HANG SENG INDEX FUTURES OPEN INTEREST AND ITS RELATIONSHIP WITH THE CASH MARKET

Key Points:

- *Taking large open positions in the Hang Seng Index (HSI) futures formed part of the strategy of speculators in the 1998 episode of "speculative attacks" on the Hong Kong dollar and stock markets. The open interest has risen in the past couple of years, at one point to a record high level in the latter part of 2004. This note considers whether this should be a concern, and how such information can be assessed.*

- *Given the complexity of the futures market, it is difficult to construct a structural model to explain the level of open interest. Instead, this note attempts to extract useful information from available financial statistics, which may help shed light on the issue. This is achieved by examining the relevant statistical content of data on open interest and the historical relationship between open interest and other financial variables.*

- *Specifically, open interest is found to exhibit an upward trend since early 2001. It has a long run positive relationship with turnover in the cash market and the feedback between these two variables seems to run in both directions. On the other hand, no clear statistical relationship between the open interest and the short selling turnover, the price volatility in cash market, and the HSI level can be identified.*

- *Two "adjusted" open interest indicators – the detrended open interest position and the ratio of open interest to cash market turnover – are developed to facilitate assessing market conditions. In particular, these two indicators were found to be high in the last four months of 2004, but not as alarming as the raw data of open interest would suggest.*

- *These indicators will be monitored on a regular basis. Nevertheless, in view of the lack of a structural model, the role of market intelligence in assessing market developments remains critical.*

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I. BACKGROUND[1]

The open interest of Hang Seng Index futures (open interest), as measured by the number of contracts, has been rising since April 2002. It reached 158,296 on 27 September 2004, which surpassed the highest level of 150,585 recorded during the 1998 episode of "speculative attacks" on the Hong Kong dollar and stock markets (on 28 August 1998), and increased to a record high of 172,282 on 26 November 2004. Should this record level, or more generally a high level, of open interest in the future market be a policy concern?[2] Or is it just a normal growth of futures market activities?

Given the complexity of the futures market and the lack of some essential data, it is difficult to construct a structural model to explain the change in open interest.[3] Instead, this paper extracts information that may be useful for monitoring futures market activities, from available historical financial statistics, by employing various statistical techniques. Two "adjusted" open interest indicators are produced: (i) the detrended open interest position and (ii) the ratio of open interest to cash market turnover. They can be used to supplement the open interest position and other raw data for monitoring speculative activities.

II. STATISTICAL RELATIONSHIP BETWEEN OPEN INTEREST AND CASH MARKET ACTIVITIES

Many factors can affect the open interest. Fundamentally, economic growth, flows of funds, market uncertainty and market volatility could all impact on open interest through their effect on the growth of investor base, the level of arbitrage and hedging activities, as well as speculation. It is difficult to know the exact factors behind a change in open interest. This section focuses on the relationship between cash market turnover and open interest in the futures market. The motivation of doing this is to clarify a general perception that high turnover in the cash market can cause a high open interest position in the futures market, and vice versa. It is also perceived that high volatility of HSI may generate a large open interest position because of heavy speculative activities, and a high level of HSI itself can also cause large open interest because of hedging needs. Instead of constructing a structural model between the cash and futures markets, several statistical tools are adopted to examine the relationship between open interest and cash market turnover, the volume of short selling, and the level of the Hang Seng Index (HSI) as well as its volatility.

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[1] While the open interest may also be closely related with the activities in the foreign exchange spot and forward markets, as well as the HSI options, this study only focuses on its relationship with the cash market.

[2] While the level of open interest itself does not give a clear signal for whether there is excessive speculation in the market, past experience suggests that a very high level of open interest does warrant attentions of policy makers.

[3] Data such as the outstanding amount of short selling and the portfolio position and trading activities of major players are not available.

1.   Trend Growth of Open Interest

            While the open interest volume fluctuates during the contract month, the aggregate number including all contract maturities has been rising steadily since mid 2001 (see Chart A1 for the actual data). In order to quantify this recent trend growth of open interest, a simple linear regression is conducted with the open interest volume as the dependable variable, and a constant term and a time trend as independent variables. The estimation result is presented in Table 1.

Table 1: Estimation Result
(Daily from Jan 2001 to Sep 2004)

Dependent variable : Open interest volume

Explanatory variables	Estimated coefficients
Constant	22,006.44*
	(15.84)
Time trend	90.79*
	(30.28)
Adjusted R-squared	0.86

Notes: t values are in brackets.
              * denotes coefficient significant at the 5% level.

            The estimated coefficient for the time trend variable is statistically significant and its sign is positive. The results indicate that the open interest volume has been on a growing trend since January 2001. The reason the year 2001 is chosen is because the futures market in Hong Kong had gone through a consolidation period since the Asian financial crisis until 2001. Investors then regained confidence and started to invest in the stock market. This trend growth is believed to be associated with the growth of investor base, while it is possible that a long span of speculation can also generate a rising trend.[4] Under the current economic situation, it is believed that the trend increase itself has more to do with the favourable macroeconomic environment than pure speculation. This finding of a rising trend is useful in developing one of the "adjusted" open interest indicators in Section III, when the open interest is decomposed into a trend component and de-trended component, where the de-trended component indicates short term shocks and should be monitored.

