NBA Contracts

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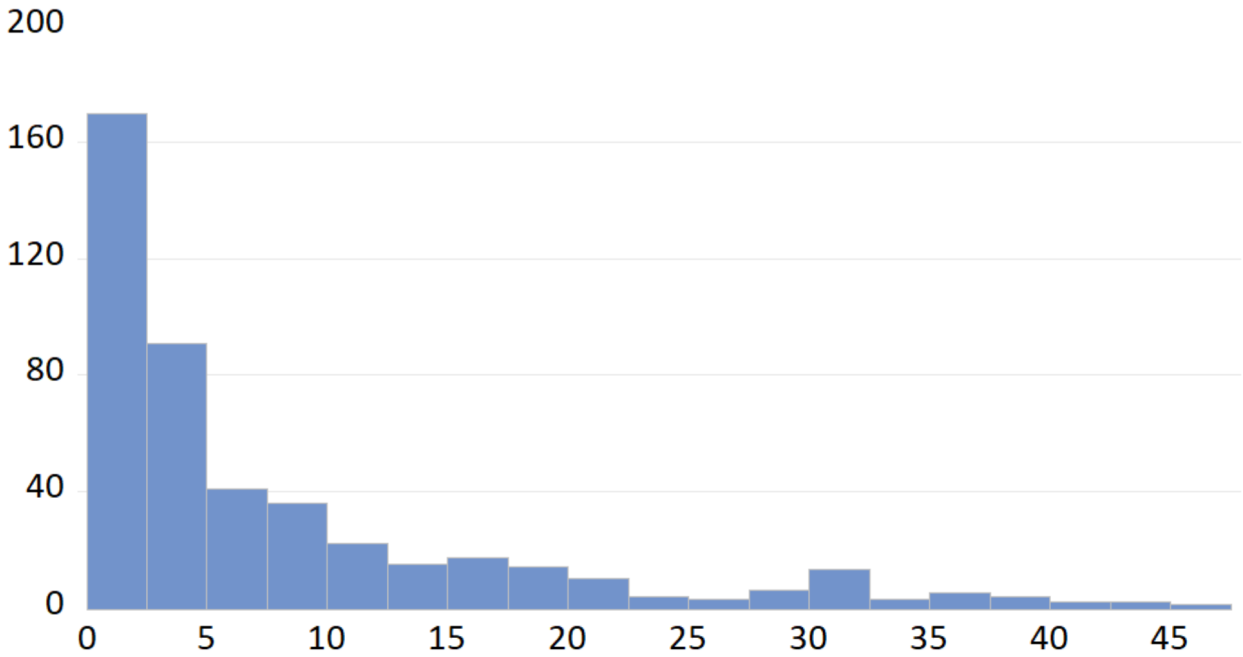
What about NBA salary ?

- Exorbitant wages of football players are not the only ones
- NBA player or businessmen ?
- NBA annual contracts

Our sample

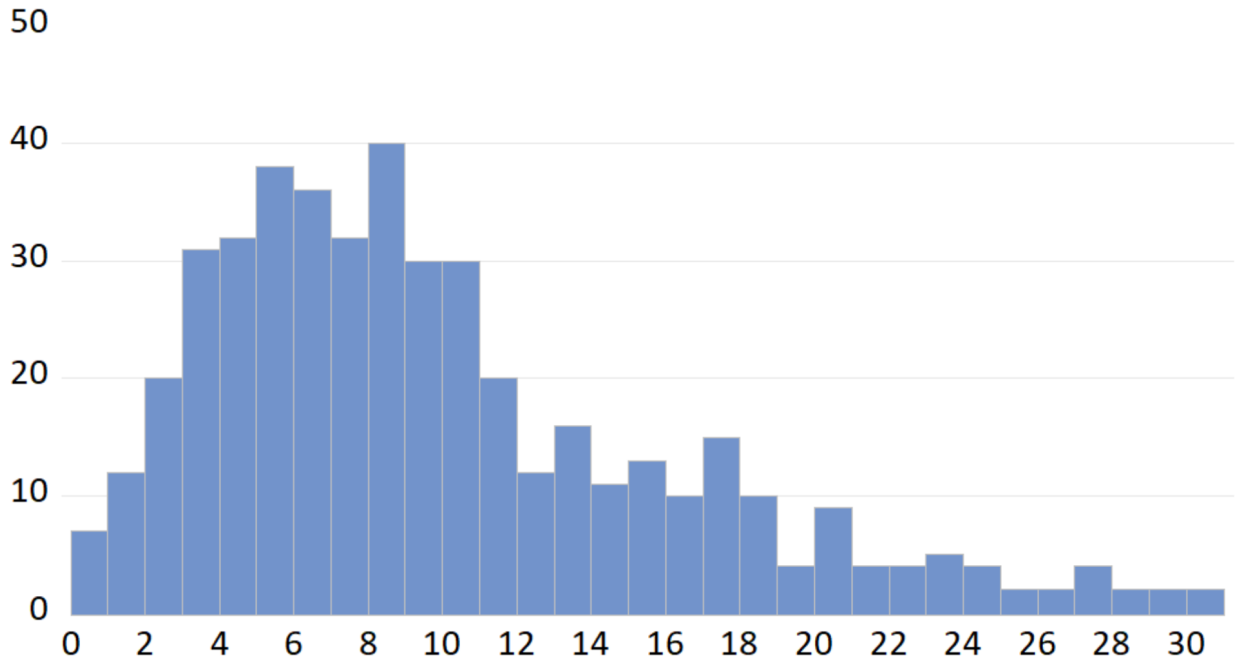
- Sample size: 459
- Data has been cleared
- Source: *https://www.basketball-reference.com*



