The Effect of Maturity, Trading Volume, and Open Interest on Crude Oil Futures Price Range-Based Volatility

Ronald D. Ripple
Macquarie University, Sydney, Australia

Imad A. Moosa
Monash University, Melbourne, Australia

EcoMod Conference on Energy and Environmental Modeling
Moscow, Russia, September 13-14, 2007

Abstract

The determinants of the volatility of crude oil futures prices are examined using an intra-day range-based measure of volatility. The contract-by-contract analysis reveals that trading volume and open interest have a significant impact on volatility and that they dominate the Samuelson-maturity effect. While the results support earlier findings of positive and significant role for trading volume, they also show the importance of open interest as a determinant of volatility. The results of the full-period time series analysis also demonstrate the significant role played by open interest in the determination of futures price volatility and further confirm the importance of trading volume.

Introduction

The objective of this paper is to analyze the relation between the volatility of futures prices and the maturity of contracts, trading volume, and open interest. The concept of open interest is introduced to find out whether or not this additional measure of market activity is useful for explaining volatility. We find that, whether we examine the relation on a contract-by-contract basis or via time series analysis over an eleven year period, open interest does contribute significantly to the explanation of futures volatility for the New York Mercantile Exchange (NYMEX) crude oil contract.

The introduction of open interest as an additional explanatory variable is motivated by the fact that open interest and its change differ significantly from trading volume, which is why we expect it to provide additional explanatory power. Open interest is defined as the number of contracts existing in a futures market that have not yet been closed out. It is reported as the number of outstanding contracts at the end of a trading day. Open interest increases from zero when a contract is first listed for trading, falling back to zero on the maturity date of the underlying contract when trading ceases. It typically reaches a maximum about one month before maturity. We expect open interest to provide additional information because the relation between open interest and trading volume is quite complex, which means that trading volume alone cannot be expected to reveal effectively this additional information.

Futures markets differ from equity markets in many respects. One specific element of difference has to do with open interest, as there is no directly comparable measure in equity markets. In the latter, there are a number of outstanding shares that may be traded, in which case the trading volume captures the number of shares traded by market participants. Of specific note is the fact that trading volume does not affect the number of outstanding shares, which is determined by a policy decision of the corporate board, thus increasing or decreasing infrequently.

In the futures markets, however, there is no set number of outstanding contracts to be traded. Contracts come into existence simply by two parties who are interested in buying and selling a contract. There is no direct, monotonic link between trading volume and open interest, which are effectively stock and flow measures of activity, respectively. However, it will be the exception, rather than the rule, to find that a change in open interest between two trading days is equal to the trading volume that occurs during the day. For any given trading volume, the open interest for a contract may rise, fall, or remain unchanged.

Consider first what happens when open interest rises. If two new traders (not already holding positions in the market) come to the market, one buying (going long) and the other selling (going short) a single contract, their trading activity will result in a trading volume of one contract, and it will increase open interest by one contract. Consider now what happens when open interest is unchanged. If a new trader comes to the market and goes long, this activity will result in a trading volume of one contract, but it will result in no change in open interest if the contract purchased had previously been owned by some other trader who has decided to close an existing position. In this case, the activity will resemble that observed in equity markets. Finally, consider the case when open interest falls. If two traders who are already in the market (one long and the other short) close their respective positions against one another, this will result in a trading volume of one contract and a decrease in open interest of one contract. In this case, the long trader closes the position by going short, and the short trader closes by going long. In each case, the observed trading volume is one regardless of the effect on open interest. Therefore, the observation of a trade does not tell us whether or not open interest has increased, decreased, or remained unchanged. It is therefore necessary to include observations on open interest directly to be able to determine whether or not this trading activity variable influences the volatility of futures prices separately from trading volume.

Literature Review

The literature contains numerous examples of papers attempting to identify the important economic variables that influence the volatility of futures prices. A subset of this research focuses on the volatility of commodity futures, and there has been recent interest in the volatility of energy futures prices. Viewed as the seminal paper in this strand of research, Samuelson (1965) demonstrated that the volatility of futures contracts should increase as maturity is approached. The logic behind this conclusion is that the market is more sensitive to news regarding near-maturity contracts than more-distant contracts, which is indicated by greater volatility for the near-maturity contract. An alternative way to think about this effect is to note that news is more relevant to near-term market concerns rather than to markets distant in time. An econometric specification of this relation should include a measure of volatility as the dependent variable and a measure of contract maturity as the independent variable. Typically, the maturity variable is a decreasing counter/index, and the expected outcome is to find the estimated coefficient to be significantly negative.

