Price of public contract and dependence on estimated value of public contract

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Abstract: This paper is dealing with the one problem of public procurement (determination of final price). The paper contains the analyses of differences between the estimated value of public contract and its tendered (or final) price. This fact surfaces that in some cases due to an inaccurately estimated price of the public contract were such public contracts awarded within a different type of an award procedure than was needed due to the public contract Law in European countries or due to the European Directives. The Subject of analysis in relation to different type of contract: supply, services and works contracts and type of supplier (its business policy and its size - bigger and smaller suppliers). There were evaluated these described relations: estimated value of contract, price and factor for critical assessment. In this study the authors defined regression model of variables mentioned. This relation is important for indication if economic competition is effective and transparent.

Key-Words: final price of public contracts, public contracts, estimated value of public contracts, suppliers, small and medium size enterprises

1 Introduction

The public procurement law in the Czech Republic is as in the other member of European Union based on European procurement directive. According to § 13 Act no. 137/2006 Coll., on public contracts, “estimated value of a public contract” shall be understood as an amount of financial liability estimated by the contracting entity and ensuing from the performance of the public contract that the contracting entity shall be obligated to set for the purposes of the award procedure, prior to its initiation. In establishing the estimated value, the price net of value added tax, shall be always conclusive. The contracting entity shall calculate the estimated value in compliance with the rules laid down in this Act and on the basis of data and information on contracts of equal or equivalent subject-matter; where such information is not available, the contracting entity shall establish the estimated value based on data and information obtained by means of market research of required performance, or, if appropriate, on the basis of data and information gained in another suitable manner. In establishing the estimated value, the date of dispatch for publication of the contract notice or the call for competition shall be conclusive. The contracting entity shall not subdivide the subject-matter of the public contract to lower thereby the estimated value below the financial thresh-olds set out in this Act. If a public contract is subdivided into lots, the total estimated values of all such lots of the public contract shall be conclusive for establishing the estimated value (Guccio and Pignataro and Rizzo, 2014).

We can agree with authors that associate the increase of efficiency in public procurement with the possibility of an easier access of small and medium enterprises to the public contracts market (Nakabayashi et al. 2013, Loader, 2011). If the contracting entity provides for rewards, prizes or payments to participants in the design contest or to participants in the competitive dialogue, the estimated value shall, in addition, include the total amount of such rewards, prizes or payments. This and additional aspects are described in literature (Kotatkova Stranska, 2012, Krause, 2013, Matatkova et al., 2014, Myskova, 2013; Koppitz, et al., 2015).

If the contracting entity reserved in the tender conditions the option pursuant to § 99, the estimated value shall, in addition, include the estimated value of all public supply contracts, public service contracts and public works contracts required by the contracting entity in the exercise of such an option; in that case the contracting entity shall be simultaneously obligated to establish separately the estimated value of the public supply contract, public service contract or public works contract, and the estimated value of supplies, services or public works in the exercise of such an option. In the case of framework agreements and the dynamic purchasing sys-tem, the estimated value shall be the maximum estimated value of all public con-tracts to be awarded during the term of duration of the framework agreement or the dynamic purchasing system. When establishing the estimated value, the contracting entity shall be obligated to sum up all estimated values of all similar mutually related supplies or services to be procured in the course of the accounting period. This provision shall not apply to supplies or services the unit prices of which vary during the accounting period, and the contracting entity acquires such supplies or services repeatedly according to its imminent requirements; the contracting entity shall, however, be always obligated to comply with the principles pursuant (Jackson and Brown, 1994, Hajek, et al., 2012). In view of the authors, it is important to mention also the fact that efficiency of public contracts itself is based, last but not least, on the “quality” of the legislation framework for public procurement. Some authors concentrate on criticism of, for example, so called European public procurement law (Korthals et al., 2010).