2.   Correlation between Open Interest and Cash Market Turnover

            The correlation between open interest and cash market turnover measures the co-movement of the two markets. Based on daily market closing data of

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[4]   According to the latest Retail Investor Survey 2004 by the Hong Kong Exchanges and Clearing Limited (HKEx), 24.6% of the Hong Kong adult population (or 1,360,000 individuals) were retail investors in stocks and/or derivatives traded on HKEx. These compared to the previous survey of 20.3% (or 1,089,000 individual) in 2001.

open interest and cash market turnover from January 1997 to September 2004, rolling correlation coefficients of the two variables are computed, using 30-day, 60-day and 90-day windows, respectively. The two series are in value terms to take the effect of price changes into account.[5]

The pattern of resulting rolling correlation coefficients for the 30-day window is not clear (see Chart 1). However, as the time horizon of the window is extended, a clearer pattern emerges. For the 60-day and 90-day windows, the correlation is unstable, but largely positive (see Charts 2 and 3). The underlying reason for this positive correlation is difficult to pin down. There could be some common factors that affect the two markets simultaneously. One such factor could be the growth of investor base. Also, when turnover in the cash market is high, there may be an increased need for hedging or arbitrage in the market.

It should be noted that the positive correlation between the two variables does not necessarily mean that the movement in one market causes the movement in the other market. A Granger causality test has been developed to assess the direction of causality. It is found that the feedback between open interest and cash market turnover generally happens in both directions (see Annex IV).

Chart 1: 30-day Rolling Correlation Coefficient between Open Interest (in value) and Cash Market Turnover

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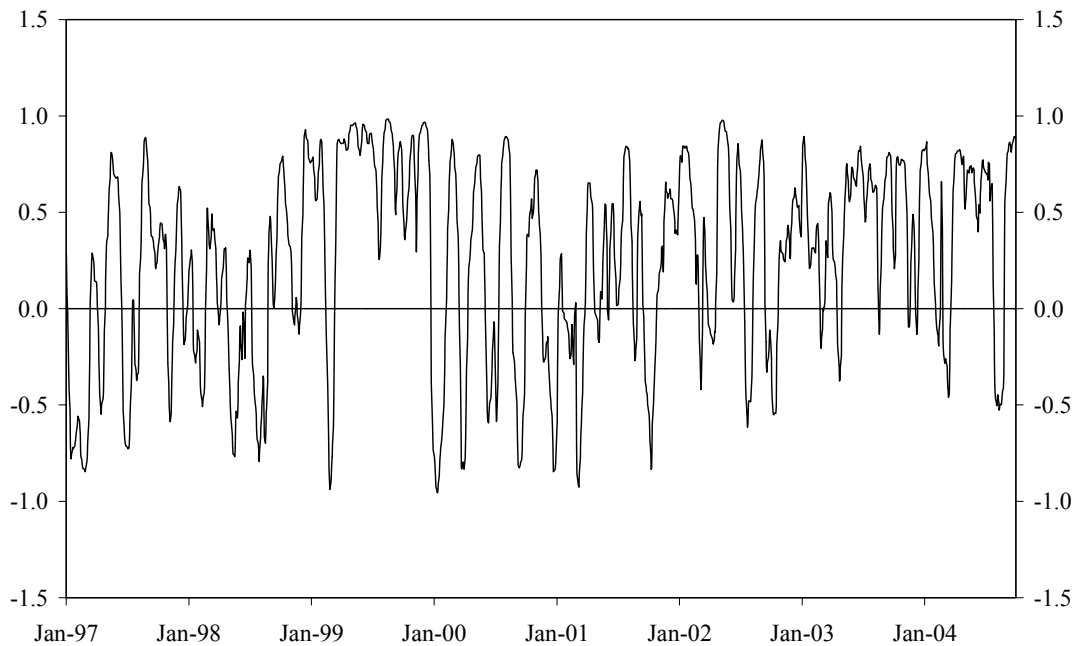
[5] The end-of-month settlement effect for the open interest data and the end-of-year holiday effect for the cash market turnover data have been adjusted (see Annex II for technical details regarding the adjustment method used to remove these calendar effects). Both series are smoothed to reduce the noise in the data (see Annex III for details of the exponential smoothing technique used).