Series: SALARY	
Sample 1 459	
Observations 459	
Mean	8.126213
Median	4.000000
Maximum	45.78097
Minimum	0.021270
Std. Dev.	9.570156
Skewness	1.821163
Kurtosis	5.738279
Jarque-Bera	397.1251
Probability	0.000000

Figure 2.1: SALARY

SALARY PTSPERGAME MINUTESPERGAME AGE ASTPERGAME TOVPERGAME RBPERGAME PFOULSPERGAME



Series: PTSPERGAME	
Sample 1 459	
Observations 459	
Mean	9.871048
Median	8.472222
Maximum	30.57353
Minimum	0.000000
Std. Dev.	6.286192
Skewness	1.028330
Kurtosis	3.724668
Jarque-Bera	90.93934
Probability	0.000000

Figure 2.2: PTSPERGAME

SALARY **PTSPERGAME** MINUTESPERGAME AGE ASTPERGAME TOVPERGAME RBPERGAME PFOULSPERGAME

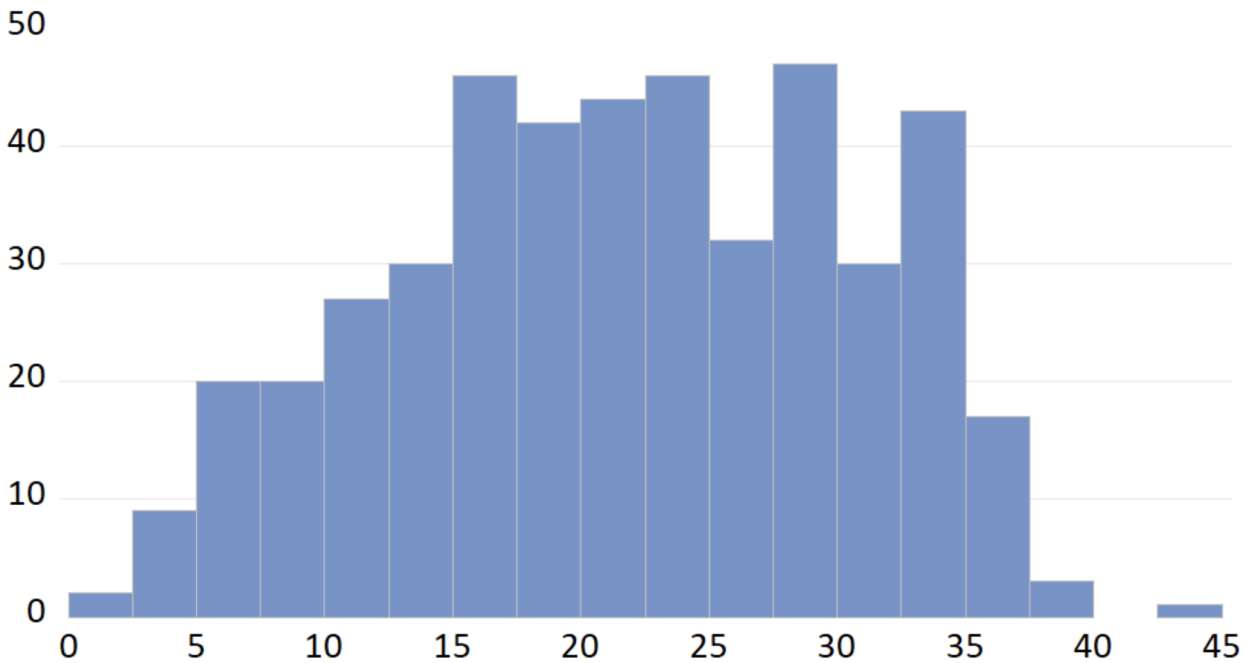
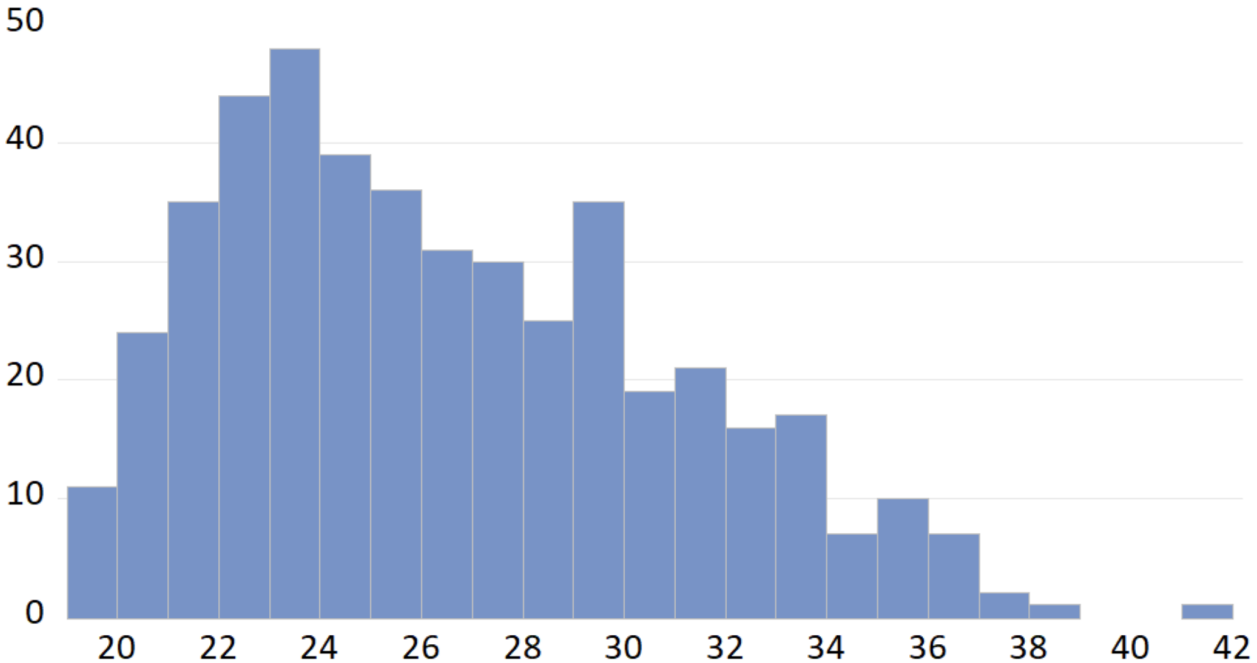


Figure 2.3: MINUTESPERGAME

SALARY PTSPERGAME **MINUTESPERGAME** AGE
ASTPERGAME TOVPERGAME RBPERGAME
PFOULSPERGAME



Series: AGE	
Sample 1 459	
Observations 459	
Mean	26.03486
Median	25.00000
Maximum	41.00000
Minimum	19.00000
Std. Dev.	4.397658
Skewness	0.545463
Kurtosis	2.573712
Jarque-Bera	26.23644
Probability	0.000002

