

STEEL INDUSTRY AND THE SECTOR'S IMPACT ON ECONOMICAL GROWTH IN TURKEY

OZKAN, Filiz*

Abstract

Turkey is largest steel producer in Europe with the exception of the Western European countries that are members of the European Union and it ranks as the eleventh in world steel production. The research task in the present study is to investigate the relationship between the data regarding steel (production, consumption, import and export) and the Gross Domestic Product (GDP), the Industrial Production (IP). In order to determine the aforementioned relation between the data regarding steel and the GDP, the Engle-Granger co-integration, Error Correction Model (ECM) and the Granger causality tests were applied. It has been found that the steel export and the production have direct relations with the GDP, whereas the steel export has a direct relation with the IP and both relations have causality effects.

Key Words: Economical growth, Steel produce, steel consumption, Engle-Granger co-integration, Error correction, Granger causality.

JEL Codes: C 22, C 53, O 14

1. Introduction

Turkey is the world's eleventh largest steel producer with a total production accounting for 2.0% of the total steel production of the world. Until the 1980s, three government-owned steel producers controlled a substantial majority of the total capacity. Over the past two decades, a significant contribution has been made to the total capacity through privately owned mini-mill investments. While the world's steel production was reduced by 23% during the economical crisis of 2009, this reduction was kept at 18.5% in Turkey. As a result of this outcome, Turkey has become one of the major players in the global steel market.

Despite several periods of economical recovery during the past 20 years in addition to a fast growing population, the use of steel in Turkey has remained below its potential levels, in terms of per head consumption stated by the global standards. While the level of steel consumption has been around 130 kg per person in 1990s, this number reached 338 kg per person with a 2.6 fold increase in the year 2007. In light of these data, Turkey may be considered to possess a potential for steel consumption as a country owing to its developing economy and young population. The steel industry is the third largest sector of export in the Turkish economy. While Turkey has exported 4 million tons of steel in 1990, this number has risen up to 16 million tons in 2008, displaying a 4 fold increase. Its ratio to the total export in 1990 was only 7% whereas it has risen up to 11% in 2008. The increasing contribution of the steel sector in export numbers can clearly be noted in these numbers (TISPA, 2009).

The level of industrial development and the stability of long term growth was even measured as a function of the total consumption of steel. In fact, the rate of economical

* Filiz Ozkan Sakarya University, Kaynarca Vocational School, Kaynarca, 54650, Sakarya, Turkey, fozkan@sakarya.edu.tr

growth is closely related to steel consumption and therefore, it was considered a constantly present constituent of the metal markets (Crompton, 1999). The earth's ability for sustainable economical growth through the provision of mineral products into the twenty first century was even considered as a result of the concerns raised by this connection between the consumption of metals and the level of economic activity (Meadows *et al.*, 1972).

A permanent downturn in the growth in the consumption of metals among the OECD economies after 1973, despite their continued growth in economic activity caught attention in the recent years (Crompton, 1999). In turn, it has been suggested by several researchers (Auty, 1985; Drucker, 1986; Larson *et al.*, 1986) that an increase in the consumption of metals was no longer thought of as a measure of economical growth and this raised questions over the future prospect of the world's metal market. Labson and Crompton (1993) further confirmed this view through the failure of the formal tests for a long run common stochastic trend between the consumption of metals and the level of economic activity.

One of the main reasons for conducting the studies regarding this topic is to explain the effect of steel sector on economy. Ghosh's (2006) study on the consumption of steel in India indicated its significance on economical growth. In this study, the relation between the consumption of steel and economical growth has been tested through the Granger causality. The results of the study indicated causality from the consumption of steel towards economy whereas the reverse condition could not be identified. This result clearly denoted the effect of the consumption of steel on economical growth. In a study conducted in Poland for the prediction of the consumption of steel, a clear relation between its consumption and GDP was determined (Rebiasz, 2006). In another study investigating the future trends in the consumption of steel in Japan, the decrease in the amount of steel that has been consumed has been related to the slower economical growth (Crompton, 2000).

The present study analyzes the relations among the data regarding steel (production, consumption, import and export) and the Gross Domestic Product (GDP) and the Industrial Production (IP) Index during the period covering the years between 2000-2009.

