(12)
Independent variable	Exp. sign	1 Quarter in size	2 Quarter in size	3 Quarter in size	4 Quarter in size	Less than median size	More than median size
Number of bids sought	(+)	0.011 (1.46)	0.012** (1.99)	0.007 (1.22)	0.010* (1.81)	0.009** (1.98)	0.007* (1.84)
Number of bids received	(-)	-0.036*** (-2.96)	-0.013 (-1.55)	-0.019** (-2.15)	-0.026*** (-3.81)	-0.021*** (-2.98)	-0.023*** (-4.03)
Value of the lowest bid	(+)	0.236 (1.33)	0.053 (0.72)	0.001 (0.09)	-0.001 (-0.43)	0.130*** (3.09)	0.000 (-0.32)
Pre crisis	(+)	0.077 (0.79)	0.217*** (4.22)	-0.033 (-0.73)	0.030 (0.82)	0.143*** (3.06)	-0.012 (-0.41)
After crisis	(+)	-0.017 (-0.40)	0.103*** (2.74)	0.030 (0.76)	0.012 (0.40)	0.053* (1.86)	0.016 (0.61)
Renovation	(+/-)	-0.101** (-2.00)	-0.104*** (-2.71)	0.022 (0.59)	0.017 (0.55)	-0.093*** (-2.88)	0.018 (0.74)
Multiple prime contract	(-)	0.122 (1.49)	-0.081 (-1.34)	-0.072 (-1.32)	-0.015 (-0.47)	0.007 (0.14)	-0.030 (-1.05)
Residential	(+/-)	0.523*** (3.20)	-0.044 (-0.60)	0.122** (2.56)	-0.175*** (-2.78)	0.068 (0.93)	0.083*** (2.73)
Public building	(+/-)	-0.098 (-1.16)	0.026 (0.44)	0.031 (0.47)	-0.252*** (-3.12)	-0.043 (-0.85)	-0.008 (-0.17)
Intercept		0.841*** (11.31)	0.774*** (9.11)	0.915*** (12.74)	1.202*** (15.95)	0.814*** (16.74)	0.964*** (21.22)
N		124	124	124	124	248	248
Adjusted R2		0.172	0.252	0.152	0.160	0.207	0.160
Significance F		0.000	0.000	0.001	0.001	0.000	0.000

Note: OLS regressions, t-statistics in parentheses: *,**, and *** indicate statistical significance at the 10% (p<0.1), 5% (p<0.05), and 1% (p<0.01) levels, respectively.

Table 9

Regression analysis on factors affecting the relative number of bids received

		Dependent variable: Relative number of bids received					
Regression		(13)	(14)	(15)	(16)	(17)	(18)
Independent variable	Exp. sign	Full sample	Renovation	New construction	Residential	Public building	Infrastructure
Number of bids sought	(-)	-0.018*** (-8.00)	-0.019*** (-7.90)	-0.015*** (-3.15)	-0.024*** (-4.37)	-0.019*** (-7.61)	-0.003 (-0.44)
Value of the lowest bid	(+/-)	0.000 (-0.21)	-0.003 (-0.52)	0.001 (0.65)	0.000 (0.02)	-0.007 (-1.28)	0.007 (0.95)
Pre crisis	(-)	-0.014 (-0.48)	-0.029 (-0.77)	0.010 (0.23)	0.015 (0.28)	-0.093 (-1.58)	0.068 (1.29)
After crisis	(-)	-0.086*** (-4.13)	-0.082*** (-3.44)	-0.098** (-2.54)	-0.053 (-1.12)	-0.106*** (-4.36)	-0.044 (-0.89)
Renovation	(+/-)	0.010 (0.46)			0.040 (0.86)	-0.012 (-0.40)	-0.037 (-0.89)
Multiple prime contract	(+/-)	-0.140*** (-5.21)	-0.025 (-0.69)	-0.232*** (-5.07)	-0.219*** (-4.77)	-0.023 (-0.54)	-0.011 (-0.15)
Residential	(+/-)	-0.041 (-1.39)	0.032 (0.81)	-0.040 (-0.80)			
Public building	(+/-)	0.206*** (5.87)	0.129*** (3.28)	0.308*** (4.38)			
Intercept		0.790*** (23.50)	0.778*** (20.59)	0.775*** (13.05)	0.779*** (10.92)	0.941*** (14.86)	0.620*** (8.52)
N		496	298	198	164	230	102
Adjusted R^2		0.174	0.189	0.187	0.183	0.236	0.021
Significance F		0.000	0.000	0.000	0.000	0.000	0.236

Note: OLS regressions, t-statistics in parentheses: *,**, and *** indicate statistical significance at the 10% (p<0.1), 5% (p<0.05), and 1% (p<0.01) levels, respectively.

Table 10

Regression analysis on factors affecting bid variance, bid accuracy, budget overruns and the number of bids received

		Dependent variable: Bid variance		Dependent variable: Accuracy of the pre-bid cost estimation[1]		Dependent variable: Relative budget overrun		Dependent variable: Number of bids received
Regression		(19)		(20)		(21)		(22)
Independent variable	Exp. sign	Full sample	Exp. sign	Full sample	Exp. sign	Full sample	Exp. sign	Full sample
Relative bid price					(-)	-0.162** (-2.16)		
Number of bids sought	(+)	0.001 (0.46)	(+/-)	-0.005** (-2.44)			(+)	0.482*** (23.93)
Number of bids received	(+)	0.000 (0.18)	(+/-)	0.010*** (2.88)				
Value of the lowest bid	(-)	-0.002** (-2.56)	(-)	-0.003** (-2.22)	(+)	-0.004 (-0.96)	(-)	0.002 (0.09)
Pre crisis	(+)	0.032** (2.46)	(+/-)	0.000 (0.02)	(-)	-0.079** (-2.38)	(-)	-0.354 (-1.39)
After crisis	(+)	-0.005 (-0.53)	(+/-)	-0.035** (-2.44)	(-)	-0.004 (-0.96)	(-)	-0.777*** (-4.16)
Renovation	(+)	0.019** (2.15)	(+)	0.005 (0.33)	(+)	-0.082** (-2.15)	(+/-)	-0.189 (-0.98)
Multiple prime contract	(+/-)	0.006 (0.43)	(+/-)	0.012 (0.67)	(+/-)	0.015 (0.43)	(+)	-1.038*** (-4.29)
Residential	(+/-)	-0.037*** (-2.71)	(+/-)	-0.079*** (-4.02)	(+/-)	-0.173*** (-2.89)	(+/-)	-0.461* (-1.75)
Public building	(+/-)	-0.020 (-1.20)	(+/-)	0.034 (1.42)	(+/-)	0.091** (2.26)	(+/-)	1.277*** (4.03)
Intercept		0.118*** (6.97)		0.223*** (9.64)		0.405*** (5.08)		1.492*** (4.93)
N		366		496		183		496
Adjusted R^2		0.130		0.233		0.153		0.656
Significance F		0.000		0.000		0.000		0.000

Note: OLS regressions, t-statistics in parentheses: *,**, and *** indicate statistical significance at the 10% (p<0.1), 5% (p<0.05), and 1% (p<0.01) levels, respectively.
[1]A negative sign stands for better accuracy

The chosen regression variables were able to explain 27.7% of the variation in the relative bid price, as suggested by adjusted R-square in regression (1) in Table 7. Is 27.7% a low figure? The answer is no, since any study that attempts to predict human behavior, such as economics, typically has R-square values far lower than 50%. For example Paul and Carr (2005), who found that there will be 3.79% increase in project costs, on average, for each bidder lost, had R-square value of just 10.2% for the linear regression and 38% for the curvilinear regression. Furthermore, even if R-square values are low, statistically significant coefficients still represent the mean change in the response to one unit of change in the variable while holding other variables constant.

Regression (1) in Table 7 shows that per each of the additional bid received, the relative bid price decreases about 2.1%. T-value of -4.36 suggests a very strong statistical significance. The likelihood of this finding to be caused sheer by chance is just 0.0016%. However, the client cannot decrease bids sheer by asking for more, because per each of the additional bid sought, the relative bid price increases about 1.1%. This is evidence of the entry effect and Hypothesis 4. Moreover, the finding is supported by the result of regression (13) in Table 9, which shows that the higher the number of bids sought, the lower the relative number of bids received. The null hypothesis of Hypothesis 4 can thus be rejected. It very clear that contractors bid less aggressively or choose not to bid at all, when the number of potential bidders increases. This very interesting finding and contrast with the univariate result in the previous section. To recall, the correlation between the number of bid sought and the relative bid price was -0.182. When multiple factors are taken into account simultaneously, the sign of the correlation changes. Previous studies have used only the number of bids received as the measure for the level of competition. For example the finding of Paul and Carr (2005) that there will be 3.79% increase in project costs, on average, for each bidder lost, is alone misleading. Paul and Carr did not take into account that in order to get more bids, the client has to seek more, which increases bids trough the winner's curse and the entry effect.

Since just 48.2% of the contractors whom the client asks to submit a bid, eventually submit it, see regression (22) in Table 10, bids have to be asked at least from two contractors in order to receive one additional bid. However, asking for two more bids increases the lowest bid by about 2.2%, which outweighs the impact of receiving one additional bid. The client cannot thus benefit from seeking additional bids sheer by asking for more. Benefits could though be obtained if the entry effect and the winner's curse effect can somehow be simultaneously reduced. There are two possible solutions for the problem, of which the first one is easier to implement.

First, many academic papers have argued that the release of information regarding the seller's valuation of the object in sale may cause bidders to bid more aggressively, because it reduces the negative impact of the winner's curse (see Milgrom and Weber 1982, Harstad 1990, and Campbell and Levin 2000). De Silva et al. (2005) tested this theory empirically buy examining the impact of a policy change by the Oklahoma Department of Transportation to the release the state's internal cost estimations of highway projects. They found that the average level of bids was lower after the release of additional information. The average level of bids and the standard deviation of bids, fell strongly for bridgework projects, but did not have any impact on bids for paving works. According to researchers, bridgework projects contain more uncertainty, common to all bidders, whereas asphalt paving projects possess more private-value characteristics. Although De Silva et al. did not find evidence that the releasing of additional information would result in statistically significant lower winning bids, this approach should be considered especially for complex renovation projects or projects that are technically very challenging.

Second, it should be considered whether the second-price sealed-bid auction method should be put in place at least for auctions where the common uncertainty is great.[30] Consider a first-price sealed bid auction. Uncertain of the underlying value of the item, each bidder must bid significantly below one's estimate to avoid the winner's curse. The client thus gets the project with the lowest price, but the price is not as low as it were if there was not common uncertainty. In a second-price sealed-bid auction, instead, a dominant strategy for a bidder is to bid one's true value. This is because, by bidding your true value, you will maximize the likelihood of winning the contract, but you will always get the project with a price higher than your own estimation. The second-price sealed-bid method thus reduces the negative impact of the winner's curse. Although the client has to pay the second lowest price, bids are in general more competitive. (Chatterjee & Samuelson 2001: 306-307) The second-price sealed-bid auction could produce better outcomes in auctions, where the winner's curse effect is particularly strong e.g. large renovation projects mixed with a lump sum price.

Of the two solutions presented, the releasing of information about the pre-bid cost estimation is the easier way to reduce the negative impact of the winner's curse. This is because; Public Procurement Act does not permit of procuring public projects by using the second-price auction methods, at least not to my knowledge. The using of this method would require legal

[30] To recall, in the second-price sealed-bid auction, bidders submit sealed bids individually without seeing other bidders' bids. The bidder, who submits the highest bid, gets the object at the price of the second highest bid.

changes at the European Union level, which is not in sight in the short-term future. Moreover, the using of the second-price sealed-bid method could be difficult to justify to the taxpayers although it would yield a better outcome. In turn, to my knowledge there are not any obstacles for the releasing of information about the pre-bid cost estimation.