Figure 2.4: AGE

SALARY PTSPERGAME MINUTESPERGAME **AGE**
ASTPERGAME TOVPERGAME RBPERGAME
PFOULSPERGAME

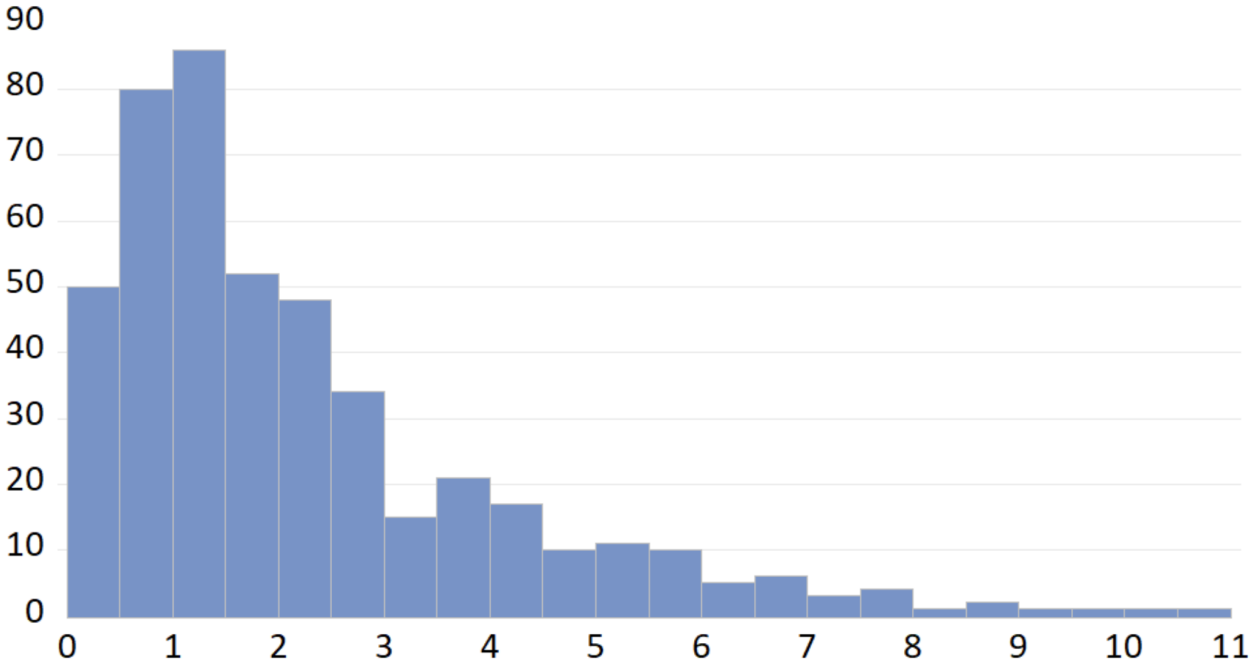


Figure 2.5: ASTPERGAME