2. Economical model and methodology

2.1. Data collection

The present study makes use of data regarding steel (production, consumption, import and export) and the GDP, as well as the monthly IP data. This data for steel have been gathered from the databases of the Turkish Iron and Steel Producers Association and the data for GDP and IP was obtained from the databases of the Central Bank of Turkey. The GDP and the IP data refer to the prices between January 2000 and December 2009 by taking into consideration the expenditure data within this period. The production, consumption, export and import data for steel refer to a comparison of the prices for the expenditure data for the period of 2000:01-2009:12 as announced by the state. The values are given in the currency of the United States Dollars. During the

analysis, the logarithmic values pertaining to the series were used and the series have been cleared off of the seasonal effects as well as of the trend effect.

2.2. Methodology

The stationary structures of the series were analyzed using the Augmented Dickey Fuller (ADF) and The Phillips-Perron (PP) unit root tests. Engle-Granger co-integration test was employed in order to reveal a possible co-integration among the series. Following the identification of the co-integration between the series, the error correction model taking the variables in causality relation into consideration was analyzed. Finally, the Granger causality test was applied in order to define the direction of causality among the series.

2.2.1. Unit root test

A suitable test for a unit root in a time series sample is the Augmented Dickey-Fuller (ADF) test in econometrics. The following formulation is used in this method to put the unit root test into practice:

$$\Delta Y_t = a + \rho Y_{t-1} + \delta T + \sum_{i=1}^n b_{1i} \Delta Y_{t-i} + \varepsilon_t \quad i = 1, 2, \dots, n \quad (1)$$

ADF statistics and McKinnon's critical values were derived using the fixed term regressions with trend. In the formulation, $\Delta Y_t = Y_t - Y_{t-1}$, a , is the drift term, and T is the time trend with the null hypothesis being $H_0: \rho = 0$ and its alternative hypothesis being $H_1: \rho \neq 0$, n is the number of lags necessary to obtain white noise and ε is the error term. If the time series is non-stationary, then this would result in a failure in rejecting the hypothesis H_0 (Dickey and Fuller, 1979).

A number of unit root tests, which have become popular in the analysis of financial time series have been developed by Phillips and Perron (1988). The approach that the tests follow in dealing with serial correlation and heteroskedasticity in the errors is different for the PP unit root tests and the ADF tests. While the ADF tests use a parametric auto-regression to approximate the ARMA structure of the errors in the test regression, the PP tests do not acknowledge any serial correlation in the test regression. The PP tests use a test regression term in the following formulation;

$$\Delta y_t = \beta' D_t + \pi y_{t-1} + u_t \quad (2)$$

with u_t is $I(0)$ and the formulation may be heteroskedastic. Any serial correlation and heteroskedasticity in the errors u_t of the test regression are corrected in the PP tests through the direct modification of the test statistics $t_{\pi=0}$.

2.2.2. Engle-Granger co-integration

The existence of co-integration among the series is determined through the use of the Engle-Granger (1987) co-integration test. Modeling and estimation of the long term causality among non-stationary time series is generally considered as the main aim of the co-integration analysis.

In order to test the possible co-integration among two time series, x_t and y_t , the following procedure is followed. The presence of a unit root for both series, i.e. both

series being individually $I_{(1)}$ nonstationary is a pre-requisite for co-integration. With this requirement fulfilled, the co-integration that is obtained from their linear combination would also be stationary ($I_{(0)}$). Two stages are involved in the Engle-Granger (EG) test. The ordinary Least Squares (OLS) regression (Noriega and Ventosa-Santaul`aria 2006) is followed in the first stage:

$$y_t = \beta_0 + \beta_1 x_t + u_t \quad (3)$$

with y and x being non-stationary series capturing any potential long-run relationship among the variables. The Dickey-Fuller (DF) regression is used with the residuals in the following form in the second stage:

$$u_t = \gamma u_{t-1} + \eta_t \quad (4)$$

The presence of a unit root in the residuals would show itself if the hypothesis $\gamma = 0$ could not be rejected and in conjunction with this, the series x_t and y_t would not be co-integrated. On the contrary, the presence of stationary residuals indicating co-integration between x_t and y_t would be confirmed by a t-statistic for testing the hypothesis $\gamma = 0$, which would be smaller than the corresponding critical value.

Because the error correction model can be formally derived from the properties of integrated time series, it is the preferred method for estimation when two integrated time series are statistically related or co-integrated.