Serletis (1992) estimated the effect of maturity and trading volume on the price volatility of NYMEX energy futures contracts over the period of January 1987 to July 1990. His model augments the Samuelson-type volatility-maturity model with observations on trading volume. The contracts he examined included crude oil, heating oil, and unleaded gasoline (43 contracts for each). He used all observations for a contract from the first trading day to maturity. The measure of volatility he used is based on Parkinson (1980) and Garman and Klass (1980), which is calculated from the high and low prices observed for each trading day. He conducted the analysis on a contract-by-contract basis. For crude oil he found that once trading volume is added to the specification, the number of contracts that exhibit significantly negative coefficients on maturity falls to about 30 percent (13 out of 43) from 65 percent (28 out of 43) when maturity is specified alone. Similar results were found for the other two contracts. One concern about the work of Serletis is the inclusion of data extending back to the initial trading days of a contract when there is often little or no trading activity. The market is not focused on these contracts because they are by definition far from maturity, and their economic effect is distant from the current physical market activity.

Herbert (1995) studied the relation between volatility and maturity and trading volume for the natural gas futures traded on the NYMEX over the period from June 1990 to May 1994. He employed the same high-low price measure of volatility as Serletis (1992), but he used the observations for near-month contracts only. The decision to limit observations was explained by noting concerns about the lack of trading activity during the early months of trading in a contract. However, this decision also introduces limitations, since it reduces the average number of observations per contract to around twenty. The results reported by Herbert fail to support

Samuelson's finding that volatility should increase as maturity is approached. For the natural gas contracts, even when maturity is specified alone, the number of significant negative coefficients is only 13 out of 47, or 28 percent. Once trading volume is included in the specification, this falls to 3 out of 47, or 6 percent. These results led Herbert to conclude that trading volume dominates maturity in explaining futures returns volatility.

Bessembinder and Seguin (1993) employ a different modeling approach. They use a measure of volatility based on daily closing prices and time series methods rather than examining single contracts. As such, there is no role for a maturity variable, but in addition to trading volume, they introduce open interest as a measure of trading activity, which is meant to capture market depth. In their analysis of the price volatility of near-month contracts, and for both trading volume and open interest, they employ observations that represent aggregations over all traded contracts, no matter how distant the maturity is. Their results indicate that trading volume has a significant positive effect on volatility, while open interest has a significant negative effect.

This paper extends this research. We follow Serletis (1992) and Herbert (1995) by using the high-low price measure of volatility, and we bring open interest into the analysis, following Bessembinder and Seguin (1993). We address the stated data issues by employing observations on trading volume and open interest for the specific contract of interest rather than on an aggregate for traded contracts. We also take an intermediate position between Serletis (1992) and Herbert (1995) by employing two months of observations for each contract rather than all (Serletis) or just one month (Herbert). This adds useful observations without reaching too far into the relatively lightly traded past of a contract. We examine the relations both on a contract-by-contract basis and in a time series framework.

Model Development and Estimation Methodology

In this section we discuss the model structure and model selection methodology employed to evaluate the role of each of the three explanatory variables: maturity, trading volume, and open interest. We utilize two approaches, one employing data on a contract-by-contract basis and the other employing a time series framework for the entire period. The former calls for analyzing the data associated with individual contracts, and determining what is the most meaningful set of data for a contract, whereas the latter requires "splicing" together the data series over the entire period.

The models and estimation methods must also differ as a result of these different approaches. For example, there is no meaningful role to be played by maturity when we use the spliced time series data. For the contract-by-contract analysis, the series length seriously limits our ability to assess lag structures for the variables, a limitation that does not hold for the full-period time series analysis.