SALARY PTSPERGAME MINUTESPERGAME AGE
ASTPERGAME TOVPERGAME RBPERGAME
PFOULSPERGAME

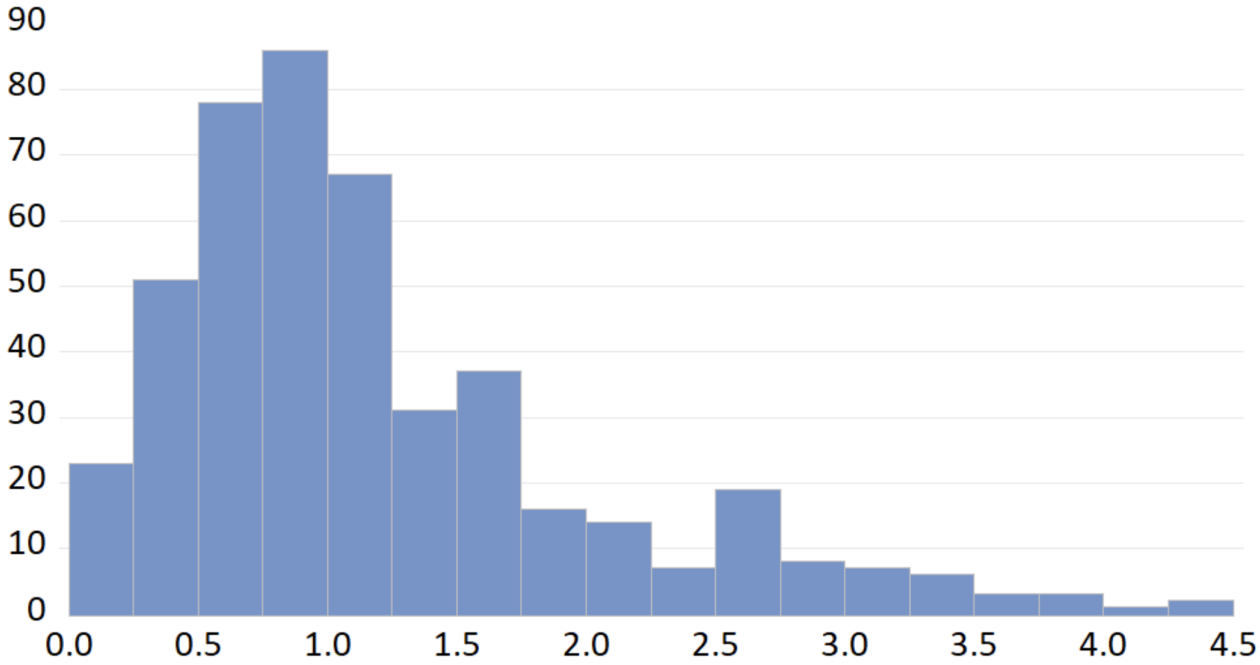
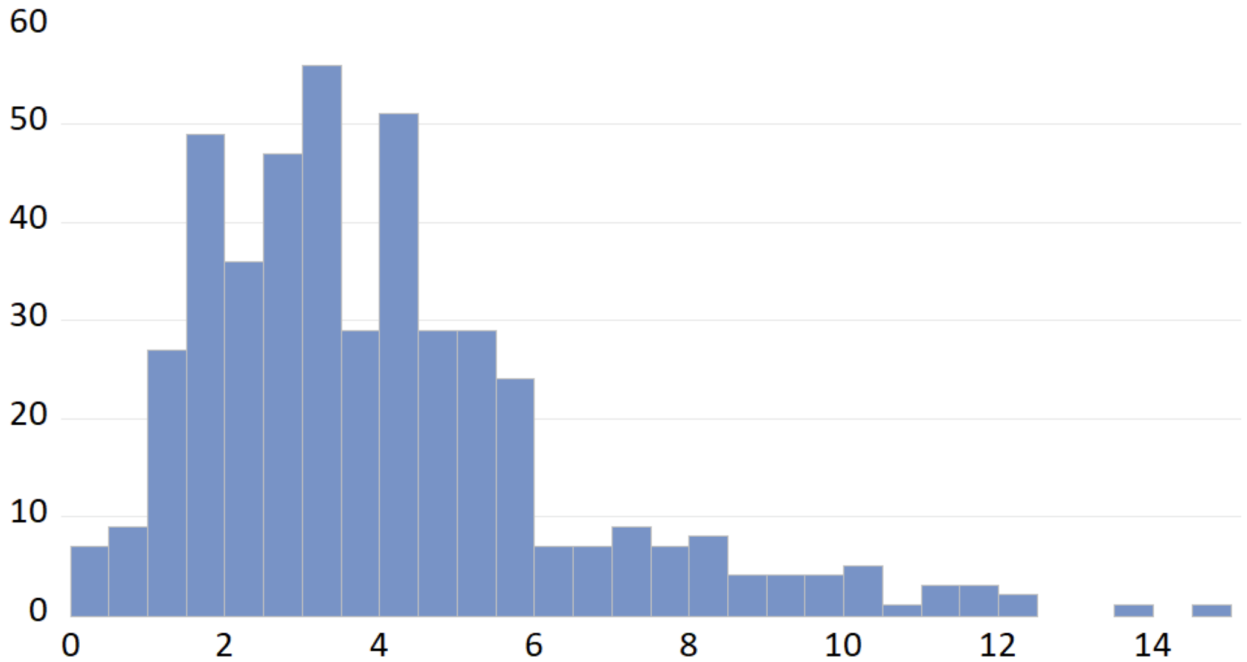