Since it allows both the short term and the long run effects of explanatory time series variables to be estimated by the analyst, error correction model is especially powerful. For instance, a bi-variate single-equation error correction model can be considered:

$$\Delta Y_t = \alpha_0 - \alpha_1 (Y_{t-1} - \beta_1 X_{t-1}) + \beta_0 \Delta X_t + \varepsilon_t \quad (5)$$

Where equation (4) would be used to compute $(Y_{t-1} - \beta_1 X_{t-1})$.

The long run relationship between the GDP and the data available for steel will be analyzed through the use of the Engle-Granger co-integration method in the present study. The effect of an impulse perturbation in any of series defined to be in relation on the relationship in the long run will be shown through making use of the error correction model.

2.2.3. Granger causality

In order to determine whether one time series is useful in forecasting another, a technique called the Granger causality test is utilized. The super-consistency properties of estimation (Granger, 2001) allow the Granger causality tests to use the $I_{(1)}$ data if the series, X and Y are individually $I_{(1)}$ and co-integrated:

$$X_t = a_0 + \sum_{i=1}^m \alpha_{1i} X_{t-i} + \sum_{i=1}^n \alpha_{2i} Y_{t-i} + u_t \quad (6)$$

$$Y_t = b_0 + \sum_{i=1}^q b_{1i} Y_{t-i} + \sum_{i=1}^r b_{2i} X_{t-i} + v_t \quad (7)$$

with the random, serially uncontrolled disturbances u_t and v_t having zero mean.

The Schwarz Bayesian (SBC) and/or log-likelihood ratio (LR) test criteria are used to determine the optimum lag lengths m , n , q and r .

Y Granger causes X in Eq. (6) if

X Granger causes Y in Eq. (7) if

The direction of causality in series which have already been detected to be in relation according to the Engle-Granger co-integration method is determined by the causality test in the current study.

The dependent variable is first included in the model with their respective lag lengths in Equations (6) and (7) and then the other variable is included in the model with the same lag length as that of the dependent variable. The error associated with these models is determined by the sum of the squares method. Later, the F-statistic developed by Wald is calculated (Işığçık,1994:94).

$$F = ((RSS_R - RSS_{UR})/m) / (RSS_{UR}/(n - k)) \quad (8)$$

Here RSS_R denotes the sum of error squares for the restricted model obtained by the removal of the X_{i-t} terms for Equation (7) and the Y_{i-t} terms for Equation (6) whereas RSS_{UR} denotes the sum of error squares obtained from the unrestricted models in Equations (6) and (7). m denotes the number of variables removed from the unrestricted model, n denotes the sample volume and k denotes the number of parameters in the unrestricted model.

3. Empirical result and discussion

3.1. Unit root test

The unit root of the stochastic process revealing the relevant datum generally characterizes the macro-economic time series with already analyzed causality/cointegration relationships. The time series characteristics of the data are determined by the generalized ADF and PP unit roots tests in this study. Table 1 summarizes the results of the unit root test of the series.

Table 1. Results of the unit root test

		reelgdp _λ	IP	Exp. (ton)	Exp. (usd)	Imp. (ton)	Imp. (usd)	Cons.	product _λ
ADF	Level	-2.152	- 1.904	-2.316	- 2.976	-1.704	-1.595	- 1.683	-1.021
	No trend	-5.142	- 2.812	-3.380	- 5.470	-3.036	-2.124	- 3.701	-3.086
PP	Level	-1.708	- 1.427	-2.202	- 2.881	-1.627	-1.530	- 1.586	-0.739
	No trend	-4.927	- 2.640	-3.106	- 5.473	-3.036	-2.404	- 3.734	-3.198

λ shows that the non-stationary series is filtered off the seasonal effects through the use of moving averages. The comparison of the ADF and PP test statistics provide the critical values of -3.67, -2.96 and -2.62 for the confidence levels of 1%, 5% and 10%, respectively.

Investigation of the unit root test results indicated that not all variables were non-stationary in terms of their levels. All series were determined to include a trend effect via their investigation using the polynomial trend model method and the series were debugged from the trend effect. Additionally, steel production and real GDP variables were determined to contain seasonal effects and the seasonal effects were removed from these two series by the method of moving averages. The series became stationary following these transitions and the outcome is observed in Table 1.