In the field of public procurement, an important role is that of the rate of corruption which strongly devalues the quality of economic competition in individual countries. Therefore, some of authors deal with the influence of corruption in public contracts on economic competition (Ateljevic et al., 2010, Smekalova et al., 2015). It is possible to refer to other authors dealing with efficiency in public procurement, this for example in public procurement of contracts for cultural heritage conservation works in Italy (Guccio et al., 2014) or it is possible to cover, in relation with assessment of efficiency of public contracts, the context of so called electronic public procurement which, according to many authors, improve its efficiency (Costa et al., 2013; Koppitz et al., 2015).

The structure of this paper is following. After literature review made in chapter introduction we use the regression analysis to study relationship between the estimated value of a public contract and real price of a public contract after tender. This is done in chapter 2. In next chapter 3, there are discussion the results and in final chapter 4, they included conclusions.

2 Materials and methods

As it was mentioned, regression analysis will be used to study relationship between the estimated value of a public contract without VAT established by the contracting authority before the tender according to § 13 et seq. Act no. 137/2006 Coll., on public procurement and real price of a public contract without VAT after tender. In other words dependant variable in the analysis is the real price of the public contract without VAT after tender. Independent variable is price of the public contract without VAT established by the contracting authority before the tender. There will be found out, what is the relationship between these two variables in total and also how this relationship changes when the public contracts are separated according to its purpose: public contracts on supplies, services and construction works. To describe a possible dependency of selected parameters influencing the relation between estimated value of public contract and its final price, we have performed the quantitative analysis of secondary data obtained from the Journal of Public Contracts (TED, 2014), sample covering tendered public contracts pursuant to the Public Contract Law. The authors have left aside small scale public contracts and bellow thresholds public contracts. The data have been chosen using systematic selection and cover only the period of 2014, it means a sufficiently long period. Due to a high error rate of the secondary data (missing values or two different tendered prices (the tendered price is the price offered by the winning bidder in the tender who carried off the contract) within one tender, the authors had to remove the faulty data because of impossibility to correct them. Together 200 records have been selected and validated. Aim of this work is to study relationship between the estimated value of a public contract without VAT established by the contracting authority before the tender according to § 13 et seq. Czech Act no. 137/2006 Coll., on public procurement and real price of a public contract without VAT after tender. This is regulates in the same way as in the procurement directives of EU. Relationship will be study using regression analyses. Regression analysis is a statistical method, which goal is approaching to the so-called causal context. Causality means dependence existence of a one phenomenon on the occurrence of other phenomenon. More over regression analysis describes oscillation of one variable (dependant) as a function of one or more independent variables (explanatory, regressors) in a single regression model function. Regression analysis is capable of quantifying dependencies between economic variables and therefore, it is one of the most used statistical method. Relationship between variables Y (dependant) and X (independent) can be described by general regression model:

$$Y = f(X) + \varepsilon \quad (1)$$

More specifically linear regression model has the following form:

$$Y = \beta 0 + \beta 1 * X1 + \beta 2 * X2 + \ldots + \beta K * XK + \varepsilon \quad (2)$$

where β0 is a level constant, β1, β2, ..., βK are the regression parameters and + ε is stochastic term. Stochastic residual (error) term ε is variable representing a wide array of factors influencing the dependent variable Y, which are not explained by the explanatory variables X included in the model.

However, performing a regression does not automatically gives a reliable relationship between variables. Classical assumptions of well specified model must be fulfilled: Regression model is linear in parameters; it is correctly specified and it has an additive error term. -Expected value of the error term is zero. All explanatory variables are uncorrelated with the error term. Error terms are uncorrelated = No serial correlation. Error term has constant variance = No heteroskedasticity. No explanatory variable is a perfect linear combination of other explanatory variable(s) = No perfect multicollinearity. (Wooldridge, 2009). **Method of ordinary least squares (OLS)** is the most frequently used procedure to estimate numerical values of regression coefficients from a linear model. It is applicable to regression models, which are linear in parameters or can be linearized by some suitable transformation, such as logarithmic, reciprocal, etc. OLS estimates the coefficients of regression models linear in parameters, where the dependent variable Y is modelled as an additive function of the products between the β coefficients and explanatory variables X, the regressors or their function forms.