**Chart 2: 60-day Rolling Correlation Coefficient between
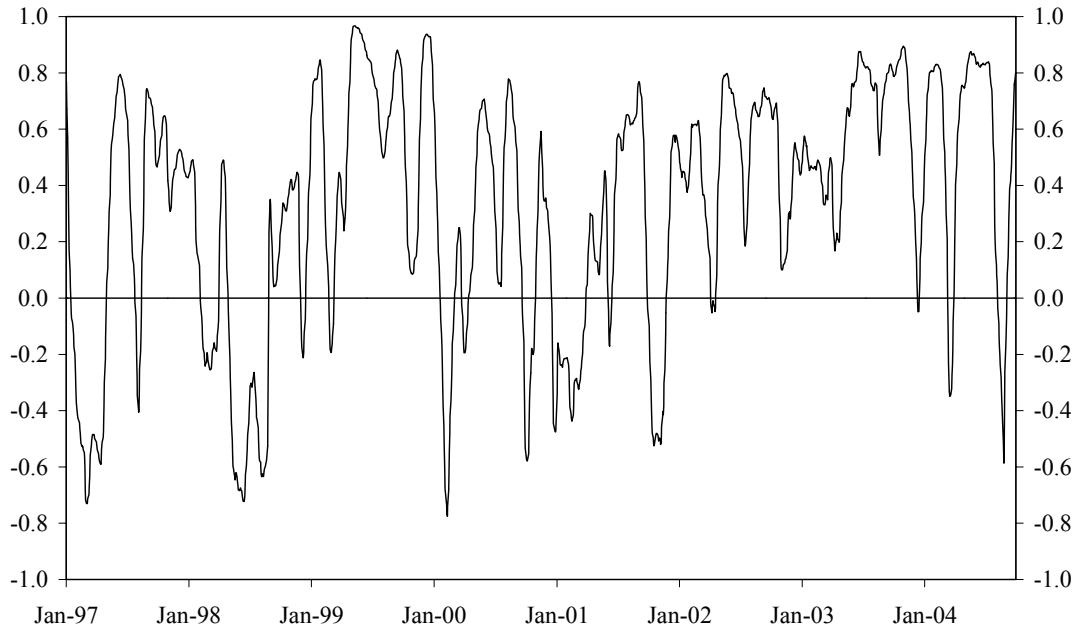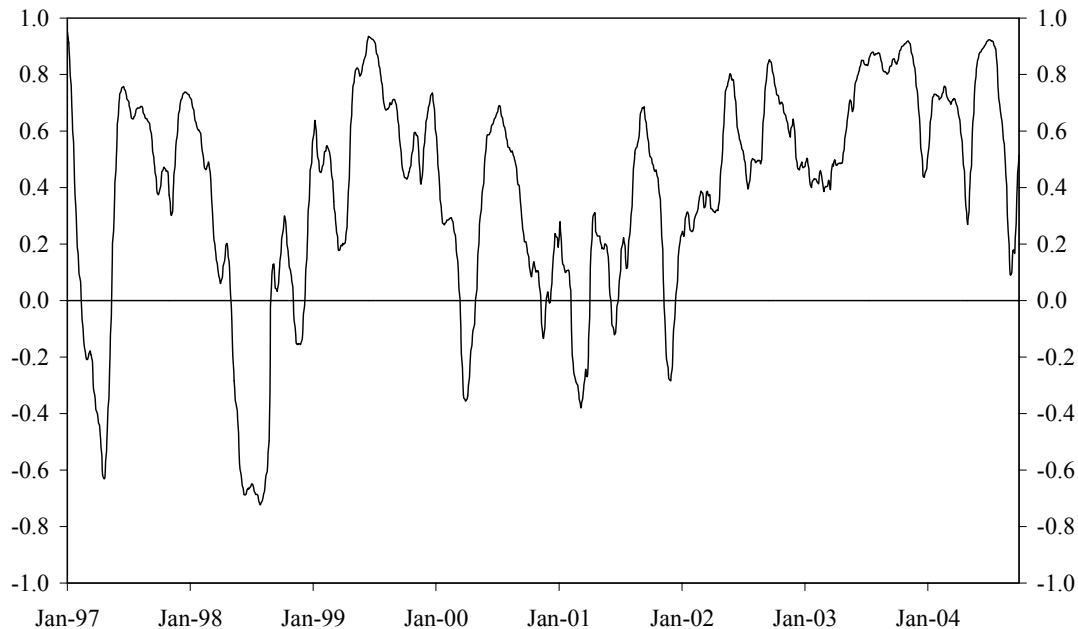Open Interest (in value) and Cash Market Turnover**

**Chart 3: 90-day Rolling Correlation Coefficient between
Open Interest (in value) and Cash Market Turnover**


3.   Correlation between Open Interest and Short Selling Turnover

        Short selling of HSI constituent stocks in the cash market and the short
selling of HSI futures contracts were an integral part of the speculative attacks against
the Hong Kong dollar in June and August of 1998. During that episode, the HSI fell

significantly and the open interest recorded sharp increases. Short selling activities in the cash market also rose considerably from an average of around HK$150 million during February-April 1998 to HK$400 million during April-June 1998. The daily short selling turnover increased significantly in late August 1998, reaching a record high of HK$9 billion on 28 August 1998, or equivalent to 11% of the total cash market turnover on the same day (see Chart 4).

A similar correlation analysis is conducted on the relationship between open interest in the futures market and short selling turnover in the cash market. However, the resulting rolling correlation shows no clear pattern (see Annex V).