We begin with a contract-by-contract analysis. Our basic specification is as follows:

$$s_t = \beta_0 + \beta_1 m_t + \beta_2 v_t + \beta_3 o_t + \varepsilon_t \tag{1}$$

where s is the measure of volatility, calculated as $(\ln(H) - \ln(L))^2 / (4\ln 2)$, where H represents the high price recorded for the day's trading and L the low price for the day. m is the maturity variable, which is a simple decreasing counter; v is trading volume; o is open interest; and ε is the regression residual term. The trading volume and open interest variables are measured by the number of contracts. We follow Herbert (1995) by not transforming these variables into logarithms, but we base this decision on non-nested tests for alternative linear specifications.[1]

We accept the results of earlier work that include both maturity and trading volume variables, and then we systematically examine alternative specifications to find out whether or not open interest should be included in the equation to explain volatility. This allows us to make direct comparisons of our results with those of Serletis (1992) and Herbert (1995), while extending the literature by evaluating the role of open interest as an explanatory variable. We employ non-nested tests for alternative specifications, and we employ tests for both the deletion and addition of variables to confirm that open interest belongs in the specification.[2]

Following our examination of the contract-by-contract data, we conclude that maturity may be dropped from the specification, and this allows us to shift to a time series analysis of the roles for trading volume and open interest in explaining futures volatility. From our 131 contracts we find that only 5 percent (7 out of 131) of the estimated coefficients on maturity are significant and negative.

The time series specification is as follows:

$$s_t = \beta_0 + \sum_{l=1}^{n} \beta_{1l} s_{t-l} + \sum_{i=0}^{p} \beta_{2i} v_{t-i} + \sum_{j=0}^{q} \beta_{3j} o_{t-j} + \varepsilon_t \qquad (2)$$

[1] The non-nested model selection tests include the Cox N-test, the adjusted Cox NT-test, the Wald-type W-test, the J-test and JA-test. Information criteria, such as AIC and SBC, can be used for the same purpose. For details, see Pesaran and Persaran (2003). The results are not reported here but they are available from the authors upon request.
[2] *Microfit 4.0* computes an LM statistic, an LR statistic, and an F-statistic to test the null hypothesis that coefficient on the deleted or added variable is zero. Again, these results are not reported but they are available upon request.

This model is estimated over the entire eleven year period, employing the autoregressive distributive lag methodology. The ARDL(*n*,*p*,*q*) specification selection criteria used is the Schwarz Bayesian Criterion (SBC), which produces an optimal selection of ARDL(5,5,0). The Akaike Information Criterion (AIC) selected model tends to contain more lags for each variable, producing an ARDL(6,5,7) model.[3] The variables are defined the same as for the contract-by-contract estimation.

Data Collection and Processing

The crude oil futures contract series are sourced directly from the NYMEX. The time period covered is January 1995 through December 2005, and the data are daily. For the contract-by-contract analysis, we use 131 contracts, and for the full-period time series analysis we have 2,739 daily observations. These data include the daily high and low prices, the daily trading volume, and the daily open interest. The high and low prices are used to construct a volatility measure, as defined earlier. Trading volume and open interest enter the estimation in levels (number of contracts).

Each estimation operation requires special handling of the data. As noted above, Serletis (1992) used all observations for a contract beginning with its listing, whereas Herbert (1995) used only the near month. In our contract-by-contract analysis, we employ the last two months of the series observations to take advantage of as much meaningful data as possible. With the objective of having observations to be representative of the focus of market activity, our choice falls on two

[3] Given the number of observations and variables, *Microfit 4.0* limited the maximum number of lags that could be estimated to seven. All possible models are estimated, and setting the maximum lag length to seven implies that 512 models are estimated $(m+1)^{k+1}$, where m=7 is the specified maximum lags and k=2 is number of explanatory variables.

months as the length of the period used to analyze the relations between the high, low, and settlement prices for the individual contracts.

The daily settlement price is determined by the Exchange Settlement Committee for all but a very few near-maturity contracts. For thinly-traded contracts, especially those for far distant maturity, it is not unusual to observe a settlement price that is outside the range for the daily high and low for that contract. This results from the judgment of the Committee as to the overall market sentiment, which is motivated by the desire to maintain continuity between different maturities even in the face of limited (or no) trading in some distant maturity contracts. We determined that for nearly all of the 131 contracts, the settlement price was observed to fall within the high-low price range throughout the last two months of trading. This implies that the volatility measure constructed from the daily high and low prices should provide a good representation of volatility. Reflecting on Serletis (1992), this suggests that much of his constructed volatility observations, based on the same daily high and low methodology, were not representative of the market's actual assessment of the volatility of the contracts, since it would be revealed that settlement prices for most of the contracts maturing beyond two months would have fallen outside of the high-low range. On the other hand, Herbert's (1995) use of only near-month observations ignores information that is representative of the volatility associated with market activity. Our choice of two months of observations typically results in more than 40 observations, doubling the number of observations used by Herbert (1995).