Statistical hypothesis is an assumption about the parameters. Hypotheses are formulated in such a way that their interpretation after validation allow decision making with a predetermined risk dispersion consisting in unauthorized rejection of true assumption. For their verification statistical tests are used. Tests of statistical hypotheses are decision-making procedures, which, on the basis of the results obtained from the random selection, objectively determines decision whether the hypothesis should be rejected or not.

The recommended procedure for testing statistical of hypotheses is:

- formulation of the problem,
- determination of H_0 (null hypothesis) and H_1 (alternative hypothesis)
- choice of significance level α (probability of incorrect rejection of $H_{0,}$
- obtaining the sample,
- calculation of test statistics,
- decision to reject /not reject null hypothesis based on the critical field
- interpretation of results.

The coefficient of determination is based on the decomposition of the total sum of squares (TSS) on regression (ESS) and residual (RSS) the sums of squares. It measures the variance of empirical observations of the dependant variable around the regression model. The smaller the variance, the more complete explanation of the changes of the dependant variable due to changes in the independent variables. The coefficient of determination R^2 takes values in the interval from 0 to 1. The closer is coefficient to 1, the more variability is explained, and vice versa. But the problem with unadjusted R^2 coefficient is that it may increase in situations, when nonsense explanatory variable(s) are added to the model. For this reason **adjusted R^2 coefficient of determination** is used, because it increases only when a statistically significant regressor is added to the model. The higher R^2 adj is the better.

$$R^2 = RSS/TSS = 1-(ESS/TSS) \quad (3)$$

Another indicator of good model are **information criteria**. There are Akaike information criteria (AIC), Schwarz´s (Bayesian) information criterion (BIC) and Hannan-Quinn information criterion (HQC). The criteria are derived from transformed residual variance of the model corrected or sample size (n) and model complexity. Optimum regression model, in each criterion, should produce minimum value of that criterion.

T-test is testing significance of a chosen variable. Hypothesis for a t-test are: H_0: coefficient is not significant, H_1: coefficient is significant. H_O is rejected when p-value of the regressor is lower than level α (chosen α for the thesis is 0,1) or when a t-ratio in its absolute value is greater than approximately 2. **P – value** is used to evaluate any statistical test, which implies known distribution of the test statistics. It is probability of observing more extreme value of the test statistics than that, which was received from the data. (Gujarati, 2004)

F-test is a statistical test to test the significance of one or more regression parameters simultaneously, or testing of evidence of supporting the model as a whole. It is based on the decomposition of the total sum of squares where the total sum of squares equal to variability explained by the regression model and variability unexplained by the model, the residual error sum of squares:

$$TSS = RSS + ESS \quad (4)$$

The output of this test is Anova table. Hypothesis of F-test from ANOVA table are:: model is not statistically significant and alternative H_1: model is statistically significant. H_0 is rejected on the level of importance α, if counted F statistics is higher than $F1 - \alpha\ (p - 1, n - p)$.

Ramsey's RESET test for detection of omitted variable in the model or incorrect specification H_0: model is correctly specified. H1: model is not correctly specified. Evaluation will be based on the p-value, null hypothesis is rejected when p-value is lower than α.

One of the assumptions of the classical linear regression model is linear of the relationship between variables which can be tested by **LM test**. The null hypothesis of this test assumes that the relationship is linear. However, if p- value of this test will be lower than the significance level α, the alternative hypothesis is applied. Test of nonlinearity has two forms. The first is using squares, second works with logarithms.

Homoskedasticity means that all error terms are generated by single distribution with a constant variance. **Heteroskedasticity** is a violation of this classical assumption. All tests of variance homogeneity are based on statistical hypotheses, when null hypothesis tells: error term is homoskedastic. Opposite hypothesis H_1 says that error term is heteroskedastic. **White test** and **Breusch Pagan** test is a general test of heteroskedasticity.