Chart 4: Open Interest (in value) and Short Selling Turnover in 1998
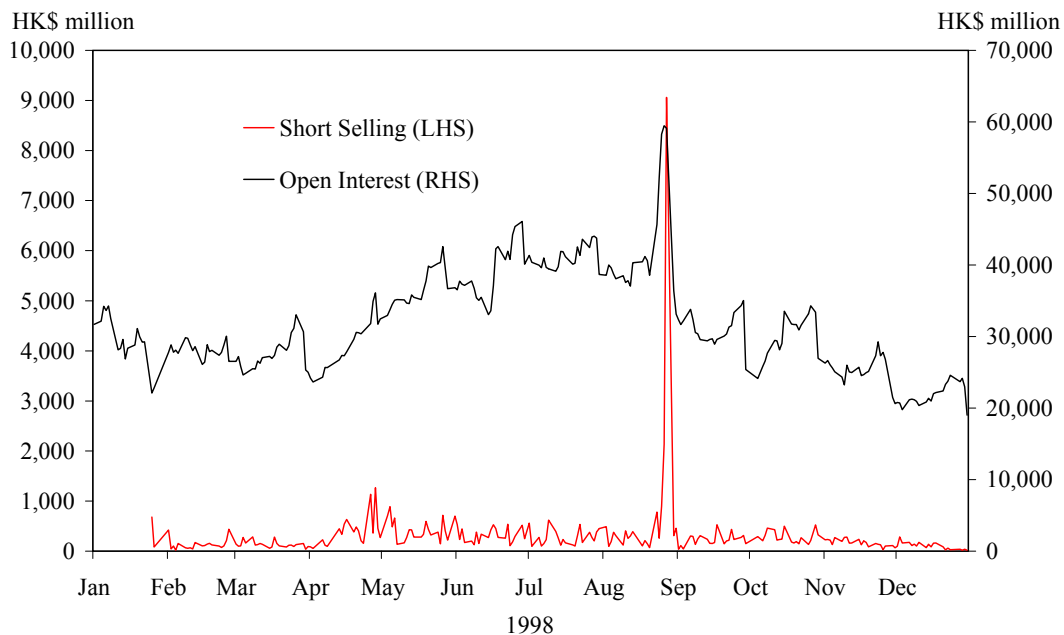
4.   Open Interest, HSI Volatility and the Level of HSI

Intuitively it is perceived that high volatility in the cash market may generate more needs for investors to hedge using the futures market, therefore causing the open interest positions in the futures market to go up. In the case of US, there is some preliminary evidence that this is true.[6] We have carried out a preliminary examination on this based on a regression analysis with open interest as the dependent variable, and cash market turnover, cash market volatility and the level of HSI as independent variables. The cash market volatility is measured by a 30-day standard deviation of values of HSI. No such conclusion can be drawn from Hong Kong's data. When the volatility measure is changed to a 30-day standard deviation of daily percentage changes of HSI, the conclusion that there is no clear relationship between volatility and open interest positions remains the same. Regarding the relationship

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[6]   Chen, N. F., Charles J. Cuny and Robert A. Haugen (1995), "Stock Volatility and the Levels of the Basis and Open Interest in Futures Contracts", *Journal of Finance*, 50, 281-300.

between open interest and cash market volatility, more thorough research may need to be done. The regression results are not reported here.

As for the relationship between open interest and the HSI level, in general, a high level of HSI itself can go with either high or low open interest positions in the futures market. Although a continuing increase of HSI to a high level over a short period may raise the needs of hedging, and may therefore generate a higher open interest. Empirically, based on a regression with the open interest as the dependable variable, the level of HSI as the independent variable, no relationship has been found between the level of HSI and the open interest in the futures market in Hong Kong.[7]

III. "ADJUSTED" OPEN INTEREST INDICATORS

In view of the observed trend growth in open interest and the positive relationship between open interest and cash market turnover, two "adjusted" open interest indicators are developed in this section, which can supplement the "raw" open interest position and other available market statistics in monitoring cash market activities.

1.   Decomposition of Open Interest

In order to look at the fluctuation of the open interest position, the actual data series is decomposed into a trend component and a de-trended component. The de-trended component is the actual data series minus the trend. The idea is to see whether the increase in open interest is due to a general trend or some short-term shocks to the futures market. The de-trended open interest position can be used to indicate short-term shocks that could be due to excessive speculative activities. The trend itself could be caused by fundamental factors such as a growth in investor base, or a general increase in the appetite for risk. It is unlikely that speculators' would take such a long-term horizon to implement their trading strategies. The volatile part, which is the de-trended series, is therefore the focus of this study.