Figure 2.6: TOVPERGAME

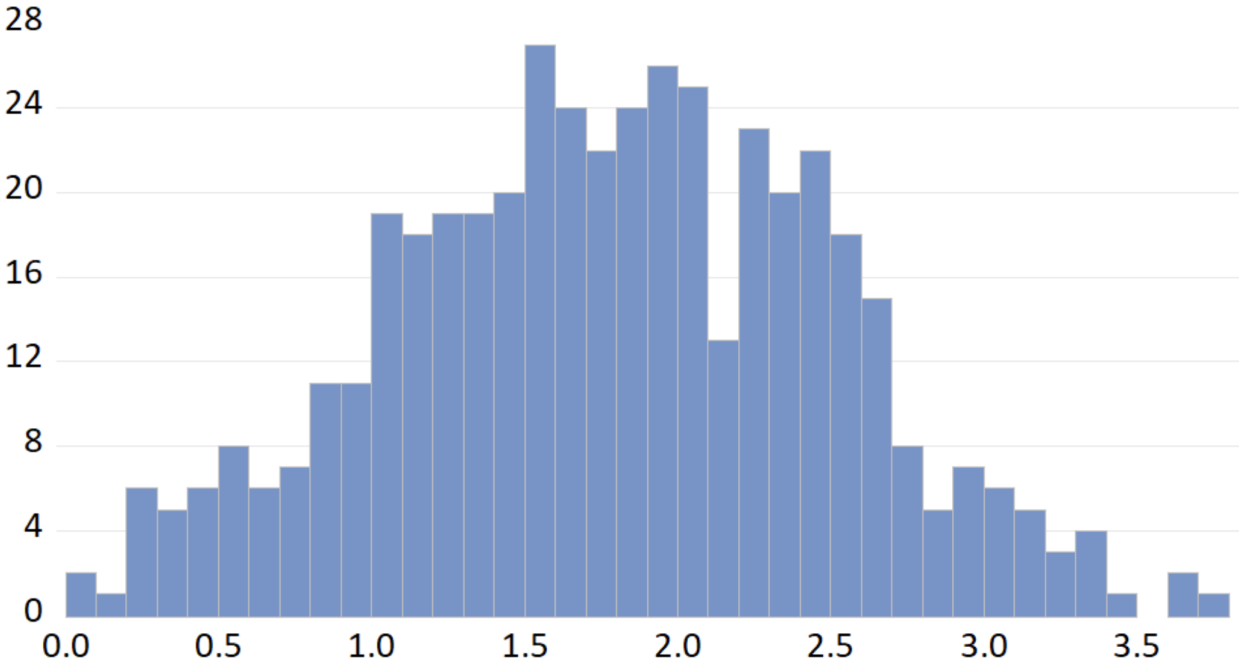
SALARY PTSPERGAME MINUTESPERGAME AGE ASTPERGAME **TOVPERGAME** RBPERGAME PFOULSPERGAME