Classical assumption VI refers about **multicollinearity**. By the definition explanatory variable is a perfect linear combination of other explanatory variable(s). There is no perfect (multi)collinearity. (Multi)collinearity can be detected by **Variance Inflation Factors, VIF(βj)**. Values > 10.0 may indicate a collinearity problem.

Normal distribution of stochastic error is classical assumption VII. There are many ways to verify normality of the error term. One of commonly used statistical test is **Chi-square test** of goodness of fit. The null hypothesis is always the same for all normality tests: H_0: the error term is normally distributed. H_1: the error term is not normally distributed. Another graphical method how to detect normality of residuals is **Q-Q plot**. (Gujarati, 2004).

3 Results and discussions

Experts dealing with the issue of public procurement both abroad (see e.g. Bergman and Lundberg, 2013; Costa and Arantes and Valadares Tavares, 2013) and in the Czech Republic (Ochrana, 2010; Jurčík, 2015, Jurčík, 2013) note, that one of the most significant breach of the law is the division of public contracts. To determine the type of public contract (if it is small scale contracts, which are not awarding according to public procurement law, above scale public contract and European union covered above thresholds public contracts) is paramount above the estimated values of public contract (Korthals, Taşan-Kok, 2010; Loader, 2011; Luo and Oliveira and BC Ramos and Maia and GS Osorio-de-Castro, 2014). The correct chosen of estimated value of public contract is necessary for the lawful public procurement procedure. The estimated value of public contract which should be identifying before awarding of public contract we can define as real estimate of price of public contract (Jurčík, 2014).

In this part of the paper we will study the relationship between the estimated value of a public contract without VAT established by the contracting authority before the tender according to § 13 et seq. Act no. 137/2006 Coll., on public procurement and real price of a public contract without VAT after tender. In other words dependant variable in the analysis is the real price of the public contract without VAT after tender. Independent variable is price of the public contract without VAT established by the contracting authority before the tender. There will be found out, what is the relationship between these two variables in total and also how this relationship changes when the public contracts are separated according to its purpose: public contracts on supplies, services and construction works.

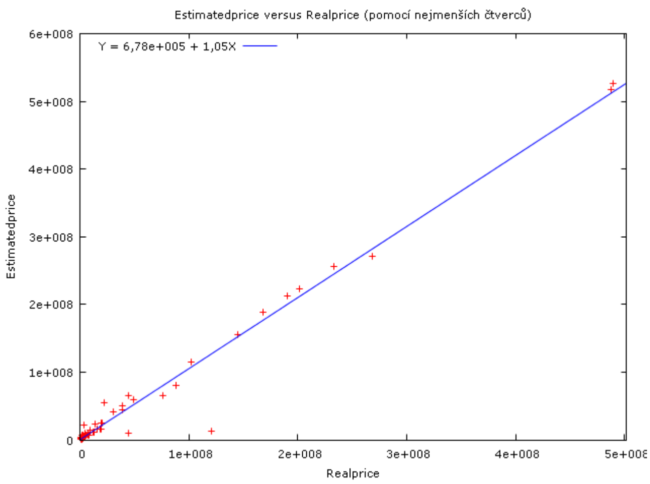
Analysis of real price and estimated price of the public contract

In the beginning an empirical analysis of dependant variable and chosen independent variable is conducted. The first step is to model real price of the public contract without VAT after tender as a function of 1 regressor (price of the public contract without VAT established by the contracting authority before the tender) using OLS method in Gretl software.

Real price of a public contract without VAT after tender) = function (Estimated price of the public contract established by the contracting authority before the tender).

We suppose that there will be a positive relationship between variables, in other words the higher is the estimated price of the public contract before tender, the higher is the real final price of public contract after tender.

Figure 1 Relationship between estimated and real price of the public contract



Source: own preparation

Figure 1 shows linear relationship between variables. From the picture it is quite clear that linear relationship is suitable for this model. There can be also claim that the higher estimated price of the public contract, the greater real price of the public contract after tender.