Xu (2013) argues that clients can intensify competition by making the entry costlier. Since this approach works only when the entry decision is made after the bidders know their valuations, I do not regard it a reasonable solution for the problem. If bidders make entry decisions before knowing their own valuations, making of entry costlier would reduce both the probability of entry and the expected number of actual bidders. In turn, the actual bidders would face less competition and bid less aggressively. Therefore, the proposed solution i.e. the releasing of information about the pre-bid cost estimation is the best solution for the problem.

Hypothesis 1 states that the level of competition affects the winning bid downward more strongly in auctions for new construction projects than for renovation projects. Based on the sample of this study, this statement is not true. The null hypothesis that there is no difference cannot be rejected. The number of bids sought and received seem to have about the same impact on the relative bid price for renovation and new construction projects, see regression (2) and (3) in Table 7. In fact it seems that an increase in competition affects the winning bid downward more strongly in auctions for renovation projects than for new construction projects, however, the difference is not statistically significant. Each additional bid received appears to decrease the lowest bid by 2.4% when the project is considered as renovation and 2.2% when new construction. These findings are statistically significant at .00004 and .007 level, respectively. Each additional bid sought seems to increase the lowest bid by 1.1% when the project is considered as renovation and 1.6% when new construction. Both of the findings were statistically very significant. Nor there was much difference between different types of projects.

Hypothesis 2 states that the level of competition affects the winning bid downward more strongly in auctions for small projects than for large projects. No evidence was found that would support this hypothesis. The difference in coefficients in regressions (11) and (12) in Table 8 were not statistically different from each other. The null hypothesis cannot thus be rejected. Each additional bid received decreased the lowest bid by 2.1% when the contract was worth less than the median and 2.3% when more than the median. Both of the findings were statistically very significant as suggested by t-values of -2.98 and -4.03, respectively.

Each additional bid sought seems to increase the lowest bid by 0.9% when the contract was worth less than the median and 0.7% when more than the median. Findings were statistically significant only at .05 and .01 level. The difference between different types of projects was neither found to be statistically significant. An increase in the level of competition seems to have more or less similar impact on the lowest bid regardless of the type of project or the size of the contract.

The value of the lowest bid does not seem to have a statistically significant impact on the relatively bid price in the regression (1) in Table 1. However, the value of the lowest bid seems to be positively correlated with the relative bid price in terms of renovation projects, public buildings and small contracts, regression (2) and (5) in Table 7, and regression (11) in Table 8. Per each additional million in contract size, the lowest bid becomes about 1.5% less competitive, when compared to the pre-bid cost estimation. The impact for public buildings and for smaller contracts is 1.8% and 13% towards a higher price. All of the findings were statistically significant at least at .05 level. There are at least three possible explanations for the result.

First, larger projects may call for more conservative bids e.g. due to the weakening diversification of the project portfolio. Second, competition between the contractors competing for large contracts might be less intense than competition between contractors competing for small contracts. Thirdly, and perhaps the most plausible explanation is that more effort is put on pre-bid cost estimation, when the contract size increases. Smaller contracts are estimated roughly, but conservatively to avoid budget overruns. This argument is supported by the fact that side-contract variable in regression (1) in Table 7 get a value of -0.077, while being statistically very significant. This means that side-contracts in the sample were associated with 7.7% lower relative bid price than main contracts or contracts of structural works in a multiple prime contract.

I found very strong evidence of Hypothesis 6. Bids really become less competitive in an economic upturn. Regression (1) shows that bids were about 6.7% higher before the crisis and about 5.7% higher after the crisis compared with the crisis in 2009 and 2010. The former finding is statistically significant at 0.0114 level and the latter at .0039 level. The impact is similar in magnitude than getting about three additional bids for a contract. Such a high impact cannot be explained purely by lower margins of contractors taking part in the auction. Besides the lower margins of the contractors, the state of the economy must affect prices in the whole production chain. That is to say that contractor must be able to purchase materials,

subcontracts and perhaps even work force with lower prices when the economy is doing poorly.

It seems that an economic downturn does not have as strong impact on bid prices, when regressions are run for the subsets of data. For example, economic situation does not have any impact on bids for residential projects, regression (4) in Table 7. Interestingly, the state of the economy has a much stronger impact on bids for small contracts than bids for large contracts. Regression of the contracts less than median in value, regression (11) in Table 8, shows that bids were about 14.3% higher before the crisis and about 5.3% higher after the crisis when compared with the crisis. The first finding is statistically significant at .002 level and the second at .064 level. The state of the economy however does not have any impact on bid prices in the group of contracts above the median value, regression (12) in Table 8. A possible explanation is that large projects invoke large companies that have very effective procurement systems and can utilize the economies of scale. The margins of material suppliers and subcontractors may thus be at a very competitive level not only during the years of low construction volume. In turn, smaller projects call for smaller contractors, who do not have as effective procurement systems. During normal times, material and subcontract prices hence might not be as competitive as in large projects, but becomes nearly as competitive when the economy plummets. This finding supports the idea that weak competition between the contractors competing for large contracts cannot be the reason why the lowest bid is negatively correlated with the relative bids. The reason must be either more conservative bids when the project size increases or that more effort is put on pre-bid cost estimation, when the contract size increases.

Regression (1) shows that the relative bid price is 4.6% lower for renovation projects than for new construction projects. Moreover, this effect seems to be limited only to smaller contracts as shown in regressions (7), (8) and (11) in Table 8. A reasonable explanation for this finding is that pre-bid cost estimations are in general more conservative for renovation projects, and less conservative for new construction projects. It is of course possible that some competitive element not captured by the competition proxies causes the difference.

Variables for multiple prime contracts, side contracts and type of projects were included in the regressions mostly as control variables. However, based on regression (1) in Table 7, multiple prime contract does not have a statistically significant impact on bid prices. Residential projects instead seem to receive much higher relative bids on average than infrastructure projects. The difference between the groups is 8.6%. However, as mentioned earlier there is

not much point in comparing different types of projects together due to differences in the approach to pre-bid cost estimations. These variables were added in to the models mostly in controlling means i.e. to reduce statistical noise in variables of interest in this study.

Table 9 shows the regression results of factors affecting the relative number of bids received. As mentioned earlier the higher the number of bids sought, the lower the relative number of bids received as shown by the regression (13) in Table 9. When the number of bids sought increases by one, the relative number of bids received decreases by 1.8%. That is to say that if 50% of the contractors asked to submit bids eventually submits it, the proportion drops to 48.2%, when the number of bids sought increases by one. The effect is however weak though statistically very significant with a t-value of -8.00. Interestingly, the after crisis dummy gets a value of -0.086 in regression (13) in Table 9. T-value of the finding is -4.13, which suggests statistically a very significant correlation. Clients have thus received about 8.6% less bids after the crisis relative to the number of bids sought. This is a significant difference. The finding is furthermore supported by the results of the regression (24) in Table 10. Contracts received on average -0.777 less bids after the crisis than during the crisis. This finding is statistically significant at .00004 level. Economic situation clearly impacts contractors' willingness to submit bids. This is very strong evidence of Hypothesis 5 and the null hypothesis that there is not a relation can be rejected.

Hypothesis 7 states that bids become more volatile in an economic upturn. I found that this is somewhat true. Regression (19) in Table 10 shows that variance in bids was 3.2% higher before the crisis than during the crisis. This finding is statistically significant at .015 level. Since the market has not yet reached the levels before the crisis, it was not very surprising that no evidence was found that bids would have turned more volatile after the crisis compared with the crisis. Interestingly, the value of the contract appears to be negatively correlated with the standard deviation of bids. The relative standard deviation becomes 0.2% lower per each additional million in contract value. This finding is statistically significant at .0109 level. The larger the contract, the closer the bids are to each other. This finding indirectly suggests that the difference between large contractors is smaller than the difference between small contractors, because large contractors tend to compete for large contracts and vice versa. This argument is in line with the finding that a recession does not have any impact on bid prices in the group of contracts above the median contract value, but have a strong negative impact on smaller contracts. One could thus argue that although there are less contractors competing for large contracts, competition between these contractors is fiercer than competition between

contractors competing for small contracts. When the economy eventually turns in to downturn, competition intensifies relatively more among the small contracts than among the large ones, which is why the recession has stronger negative impact on bid prices for small contracts than for large contracts.

Bids for renovation contracts seem to be more volatile than bids for new construction contracts. The standard deviation of bids is 1.9% higher for renovation projects. The finding is statistically significant at .032 level. Since renovation projects contain more uncertainty, this finding is not very surprising.

Regression (20) in Table 10 shows that pre-bid cost estimations become more accurate when the value of the contract increases. This is strong evidence of Hypothesis 3 and in line with the univariate results in the previous section. Each additional million in contract size improves the accuracy of the pre-bid estimation by 0.3%. The finding is statistically significant at .027 level. A likely explanation is that more effort is put on pre-bid cost estimations when the contract size increases. Surprisingly, pre-bid cost estimations have become 3.5% more accurate after the financial crisis. This finding is statistically significant at .015 level. Perhaps budgets are today tighter than they used to be. The level of competition seems also to affect the accuracy of the pre-bid cost estimations. The more bids received, the less accurate the pre-bid estimate. Each additional bid received seems to be associated with 1.0% decrease in the accuracy of the pre-bid estimate, whilst each additional bid sought seem to improve the accuracy by 0.5%. The first finding is statistically significant at .004 level, and the second at .015 level. Furthermore, residential projects seem to be associated with 7.9% more accurate pre-bid cost estimations than infrastructure projects.

Hypothesis 8 states that budget overruns are in relative terms greater in larger projects than in smaller projects. Based on the sample collected for this study, this statement is not true. The value of the contract does not seem to have any impact on budget overruns as evident in regression (21) in Table 10. I did not find evidence for Hypothesis 9 that budget overruns would be in relative terms greater in renovation projects than in new construction projects. Budget overruns were actually 8.2% lower in renovation projects compared with new construction projects. Although the finding was statistically significant at .033 level, I don’t regard it plausible, since industrial knowledge is so strong in this particular matter. The finding was moreover in contrast with the univariate results that showed that budget overruns

were higher in renovation projects than in new construction projects on absolute level, see Table 4. Additional research with a more controlled sample is therefore needed.

The relative bid price was found to be negatively correlated with relative budget overrun. That is to say that the lower the relative bid, the higher the budget overrun. One percent drop in the lowest bid, increases budget overruns by 0.162%. This finding is statistically significant at .032 level. The finding is in line with the reasoning that when a possible underpricing becomes evident, the contractor initiates a claim strategy for seeking additional profit through change orders and extra works. This is not however the only conclusion that can be made from the results. Another explanation is the poor quality of contract documents which for the contractor is not able come up with a fully priced bid. When the construction begins, change orders and extra works are then needed to fix the situation. These two explanations are not mutually exclusive. However, one could perhaps argue that the effect of poor contract documents should be the other way around if contractors do not act opportunistically. This is because, if contractors are aware of these deficiencies in the contracts documents when preparing the bid, they should add risk contingency, not decrease it. It thus seems that contractors act at least somewhat opportunistically though rationally.

Interestingly, budget overruns were 7.9% lower before the financial crisis than during the crisis, see regression (21) in Table 10. The finding is though somewhat dubious, because the sample contained just 55 contracts before the crisis. Thus I would not make far-reaching conclusions from it.