Chart 5 plots the de-trended series together with the plus and minus two-standard deviation lines. The series is de-trended using LOWESS method. The standard deviation is calculated using the actual data. It is the past 250-day moving standard deviation. This decomposition does identify the exceptional period prior to the 1998 episode, when the de-trended open interest position was persistently far outside a range of two standard deviations.[8, 9]
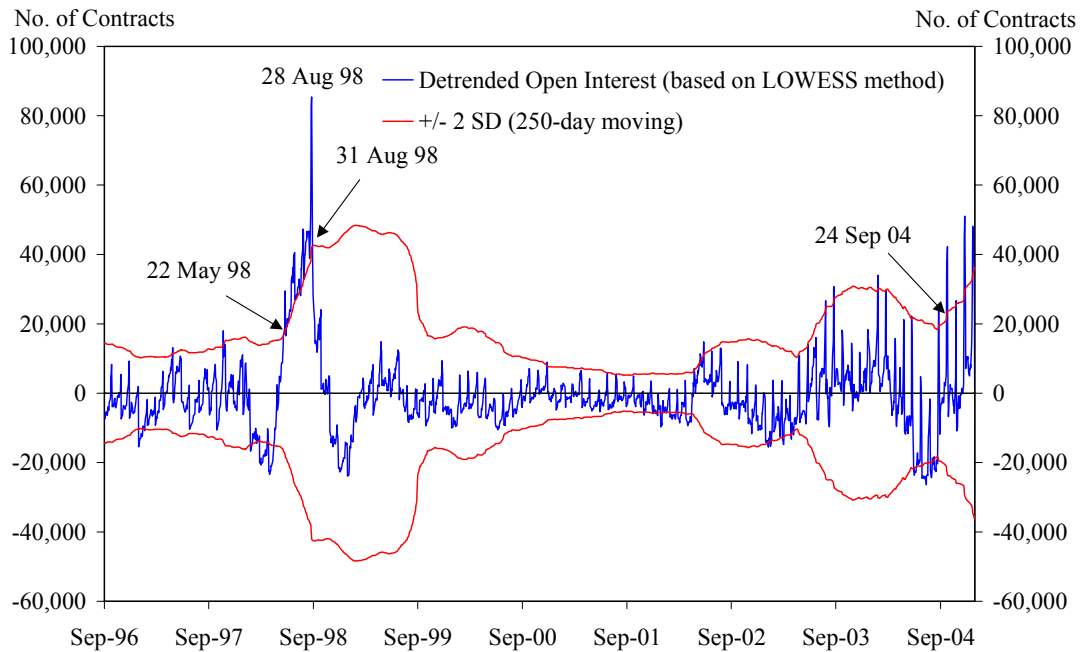
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[7]   To take into consideration of unit roots, the first difference of both variables are used.

[8]   The trend line is calculated using Locally Weighted Scatterplot Smoothers (LOWESS). See Bianchi, M., Martin Boyle and Deirdre Hollingsworth (1999), "A Comparison of Methods for Trend Estimation", *Applied Economic Letters*, 6, 103-109.

[9]   Some other de-trended methods, such as the 250 days moving average, have also been used. However, similar to the raw data of open interest, they fail to distinguish the 1998 episode and a number of other occasions of high open interest during the periods from mid-April 2002 to December 2004 in which no substantial speculative activities could be identified.

The recent trend of increase in open interest started in early 2001. Since then the de-trended component has been generally within the range of two standard deviations. From late September 2004 onwards, the level of open interest rose out of the range on a few occasions. While the rises were sharp, the levels of open interest quickly returned back within the range. These observations show that the de-trended open interest position could be a useful indicator for monitoring speculative activities in the futures market.

Chart 5: Decomposition of Open Interest

By LOWESS Method

No. of Contracts   No. of Contracts

Detrended Open Interest (based on LOWESS method)

+/- 2 SD (250-day moving)

28 Aug 98

31 Aug 98

22 May 98

24 Sep 04

Sep-96 Sep-97 Sep-98 Sep-99 Sep-00 Sep-01 Sep-02 Sep-03 Sep-04

2.   The Ratio of Open Interest to Cash Market Turnover

The second "adjusted" indicator is the ratio of open interest to cash market turnover. Chart 6 shows the rolling ratio of monthly maximum open interest to average daily cash market turnover of that particular month, both in value terms. This ratio in general is within a range of 2 to 6. However, during the period prior to the speculative attack in 1998, the ratio was far outside the range. The highlighted point on the dashed line is the ratio of a month and a half before the government's stock market operation. Since July 2004, this indicator has been higher than 6, but remained significantly lower than the figures in the 1998 episode.

Exceptional value may indicate something abnormal. For monitoring speculative activities, any exceptional value of the ratio thus deserves attention of the policy makers.