Series: RBPERGAME	
Sample 1 459	
Observations 459	
Mean	4.008628
Median	3.478873
Maximum	14.66667
Minimum	0.000000
Std. Dev.	2.408794
Skewness	1.313825
Kurtosis	5.124992
Jarque-Bera	218.4101
Probability	0.000000

Figure 2.7: RBPERGAME

SALARY PTSPERGAME MINUTESPERGAME AGE ASTPERGAME TOVPERGAME **RBPERGAME** PFOULSPERGAME



Series: PFOULSPERGAME	
Sample 1 459	
Observations 459	
Mean	1.782904
Median	1.784615
Maximum	3.750000
Minimum	0.000000
Std. Dev.	0.721058
Skewness	-0.008003
Kurtosis	2.648002
Jarque-Bera	2.374534
Probability	0.305054

Figure 2.8: PFOULSPERGAME

SALARY PTSPERGAME MINUTESPERGAME AGE
ASTPERGAME TOVPERGAME RBPERGAME
PFOULSPERGAME

- Let's do our first regression on 8 explanatory variables
- Explanatory variables chosen are the most often considered in analysis of players' performances .

$$SALARY = C + \beta_0 \mathrm{PTSPERGAME} + \beta_1 \mathrm{MINUTESPERGAME} + \beta_2 \mathrm{MINUTESPERGAME}^2 + \beta_3 \mathrm{AGE} + \beta_4 \mathrm{ASTPERGAME} + \beta_5 \mathrm{TOVPERGAME} + \beta_6 \mathrm{RBPERGAME} + \beta_7 \mathrm{PFOULSPERGAME}$$

Dependent Variable: SALARY
Method: Least Squares
Date: 04/16/22 Time: 14:35
Sample: 1 459
Included observations: 459

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13.77649	2.035531	-6.768010	0.0000
PTSPERGAME	0.898527	0.117813	7.626693	0.0000
MINUTESPERGAME	-0.684546	0.161815	-4.230420	0.0000
MINUTESPERGAME^2	0.015060	0.003872	3.889765	0.0001
AGE	0.696452	0.063543	10.96031	0.0000
ASTPERGAME	0.540871	0.335879	1.610316	0.1080
TOVPERGAME	-0.147541	0.957217	-0.154135	0.8776
RBPERGAME	0.626845	0.165971	3.776841	0.0002
PFOULSPERGAME	-1.140277	0.617767	-1.845803	0.0656

R-squared	0.638635	Mean dependent var	8.126213
Adjusted R-squared	0.632211	S.D. dependent var	9.570156
S.E. of regression	5.803884	Akaike info criterion	6.374345
Sum squared resid	15158.28	Schwarz criterion	6.455306
Log likelihood	-1453.912	Hannan-Quinn criter.	6.406229
F-statistic	99.40969	Durbin-Watson stat	1.922102
Prob(F-statistic)	0.000000		

Figure 3.1: First regression

- $R^2 = 0.638635$
- $Fstatistic = 99.40969[0.00000]$

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	5.870491	Prob. F(43,415)	0.0000
Obs*R-squared	173.5998	Prob. Chi-Square(43)	0.0000
Scaled explained SS	318.3586	Prob. Chi-Square(43)	0.0000

Test

$$\begin{cases} H_0 : \text{Homoskedasticity} \\ H_1 : \text{Heteroskedasticity} \end{cases} \quad (1)$$

- $nR^2 = 173.5998$
- $Prob = 0.0000$
- We reject H_0, we have **heteroskedasticity**.