Regression (22) shows the results of factors affecting the number of bids received. Obviously the number of bids sought impacts the number of bids received the most. Per each of the additional bid sought, about 0.482 additional bids are received. T-value of the finding is 23.93. Moreover, financial crisis appears to be associated with more bids, when compared with the years after the crisis. As mentioned earlier, clients received on average 0.777 bids more for contracts during the financial crisis than after it. Interestingly, the value of the contract does not seem to have any impact on the number of bids received. This is because the variable; the number or bids sought, captures the impact of competitive situation in the market. Multiple prime contracts as well as contracts for public buildings seem to receive more bids than other type of residential and infrastructure projects. These findings are however somewhat noisy due to the aforementioned reasons. Overall, the timing of the procurement and the number of bids sought seem to be the most important determinants of how many bids will eventually be received.

8 CONCLUSION

Researchers have found mixed evidence of how the level of competition affects bids in auctions. According to conventional economic theory, an increase in competition should make bids more competitive. This is especially true in auctions, where each bidder knows how much he values the object, but his value is private information and unaffected by the information about other bidder's valuation i.e. private-value auction. In auctions, where the value of the object is the same for all bidders, but bidders have different views of that value, i.e. common-value auction, the winner of the auction might be the bidder with the most overly optimistic view and ends up paying too much for the object on sale. This phenomenon is generally known as the winner's curse. In equilibrium, rational bidders should take this into account by bidding less aggressively. When the number of potential bidders increases, bidders may become less aggressive also due to the entry effect. This is because, an increase in the number of potential bidders decreases the likelihood of winning the contract, yet participation costs remain constant. Rational bidders should take this into account by deciding not to bid or by bidding less aggressively. There are thus three competition related effects affecting bids simultaneously.

Auctions are rarely pure private or pure common-value auctions, instead, have components of both types. Auctions may though differ in how much they possess these characteristics. Some auctions have more common value elements and some private-value elements. In this thesis, I studied empirically using Finnish data, how the level of competition affects bids in auctions for public construction projects. Different types of contracts were expected to differ in how they possess common-value and private-value characteristics. The level of competition was thus expected to affect bids differently.

If a contractor realizes that they have made a too generous bid e.g. due to the winner's curse, they may initiate a further claim strategy for seeking additional revenues through change orders and extra works. Moreover, the contractor might has spotted inconsistencies in the tender documents, and decides to submit a very aggressive bid deliberately by simultaneously knowing that they can seek additional profit afterwards through change orders and extra works. Both of the above examples suggest that lower bids are associated with higher budget overruns. Factors affecting the competitive behavior and budget overruns were therefore also studied in this thesis.

The full data of the study contained 496 contracts of various kinds of public construction projects. The data was analyzed using statistical methods such as multivariate regression

analysis. I found that per each additional bid received the lowest bid decreases significantly when compared to the pre-bid cost estimation. This finding is in line with the conventional economic theory. The effect was negative in all of the regressions and statistically very significant in almost all regressions. The client cannot though benefit from seeking more bids sheer by asking for more, since per each additional bid sought, the lowest bid increases. This is strong evidence of the winner's curse and the entry effect. No evidence was however found that these effects would differ between different types of contracts. Based on previous findings such as those of Hong and Sum (2002), it is though hard to believe that there would be any difference between different types of contracts. Additional studies with a more controlled sample and perhaps with more sophisticated research methods are thus needed to confirm the finding. Based on previous studies e.g. Paul and Carr (2005) it is plausible that the relation between the variables is curvilinear, as depicted in Figure 15. An increase in competition first decreases bids due to the competition effect, but starts to increase bids after some point, due to the winner's curse and the entry effect. The optimum could perhaps be found with more sophisticated methods assuming non-linearity.

Nonetheless, since it is clear that the winner's curse and the entry effect affect bids negatively regardless of the contract type, there is a major need for means to reduce the impact of them. I propose two solutions: the release of information about pre-bid cost estimation in advance and the use of the second-price sealed-bid auction method. Both of the suggested means reduce the impact of the winner's curse by reducing common uncertainty. The use of these methods is worth considering especially for projects that possess high common uncertainty. Large renovation projects mixed with a lump sum price or technically very challenging projects would be good candidates for this purpose.

I found strong evidence that an economic downturn is associated with the higher number of bids, lower bid volatility and more competitive bids, when compared to the pre-bid cost estimation. The impact of the general macroeconomic situation though seems to be stronger for small contracts than for large contracts. Mixed with the fact that common interest rates are at low levels during an economic downturn, clients should really target their procurements at economically weaker times. Contract types that allow the design and construction to proceed simultaneously should be preferred during economic downturns. In turn, the client should slow down the process by choosing a contract type that effectively separates the design and the construction processes from each other during an economic upturn.

Previous studies e.g. Sweeney (2009) suggest that budget overruns are greater in larger projects. I did not find evidence that would support this theory. However, I did find that the lower the lowest bid, the higher the budget overrun. The finding suggests that contractors do act somewhat opportunistically though rationally. Despite the reasons, the finding gives support for the idea of awarding the contract to the most economically advantageous bidder instead of the cheapest one.

Pre-bid cost estimations provided by the client were used as a benchmark value for the competitiveness of bids in this study. Although this method has major benefits, the non-standard nature of the pre-bid cost estimations weakens the statistical significance and the interpretation of the findings. Further research with more controlled samples is there for needed. Moreover, there is a major need for alternative measures for the price competitiveness of bids. If similar findings were found when approaching the issue from a different angle, it would be a very strong indicator that findings were not caused by sheer by change or errors in statistical modelling. Additional research is needed also due to the very large impact of public procurements on the overall economy. Just a slight improvement in the effectiveness of procurement processes would save millions of euro of tax payers' money. Moreover, additional research may help the construction of auctions not only for construction projects, but also for other types of objects such as emissions trading, healthcare services, IT system.

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Appendix A

Table A: Sample data for studying Hypotheses 1 to 7

Note: Hypotheses 5 to 7 were studied using a subsample of 366 contracts including price information of all bids received. Due to practical reasons not all bids were shown in this table.

Contract	Year	Pre-bid cost estimation	Lowest bid	Bids sought	Bids received	Renovation	Multiple Prime	Infrastructure works	Residential	Public Building
Contract 1	2010	4 412 000 €	5 595 000 €	9	5	0	0	0	1	0
Contract 2	2012	7 573 000 €	8 230 000 €	9	5	0	0	0	1	0
Contract 3	2013	5 045 000 €	5 717 700 €	6	4	0	0	0	1	0
Contract 4	2010	15 000 000 €	16 465 531 €	8	2	0	0	0	1	0
Contract 5	2009	13 553 000 €	11 393 065 €	11	9	0	0	0	1	0
Contract 6	2009	8 496 000 €	8 280 952 €	13	10	0	0	0	1	0
Contract 7	2007	5 971 000 €	7 923 900 €	10	5	0	0	0	1	0
Contract 8	2009	9 501 000 €	7 247 844 €	10	7	0	0	0	1	0
Contract 9	2009	11 121 000 €	10 614 000 €	9	3	0	0	0	1	0
Contract 10	2006	7 254 000 €	9 053 000 €	12	2	0	0	0	1	0
Contract 11	2005	4 409 000 €	4 857 000 €	13	9	0	0	0	1	0
Contract 12	2009	5 374 000 €	5 132 090 €	13	12	0	0	0	1	0
Contract 13	2013	4 000 000 €	3 753 724 €	8	4	0	0	0	1	0
Contract 14	2014	10 000 000 €	12 879 752 €	14	10	0	0	0	1	0
Contract 15	2008	5 000 000 €	4 057 720 €	8	7	1	0	0	1	0
Contract 16	2014	38 963 000 €	35 411 453 €	4	3	0	0	0	1	0
Contract 17	2013	9 028 000 €	8 734 752 €	7	5	0	0	0	1	0
Contract 18	2013	11 590 000 €	8 815 160 €	12	9	0	0	0	1	0
Contract 19	2002	4 742 000 €	5 282 000 €	11	3	0	1	0	1	0
Contract 20	2002	3 752 800 €	4 161 900 €	11	3	0	1	0	1	0
Contract 21	2003	11 010 200 €	11 074 000 €	9	2	0	1	0	1	0
Contract 22	2011	14 038 240 €	15 147 000 €	6	2	0	1	0	1	0
Contract 23	2011	10 772 230 €	12 585 305 €	8	3	0	1	0	1	0
Contract 24	2012	5 883 040 €	5 496 700 €	9	3	0	1	0	1	0
Contract 25	2012	8 730 200 €	8 798 000 €	5	2	0	1	0	1	0
Contract 26	2004	14 938 870 €	13 992 000 €	8	2	0	1	0	1	0
Contract 27	2008	8 008 417 €	8 099 000 €	10	2	0	1	0	1	0
Contract 28	2011	11 523 645 €	11 757 000 €	10	4	0	1	0	1	0
Contract 29	2012	8 944 300 €	10 657 000 €	9	1	0	1	0	1	0
Contract 30	2012	11 331 600 €	13 075 796 €	10	2	0	1	0	1	0

Contract 31	2012	16 786 220 €	16 979 434 €	8	2	0	1	0	1	0
Contract 32	2007	16 879 700 €	18 983 200 €	3	1	0	1	0	1	0
Contract 33	2007	27 904 458 €	32 309 260 €	4	1	0	1	0	1	0
Contract 34	2007	6 530 000 €	7 716 225 €	4	2	0	1	0	1	0
Contract 35	2007	11 229 000 €	14 026 340 €	3	1	0	1	0	1	0
Contract 36	2007	16 950 000 €	15 071 000 €	4	2	0	1	0	1	0
Contract 37	2007	15 047 000 €	13 684 740 €	3	3	0	1	0	1	0
Contract 38	2008	14 850 000 €	13 822 289 €	3	3	0	1	0	1	0
Contract 39	2008	10 155 600 €	10 212 000 €	4	2	0	1	0	1	0
Contract 40	2008	15 228 500 €	12 987 456 €	4	4	0	1	0	1	0
Contract 41	2008	17 318 939 €	15 264 080 €	3	1	0	1	0	1	0
Contract 42	2008	10 579 940 €	9 352 459 €	9	6	0	1	0	1	0
Contract 43	2008	5 938 558 €	4 254 150 €	7	4	0	1	0	1	0
Contract 44	2008	9 049 183 €	6 517 742 €	5	3	0	1	0	1	0
Contract 45	2009	13 310 000 €	12 244 364 €	13	3	0	1	0	1	0
Contract 46	2009	11 238 628 €	10 123 367 €	8	1	0	1	0	1	0
Contract 47	2009	17 528 300 €	16 566 969 €	4	1	0	1	0	1	0
Contract 48	2009	3 219 100 €	2 987 048 €	4	3	0	0	0	1	0
Contract 49	2009	20 068 000 €	19 154 894 €	8	4	0	1	0	1	0
Contract 50	2009	14 415 000 €	13 157 410 €	7	5	0	1	0	1	0
Contract 51	2009	3 562 500 €	3 578 775 €	3	2	0	1	0	1	0
Contract 52	2009	17 675 000 €	18 886 116 €	5	3	0	1	0	1	0
Contract 53	2010	6 616 200 €	6 754 918 €	5	3	0	1	0	1	0
Contract 54	2010	11 897 000 €	13 384 860 €	5	1	0	1	0	1	0
Contract 55	2010	7 508 000 €	7 546 050 €	6	2	0	1	0	1	0
Contract 56	2010	5 002 000 €	4 989 132 €	3	2	0	0	0	1	0
Contract 57	2010	4 919 000 €	5 705 064 €	1	1	0	0	0	1	0
Contract 58	2010	20 986 000 €	21 720 500 €	5	1	0	1	0	1	0
Contract 59	2010	18 242 402 €	16 398 581 €	5	2	0	0	0	1	0
Contract 60	2010	13 548 300 €	15 740 310 €	5	1	0	1	0	1	0
Contract 61	2010	8 288 300 €	8 253 300 €	5	1	0	1	0	1	0
Contract 62	2010	14 245 000 €	15 624 690 €	4	2	0	1	0	1	0
Contract 63	2011	11 158 000 €	12 405 534 €	4	1	0	0	0	1	0
Contract 64	2011	15 541 000 €	15 566 671 €	6	2	0	1	0	1	0
Contract 65	2011	24 868 000 €	26 655 427 €	4	1	0	1	0	1	0
Contract 66	2011	3 730 000 €	3 698 712 €	5	4	0	0	0	1	0
Contract 67	2011	6 899 000 €	7 195 095 €	3	1	0	1	0	1	0
Contract 68	2011	15 871 440 €	16 901 430 €	7	1	0	0	0	1	0
Contract 69	2011	25 053 000 €	25 563 000 €	3	2	0	0	0	1	0
Contract 70	2011	48 124 000 €	49 549 000 €	4	3	0	0	0	1	0