**Chart 6: Ratio of Open Interest (Monthly Maximum)
to Cash Market Average Turnover**
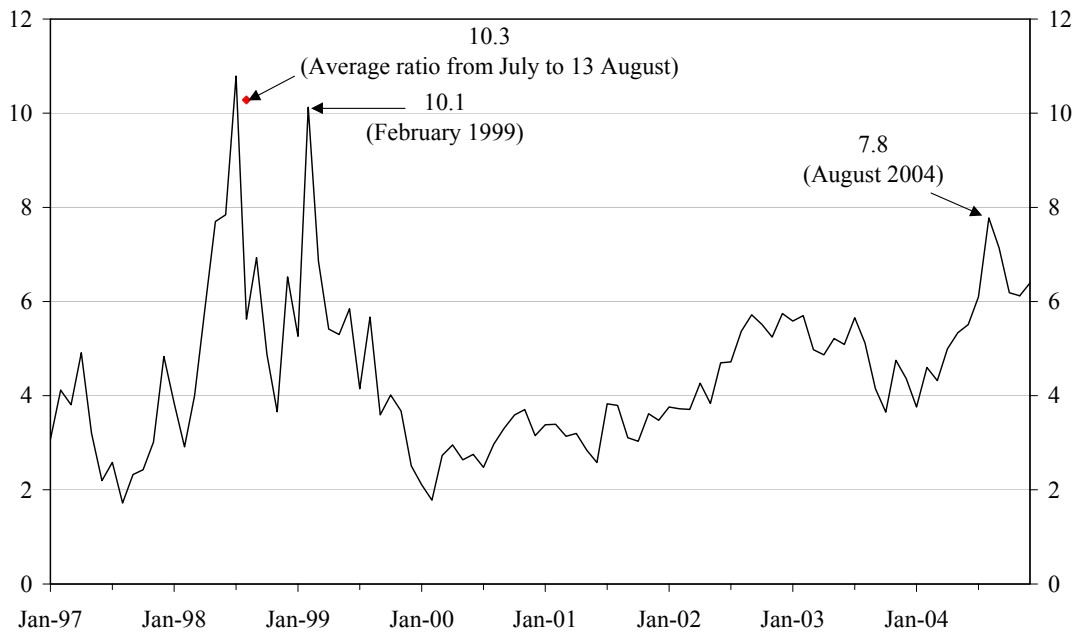
Note: The sharp rise in the ratio to 10.1 in February 1999 was due to a significant drop in market turnover during the month. The maximum open interest was at a moderate level of around 63,000 contracts.

IV. CONCLUSION

In general, it is found that open interest and cash market turnover are positively correlated. The level and volatility of HSI are however not statistically significant in explaining the recent increase in open interest. No clear relationship between open interest and short selling turnover can be established. The feedback between open interest and cash market turnover seems to occur in both directions.

The de-trended open interest position and the ratio between open interest and cash market turnover are two "adjusted" open interest indicators that provide a tool to look at the level of open interest with reference to trend growth and cash market developments. Although the construction of these "adjusted" indicators are not founded on complete economic analysis, they could supplement the open interest position and other raw data in monitoring stock market activities.

In assessing the few rounds of sharp rise in open interest during late September and the fourth quarter of 2004, it is found that the levels of the two "adjusted" indicators were relatively high. However, comparing with the situation prior to the 1998 episode, both indicators do not appear to be as alarming as the raw data would have suggested.

These two indicators could be monitored on a regular basis together with the actual data. However, in view of the lack of a structural model, the role of market intelligence in monitoring market developments remains critical.