The time series analysis requires the construction of a spliced time series for the eleven-year period. Since all futures contracts eventually mature and cease to trade, the typical approach is to splice the near-month prices for consecutive contracts. We employ a somewhat different splicing methodology, which employs prices and associated trading activity that are representative of the focus of the market. As a contract approaches maturity, the market shifts its attention to the next-to-near contract before the near-month contract reaches its last trading day. We avoid using observations near the maturity date of the contracts.

We established a two-criterion test to determine when we should shift from the near-month contract observations to the next-to-near month contract. When both the daily trading volume and open interest for the next-to-near month contract exceed those for the near-month contract, we take this as evidence that the market's attention has shifted away from the near-month contract. At this point we shift the series to the next-to-near month contract.[4] This methodology also has the effect of smoothing the series. For example, if we splice the series on the last trading day, the shift from the closing near-month contract to the new near-month contract will see observations on open interest leap from zero (or very near zero) to substantially large open interest. This leap is an artifact of the life-cycle of futures contracts that does not really carry meaningful market information.

Finally, our approach differs from that of Bessembinder and Seguin (1993) by considering the trading volume and open interest matching the contract prices that are the basis for our volatility measure. Rather than implying that there is some role to be played by total market trading activity in determining the near-month contract price volatility, we estimate the relation between a contract's price volatility and its own trading activity.

---

[4] Through extensive testing, we have determined that once both conditions are met, the near-month contract never again regains the focus of trading activity.

Results: Contract-by-Contract

Table 1 reports a selected subset of the results for the 131 contract-by-contract analysis. It reports the twenty-two June and December contracts for the period, because they are typically the most heavily traded contracts. It is invariably the case that the only time another month's contract exceeds the trading activity associated with June and December contracts is when it is the near-month contract. The table reports the coefficient estimates, their associated p-values, and the adjusted-R^2. Maturity is shown to be rarely significant, whereas volume and open interest tend to be significant. The signs for volume and open interest are as expected, indicating that an increase in trading volume leads to an increase in volatility, whereas an increase in open interest reduces volatility by increasing market depth. The adjusted-R^2 column shows that the explanatory power of these models is reasonable. However, the general specification employed seems to lose what explanatory power it has when we reach the end of the period. Explaining this change is part of ongoing research.

Table 2 summarizes the statistical significance of the coefficient estimates. The first three columns simply identify occurrences of statistical significance at the 95% level (1 indicates significance). Maturity is shown to be statistically significant 45% of the time, while trading volume is significant 95% of the time and open interest 73% of the time. The last three columns report the occurrences of both statistical significance and correct sign (1 indicates that both are satisfied). Maturity never has the correct sign for the June and December contracts. It has the right sign (negative) and significance in just 5% of the total 131 cases. On the other hand, trading volume and open interest also have the correct sign in all cases.[5]

The magnitudes of the coefficients warrant mention. The very small magnitudes are due to the relative magnitudes of the dependent and independent variables. The volatility is in terms of a variance measure, so in scientific notation these observations are typically in the E-3 to E-5 range, while the trading volume and open interest are in terms 10s to 100s of thousands of contracts. More interesting is the relation between the magnitudes of the coefficients on volume and open interest, especially since they are expected to (and do) have opposite signs. For the June and December subset, there are no instances where the magnitude of the negative open interest coefficient exceeds the positive for volume (for all 131 contracts there are just four occurrences). On average, the magnitude of volume coefficients is 3 times larger than that for open interest for the June-December set, and nearly five times larger when accounting for all 131 contracts.

Results: Full Period Time Series

Table 3 reports the results of the full-period time series analysis, displaying the estimated coefficients and their t statistics, as well as the unadjusted and adjusted coefficient of determination, the standard error of the estimated equation (SE) and the $\chi^2(1)$ test statistic for serial correlation (SC). As noted above, the optimal lag structure is represented by the ARDL(5,5,0) model, based on the SBC selection criterion. The long-run stability for our period of analysis of the selected model specifications is supported by the CUSUM and the CUSUMSQ tests. However, there is evidence that the structure was changing toward the end of the period.

[5] The results for all 131 contracts have a quite similar pattern. For significance only, maturity is significant 41% of the time, volume 90% of the time, and open interest 63% of the time. For significance and sign, maturity satisfies both only 5% of the time, volume 90% of the time, and open interest 63% of the time.