3.2. Engle-Granger co-integration

The long-term relationships among non-stationary time series can be suitably estimated by the co-integration test. Such an application where the independent variable is integrated at least to the same order as that of the dependent variable is a generalization of the case study where the integrated series were of the same order to be used in the Engle Granger cointegration test. The results of the ADF test analyses were displayed in Table 2. The variables regarding the GDP and the steel production were used in the determination of the error terms resulting from the binary regression analysis. The co-integration among the two series were determined based on the results that the coefficients were statistically significant and that the absolute values of the ADF test statistics were higher than those of the Engle-Granger critical values.

Table 2 Engle-Granger co-integration test results

	Export (tons)	Export (USD)	Import (tons)	Import (USD)	Consump.	Product
real	-**	-1,400	-0,202	-2,472	0,096	-6,247*
IP	-*	-*	-4,971*	-*	-4,659*	-5,006*

Note: The Engle Granger critical values for the statistical significance levels of 1%, 5% and 10% were determined as -3.90, -3.34 and -3.04, respectively. “*” denotes that co-integration was meaningful at 1% level of significance whereas “**” denotes that it was meaningful at 10% level of significance.

Table 2 analyzes the cointegration between growth variable and steel variables. Though there seems to be no cointegration between real GDP and Export (USD), Import (ton), Import (USD) and steel consumption, there is cointegration between real GDP and Export (ton), Production and IP between Export (ton), Export (USD), Import (ton), Import (USD), Production and Consumption.

The Error Correction Model (ECM) acknowledges that two or more variables are co-integrated in the long run as a result of them having a common trend. The general formulation of the error correction models for the series among which co-integration was detected is as follows:

$$\Delta Y_t = \alpha_0 - \alpha_1(Y_{t-1} - \beta_1 X_{t-1}) + \beta_0 \Delta X_t + \varepsilon_t \quad (9)$$

Here, Y represents the GDP and the IP variables, $\Delta(X)$ stands for the first difference for the series among which co-integration exists and $(Y_{t-1} - \beta_1 X_{t-1})$ stands for the first lag of error terms derived from the co-integration equation. Table 3 displays the results of the error correction model for the series.

Table 3 Results of the error-correction model test

	ECM term	t-St.	R ²	DW	Schwarz Criterion	F-st.
real GDP-Export(tons)	0.508	3.414 (0.0018)	0.292	1.862	22.199	0.005
real GDP-production	0.663	2.127 (0.0421)	0.332	1.795	22.276	4.822
IP-Export (tons)	1.000	22.695 (0.000)	0.947	0.086	2.853	278.406
IP- export USD	0.099	2143.98 (0.000)	0.999	2.005	-4.502	219173.0
IP-import tons	0.462	3.158 (0.0037)	0.585	1.690	5.009	13.661
IP- import USD	1038145	161.893 (0.000)	0.998	1.462	-0.387	4159.439
IP-production	-0.281*	-2.179 (0.0371)	0.314	1.960	5.418	7.106
IP-production	0.863	9.254 (0.00)	0.824	2.172	4.058	72.591

Results of the error correction model analysis indicate that the error correction terms have been determined to be statistically significant in all models. The coefficient has been determined as negative in the model regarding the industrial production index and steel production and as positive in the rest of the models. These results indicate that only the relationship between the production of steel and IP is unaffected from the short-term perturbations and 28% of the deviation that has occurred is recovered or improved after a period of time. On the other hand, the relationships among the variables were affected by the short-term perturbations in the rest of the models and they appeared to deviate from their relationship equilibrium in the long run. A long-term relationship has been identified between the GDP growth and the consumption of steel in India, which ranks the second largest steel producer in the world (Ghosh, 2006). In a similar study in the United Kingdom, the relationship between the production of steel and economical activity has been investigated and the presence of a long-term relationship was identified. In the present study, the relationship between GDP and IP has been investigated and in contrast to the results of the studies conducted in India and the United Kingdom, a relationship between the consumption of steel and GDP could not be identified. Although a long-term relationship between the GDP and the production / export couple could be identified, this relationship was affected from short-term perturbations (Evans, 2010).

3.3. Granger causality

The causality was identified through the Granger causality test and the restricted and the unrestricted models were determined by the Ordinary Least Squares Method taking the Schwarz Criterion into consideration. The F-values and the statistics regarding the mean error squares obtained from both models are given in Table 4.