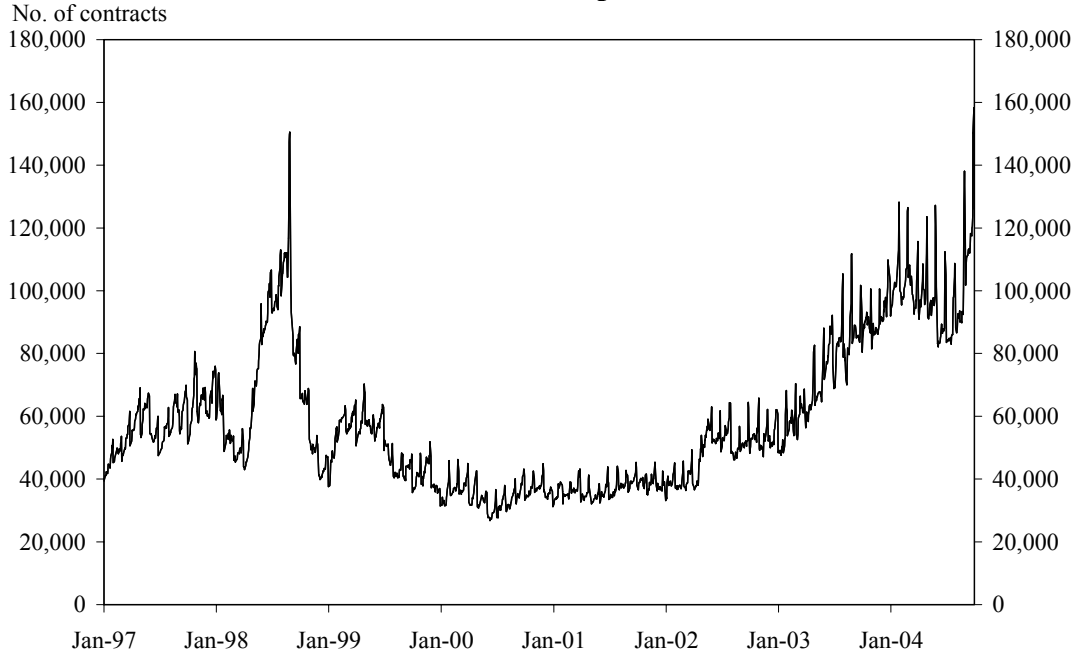**Charts of Historical Data**
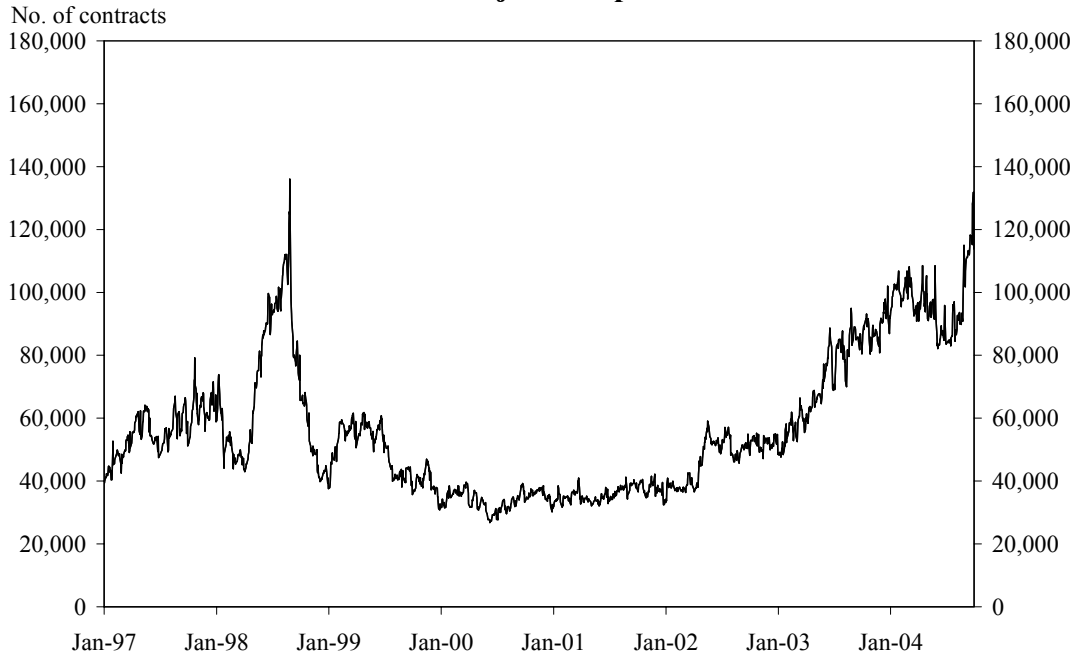
Chart A1: Actual Open Interest

No. of contracts

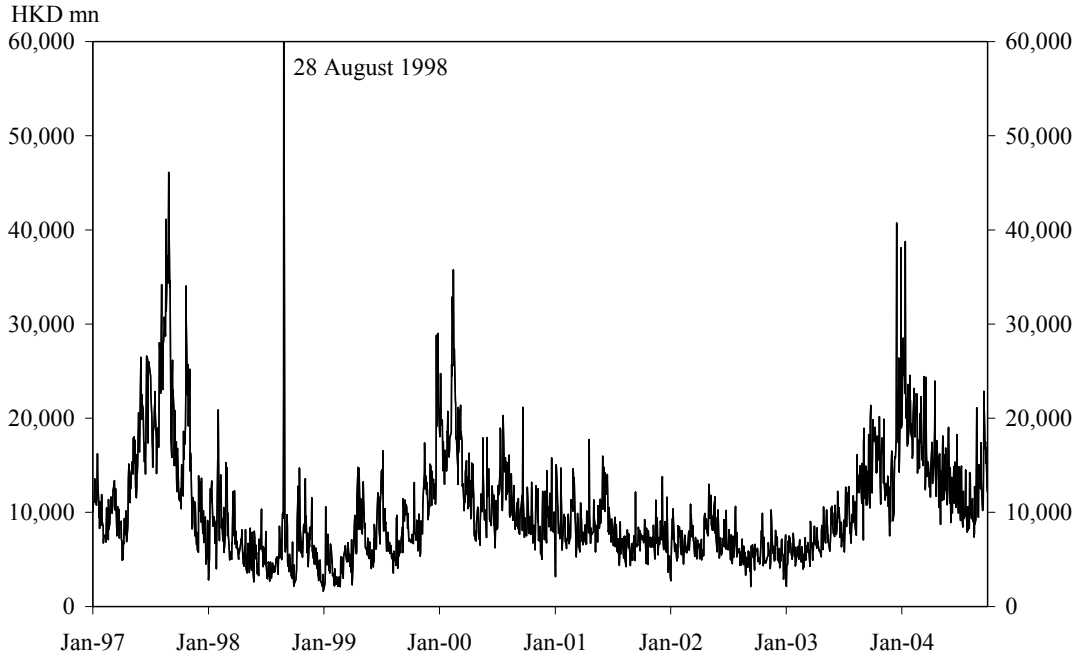**Chart A2: Adjusted Open Interest**

No. of contracts

Chart A3: Actual Cash Market Turnover Value

HKD mn

28 August 1998

Note: Cash Market turnover amounted to HK$79 billion on 28 August 1998.