Contract 71	2011	9 719 000 €	11 230 000 €	5	1	0	0	0	1	0
Contract 72	2011	15 100 000 €	16 092 090 €	4	1	0	1	0	1	0
Contract 73	2011	10 821 400 €	11 350 498 €	3	1	0	1	0	1	0
Contract 74	2011	6 587 000 €	6 579 270 €	6	3	0	1	0	1	0
Contract 75	2011	20 401 000 €	20 721 684 €	6	2	0	0	0	1	0
Contract 76	2011	4 532 300 €	5 206 000 €	2	2	0	0	0	1	0
Contract 77	2011	26 279 600 €	25 452 495 €	6	2	0	0	0	1	0
Contract 78	2011	31 106 000 €	29 081 107 €	7	2	0	0	0	1	0
Contract 79	2011	2 537 500 €	2 647 000 €	4	1	0	0	0	1	0
Contract 80	2011	3 452 000 €	3 852 163 €	4	2	0	0	0	1	0
Contract 81	2012	12 760 000 €	13 347 960 €	10	3	0	0	0	1	0
Contract 82	2012	5 987 000 €	5 975 000 €	8	5	0	0	0	1	0
Contract 83	2012	20 331 000 €	21 997 000 €	8	4	0	0	0	1	0
Contract 84	2012	8 578 000 €	8 991 300 €	6	2	0	0	0	1	0
Contract 85	2012	6 317 500 €	6 452 558 €	7	6	0	0	0	1	0
Contract 86	2012	35 358 000 €	37 035 000 €	2	1	0	0	0	1	0
Contract 87	2012	15 943 000 €	16 890 000 €	4	1	0	0	0	1	0
Contract 88	2012	4 871 000 €	5 098 350 €	2	1	0	0	0	1	0
Contract 89	2012	14 720 000 €	13 396 914 €	8	5	0	0	0	1	0
Contract 90	2012	8 628 000 €	9 489 450 €	7	2	0	0	0	1	0
Contract 91	2012	9 564 500 €	9 046 497 €	8	5	0	0	0	1	0
Contract 92	2012	3 807 100 €	3 675 235 €	2	2	0	0	0	1	0
Contract 93	2012	13 774 100 €	12 683 977 €	8	4	0	0	0	1	0
Contract 94	2013	10 060 000 €	8 399 072 €	9	6	0	0	0	1	0
Contract 95	2013	12 180 000 €	11 808 520 €	9	7	0	0	0	1	0
Contract 96	2013	4 842 000 €	5 203 950 €	6	4	0	0	0	1	0
Contract 97	2013	20 731 000 €	18 268 705 €	3	3	0	0	0	1	0
Contract 98	2013	20 926 550 €	20 926 550 €	1	1	0	0	0	1	0
Contract 99	2013	23 604 000 €	21 235 000 €	8	3	0	0	0	1	0
Contract 100	2013	7 998 000 €	6 454 200 €	7	6	0	0	0	1	0
Contract 101	2013	11 520 000 €	11 285 333 €	8	4	0	0	0	1	0
Contract 102	2013	8 155 000 €	9 481 000 €	7	2	0	0	0	1	0
Contract 103	2014	20 905 000 €	21 673 900 €	1	1	0	0	0	1	0
Contract 104	2013	10 065 000 €	5 565 641 €	8	3	0	0	0	1	0
Contract 105	2014	12 790 000 €	13 870 640 €	7	2	0	0	0	1	0
Contract 106	2014	9 975 808 €	10 991 360 €	8	4	0	0	0	1	0
Contract 107	2014	43 201 000 €	45 317 957 €	3	3	0	0	0	1	0
Contract 108	2014	56 631 000 €	50 419 640 €	4	4	0	0	0	1	0
Contract 109	2014	7 067 500 €	8 025 000 €	4	1	0	0	0	1	0
Contract 110	2014	11 166 300 €	9 977 283 €	8	2	0	0	0	1	0

Contract 111	2001	5 141 815 €	5 462 000 €	13	6	1	0	0	1	0
Contract 112	2003	956 860 €	951 600 €	16	5	1	0	0	1	0
Contract 113	2003	1 131 843 €	1 197 500 €	17	5	1	0	0	1	0
Contract 114	2008	2 360 985 €	2 659 600 €	14	4	1	0	0	1	0
Contract 115	2011	3 079 864 €	3 623 400 €	12	5	1	0	0	1	0
Contract 116	2001	5 842 589 €	5 930 000 €	9	5	1	0	0	1	0
Contract 117	2004	856 009 €	644 000 €	11	4	1	0	0	1	0
Contract 118	2005	5 824 976 €	6 100 000 €	11	7	1	0	0	1	0
Contract 119	2005	3 401 851 €	2 984 218 €	12	2	1	0	0	1	0
Contract 120	2009	2 199 419 €	2 592 000 €	12	3	1	0	0	1	0
Contract 121	2010	1 307 633 €	1 173 000 €	13	6	1	0	0	1	0
Contract 122	2001	8 273 723 €	7 900 000 €	9	5	1	0	0	1	0
Contract 123	2002	1 818 655 €	2 537 600 €	18	5	1	0	0	1	0
Contract 124	2011	284 663 €	379 908 €	20	10	1	0	0	1	0
Contract 125	2001	1 549 435 €	1 576 000 €	14	7	1	0	0	1	0
Contract 126	2005	12 844 942 €	10 451 740 €	7	4	1	0	0	1	0
Contract 127	2009	4 991 978 €	5 072 000 €	9	4	1	0	0	1	0
Contract 128	2010	2 641 085 €	3 280 580 €	10	5	1	0	0	1	0
Contract 129	2011	8 088 949 €	8 259 000 €	10	5	1	0	0	1	0
Contract 130	2011	3 266 150 €	3 983 537 €	10	5	1	0	0	1	0
Contract 131	2010	1 699 213 €	1 915 400 €	9	6	1	0	0	1	0
Contract 132	2011	6 003 169 €	6 351 320 €	9	6	1	0	0	1	0
Contract 133	2012	3 125 914 €	3 174 000 €	11	8	1	0	0	1	0
Contract 134	2003	7 586 728 €	7 557 000 €	10	6	1	0	0	1	0
Contract 135	2005	1 361 509 €	1 360 000 €	6	4	1	0	0	1	0
Contract 136	2006	446 404 €	519 000 €	9	5	1	0	0	1	0
Contract 137	2009	6 535 732 €	6 164 660 €	5	5	1	0	0	1	0
Contract 138	2012	996 618 €	956 000 €	6	5	1	0	0	1	0
Contract 139	2012	208 052 €	235 000 €	3	2	1	0	0	1	0
Contract 140	2012	4 156 985 €	3 940 600 €	8	4	1	0	0	1	0
Contract 141	2001	6 413 080 €	4 722 620 €	8	3	1	0	0	1	0
Contract 142	2002	838 318 €	598 500 €	10	7	1	0	0	1	0
Contract 143	2002	3 875 624 €	4 064 000 €	8	6	1	0	0	1	0
Contract 144	2003	1 347 026 €	1 110 000 €	7	4	1	0	0	1	0
Contract 145	2008	6 731 389 €	8 728 310 €	12	11	1	0	0	1	0
Contract 146	2011	4 486 769 €	4 452 600 €	12	8	1	0	0	1	0
Contract 147	2011	3 847 579 €	2 872 050 €	13	7	1	0	0	1	0
Contract 148	2003	6 074 918 €	4 697 000 €	7	5	1	0	0	1	0
Contract 149	2004	7 467 364 €	7 800 000 €	9	6	1	0	0	1	0
Contract 150	2011	7 506 747 €	7 523 664 €	6	3	1	0	0	1	0

Contract 151	2011	1 255 654 €	1 298 345 €	7	7	1	0	0	1	0
Contract 152	2012	11 313 515 €	11 106 900 €	5	3	1	0	0	1	0
Contract 153	2013	9 238 962 €	8 874 000 €	7	5	1	0	0	1	0
Contract 154	2013	14 206 477 €	13 341 667 €	7	4	1	0	0	1	0
Contract 155	2013	1 283 677 €	1 429 961 €	5	2	1	0	0	1	0
Contract 156	2013	7 276 536 €	6 564 903 €	6	3	1	0	0	1	0
Contract 157	2013	8 010 955 €	7 178 386 €	6	4	1	0	0	1	0
Contract 158	2013	12 335 327 €	12 376 647 €	5	3	1	0	0	1	0
Contract 159	2013	3 357 767 €	3 546 400 €	7	4	1	0	0	1	0
Contract 160	2014	8 543 645 €	8 366 280 €	6	4	1	0	0	1	0
Contract 161	2014	7 437 054 €	7 896 395 €	7	3	1	0	0	1	0
Contract 162	2014	11 545 017 €	11 805 792 €	7	4	1	0	0	1	0
Contract 163	2014	5 661 330 €	5 796 000 €	3	2	1	0	0	1	0
Contract 164	2014	19 400 293 €	15 793 800 €	6	6	1	0	0	1	0
Contract 165	2010	125 000 €	128 000 €	4	1	1	0	1	0	0
Contract 166	2010	175 000 €	153 111 €	7	2	0	0	1	0	0
Contract 167	2010	250 000 €	185 520 €	12	8	1	0	1	0	0
Contract 168	2011	250 000 €	245 429 €	6	3	0	0	1	0	0
Contract 169	2013	250 000 €	366 828 €	4	3	0	0	1	0	0
Contract 170	2013	270 000 €	179 000 €	3	3	0	0	1	0	0
Contract 171	2012	300 000 €	339 900 €	5	2	0	0	1	0	0
Contract 172	2007	335 000 €	460 000 €	9	5	0	0	1	0	0
Contract 173	2007	340 000 €	199 477 €	8	4	0	0	1	0	0
Contract 174	2007	348 000 €	474 600 €	8	3	0	0	1	0	0
Contract 175	2011	350 000 €	326 600 €	8	6	0	0	1	0	0
Contract 176	2010	350 000 €	206 000 €	7	4	1	0	1	0	0
Contract 177	2007	400 000 €	539 000 €	9	4	0	0	1	0	0
Contract 178	2006	410 000 €	527 705 €	6	5	0	0	1	0	0
Contract 179	2010	500 000 €	287 000 €	11	7	1	0	1	0	0
Contract 180	2010	500 000 €	351 500 €	14	7	0	0	1	0	0
Contract 181	2011	500 000 €	439 000 €	6	1	1	0	1	0	0
Contract 182	2012	500 000 €	358 800 €	9	6	1	0	1	0	0
Contract 183	2012	500 000 €	500 700 €	5	4	0	0	1	0	0
Contract 184	2010	509 000 €	401 530 €	5	2	1	0	1	0	0
Contract 185	2010	600 000 €	566 560 €	8	4	1	0	1	0	0
Contract 186	2012	600 000 €	320 000 €	5	3	1	0	1	0	0
Contract 187	2007	603 190 €	577 000 €	11	8	0	0	1	0	0
Contract 188	2008	620 000 €	682 000 €	11	6	0	0	1	0	0
Contract 189	2007	650 000 €	495 300 €	8	5	0	0	1	0	0
Contract 190	2010	656 347 €	487 500 €	11	5	0	0	1	0	0