The magnitudes of the coefficients have the same basis as already mentioned. The signs of the contemporaneous trading volume and open interest are as expected: positive for volume and negative for open interest, and both are highly significant. In this specification, only the fourth lag of the dependent variable and the third lag of volume are insignificant. While the coefficients on the lags of the dependent variable appear to dominate those for trading volume and open interest, this is again an artifact of the relative magnitudes of the variable inputs. In fact, if trading volume and open interest are scaled to match that of the volatility measure (i.e., each divided by one million) the coefficient on volume becomes 1.3448 and that for open interest becomes a negative 0.0837, placing them on a stronger relative footing with coefficients on the lagged dependent variable.

It is interesting again to examine the relation between the magnitudes of the volume and open interest coefficients, especially since in this analysis the coefficients on lagged volume are negative, providing a counter to the positive influence that contemporaneous trading volume has on volatility. The cumulative effect of volume (summing the estimated coefficients) is 0.260E-8, compared to the -0.838E-9 for open interest.[6] Therefore, the relative magnitude based on these estimates shows trading volume to exceed open interest by roughly three times, which is quite similar to the results found in the contract-by-contract analysis.

It is interesting also to revisit the earlier discussion of the relation between trading volume and open interest in the context of these relative magnitudes of offsetting effects on volatility.

[6] When the coefficient on contemporaneous volume is put on a comparable scale with the lagged dependent variables, its magnitude is more than double the cumulative effect of the lagged dependent variables. However, the cumulative magnitude for all volume variables is less than half that for the cumulative lagged dependent variable.

Recalling that trading volume does not unambiguously add to open interest, the change in open interest must be less than the observed trading volume. On any given day, therefore, the offsetting effect of open interest is less than the simple comparison of cumulative coefficient values. Also, it is worth noting that as maturity of a contract is approached, the influence of open interest on volatility tends to amplify that of trading volume, rather than operate as an offset. This is because as maturity is approached, open interest tends to fall, thus having a positive effect on volatility through its negative coefficient.

Conclusion

In this paper two different estimation approaches were employed to evaluate the determinants of volatility for crude oil futures prices. In applying both approaches, we used an intra-day range-based measure of volatility, as opposed to an inter-day, close-to-close.

The contract-by-contract analysis revealed that trading volume and open interest have significant roles to play in determining price volatility and that they dominate the Samuelson-maturity effect. Indeed, the results of non-nested linear specification testing suggest that maturity may be excluded from model specifications when trading volume and open interest are present. Our results support earlier findings of the positive and significant role for trading volume, and we add to the findings in the literature by showing the importance of open interest in determining crude oil futures price volatility (statistically significant and negative as expected).

The results of the full-period time series analysis also demonstrate the significant role played by open interest in the determination of futures price volatility and further confirms the importance of trading volume. However, it is noted that the role of open interest is smaller than that for trading volume. The magnitude of the effect of trading volume on volatility is roughly three times that for open interest.

Both approaches suggest that some structural change may be occurring toward the end of the time period under study, 1995-2005. These results collectively suggest that further analysis of these relations and their evolution are warranted, especially as they relations may be changing going into the future.

References

Bessembinder, H. and Seguin, P.J. (1993) Price Volatility, Trading Volume, and Market Depth: Evidence from Futures Markets," *Journal of Financial and Quantitative Analysis*, 28, 21-39.

Garman, M.B. and Klass, M. (1980) On the Estimation of Security Volatilities from Historical Data, *Journal of Business*, 53, 67-78.

Herbert, J.H. (1995) Trading Volume, Maturity and Natural Gas Futures Price Volatility, *Energy Economics*, 17, 293-299.

Pesaran, M.H. and Pesaran, B. (2003) *Microfit 4.0*, Oxford: Oxford University Press.

Parkinson, M. (1980) The Extreme Value Method for Estimating the Variance of the Rate of Return, *Journal of Business*, 53, 61-65.

Samuelson, P.A. (1965) Proof that Properly Anticipated Prices Fluctuate Randomly, *Industrial Management Review*, 6, 41-49.

