In [1]:

```
# библиотеки/для latex
import IPython
import pandas as pd
import statsmodels.formula.api as smf
import numpy as np

# преобразлвание в latex таблицу
def _repr_latex_(self):
    return self.to_latex()
```

Уровень расхода домохозяйств

In [2]:

```
# загружаем базу данных
csvtab = pd.read_csv('C:/Users/timha/OneDrive/Рабочий стол/data2.csv', sep =
 ↪  ';', decimal='.', engine='python')
csvtab
```

Out [2]:

	t	Ct	Yt	Crt	Sant
0	2003	11159.80000	27312.30000	0	0
1	2004	12550.70000	29304.90000	0	0
2	2005	14087.40000	31407.80000	0	0
3	2006	15799.70000	33410.50000	0	0
4	2007	18060.80000	36134.60000	0	0
5	2008	19967.00000	39218.70000	0	0
6	2009	18946.60000	41276.80000	1	0
7	2010	19993.80000	38048.60000	0	0
8	2011	21356.20000	39762.20000	0	0
9	2012	23053.80000	41457.80000	0	0
10	2013	24263.15976	42973.50000	0	0
11	2014	24736.37084	43740.70411	0	0
12	2015	22418.53533	44063.79745	0	1
13	2016	21780.76321	42945.28104	0	1
14	2017	22511.92051	42871.14425	0	1

In [3]:

```
# Отбираем экзогенные и эндогенные переменные
Y = csvtab['Ct']
X = sm.add_constant(csvtab[['Yt', 'Crt', 'Sant']]) # добавляем
 ↪  intercept(const)
results = sm.OLS(Y, X).fit() # линейная регрессия
print('Residual standard error:', np.sqrt(results.scale)) # вычисление
 ↪  Residual standard error
results.summary()
```

```
Residual standard error: 406.519064173296
```

Out [3]:

```
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                     Ct   R-squared:                       0.993
Model:                            OLS   Adj. R-squared:                  0.991
Method:                 Least Squares   F-statistic:                     505.5
Date:                Sun, 20 Oct 2019   Prob (F-statistic):           4.62e-12
Time:                        15:59:07   Log-Likelihood:                -109.07
No. Observations:                  15   AIC:                             226.1
Df Residuals:                      11   BIC:                             229.0
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const      -1.211e+04    851.717    -14.214      0.000    -1.4e+04   -1.02e+04
Yt             0.8397      0.023     36.478      0.000       0.789       0.890
Crt        -3606.3103    437.942     -8.235      0.000   -4570.215   -2642.406
Sant       -2009.1504    306.166     -6.562      0.000   -2683.018   -1335.283
==============================================================================
Omnibus:                        3.036   Durbin-Watson:                   1.392
Prob(Omnibus):                  0.219   Jarque-Bera (JB):                1.156
Skew:                          -0.621   Prob(JB):                        0.561
Kurtosis:                       3.553   Cond. No.                     3.20e+05
==============================================================================
"""
```

Сравним с Excel:

a3	a2	a1	a0
-2009.150407	-3606.31029	0.839684	-12106.6
306.1664607	437.9424085	0.023019	851.7167
0.992798771	406.519065	#Н/Д	#Н/Д
505.5056988	11	#Н/Д	#Н/Д
250616203.5	1817835.253	#Н/Д	#Н/Д

Как мы видим результаты совпали

Объём инвестиция страны *I*

In [4]:

```
I = pd.read_csv('C:/Users/timha/OneDrive/Рабочий стол/data3.csv', sep = ';',
 ↪  decimal='.', engine='python')
I
```

Out [4]:

	t	It	triangleYt-1	Crt	Sant
0	2003	5396.900000	1992.600000	0	0
1	2004	6056.200000	2102.900000	0	0
2	2005	6631.100000	2002.700000	0	0
3	2006	7806.400000	2724.100000	0	0
4	2007	9526.500000	3084.100000	0	0
5	2008	10526.100000	2058.100000	0	0
6	2009	6209.800000	-3228.200000	1	0
7	2010	7982.200000	1713.600000	0	0
8	2011	9656.300000	1695.600000	0	0

```
9    2012  10084.862960   1515.700000     0      0
10   2013   9525.047860    767.204112     0      0
11   2014   8947.736489    323.093343     0      0
12   2015   7848.354778  -1118.516417     0      1
13   2016   7700.652187    -74.136787     0      1
14   2017   8269.508000    662.605739     0      1
```

In [5]:

```
# Отбираем экзогенные и эндогенные переменные
Y = I['It']
X = sm.add_constant(I[['triangleYt-1', 'Crt', 'Sant']]) # добавляем
 ↪  intercept(const)
results = sm.OLS(Y, X).fit() # линейная регрессия
print('Residual standard error:', np.sqrt(results.scale)) # вычисление
 ↪  Residual standard error
results.summary()
```

```
Residual standard error: 1633.6540201758721
```