Using OLS method there is recognized relationship between variables:

Table 1 Model 1 (linear): Dependent variable: Real price of the public contract (OLS, using observations 1-120)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
Const	733262	1.69345e+06	0,4330	0.6658
Estimated price of the public contract	0.929764	0.0139076	66,85	1.20e-095

Mean dependent var	52994576	S.D. dependent var	1.02e+08
Sum squared resid	3.20e+16	S.E. of regression	16455984
R-squared	0.974277	Adjusted R-squared	0.974059
F(1, 98)	4469.336	P-value(F)	1.20e-95
Log-likelihood	−2163.208	Akaike criterion	4330.416
Schwarz criterion	4335.991	Hannan-Quinn	4332.680

Source: own preparation

From table 1 it can be seen that the higher is estimated price of the public contract, the higher is its real price. But from the p-value of the constant can be claim, that constant is not significant (p-value is higher than 0.05). For this reason model is modified into the model without constant. Result can be seen bellow.

Table 2 Model 2 (linear without constant): Dependent variable: Real price of the public contract (liOLS, using observations 1-120)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Estimated price of the public contract	0.932543	0.0122949	75.85	1.32e-102	***

Mean dependent var	52994576	S.D. dependent var	1.02e+08
Sum squared resid	3.20e+16	S.E. of regression	16399709
R-squared	0.979734	Adjusted R-squared	0.979734
F(1, 98)	5752.933	P-value(F)	1.3e-102
Log-likelihood	−2163.303	Akaike criterion	4328.607
Schwarz criterion	4331.394	Hannan-Quinn	4329.739

Source: Own preparation

From table 2 it is clear that between these two models the better one is the model 2 –linear model without constant. It has lower value of information criteria (Akaike, Schwarz and Hannah) and higher value of adjusted R^2. Also the variables is significant (p-value is much lower than 0.05).

Relationship between variables

From the previous table can be say, than the relationship between real price of the public contract without VAT after tender and price of the public contract without VAT established by the contracting authority before the tender is:

Real price of the public contract (in CZK without VAT) = 0.9325 * Estimated price of the public contract established by the contracting authority before the tender (in CZK without VAT) (5)

Meaning that real price of the public contract represents 93 % of its estimated price established by the contracting authority before the tender. And if the estimated price of the public contract increases by 1 000 CZK the real price of the public contract increased only by 932 CZK.

Classical assumptions

The estimation created through regression produced a linear relationship between the variables. However, performing a regression does not automatically give a reliable relationship between variables. Seven classical assumptions of well specified model must be fulfilled. The model must be tested on all classical assumptions. Firstly it will be test on correct specification. Because model is linear it can be tested by Lagrange Multiplier (LM) test of linearity.

Table 3 LM test

LM test: results	p-value
Polynomic form	0.530718
Logarithmic form	0.68771

Source: Own preparation

From the both results of LM tests it is obvious that function form of the model is OK and model is linear - logarithmic (both p-values are higher than 0.05, H_0: that the relationship is linear fail to be rejected. Model is linear. Another used test was Ramsey's RESET test for detection of omitted variable in the model or incorrect specification of the model. It's with p-value was 0.776 from which it is clear that null hypotheses that model is correctly specified failed to be rejected and model is correctly specified. More ways to verify correct model specification are adjusted coefficient of determination (R^2_{adj}) and Information criteria. Results of those tests were presented in the Model 2 (table 2), where can be seen that 97.97 % of variability was explained by regression model to the total variability which is great success.