Table 1: Selected Results for the Contract-by-Contract Analysis

Contract	*m*	P-value	*v*	P-value	*o*	P-value	$\overline{R}^2$
Jun-95	3.92E-07	0.724	5.95E-09	0.000	-1.33E-09	0.052	0.44655
Dec-95	4.90E-06	0.000	7.25E-09	0.000	-3.24E-09	0.000	0.63766
Jun-96	5.19E-06	0.702	4.26E-08	0.007	-2.29E-08	0.013	0.18439
Dec-96	1.14E-05	0.016	2.43E-08	0.000	-1.32E-08	0.000	0.44948
Jun-97	8.44E-06	0.033	1.51E-08	0.000	-7.57E-09	0.000	0.38192
Dec-97	2.72E-06	0.520	1.20E-08	0.003	-5.87E-09	0.037	0.15054
Jun-98	2.06E-05	0.183	3.32E-08	0.004	-2.94E-08	0.000	0.26417
Dec-98	7.33E-06	0.127	2.26E-08	0.000	-8.94E-09	0.000	0.58052
Jun-99	7.47E-06	0.046	9.38E-09	0.000	-3.83E-09	0.001	0.25433
Dec-99	1.56E-05	0.009	1.39E-08	0.000	-5.03E-09	0.006	0.30415
Jun-00	5.56E-06	0.244	9.98E-09	0.002	-1.24E-09	0.596	0.22756
Dec-00	3.12E-05	0.000	3.43E-08	0.000	-5.77E-09	0.053	0.59262
Jun-01	7.51E-06	0.007	1.18E-08	0.000	-3.59E-09	0.068	0.29709
Dec-01	7.46E-06	0.776	4.84E-08	0.002	-3.30E-08	0.000	0.35282
Jun-02	1.10E-05	0.072	1.50E-08	0.001	-6.95E-09	0.010	0.18668
Dec-02	6.32E-07	0.805	8.62E-09	0.000	-3.72E-09	0.000	0.52933
Jun-03	3.29E-05	0.000	1.80E-08	0.000	-5.92E-09	0.002	0.43892
Dec-03	1.01E-05	0.015	1.13E-08	0.000	-3.36E-09	0.004	0.36296
Jun-04	7.52E-06	0.036	4.36E-09	0.035	-1.80E-09	0.012	0.13113
Dec-04	4.59E-06	0.229	1.09E-08	0.000	-2.36E-09	0.004	0.53666
Jun-05	4.59E-06	0.217	5.89E-09	0.007	-1.13E-09	0.145	0.12387
Dec-05	3.83E-06	0.144	9.80E-10	0.538	-3.48E-10	0.510	-0.0182

Table 2: Measures of Correct Sign and Significance

	Significance Only			Sign and Significance		
	m	*v*	*o*	*m*	*v*	*o*
Jun-95	0	1	0	0	1	0
Dec-95	1	1	1	0	1	1
Jun-96	0	1	1	0	1	1
Dec-96	1	1	1	0	1	1
Jun-97	1	1	1	0	1	1
Dec-97	0	1	1	0	1	1
Jun-98	0	1	1	0	1	1
Dec-98	0	1	1	0	1	1
Jun-99	1	1	1	0	1	1
Dec-99	1	1	1	0	1	1
Jun-00	0	1	0	0	1	0
Dec-00	1	1	0	0	1	0
Jun-01	1	1	0	0	1	0
Dec-01	0	1	1	0	1	1
Jun-02	0	1	1	0	1	1
Dec-02	0	1	1	0	1	1
Jun-03	1	1	1	0	1	1
Dec-03	1	1	1	0	1	1
Jun-04	1	1	1	0	1	1
Dec-04	0	1	1	0	1	1
Jun-05	0	1	0	0	1	0
Dec-05	0	0	0	0	0	0
Percent	0.45	0.95	0.73	0	0.95	0.73
Number	10	21	16	0	21	16

Table 3: The Time Series Results

Coefficient/Statistic	Estimated Value	t Statistic
β_0	0.8232E-4	3.12
β_{11}	0.20937	10.98
β_{12}	0.20379	10.45
β_{13}	0.090474	4.57
β_{14}	0.025172	1.29
β_{15}	0.097990	5.13
β_{20}	0.1345E-7	30.28
β_{21}	-0.4537E-8	-8.52
β_{22}	-0.2177E-8	-4.07
β_{23}	-0.3837E-9	-0.72
β_{24}	-0.1116E-8	-2.07
β_{25}	-0.2639E-8	-5.15
β_{30}	-0.8378E-9	-3.52
R^2	0.36	
$\bar{R}^2$	0.36	
SE	0.4094E-3	
SC	2.91	