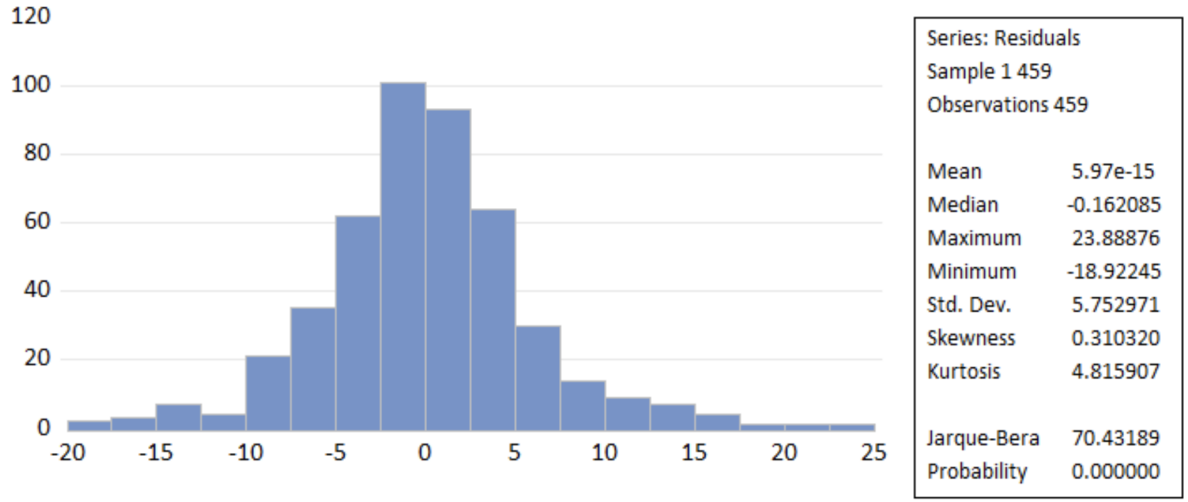


Figure 3.2: Residuals from first regression

Test

$$\begin{cases} H_0 : \text{normality of the error} \\ H_1 : \text{non normality of the error} \end{cases} \quad (2)$$

- $\frac{n-k}{n} JB = \frac{459-9}{459} \times 70.43189 = 69.05 > \chi_{0.99}(2)^2 = 9.21$
- We reject H_0, we don't have normality of the errors.

Results

- Non normality of the errors suggests that **inference will need to be asymptotic**.
- Heteroskedasticity means we will need to **use White's standard errors**, not ordinary least squares standard errors.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13.77649	2.102127	-6.553596	0.0000
PTSPERGAME	0.898527	0.163511	5.495210	0.0000
MINUTESPERGAME	-0.684546	0.163897	-4.176681	0.0000
MINUTESPERGAME^2	0.015060	0.004840	3.111505	0.0020
AGE	0.696452	0.073859	9.429542	0.0000
ASTPERGAME	0.540871	0.375731	1.439517	0.1507
TOVPERGAME	-0.147541	1.146628	-0.128674	0.8977
RBPERGAME	0.626845	0.201252	3.114729	0.0020
PFOULSPERGAME	-1.140277	0.655172	-1.740423	0.0825

R-squared	0.638635	Mean dependent var	8.126213
Adjusted R-squared	0.632211	S.D. dependent var	9.570156
S.E. of regression	5.803884	Akaike info criterion	6.374345
Sum squared resid	15158.28	Schwarz criterion	6.455306
Log likelihood	-1453.912	Hannan-Quinn criter.	6.406229
F-statistic	99.40969	Durbin-Watson stat	1.922102
Prob(F-statistic)	0.000000	Wald F-statistic	69.59011
Prob(Wald F-statistic)	0.000000		

Figure 3.3: Second regression with heteroskedasticity-consistent standard errors and covariance

- $m.e_{MPG} = -0.684546 + 20.015060 MPG$
- $\text{turningpoint}_{MPG} = 22.7$
- TOV and AST are not significant

- Let's do a second equation with 4 additional explanatory variables

	EFGPERC	STLPERGAME	BLKPERGAME	GAMESSTARTED
Mean	0.529103	0.687538	0.433921	26.35590
Median	0.530000	0.629101	0.333333	14.50000
Maximum	1.000000	2.161290	2.809524	82.00000
Minimum	0.156000	0.000000	0.000000	0.000000
Std. Dev.	0.078839	0.387066	0.386763	26.77326
Skewness	0.407888	0.676984	2.153778	0.697839
Kurtosis	10.09091	3.503662	9.716580	1.948821
Jarque-Bera	972.2290	39.82509	1214.988	58.25938
Probability	0.000000	0.000000	0.000000	0.000000
Sum	242.3290	314.8922	198.7359	12071.00
Sum Sq. Dev.	2.840526	68.46781	68.36068	327581.0
Observations	458	458	458	458