Table 4. Results of the causality test

Causality	F _{hes}	F _{tablo}	Causality
realGDP→Steel Production	10.01875	4.17	+
Steel Production → realGDP	0.312704	4.17	-
realGDP → Export(tons)	2.252595	4.17	-
Export(tons) → realGDP	4.626866	4.14	+
IP → Export(tons)	16.26733	4.17	+
Export(tons)→ IP	10.74055	3.32	+
IP → Export(USD)	9.232742	4.17	+
Export(USD) → IP	3.866047	3.32	+
IP → Import(tons)	3.015198	4.17	-
Import(tons) → IP	1.205776	4.17	-
Import(USD) →IP	0.132279	4.17	-
IP→ Import(USD)	14.52882	4.17	+
IP → Steel Consumption	0.23882	4.17	-
Steel Consumption →IP	3.904845	4.17	-
IP → Steel Production	3.102253	4.17	-
Steel Production →IP	1.454877	4.17	-

Investigation of the results of the causality test indicates that a causality relationship exists from the production of steel and its export towards Real GDP, from the industrial production index towards the export (tons), export (USD) and the import (USD) variables and from the export (tons) and the export (USD) towards the industrial production index.

The presence of a causality relationship from economical growth towards industrial production is apparent from the obtained results. Steel is one of the most significant materials of production. Its production increases as the economy expands and thus the demand also increases in the same direction as the production. As an increase is observed in the production of steel and its export, the economy expands. The production of steel affects major sectors including the durable goods, automotive, construction, infrastructure and similar sectors.

Investigation of the causality relationship between IP and steel data indicate a duplex relationship between IP and export. As the export increases, the demand for steel also increases. As the export and the import of steel increase, the economy expands (Nushiwat, 2008; Guisan and Exposito, 2008). This indicates the presence of a duplex causality. In a study of the investigation of the causality relationship between the production of steel and GDP in India, Ghosh (2006) has identified a causality

relationship from GDP towards the consumption of steel. The author reports an increase in the production as a result of growth and with that increase, a demand for the basic production item steel would increase. Generally speaking, an increase in the national income per capita and growth was reported as a result of increase in production in general (Guisan and Expoisto, 2007; Aguayo and Guisan, 2007; Guisan and Expoisto, 2006; Guisan, 2008). Since the basic consumables, automotive, construction and infrastructure sectors are in relation with the production of steel, it was concluded that these sectors grow as a result of the growth in GDP increasing the demand for steel.

4. Conclusion

In the present study, the presence of along-term relationship between the GDP / IP couple and the data available for the steel sector was identified. A unidirectional causality has been detected between the production of steel / export couple and GDP whereas a duplex causality was determined between IP and the export of steel. Since steel sector provides the basic input for many industrial activities, it has a significant impact on industrial production and economical growth. A 5% annual demand increase in the consumption of steel is acknowledged. As a result of this increase in demand, the energy rates and the steel production input rates increase. Taking the increase in raw material costs and input costs into consideration together with the increase in the demand for steel, the production of steel looms large. Meeting the national demand for steel through import results in an additional burden on the national economy and creates budget related issues. The relationship between the export of steel and the economical growth presents the importance of the steel sector once more. The increase in the production and specifically the export of steel acts as a locomotive force on economical growth.

A developing, dynamic country such as Turkey needs to focus on infrastructural investments such as roads, industrial plants, harbors and such in order to have a voice in the global arena. Energy and steel are the most basic inputs of the infrastructural investments. Many difficulties exist for a developing country that imports steel and energy in order for it to have a voice in the global arena. For this reason, countries need to find solutions to liberate themselves from this foreign dependence in terms of the production of steel. Increase in the production of steel will aid in the economical growth and result in an increase in the export of steel. As a result of this process, the realization of the desired growth would be inevitable.