Out [5]:

```
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                     It   R-squared:                       0.151
Model:                            OLS   Adj. R-squared:                 -0.081
Method:                 Least Squares   F-statistic:                    0.6509
Date:                Sun, 20 Oct 2019   Prob (F-statistic):              0.599
Time:                        16:16:29   Log-Likelihood:                -129.94
No. Observations:                  15   AIC:                             267.9
Df Residuals:                      11   BIC:                             270.7
Df Model:                           3
Covariance Type:            nonrobust
================================================================================
                   coef    std err          t      P>|t|      [0.025      0.975]
--------------------------------------------------------------------------------
const         8944.0977   1178.232      7.591      0.000    6350.827    1.15e+04
triangleYt-1    -0.3126      0.589     -0.530      0.606      -1.610       0.984
Crt          -3743.4451   3427.547     -1.092      0.298   -1.13e+04    3800.535
Sant         -1059.8244   1584.789     -0.669      0.517   -4547.921    2428.272
==============================================================================
Omnibus:                        0.910   Durbin-Watson:                   0.568
Prob(Omnibus):                  0.635   Jarque-Bera (JB):                0.693
Skew:                          -0.474   Prob(JB):                        0.707
Kurtosis:                       2.542   Cond. No.                     1.70e+04
==============================================================================
"""
```

Сравним с Excel:

b3	b2	b1	b0
-1059.82436	-3743.4451	-0.3126	8944.098
1584.788669	3427.5468	0.589281	1178.232
0.150751915	1633.654	#Н/Д	#Н/Д
0.650878147	11	#Н/Д	#Н/Д
5211240.505	29357080	#Н/Д	#Н/Д

Как мы видим результаты совпали

Государственные расходы *G*

In [6]:

```
G = pd.read_csv('C:/Users/timha/OneDrive/Рабочий стол/data4.csv', sep = ';',
 ↪  decimal='.', engine='python')
G
```

Out [6]:

	t	Gt	Gt-1	Crt	Sant
0	2003	6540.200000	6390.000000	0	0
1	2004	6679.000000	6540.200000	0	0
2	2005	6775.300000	6679.000000	0	0
3	2006	6931.900000	6775.300000	0	0
4	2007	7120.700000	6931.900000	0	0
5	2008	7359.900000	7120.700000	0	0
6	2009	7314.500000	7359.900000	1	0
7	2010	7205.700000	7314.500000	0	0
8	2011	7306.700000	7205.700000	0	0
9	2012	7498.700000	7306.700000	0	0
10	2013	7562.671176	7498.700000	0	0
11	2014	7401.995126	7562.671176	0	0
12	2015	7170.732664	7401.995126	0	1
13	2016	7238.265190	7170.732664	0	1
14	2017	7264.271927	7238.265190	0	1

In [7]:

```
# Отбираем экзогенные и эндогенные переменные
Y = G['Gt']
X = G[['Gt-1', 'Crt', 'Sant']] # intercept(const) здесь не нужно
results = sm.OLS(Y, X).fit() # линейная регрессия
print('Residual standard error:', np.sqrt(results.scale)) # вычисление
 ↪  Residual standard error
results.summary()
```

```
Residual standard error: 134.17688134260314
```

Out [7]:

```
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                     Gt   R-squared:                       1.000
Model:                            OLS   Adj. R-squared:                  1.000
Method:                 Least Squares   F-statistic:                 1.425e+04
Date:                Sun, 20 Oct 2019   Prob (F-statistic):           1.43e-21
Time:                        16:22:21   Log-Likelihood:                -93.098
No. Observations:                  15   AIC:                             192.2
Df Residuals:                      12   BIC:                             194.3
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
Gt-1           1.0131      0.006    176.292      0.000       1.001       1.026
Crt         -141.8664    140.685     -1.008      0.333    -448.393     164.661
Sant        -141.2001     88.016     -1.604      0.135    -332.970      50.570
```

```
==============================================================================
Omnibus:                        4.116   Durbin-Watson:                   1.346
Prob(Omnibus):                  0.128   Jarque-Bera (JB):                2.742
Skew:                          -1.043   Prob(JB):                        0.254
Kurtosis:                       2.806   Cond. No.                     2.90e+04
==============================================================================
"""
```

Сравним с Excel:

g2	g1	g0
-141.20014	-141.866	1.013107
88.01584075	140.6853	0.005747
0.999719361	134.1769	#Н/Д
14249.18953	12	#Н/Д
769603093	216041.2	#Н/Д

Как мы видим результаты совпали