Figure 4.1: 4 new additional statistics

$$SALARY = C + ... + \beta_8 \mathrm{STLPERGAME} + \beta_9 \mathrm{BLKPERGAME} + \beta_{10} \mathrm{GAMESSTARTED} + \beta_{11} \mathrm{EFGPERC}$$

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.11403	2.722889	-4.081706	0.0001
PTSPERGAME	0.942900	0.119273	7.905398	0.0000
MINUTESPERGAME	-0.714067	0.169707	-4.207640	0.0000
MINUTESPERGAME^2	0.014171	0.004135	3.427109	0.0007
AGE	0.716788	0.063612	11.26821	0.0000
ASTPERGAME	0.443755	0.351688	1.261788	0.2077
TOVPERGAME	-0.043907	0.959983	-0.045737	0.9635
RBPERGAME	0.404019	0.198089	2.039586	0.0420
PFOULSPERGAME	-1.691969	0.647544	-2.612904	0.0093
STLPERGAME	1.388533	1.128850	1.230043	0.2193
BLKPERGAME	2.613014	1.039814	2.512961	0.0123
GAMESSTARTED	0.013710	0.017992	0.762046	0.4464
EFGPERC	-5.606442	3.820038	-1.467640	0.1429

R-squared	0.646481	Mean dependent var	8.143191
Adjusted R-squared	0.636948	S.D. dependent var	9.573698
S.E. of regression	5.768519	Akaike info criterion	6.370681
Sum squared resid	14807.73	Schwarz criterion	6.487820
Log likelihood	-1445.886	Hannan-Quinn criter.	6.416816
F-statistic	67.81433	Durbin-Watson stat	1.896736
Prob(F-statistic)	0.000000		

Figure 4.2: A first regression

Tests

- $nR^2 = 202.9172[0.0000] \implies$ Heteroskedasticity.
- $\frac{n-k}{n} JB = 80.729 \implies$ Non normality of the errors.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.11403	2.316193	-4.798406	0.0000
PTSPERGAME	0.942900	0.164113	5.745417	0.0000
MINUTESPERGAME	-0.714067	0.170258	-4.194034	0.0000
MINUTESPERGAME^2	0.014171	0.005662	2.502686	0.0127
AGE	0.716788	0.074476	9.624407	0.0000
ASTPERGAME	0.443755	0.403665	1.099317	0.2722
TOVPERGAME	-0.043907	1.136467	-0.038634	0.9692
RBPERGAME	0.404019	0.228574	1.767562	0.0778
PFOULSPERGAME	-1.691969	0.699181	-2.419930	0.0159
STLPERGAME	1.388533	1.190526	1.166320	0.2441
BLKPERGAME	2.613014	1.081855	2.415308	0.0161
GAMESSTARTED	0.013710	0.024167	0.567313	0.5708
EFGPERC	-5.606442	2.692893	-2.081940	0.0379

R-squared	0.646481	Mean dependent var	8.143191
Adjusted R-squared	0.636948	S.D. dependent var	9.573698
S.E. of regression	5.768519	Akaike info criterion	6.370681
Sum squared resid	14807.73	Schwarz criterion	6.487820
Log likelihood	-1445.886	Hannan-Quinn criter.	6.416816
F-statistic	67.81433	Durbin-Watson stat	1.896736
Prob(F-statistic)	0.000000	Wald F-statistic	50.88754
Prob(Wald F-statistic)	0.000000		

Figure 4.3: Second regression with heteroskedasticity-consistent standard errors and covariance

- $R^2 = 0.646481$
- $Fstatistic = 67.81433[0.00000]$

- Can the second equation be reduced into the first one ?

Test

$$\begin{cases} H_0 : \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0 \\ H_1 : \overline{H_0} \end{cases} \tag{3}$$

- $qF = 10.6 < \chi_{0.99}(4)^2 = 13.27$
- We do not reject H_0, equation 2 **can be reduced** into the first one.

Conclusion

- We examined impact of NBA players' performance on their salary.
- Performance plays an important role in the variation of the value of the annual contracts of NBA players
- Parts of the game that are hard to achieve in a basketball game have the biggest impact on salary. e.g. a block
- What about position of all the players, the bonuses, the status of superstar, the level of fame ?
- Both models explain more than 60% of the variation in SALARY.

We would like to thank Steve Lawford for offering us the possibility to carry out our study thanks to all kind of methods and analysis learned through the econometrics and forecasting course that he is teaching.

Any questions ?