Contract 191	2008	685 000 €	843 091 €	8	4	1	0	1	0	0
Contract 192	2011	700 000 €	568 000 €	15	10	1	0	1	0	0
Contract 193	2012	732 000 €	248 000 €	6	2	0	0	1	0	0
Contract 194	2006	800 000 €	994 297 €	13	8	0	0	1	0	0
Contract 195	2006	849 784 €	994 297 €	13	8	0	0	1	0	0
Contract 196	2011	870 000 €	1 067 755 €	10	4	0	0	1	0	0
Contract 197	2009	900 000 €	888 295 €	15	7	1	0	1	0	0
Contract 198	2007	930 000 €	774 161 €	11	10	0	0	1	0	0
Contract 199	2010	1 000 000 €	734 914 €	15	8	1	0	1	0	0
Contract 200	2011	1 000 000 €	1 155 000 €	12	6	1	0	1	0	0
Contract 201	2010	1 000 000 €	788 800 €	10	3	1	0	1	0	0
Contract 202	2011	1 000 000 €	882 900 €	8	5	1	0	1	0	0
Contract 203	2011	1 000 000 €	734 000 €	9	5	1	0	1	0	0
Contract 204	2011	1 000 000 €	916 851 €	6	4	0	0	1	0	0
Contract 205	2011	1 000 000 €	950 000 €	4	1	0	0	1	0	0
Contract 206	2014	1 000 000 €	712 339 €	4	3	0	0	1	0	0
Contract 207	2014	1 000 000 €	1 067 777 €	8	5	0	0	1	0	0
Contract 208	2012	1 037 000 €	792 330 €	4	1	1	0	1	0	0
Contract 209	2012	1 100 000 €	939 864 €	4	2	0	0	1	0	0
Contract 210	2010	1 200 000 €	1 019 000 €	14	10	1	0	1	0	0
Contract 211	2007	1 300 000 €	1 296 556 €	5	4	0	0	1	0	0
Contract 212	2008	1 300 000 €	1 088 000 €	7	6	1	0	1	0	0
Contract 213	2008	1 300 000 €	743 263 €	7	6	1	0	1	0	0
Contract 214	2010	1 300 000 €	979 900 €	8	4	0	0	1	0	0
Contract 215	2011	1 300 000 €	990 900 €	6	4	1	0	1	0	0
Contract 216	2011	1 300 000 €	1 240 000 €	12	8	1	0	1	0	0
Contract 217	2011	1 400 000 €	1 485 000 €	11	4	1	0	1	0	0
Contract 218	2011	1 400 000 €	1 320 069 €	8	5	1	0	1	0	0
Contract 219	2010	1 450 000 €	1 287 760 €	15	8	0	0	1	0	0
Contract 220	2009	1 500 000 €	1 109 000 €	9	4	1	0	1	0	0
Contract 221	2010	1 500 000 €	1 291 700 €	8	5	1	0	1	0	0
Contract 222	2010	1 500 000 €	1 691 000 €	18	14	0	0	1	0	0
Contract 223	2011	1 500 000 €	1 066 243 €	12	8	1	0	1	0	0
Contract 224	2007	1 523 998 €	1 392 000 €	10	2	1	0	1	0	0
Contract 225	2010	1 600 000 €	1 472 000 €	9	8	1	0	1	0	0
Contract 226	2012	1 700 000 €	2 244 000 €	7	5	1	0	1	0	0
Contract 227	2010	1 750 000 €	1 647 368 €	11	5	1	0	1	0	0
Contract 228	2010	1 800 000 €	888 958 €	7	3	0	0	1	0	0
Contract 229	2006	1 852 700 €	1 695 400 €	8	5	0	0	1	0	0
Contract 230	2011	1 900 000 €	1 680 807 €	11	6	1	0	1	0	0

Contract 231	2012	1 900 000 €	2 094 800 €	6	3	1	0	1	0	0
Contract 232	2006	1 950 000 €	1 437 000 €	9	5	0	0	1	0	0
Contract 233	2007	2 000 000 €	1 274 000 €	7	4	1	0	1	0	0
Contract 234	2010	2 000 000 €	1 876 400 €	8	5	0	0	1	0	0
Contract 235	2011	2 000 000 €	2 202 250 €	12	6	1	0	1	0	0
Contract 236	2011	2 200 000 €	2 620 000 €	6	2	1	0	1	0	0
Contract 237	2008	2 300 000 €	2 342 540 €	13	10	1	0	1	0	0
Contract 238	2008	2 325 000 €	2 871 251 €	3	3	1	0	1	0	0
Contract 239	2010	2 350 000 €	1 765 092 €	15	6	0	0	1	0	0
Contract 240	2010	2 800 000 €	1 809 752 €	14	8	1	0	1	0	0
Contract 241	2011	2 800 000 €	1 899 000 €	9	4	1	0	1	0	0
Contract 242	2004	2 900 000 €	2 058 999 €	8	7	0	0	1	0	0
Contract 243	2008	2 900 000 €	2 184 150 €	14	7	1	0	1	0	0
Contract 244	2006	3 000 000 €	2 727 000 €	6	3	0	0	1	0	0
Contract 245	2008	3 200 000 €	2 173 165 €	7	7	0	0	1	0	0
Contract 246	2009	3 300 000 €	2 121 400 €	12	7	0	0	1	0	0
Contract 247	2010	3 500 000 €	1 935 000 €	9	8	1	0	1	0	0
Contract 248	2007	3 600 000 €	3 095 000 €	8	6	0	0	1	0	0
Contract 249	2009	4 107 900 €	3 098 000 €	9	7	0	0	1	0	0
Contract 250	2012	5 000 000 €	5 182 500 €	9	5	1	0	1	0	0
Contract 251	2012	5 300 000 €	7 127 000 €	7	2	1	0	1	0	0
Contract 252	2008	7 300 000 €	4 188 000 €	12	9	1	0	1	0	0
Contract 253	2014	45 000 €	46 580 €	4	1	1	1	1	0	0
Contract 254	2010	12 000 €	17 900 €	1	1	1	1	0	0	1
Contract 255	2010	28 000 €	15 100 €	6	5	1	1	0	0	1
Contract 256	2009	32 000 €	28 500 €	1	1	1	1	1	0	0
Contract 257	2008	33 000 €	39 000 €	9	4	0	1	0	0	1
Contract 258	2008	33 000 €	38 300 €	15	10	0	1	0	0	1
Contract 259	2011	33 500 €	25 964 €	1	1	1	1	0	0	1
Contract 260	2011	35 000 €	29 950 €	1	1	1	1	0	0	1
Contract 261	2009	37 000 €	28 500 €	1	1	1	1	0	0	1
Contract 262	2009	39 000 €	33 800 €	6	5	1	1	0	0	1
Contract 263	2010	44 000 €	34 250 €	1	1	1	1	0	0	1
Contract 264	2010	45 000 €	37 800 €	4	3	1	1	0	0	1
Contract 265	2009	50 000 €	44 200 €	10	5	1	1	1	0	0
Contract 266	2008	50 000 €	45 960 €	9	6	0	1	0	0	1
Contract 267	2011	51 000 €	39 000 €	1	1	1	1	0	0	1
Contract 268	2012	51 000 €	48 000 €	5	4	1	1	0	0	1
Contract 269	2010	66 000 €	56 700 €	13	7	1	1	0	0	1
Contract 270	2010	67 000 €	82 000 €	1	1	0	1	0	0	1

Contract 271	2014	68 000 €	48 150 €	3	3	1	1	0	0	1
Contract 272	2011	75 000 €	47 200 €	4	4	0	1	0	0	1
Contract 273	2010	77 000 €	59 900 €	2	1	1	1	0	0	1
Contract 274	2009	79 100 €	42 615 €	7	3	1	0	0	0	1
Contract 275	2014	80 000 €	76 000 €	1	1	1	1	0	0	1
Contract 276	2009	82 000 €	57 500 €	1	1	1	1	0	0	1
Contract 277	2010	85 000 €	69 500 €	6	4	1	1	0	0	1
Contract 278	2011	88 000 €	67 828 €	10	9	1	1	0	0	1
Contract 279	2010	102 000 €	65 000 €	1	1	1	1	0	0	1
Contract 280	2013	102 000 €	42 700 €	5	5	1	1	0	0	1
Contract 281	2012	105 000 €	69 134 €	4	3	1	1	0	0	1
Contract 282	2011	105 000 €	61 500 €	9	5	1	1	0	0	1
Contract 283	2013	107 000 €	55 514 €	7	6	1	1	0	0	1
Contract 284	2010	108 000 €	70 400 €	6	4	1	1	0	0	1
Contract 285	2011	109 000 €	55 389 €	4	4	1	1	0	0	1
Contract 286	2014	133 000 €	99 000 €	9	5	1	1	0	0	1
Contract 287	2009	138 000 €	35 610 €	19	11	1	1	0	0	1
Contract 288	2013	144 000 €	114 790 €	5	5	1	1	0	0	1
Contract 289	2012	147 000 €	107 475 €	6	4	1	1	0	0	1
Contract 290	2009	149 000 €	94 910 €	19	6	1	1	0	0	1
Contract 291	2008	154 000 €	48 900 €	5	5	1	1	0	0	1
Contract 292	2013	157 000 €	67 620 €	8	7	0	1	0	0	1
Contract 293	2010	161 000 €	98 000 €	11	7	0	1	0	0	1
Contract 294	2009	163 000 €	120 425 €	17	12	1	1	0	0	1
Contract 295	2014	164 000 €	143 350 €	9	4	0	1	0	0	1
Contract 296	2012	168 000 €	75 750 €	3	2	0	1	0	0	1
Contract 297	2009	170 000 €	43 900 €	8	8	1	1	0	0	1
Contract 298	2011	172 000 €	79 700 €	7	5	1	1	0	0	1
Contract 299	2010	172 000 €	96 980 €	17	13	1	1	0	0	1
Contract 300	2012	175 000 €	81 770 €	6	4	1	1	0	0	1
Contract 301	2010	176 000 €	120 300 €	15	7	1	1	0	0	1
Contract 302	2010	182 000 €	142 800 €	22	16	1	1	0	0	1
Contract 303	2012	185 000 €	98 700 €	6	2	1	1	0	0	1
Contract 304	2009	185 000 €	168 000 €	14	7	1	1	0	0	1
Contract 305	2010	208 000 €	144 900 €	14	6	1	1	0	0	1
Contract 306	2014	210 000 €	204 644 €	12	6	0	1	0	0	1
Contract 307	2011	223 000 €	198 700 €	6	5	1	1	0	0	1
Contract 308	2009	228 000 €	128 000 €	19	10	1	1	0	0	1
Contract 309	2013	237 000 €	317 488 €	12	3	0	1	0	0	1
Contract 310	2013	237 000 €	146 500 €	8	6	1	1	0	0	1