Classical assumption number 1 which says that regression model is linear in parameters, it is correctly specified and it has an additive error term was confirmed. Another classical assumption is correlation. Existence of serial correlation implies that the error term from one time period depends on error term from other time periods. But because data are cross sectional, correlation cannot appear in the model. By the classical assumption number V error term has constant variance which is requirement for homoskedasticity of the error term. Homoskedasticity was tested using White test. Test resulted with p-value 0.860629. P-values is greater than alpha (0.05), not rejection of the null hypothesis, there is no heteroskedasticity in the model. Errors are homoskedastic. Assumption number V is fulfilled. Classical assumption VI refers about multicollinearity which can be detected by Variance Inflation Factors, VIF(βj). But because in our model only one independent variable stayed, there can be no multicollinearity. Normal distribution of stochastic error is classical assumption VII. There are many ways to verify normality of the error term. One of commonly used statistical test is Chi-square test of goodness of fit. Its p-value was higher than 0.05, failure of H_0 rejection. Classical assumption number seven was fulfilled.

Public contracts according to its character

In this subchapter there is a comparison of models which represents relationship between dependant variable, real price of a public contract in total, on supplies, on construction works and on services without VAT after tender and chosen independent variable, estimated price of the public contract in total, on supplies, on construction works and on services established by the contracting authority before the tender.

When we analyse the relation between the estimated value and real price we can assume the greater difference is at public contract on services. To confirm this assumption there were performed analyses individually for public contracts on services, supplies and construction works. Using the same methodology which was described above, we obtained these results:

Public contracts in total: Real prices of public contracts represents on average 93, 25 % of the estimated prices.

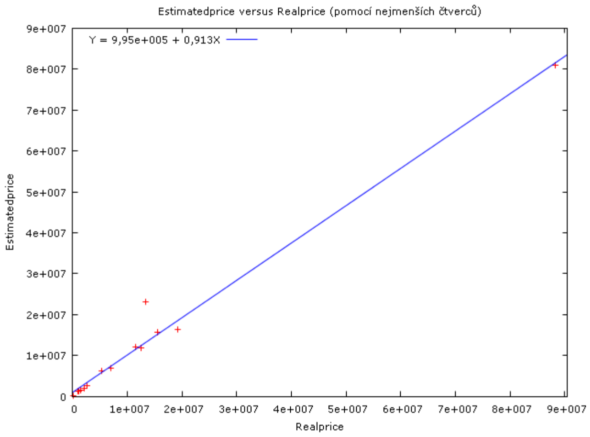
Real price = 0, 9325 * Estimated price (5)

Public contracts on supplies:

Next the same empirical analysis of dependant variable and chosen independent variable is conducted but there are used only data about public contracts on supplies. Methodology is the same. There is also model of real price of the public contract without VAT after tender as a function of 1 regressor (price of the public contract without VAT established by the contracting authority before the tender).

Real price of a public contract on supplies without VAT after tender) = function (Estimated price of the public contract on supplies established by the contracting authority before the tender).

Figure 2 Public contracts on supplies: linear relationship



Source: own preparation

Pictures above also show linear and log-linear relationship between variables. From the pictures can be seen that linear relationship suits. There can be also claim that the higher estimated price of the public contract, the greater real price of the public contract after tender.

In the next table there the models using OLS method: linear model without constant. This model was chosen because it produces higher R^2 adj and lower information criteria (tab. 2 a tab. 3).

Real prices of public contracts on supplies represents 99, 73 % of the estimated prices.

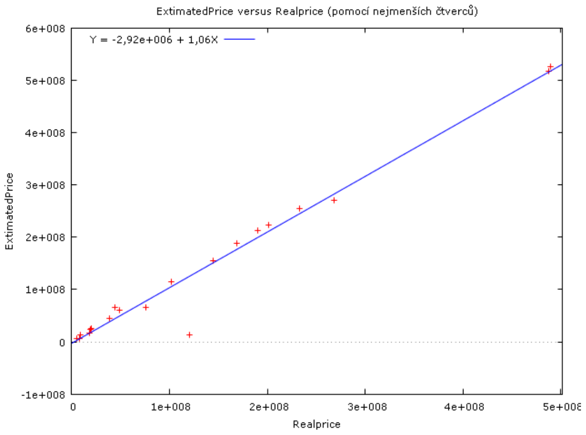
Real price = 0, 9973 * Estimated price (6)

Public contracts on construction works:

In this subchapter empirical analysis of dependant variable, real price of a public contract on construction works without VAT after tender and chosen independent variable, estimated price of the public contract on construction works established by the contracting authority before the tender is conducted. Methodology is the same as in previous chapters.