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Annex

	Production	Consumption	Export	Import
	x1000 ton	x1000 ton	(ton)	(ton)
2001-1	3391.00	2537.00	423004.00	1012432.00
2001-2	3156.00	1775.00	582967.00	902268.00
2001-3	3031.00	1950.00	536954.00	1077853.00
2001-4	3295.00	2445.00	485852.00	1234804.00
2002-1	2964.00	2098.00	473477.00	1003326.00
2002-2	3701.00	2937.00	506266.00	1349050.00
2002-3	3482.00	3293.00	603829.00	1666814.00
2002-4	3620.00	2958.00	635400.00	1474322.00
2003-1	3922.00	3377.00	723219.00	1524028.00
2003-2	3976.00	3162.00	694826.00	1711601.00
2003-3	3876.00	3605.00	725523.00	1843828.00
2003-4	3976.00	3511.00	755414.00	1740164.00
2004-1	3908.00	3764.00	898918.00	1689244.00
2004-2	4258.00	3361.00	1596324.00	1913350.00
2004-3	4544.00	4213.00	1220543.00	1874817.00
2004-4	4507.00	3948.00	1534799.00	2517027.00
2005-1	4542.00	4089.00	1271601.00	2154982.00
2005-2	4752.00	4286.00	1330939.00	2303330.00
2005-3	5132.00	5190.00	992141.00	2414937.00
2005-4	5175.00	4800.00	1274052.00	2720863.00
2006-1	5180.00	4338.00	1320530.00	2410224.00
2006-2	5874.00	5860.00	1364754.00	3187045.00
2006-3	5997.00	5255.00	1723877.00	2912547.00
2006-4	5993.00	5388.00	1660444.00	3209117.00
2007-1	6446.00	6108.00	1588855.00	3169580.00
2007-2	6668.00	5393.00	2408774.00	3013173.00
2007-3	6480.00	5993.00	2102948.00	3535113.00
2007-4	6501.00	6221.00	2007744.00	3491475.00
2008-1	6945.00	6449.00	2652639.00	3799601.00
2008-2	7020.00	5499.00	4415035.00	3560840.00
2008-3	7335.00	5314.00	5668212.00	3457623.00
2008-4	5400.00	4088.00	1965734.00	2007491.00
2009-1	5765.00	2962.00	2055394.00	2142741.00
2009-2	6728.00	4615.00	1737503.00	2566459.00
2009-3	6490.00	5266.00	1738240.00	2598629.00

	Export	Import		
	USD	USD	real-GDP	real-IPI
	x1000	x1000		
2001-1	2000039,00	318077,00	137677,84	238,06
2001-2	2750675,00	268554,00	132239,47	174,88
2001-3	2590773,00	306630,00	152347,04	158,24
2001-4	2334205,00	310118,00	128252,90	134,54
2002-1	2325420,00	279411,00	115295,55	130,46
2002-2	2501856,00	392525,00	125317,68	129,16
2002-3	2641448,00	512858,00	152390,27	121,01
2002-4	2635923,00	507735,00	138362,01	114,64
2003-1	2738576,00	571424,00	120201,95	104,79
2003-2	2487240,00	663939,00	129208,39	103,91
2003-3	2668588,00	715399,00	156759,42	109,13
2003-4	2555942,00	709093,00	145419,87	109,18
2004-1	2536999,00	807058,00	134865,77	106,78
2004-2	3597072,00	1071483,00	139283,59	104,34
2004-3	2800678,00	1112113,00	164134,58	101,73
2004-4	3260887,00	1587881,00	152553,65	96,82
2005-1	2771225,00	1439990,00	143408,06	96,75
2005-2	3001206,00	1537078,00	153348,43	96,57
2005-3	2361558,00	1378590,00	181166,19	100,10
2005-4	2940409,00	1479553,00	170590,85	106,25
2006-1	3173115,00	1316927,00	155389,56	99,99
2006-2	2947666,00	1797868,00	168999,72	99,13
2006-3	3353624,00	1881224,00	188989,11	95,87
2006-4	3191305,00	2110478,00	178762,86	99,40
2007-1	2968383,00	2133142,00	165642,30	100,64
2007-2	3982598,00	2283501,00	175651,74	98,43
2007-3	3476376,00	2568409,00	198635,89	98,22
2007-4	3364855,00	2630875,00	185153,47	99,38
2008-1	3858129,00	3015000,00	175333,62	99,98
2008-2	4995992,00	3503468,00	178242,03	88,23
2008-3	4934286,00	4184646,00	194845,06	84,05
2008-4	3000392,00	2034824,00	176711,81	77,93
2009-1	4347338,00	1410906,00	160158,82	74,14
2009-2	3871301,00	1470267,00	173486,05	75,57
2009-3	3730306,00	1634286,00	197788,91	78,38