Contract 311	2008	244 000 €	136 000 €	16	10	1	0	0	0	1
Contract 312	2014	255 000 €	214 000 €	10	3	1	1	0	0	1
Contract 313	2014	259 000 €	120 800 €	12	5	1	1	0	0	1
Contract 314	2014	266 000 €	209 700 €	7	4	0	1	0	0	1
Contract 315	2009	268 000 €	112 300 €	16	12	1	1	0	0	1
Contract 316	2011	288 000 €	227 000 €	5	4	1	1	0	0	1
Contract 317	2009	288 000 €	225 000 €	12	8	1	0	0	0	1
Contract 318	2009	308 500 €	364 000 €	18	7	1	1	0	0	1
Contract 319	2013	315 000 €	239 800 €	16	11	1	1	0	0	1
Contract 320	2010	316 000 €	94 720 €	4	3	0	1	0	0	1
Contract 321	2010	317 000 €	219 500 €	18	12	1	1	0	0	1
Contract 322	2011	319 500 €	323 200 €	7	5	1	1	0	0	1
Contract 323	2009	362 000 €	243 900 €	13	10	1	1	0	0	1
Contract 324	2013	366 000 €	215 000 €	17	10	1	1	0	0	1
Contract 325	2011	391 000 €	279 370 €	18	8	0	1	0	0	1
Contract 326	2010	392 000 €	368 000 €	21	11	1	1	0	0	1
Contract 327	2014	401 000 €	437 000 €	8	3	1	1	0	0	1
Contract 328	2012	407 000 €	364 300 €	11	5	1	1	0	0	1
Contract 329	2012	421 000 €	312 600 €	12	6	1	1	0	0	1
Contract 330	2010	428 000 €	367 300 €	11	7	1	1	0	0	1
Contract 331	2009	437 000 €	211 000 €	18	9	1	0	0	0	1
Contract 332	2013	455 000 €	319 400 €	18	9	1	1	0	0	1
Contract 333	2008	456 000 €	507 000 €	9	8	1	1	0	0	1
Contract 334	2013	471 000 €	438 800 €	18	13	0	1	0	0	1
Contract 335	2009	473 000 €	368 800 €	16	7	1	1	0	0	1
Contract 336	2010	474 000 €	335 000 €	15	7	1	1	0	0	1
Contract 337	2012	477 000 €	543 200 €	12	6	1	1	0	0	1
Contract 338	2011	478 000 €	298 700 €	11	8	0	1	0	0	1
Contract 339	2012	485 000 €	317 000 €	12	6	1	1	0	0	1
Contract 340	2009	492 000 €	459 000 €	13	8	1	1	1	0	0
Contract 341	2013	499 000 €	355 000 €	12	9	0	1	0	0	1
Contract 342	2008	511 000 €	523 400 €	13	5	0	1	0	0	1
Contract 343	2009	514 000 €	298 500 €	9	6	1	1	0	0	1
Contract 344	2010	533 000 €	333 000 €	10	7	1	1	0	0	1
Contract 345	2014	541 000 €	508 600 €	9	3	1	1	0	0	1
Contract 346	2009	545 000 €	337 400 €	9	5	1	1	1	0	0
Contract 347	2013	548 000 €	356 000 €	13	6	1	1	0	0	1
Contract 348	2010	548 000 €	308 900 €	16	10	0	1	0	0	1
Contract 349	2013	553 000 €	346 000 €	17	12	1	1	0	0	1
Contract 350	2012	571 000 €	435 000 €	13	4	1	1	0	0	1

Contract 351	2011	579 000 €	520 000 €	14	5	1	1	0	0	1
Contract 352	2008	580 000 €	528 400 €	8	2	1	1	0	0	1
Contract 353	2011	584 000 €	441 000 €	10	5	1	1	0	0	1
Contract 354	2014	586 000 €	342 670 €	15	8	1	1	0	0	1
Contract 355	2012	588 000 €	625 983 €	10	3	0	1	0	0	1
Contract 356	2010	591 000 €	427 000 €	11	6	1	1	0	0	1
Contract 357	2009	598 000 €	448 000 €	10	9	1	1	0	0	1
Contract 358	2012	601 000 €	459 000 €	6	3	0	1	0	0	1
Contract 359	2010	618 000 €	452 277 €	15	10	1	1	0	0	1
Contract 360	2010	618 000 €	445 528 €	17	11	1	1	0	0	1
Contract 361	2011	619 000 €	486 000 €	4	4	1	1	0	0	1
Contract 362	2011	619 000 €	489 150 €	17	8	1	1	0	0	1
Contract 363	2009	631 000 €	386 800 €	6	5	1	1	0	0	1
Contract 364	2011	645 000 €	784 390 €	18	10	0	1	0	0	1
Contract 365	2009	646 000 €	369 000 €	8	7	1	1	0	0	1
Contract 366	2011	650 000 €	409 126 €	15	10	1	1	0	0	1
Contract 367	2011	658 000 €	498 800 €	12	6	1	1	0	0	1
Contract 368	2010	681 000 €	403 279 €	21	12	1	1	0	0	1
Contract 369	2014	683 000 €	547 000 €	8	3	1	1	0	0	1
Contract 370	2008	686 000 €	576 167 €	11	8	1	1	0	0	1
Contract 371	2009	688 000 €	477 700 €	13	2	1	1	1	0	0
Contract 372	2012	692 000 €	624 000 €	18	11	1	1	0	0	1
Contract 373	2013	703 000 €	795 000 €	13	11	0	1	0	0	1
Contract 374	2010	704 000 €	558 100 €	12	7	1	1	0	0	1
Contract 375	2009	707 000 €	530 000 €	19	18	1	0	0	0	1
Contract 376	2011	709 000 €	772 800 €	14	4	1	1	0	0	1
Contract 377	2010	711 000 €	498 600 €	9	6	1	1	0	0	1
Contract 378	2011	734 000 €	422 000 €	8	3	1	1	0	0	1
Contract 379	2009	739 000 €	484 800 €	18	9	1	1	0	0	1
Contract 380	2014	740 000 €	543 000 €	6	5	1	1	0	0	1
Contract 381	2013	750 000 €	657 328 €	16	6	1	1	0	0	1
Contract 382	2011	750 000 €	421 400 €	16	6	1	1	0	0	1
Contract 383	2014	751 000 €	537 000 €	8	4	1	1	0	0	1
Contract 384	2009	751 000 €	539 000 €	10	7	1	1	0	0	1
Contract 385	2011	755 000 €	683 600 €	18	9	1	1	0	0	1
Contract 386	2010	757 000 €	766 000 €	9	6	0	1	0	0	1
Contract 387	2012	757 000 €	632 520 €	18	10	1	1	0	0	1
Contract 388	2011	800 000 €	673 800 €	10	5	1	1	0	0	1
Contract 389	2010	828 000 €	718 000 €	12	8	1	1	0	0	1
Contract 390	2009	830 000 €	482 000 €	9	7	1	1	0	0	1

Contract 391	2012	853 000 €	911 600 €	16	9	1	1	0	0	1
Contract 392	2009	858 000 €	641 600 €	19	16	1	1	1	0	0
Contract 393	2011	860 000 €	678 380 €	16	9	1	1	0	0	1
Contract 394	2013	864 000 €	678 000 €	13	6	1	1	0	0	1
Contract 395	2013	867 000 €	575 700 €	11	6	1	1	0	0	1
Contract 396	2011	871 000 €	763 000 €	4	4	1	1	0	0	1
Contract 397	2009	872 000 €	756 000 €	10	7	1	1	0	0	1
Contract 398	2010	872 000 €	522 900 €	14	13	0	1	0	0	1
Contract 399	2012	873 000 €	796 300 €	11	4	0	1	0	0	1
Contract 400	2010	884 000 €	420 000 €	19	10	1	1	0	0	1
Contract 401	2009	894 000 €	530 000 €	11	6	1	1	1	0	0
Contract 402	2012	904 000 €	565 000 €	19	11	1	1	0	0	1
Contract 403	2014	912 000 €	632 800 €	8	3	1	1	0	0	1
Contract 404	2011	914 000 €	1 209 600 €	11	10	1	1	0	0	1
Contract 405	2013	962 000 €	675 000 €	16	9	1	1	0	0	1
Contract 406	2010	968 000 €	687 687 €	15	12	0	1	0	0	1
Contract 407	2012	975 000 €	987 700 €	10	5	1	1	0	0	1
Contract 408	2009	980 000 €	267 450 €	11	11	1	1	0	0	1
Contract 409	2014	999 000 €	897 340 €	11	4	1	1	0	0	1
Contract 410	2009	1 010 000 €	972 100 €	8	4	1	0	0	0	1
Contract 411	2012	1 022 000 €	624 000 €	11	5	0	1	0	0	1
Contract 412	2011	1 047 000 €	988 000 €	20	7	1	0	0	0	1
Contract 413	2013	1 089 000 €	983 270 €	9	3	1	1	0	0	1
Contract 414	2009	1 117 000 €	628 500 €	10	9	1	1	0	0	1
Contract 415	2010	1 178 000 €	857 800 €	12	8	1	1	0	0	1
Contract 416	2009	1 179 000 €	922 250 €	13	8	1	1	0	0	1
Contract 417	2009	1 191 000 €	569 000 €	8	6	1	1	0	0	1
Contract 418	2012	1 207 000 €	783 900 €	18	12	1	1	0	0	1
Contract 419	2012	1 211 000 €	1 175 000 €	12	7	1	0	0	0	1
Contract 420	2011	1 217 000 €	1 169 000 €	10	7	1	0	0	0	1
Contract 421	2011	1 218 000 €	678 390 €	12	7	1	1	0	0	1
Contract 422	2010	1 280 000 €	891 803 €	14	10	0	1	0	0	1
Contract 423	2011	1 298 000 €	840 000 €	11	8	1	1	0	0	1
Contract 424	2013	1 299 000 €	1 164 000 €	10	7	1	0	0	0	1
Contract 425	2014	1 314 000 €	1 386 700 €	7	4	1	1	0	0	1
Contract 426	2014	1 323 000 €	1 129 390 €	11	7	1	1	0	0	1
Contract 427	2010	1 336 000 €	755 000 €	16	6	1	1	0	0	1
Contract 428	2010	1 337 000 €	1 123 000 €	12	10	0	1	0	0	1
Contract 429	2009	1 357 000 €	1 226 500 €	9	5	1	1	0	0	1
Contract 430	2010	1 386 000 €	1 393 000 €	17	8	1	0	0	0	1