Real price of a public contract on construction works without VAT after tender) = function (Estimated price of the public contract on construction works established by the contracting authority before the tender.

Figure 3 Public contract on construction works: linear relationship



Source: own preparation

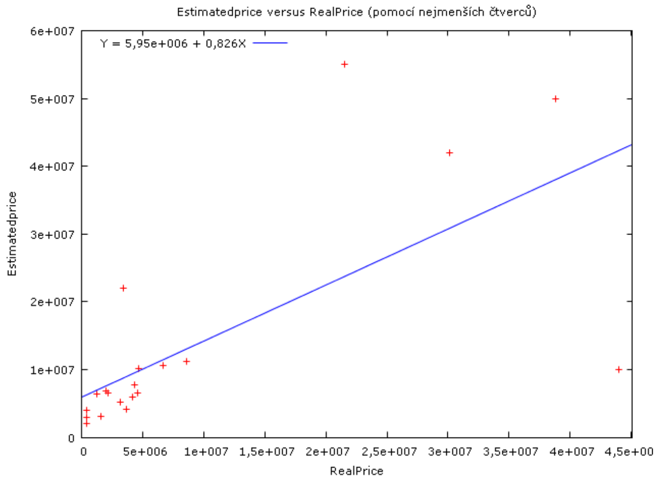
Real prices of public contracts on construction work represents 99, 33 % of the estimated prices.

Real price = 0, 9933 * Estimated price (7)

Public contracts on services:
In this subchapter empirical analysis of dependant variable, **real price of a public contract on services** without VAT after tender and chosen independent variable, **estimated price of the public contract on services** established by the contracting authority before the tender is conducted. Methodology is the same as in previous chapters.

(Real price of a public contract on services without VAT after tender) = **function Estimated price of the public contract on services** established by the contracting authority before the tender.

Figure 4 Public contract on construction works: linear relationship



Source: own preparation

Figures above show linear relationship between variables. There can be also claim that the higher estimated price of the public contract on services, the greater real price of the public contract on services after tender.

Real prices of public contracts on services represents 61, 68 % of the estimated prices.

Real price = 0, 6168 * Estimated price (8)

From the equation number 8 it can be say, than the relationship real price of a public contract on services without VAT after tender and estimated price of the public contract on services established by the contracting authority before the is positive, but, real price of the public contract on services represents only 61, 68 % of its estimated price established by the contracting authority before the tender. If the estimated price of the public contract on supplies increases by 1 000 CZK the real price of the public contract increased only by 617 CZK. All models were also tested by the same tests as the first one model number 2 . All tests confirmed 7 classical assumptions of the well specified model.

4 Conclusion

Using regression analysis there was studying relationship between real price of the public contract after tender and estimated price of the public contract established by the contracting authority before the tender. There was concluded that this relationship exist and is positive (the higher the value of the estimated price of the public contract, the greater real price of the contract after tender).

But on the other hand real price of the public contract represents only 93 % of its estimated price established by the contracting authority before the tender. Meaning if the estimated price of the public contract increases by 1 000 CZK the real price of the public contract increased only by 932 CZK.

When it comes to public contracts on supplies and construction works, estimated price of the public contract before the tender was almost the same as the real price of the public contract after the tender. Real price after tender represented 93, 3% and 99,7% of the estimated price. But real prices of the public contracts on services after tender are only 61,68 % of the estimated prices of the public contracts.

These relationships were also tested. All tests which were used concluded that classical assumptions of well specified model were fulfilled.

Acknowledgments

The contribution is processed as an output of a research project IGA *Small and Medium Size Enterprises in the public contracts* registered by the *Mendel University in Brno* under the registration number *PEF_TP_2015_17*.

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