Contract 431	2012	1 394 000 €	879 000 €	17	11	1	1	0	0	1
Contract 432	2012	1 406 000 €	1 242 000 €	12	8	1	0	0	0	1
Contract 433	2012	1 444 000 €	1 043 089 €	17	11	1	1	0	0	1
Contract 434	2009	1 499 000 €	1 309 000 €	12	5	1	1	1	0	0
Contract 435	2011	1 522 000 €	1 350 000 €	20	10	1	0	0	0	1
Contract 436	2010	1 542 000 €	1 421 800 €	12	11	0	1	0	0	1
Contract 437	2009	1 732 000 €	1 586 000 €	22	7	1	1	0	0	1
Contract 438	2010	1 849 000 €	1 098 000 €	8	5	0	1	0	0	1
Contract 439	2013	1 867 000 €	970 000 €	11	7	1	1	0	0	1
Contract 440	2013	1 888 000 €	1 184 600 €	12	7	1	1	0	0	1
Contract 441	2010	1 947 000 €	1 545 000 €	9	5	1	1	0	0	1
Contract 442	2010	1 999 000 €	1 088 080 €	13	9	1	1	0	0	1
Contract 443	2013	2 065 000 €	1 868 000 €	12	9	1	1	0	0	1
Contract 444	2011	2 128 000 €	2 169 474 €	16	10	1	0	0	0	1
Contract 445	2013	2 138 000 €	1 868 000 €	14	7	1	0	0	0	1
Contract 446	2014	2 180 000 €	1 830 000 €	10	5	1	1	0	0	1
Contract 447	2012	2 180 000 €	3 294 000 €	14	8	1	0	0	0	1
Contract 448	2012	2 290 000 €	1 995 000 €	19	8	1	1	0	0	1
Contract 449	2011	2 430 000 €	3 157 000 €	12	2	1	1	0	0	1
Contract 450	2014	2 481 000 €	2 779 320 €	8	5	0	1	0	0	1
Contract 451	2013	2 490 000 €	1 690 000 €	14	8	1	1	0	0	1
Contract 452	2011	2 501 000 €	1 748 900 €	14	6	1	1	0	0	1
Contract 453	2013	2 587 000 €	2 044 402 €	8	5	1	0	0	0	1
Contract 454	2011	2 651 000 €	2 854 800 €	6	4	1	1	0	0	1
Contract 455	2012	2 712 000 €	2 325 000 €	12	9	1	0	0	0	1
Contract 456	2011	2 754 000 €	1 970 000 €	15	8	1	0	0	0	1
Contract 457	2010	3 081 000 €	2 749 570 €	18	11	1	1	0	0	1
Contract 458	2013	3 129 000 €	3 029 000 €	7	2	0	1	0	0	1
Contract 459	2010	3 470 000 €	2 330 000 €	9	8	0	1	0	0	1
Contract 460	2010	3 563 000 €	3 324 300 €	10	5	1	1	0	0	1
Contract 461	2011	3 615 000 €	3 330 000 €	17	6	1	1	0	0	1
Contract 462	2011	3 633 400 €	3 131 000 €	13	10	0	0	1	0	0
Contract 463	2013	3 845 000 €	3 480 000 €	12	5	1	1	0	0	1
Contract 464	2013	4 513 000 €	3 987 000 €	6	3	1	1	0	0	1
Contract 465	2009	4 534 000 €	3 846 000 €	15	11	1	1	0	0	1
Contract 466	2008	4 554 000 €	2 571 000 €	12	6	1	1	0	0	1
Contract 467	2009	4 564 000 €	3 850 000 €	10	9	1	1	0	0	1
Contract 468	2010	4 571 000 €	4 208 648 €	15	11	1	1	0	0	1
Contract 469	2012	4 646 000 €	3 647 000 €	13	8	1	1	0	0	1
Contract 470	2011	5 304 000 €	5 117 000 €	7	3	0	1	0	0	1

Contract 471	2010	5 369 000 €	2 146 000 €	7	5	0	0	1	0	0
Contract 472	2011	5 506 000 €	5 094 997 €	9	6	1	1	0	0	1
Contract 473	2014	5 775 000 €	7 885 500 €	4	2	1	1	0	0	1
Contract 474	2012	5 818 000 €	5 473 000 €	15	6	1	1	0	0	1
Contract 475	2010	6 000 000 €	6 641 392 €	5	5	0	0	1	0	0
Contract 476	2010	6 012 000 €	5 498 000 €	9	5	0	1	0	0	1
Contract 477	2010	6 200 000 €	7 970 000 €	8	6	0	0	1	0	0
Contract 478	2011	6 247 000 €	3 625 521 €	13	8	1	1	0	0	1
Contract 479	2010	6 378 000 €	6 628 000 €	7	2	1	1	0	0	1
Contract 480	2009	6 418 000 €	4 690 000 €	8	8	1	1	0	0	1
Contract 481	2010	6 437 000 €	4 948 000 €	10	8	1	1	0	0	1
Contract 482	2012	6 456 000 €	4 758 000 €	12	4	1	1	0	0	1
Contract 483	2011	6 552 000 €	6 454 000 €	16	8	1	1	0	0	1
Contract 484	2013	7 085 000 €	6 477 000 €	13	2	1	1	0	0	1
Contract 485	2012	7 450 000 €	6 478 900 €	14	8	1	1	0	0	1
Contract 486	2010	7 512 000 €	4 890 000 €	15	11	1	1	0	0	1
Contract 487	2014	8 010 000 €	6 545 000 €	12	6	1	1	0	0	1
Contract 488	2013	8 599 000 €	7 334 000 €	13	6	0	1	0	0	1
Contract 489	2012	8 611 000 €	6 697 000 €	10	8	0	1	0	0	1
Contract 490	2014	8 981 000 €	9 777 000 €	8	3	1	1	0	0	1
Contract 491	2013	10 226 000 €	8 324 000 €	11	4	1	1	0	0	1
Contract 492	2010	10 592 000 €	9 739 000 €	9	5	0	1	0	0	1
Contract 493	2010	10 724 000 €	8 607 000 €	7	6	0	1	0	0	1
Contract 494	2012	11 814 000 €	8 898 000 €	11	9	1	1	0	0	1
Contract 495	2013	26 470 000 €	23 872 000 €	7	4	0	0	1	0	0
Contract 496	2012	26 882 000 €	18 898 000 €	7	7	0	1	0	0	1

Appendix B

Table B: Sample data for studying Hypotheses 8 to10

Contract	Year	Pre-bid Cost Estimation	1.Price	Multiple Prime	Renovation	Infrastructure Works	Residential	Public Building	Budget overrun
Contract 1	2010	125,000 €	128,000 €	0	0	1	0	0	10.4%
Contract 2	2011	250,000 €	245,429 €	0	1	1	0	0	129.3%
Contract 3	2007	340,000 €	199,477 €	0	1	1	0	0	14.9%
Contract 4	2011	350,000 €	326,600 €	0	1	1	0	0	2.9%
Contract 5	2007	400,000 €	539,000 €	0	1	1	0	0	6.1%
Contract 6	2006	410,000 €	527,705 €	0	1	1	0	0	5.7%
Contract 7	2011	500,000 €	439,000 €	0	0	1	0	0	11.2%
Contract 8	2008	620,000 €	682,000 €	0	1	1	0	0	29.3%
Contract 9	2007	650,000 €	495,300 €	0	1	1	0	0	16.3%
Contract 10	2008	685,000 €	843,091 €	0	0	1	0	0	-24.8%
Contract 11	2011	1,000,000 €	1,155,000 €	0	0	1	0	0	9.4%
Contract 12	2010	1,000,000 €	788,800 €	0	0	1	0	0	0.7%
Contract 13	2011	1,000,000 €	882,900 €	0	0	1	0	0	42.1%
Contract 14	2007	1,300,000 €	1,296,556 €	0	1	1	0	0	6.6%
Contract 15	2008	1,300,000 €	1,088,000 €	0	0	1	0	0	22.8%
Contract 16	2011	1,300,000 €	990,900 €	0	0	1	0	0	21.3%
Contract 17	2011	1,300,000 €	1,240,000 €	0	0	1	0	0	4.2%
Contract 18	2011	1,400,000 €	1,485,000 €	0	0	1	0	0	3.0%
Contract 19	2011	1,400,000 €	1,320,069 €	0	0	1	0	0	20.1%
Contract 20	2010	1,450,000 €	1,287,760 €	0	1	1	0	0	9.2%
Contract 21	2010	1,500,000 €	1,291,700 €	0	0	1	0	0	13.3%
Contract 22	2011	1,500,000 €	1,066,243 €	0	0	1	0	0	9.9%
Contract 23	2007	1,523,998 €	1,392,000 €	0	0	1	0	0	18.4%
Contract 24	2010	1,600,000 €	1,472,000 €	0	0	1	0	0	8.3%
Contract 25	2010	1,750,000 €	1,647,368 €	0	0	1	0	0	39.2%
Contract 26	2006	1,852,700 €	1,695,400 €	0	1	1	0	0	15.8%
Contract 27	2011	1,900,000 €	1,680,807 €	0	0	1	0	0	7.9%
Contract 28	2007	2,000,000 €	1,274,000 €	0	0	1	0	0	4.3%
Contract 29	2011	2,000,000 €	2,202,250 €	0	0	1	0	0	10.5%
Contract 30	2011	2,200,000 €	2,620,000 €	0	0	1	0	0	17.1%
Contract 31	2008	2,325,000 €	2,871,251 €	0	0	1	0	0	8.1%

Contract 32	2010	2,350,000 €	1,765,092 €	0	1	1	0	0	13.6%
Contract 33	2010	2,800,000 €	1,809,752 €	0	0	1	0	0	10.2%
Contract 34	2011	2,800,000 €	1,899,000 €	0	0	1	0	0	18.1%
Contract 35	2008	2,900,000 €	2,184,150 €	0	0	1	0	0	10.8%
Contract 36	2006	3,000,000 €	2,727,000 €	0	1	1	0	0	44.1%
Contract 37	2010	3,500,000 €	1,935,000 €	0	0	1	0	0	4.4%
Contract 38	2007	3,600,000 €	3,095,000 €	0	1	1	0	0	5.7%
Contract 39	2008	7,300,000 €	4,188,000 €	0	0	1	0	0	10.6%
Contract 40	2010	4,412,000 €	5,595,000 €	0	1	0	1	0	1.7%
Contract 41	2012	7,573,000 €	8,230,000 €	0	1	0	1	0	2.5%
Contract 42	2013	5,045,000 €	5,717,700 €	0	1	0	1	0	0.2%
Contract 43	2010	15,000,000 €	16,465,531 €	0	1	0	1	0	0.7%
Contract 44	2009	13,553,000 €	11,393,065 €	0	1	0	1	0	0.3%
Contract 45	2009	8,496,000 €	8,280,952 €	0	1	0	1	0	0.6%
Contract 46	2007	5,971,000 €	7,923,900 €	0	1	0	1	0	0.3%
Contract 47	2009	9,501,000 €	7,247,844 €	0	1	0	1	0	0.3%
Contract 48	2009	11,121,000 €	10,614,000 €	0	1	0	1	0	1.3%
Contract 49	2006	7,254,000 €	9,053,000 €	0	1	0	1	0	0.0%
Contract 50	2005	4,409,000 €	4,857,000 €	0	1	0	1	0	0.3%
Contract 51	2009	5,374,000 €	5,132,090 €	0	1	0	1	0	1.9%
Contract 52	2010	6,200,000 €	7,970,000 €	0	1	1	0	0	9.4%
Contract 53	2011	1,217,000 €	1,169,000 €	0	0	0	0	1	30.4%
Contract 54	2009	1,010,000 €	972,100 €	0	0	0	0	1	4.2%
Contract 55	2009	79,100 €	42,615 €	0	0	0	0	1	35.6%
Contract 56	2009	707,000 €	530,000 €	0	0	0	0	1	16.7%
Contract 57	2010	5,369,000 €	2,146,000 €	0	1	1	0	0	47.2%
Contract 58	2010	1,386,000 €	1,393,000 €	0	0	0	0	1	12.0%
Contract 59	2006	180,000 €	42,000 €	0	0	0	0	1	29.5%
Contract 60	2006	108,000 €	32,377 €	0	0	0	0	1	28.5%
Contract 61	2006	555,000 €	503,000 €	0	0	1	0	0	19.5%
Contract 62	2006	1,398,000 €	1,048,000 €	0	0	0	0	1	18.4%
Contract 63	2006	409,000 €	398,890 €	0	0	0	0	1	2.7%
Contract 64	2005	251,000 €	264,000 €	0	0	0	0	1	3.2%
Contract 65	2005	470,000 €	528,000 €	0	0	0	0	1	21.8%
Contract 66	2005	1,631,000 €	1,389,000 €	0	0	0	0	1	21.6%
Contract 67	2005	155,000 €	113,675 €	0	0	1	0	0	9.0%
Contract 68	2005	682,000 €	672,000 €	0	0	1	0	0	6.6%
Contract 69	2004	210,000 €	359,836 €	0	0	0	0	1	15.7%
Contract 70	2004	208,000 €	207,190 €	0	1	0	0	1	119.0%
Contract 71	2004	1,030,000 €	1,085,000 €	0	0	0	0	1	13.3%

Contract 72	2004	1,532,000 €	1,474,000 €	0	0	1	0	0	24.6%
Contract 73	2004	320,000 €	400,000 €	0	0	0	0	1	3.6%
Contract 74	2004	615,000 €	624,000 €	0	0	0	0	1	0.7%
Contract 75	2004	483,000 €	439,696 €	0	0	0	0	1	9.1%
Contract 76	2004	608,000 €	496,311 €	0	0	0	0	1	9.5%
Contract 77	2004	715,000 €	714,000 €	0	0	0	0	1	11.1%
Contract 78	2003	260,000 €	179,000 €	0	0	0	0	1	5.5%
Contract 79	2003	383,600 €	424,000 €	0	1	0	0	1	7.5%
Contract 80	2003	896,000 €	567,900 €	0	0	1	0	0	4.2%
Contract 81	2003	607,000 €	603,200 €	0	0	0	0	1	5.5%
Contract 82	2011	735,000 €	685,000 €	0	0	0	0	1	10.0%
Contract 83	2011	900,000 €	907,104 €	0	0	0	0	1	21.6%
Contract 84	2011	1,052,000 €	1,206,000 €	0	0	0	0	1	15.2%
Contract 85	2010	416,000 €	424,000 €	0	0	0	0	1	22.8%
Contract 86	2010	1,967,000 €	1,920,000 €	0	0	0	0	1	17.1%
Contract 87	2010	2,247,000 €	2,450,000 €	0	0	0	0	1	25.5%
Contract 88	2009	707,000 €	530,000 €	0	0	0	0	1	16.7%
Contract 89	2009	400,000 €	295,000 €	0	0	0	0	1	50.8%
Contract 90	2009	1,453,000 €	1,250,000 €	0	0	0	0	1	146.2%
Contract 91	2009	288,000 €	225,000 €	0	0	0	0	1	24.4%
Contract 92	2008	244,000 €	136,000 €	0	0	0	0	1	29.9%
Contract 93	2008	1,391,000 €	1,266,500 €	0	0	0	0	1	14.7%
Contract 94	2008	518,000 €	336,000 €	0	0	0	0	1	11.7%
Contract 95	2008	3,500,000 €	3,770,000 €	0	0	0	0	1	9.8%
Contract 96	2008	2,767,000 €	2,812,000 €	0	0	0	0	1	9.0%
Contract 97	2007	151,000 €	148,300 €	0	0	0	0	1	16.1%
Contract 98	2007	676,000 €	701,000 €	0	0	0	0	1	19.1%
Contract 99	2007	353,000 €	383,000 €	0	0	0	0	1	6.4%
Contract 100	2014	3,325,000 €	2,790,045 €	1	0	0	0	1	-7.9%
Contract 101	2008	10,080,000 €	10,123,200 €	1	1	0	0	1	19.1%
Contract 102	2003	2,529,000 €	2,458,877 €	1	0	0	0	1	21.3%
Contract 103	2011	7,986,000 €	7,633,097 €	1	0	0	0	1	33.2%
Contract 104	2009	442,000 €	360,000 €	1	0	0	0	1	27.2%
Contract 105	2007	415,000 €	392,600 €	1	0	0	0	1	30.9%
Contract 106	2011	1,093,000 €	1,052,443 €	1	0	0	0	1	6.0%
Contract 107	2010	8,094,000 €	7,861,150 €	1	0	0	0	1	30.9%
Contract 108	2004	904,000 €	731,900 €	1	0	0	0	1	27.9%
Contract 109	2006	1,422,000 €	1,552,103 €	1	1	0	0	1	12.2%
Contract 110	2004	866,000 €	835,266 €	1	0	0	0	1	16.1%
Contract 111	2004	2,700,000 €	1,468,000 €	1	0	0	0	1	14.1%

Contract 112	2003	3,789,000 €	3,388,757 €	1	0	0	0	1	6.9%
Contract 113	2007	1,204,500 €	1,188,500 €	1	0	0	0	1	21.7%
Contract 114	2008	473,000 €	644,174 €	1	0	0	0	1	26.3%
Contract 115	2010	6,153,000 €	5,551,949 €	1	0	0	0	1	16.7%
Contract 116	2004	5,026,000 €	4,444,269 €	1	1	0	0	1	24.4%
Contract 117	2003	15,079,000 €	14,379,600 €	1	0	0	0	1	14.9%
Contract 118	2009	7,200,000 €	5,509,400 €	1	0	0	0	1	28.1%
Contract 119	2010	9,244,000 €	7,903,703 €	1	1	0	0	1	57.6%
Contract 120	2007	3,350,000 €	3,149,310 €	1	0	0	0	1	21.6%
Contract 121	2006	1,944,000 €	1,715,410 €	1	0	0	0	1	17.5%
Contract 122	2009	3,715,000 €	3,436,984 €	1	0	0	0	1	24.8%
Contract 123	2009	1,445,000 €	1,359,016 €	1	0	0	0	1	16.0%
Contract 124	2009	6,832,000 €	5,440,000 €	1	0	0	0	1	40.8%
Contract 125	2008	6,430,000 €	4,231,467 €	1	0	0	0	1	26.8%
Contract 126	2009	1,958,000 €	1,651,210 €	1	0	0	0	1	17.4%
Contract 127	2004	1,271,000 €	1,278,761 €	1	0	0	0	1	25.4%
Contract 128	2009	2,931,000 €	2,482,300 €	1	0	1	0	0	26.0%
Contract 129	2007	1,334,000 €	1,608,050 €	1	1	0	0	1	16.3%
Contract 130	2007	1,396,000 €	1,239,378 €	1	0	0	0	1	21.2%
Contract 131	2007	1,343,000 €	1,085,800 €	1	0	0	0	1	21.0%
Contract 132	2007	31,745,000 €	32,918,396 €	1	1	0	0	1	8.3%
Contract 133	2007	547,000 €	397,158 €	1	0	0	0	1	36.7%
Contract 134	2010	4,323,000 €	3,878,800 €	1	0	0	0	1	46.5%
Contract 135	2006	6,825,800 €	6,545,877 €	1	1	0	0	1	22.1%
Contract 136	2004	4,221,000 €	3,854,950 €	1	0	0	0	1	31.9%
Contract 137	2003	4,207,000 €	4,101,479 €	1	0	0	0	1	11.3%
Contract 138	2008	632,000 €	654,810 €	1	1	0	0	1	10.6%
Contract 139	2005	4,424,000 €	4,107,598 €	1	0	0	0	1	13.4%
Contract 140	2007	624,000 €	570,844 €	1	0	0	0	1	22.8%
Contract 141	2006	6,288,000 €	5,040,250 €	1	0	0	0	1	41.7%
Contract 142	2007	2,417,000 €	2,443,900 €	1	0	0	0	1	14.5%
Contract 143	2007	24,923,411 €	27,737,205 €	1	0	0	0	1	11.3%
Contract 144	2008	2,733,141 €	3,083,291 €	1	1	0	0	1	3.3%
Contract 145	2007	2,045,000 €	2,022,823 €	1	0	0	0	1	14.8%
Contract 146	2008	3,212,000 €	3,918,941 €	1	1	0	0	1	8.4%
Contract 147	2003	1,259,000 €	1,238,810 €	1	0	0	0	1	13.9%
Contract 148	2010	2,557,000 €	1,463,260 €	1	0	0	0	1	19.6%
Contract 149	2005	758,000 €	648,300 €	1	0	0	0	1	16.2%
Contract 150	2005	1,017,000 €	977,343 €	1	0	0	0	1	18.2%
Contract 151	2007	13,096,000 €	12,951,100 €	1	1	0	0	1	18.2%

Contract 152	2007	6,283,000 €	5,711,280 €	1	1	0	0	1	5.0%
Contract 153	2007	1,423,000 €	1,386,800 €	1	0	0	0	1	29.8%
Contract 154	2004	1,221,000 €	1,192,795 €	1	0	0	0	1	17.6%
Contract 155	2003	992,000 €	706,854 €	1	0	0	0	1	76.9%
Contract 156	2009	1,636,000 €	1,578,500 €	1	1	0	0	1	19.5%
Contract 157	2009	594,000 €	408,200 €	1	1	0	0	1	40.1%
Contract 158	2007	1,495,000 €	1,434,057 €	1	0	0	0	1	16.0%
Contract 159	2003	2,598,000 €	2,446,447 €	1	0	0	0	1	17.4%
Contract 160	2008	1,827,000 €	1,811,185 €	1	1	0	0	1	16.9%
Contract 161	2007	313,000 €	338,000 €	1	1	0	0	1	15.7%
Contract 162	2009	1,915,850 €	1,452,510 €	1	0	0	0	1	24.3%
Contract 163	2003	4,843,000 €	3,898,400 €	1	0	0	0	1	18.4%
Contract 164	2005	2,269,000 €	2,261,700 €	1	0	0	0	1	5.9%
Contract 165	2006	1,160,000 €	1,185,350 €	1	0	0	0	1	40.2%
Contract 166	2005	295,000 €	327,500 €	1	0	0	0	1	47.7%
Contract 167	2006	1,101,000 €	788,850 €	1	0	0	0	1	29.5%
Contract 168	2004	930,000 €	791,050 €	1	0	0	0	1	34.5%
Contract 169	2009	8,988,000 €	6,079,800 €	1	0	0	0	1	60.6%
Contract 170	2009	644,000 €	456,000 €	1	0	0	0	1	19.6%
Contract 171	2008	1,611,000 €	1,661,432 €	1	1	0	0	1	13.0%
Contract 172	2006	978,000 €	726,603 €	1	0	0	0	1	20.7%
Contract 173	2007	913,000 €	869,019 €	1	0	0	0	1	19.3%
Contract 174	2005	2,803,000 €	1,713,100 €	1	0	0	0	1	25.9%
Contract 175	2009	17,675,000 €	18,886,116 €	1	1	0	1	0	4.6%
Contract 176	2009	14,415,000 €	13,157,410 €	1	1	0	1	0	0.9%
Contract 177	2008	15,228,500 €	12,987,456 €	1	1	0	1	0	0.3%
Contract 178	2008	9,049,183 €	6,517,742 €	1	1	0	1	0	0.6%
Contract 179	2008	14,850,000 €	13,822,289 €	1	1	0	1	0	0.4%
Contract 180	2008	5,938,558 €	4,254,150 €	1	1	0	1	0	1.2%
Contract 181	2008	10,155,600 €	10,212,000 €	1	1	0	1	0	0.5%
Contract 182	2009	20,068,000 €	19,154,894 €	1	1	0	1	0	1.3%
Contract 183	2009	3,219,100 €	2,987,048 €	0	1	0	1	0	3.3%