Chart A4: HSI

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<div align="right">**Annex II**</div>
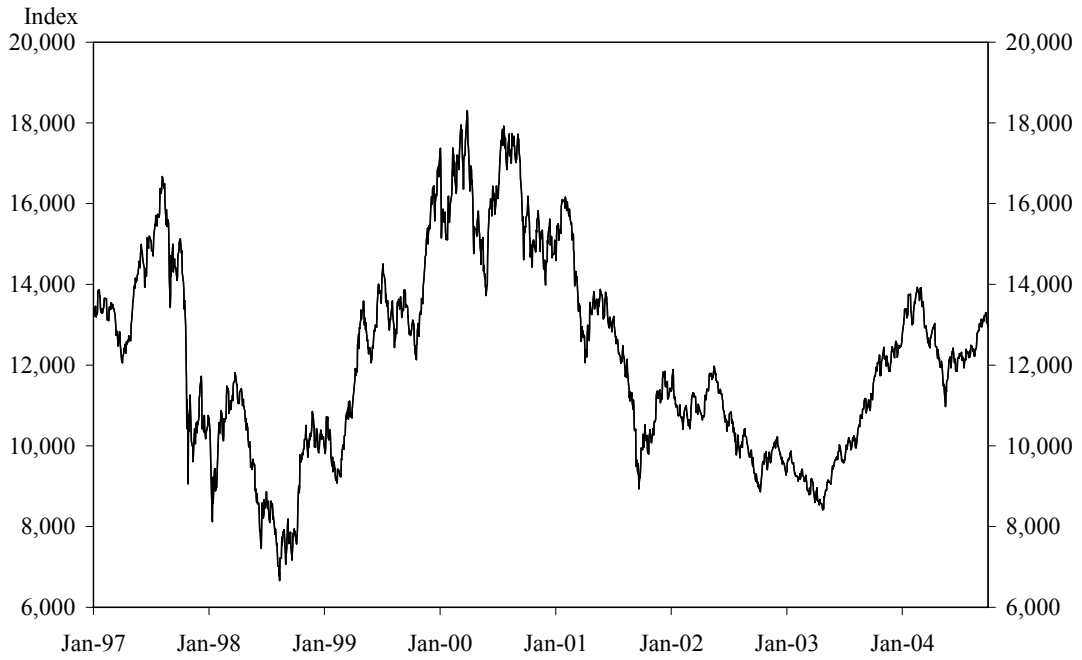
Removing Calendar Effects from Open Interest and Cash Market Turnover

a)   End-of-month effects on open interest

Hong Kong's historical data show that the number of outstanding futures contracts tends to change sharply as the contracts approach maturity. This part provides a preliminary study of how the volume of the open interest changes as the expiry date of the contract of the Spot Month is approaching.

Let F_t denote the open interest position at day t, and d_j denote a variable that takes value zero on all days except on the j-th day before the maturity of the Spot Month contract. Consider next the following equation:

(1) $\ln(F_t) = \alpha + \beta_0 d_0 + \beta_1 d_1 + ... + \beta_n d_n + \varepsilon_t$

where ε_t denotes a residual. The "normal" level of the index is given by α. Under this interpretation, the "normal" level of j days before the Spot Month contract expires is given by $\alpha + \beta_j d_j$. Thus, the β_j captures the extent to which the level of open interest deviates from the normal level as the expiry date approaches.[10]

Since preliminary work suggests that the end of the month effect is only operative during the last 6 days of the month, n is set to the value of 5. By subtracting the estimates of $\hat{\beta}_0 d_0 + \hat{\beta}_1 d_1 + ... + \hat{\beta}_5 d_5$ from the logarithm of the open interest, we can adjust the data to control for the part due to the approaching maturity date.

b)   End-of-year effects on cash market turnover

Using a similar method, the end of the year effect in the cash market turnover is adjusted, since holiday vacation causes the low turnover in the cash market.

Let V_t denote the cash market turnover at day t. Let d_j denote a variable that takes value zero on all days except on the j-th week before the end of the year. Consider next the following equation:

(2) $\ln(V_t) = \alpha + \beta_1 d_1 + ... + \beta_n d_n + \varepsilon_t$

where ε_t denotes a residual. The "normal" level of the turnover is given by α. Under this interpretation, the "normal" level j weeks before the end of the year is

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[10]   Since the data are measured in logarithms, the estimated βs can be interpreted as measuring by how many percentages the outstanding interest rise towards the end of the month.

given by $\alpha + \beta_j d_j$. Thus, the β_j captures the extent to which the level of cash market turnover deviates from the normal level as the year-end approaches.[11]

Since preliminary work suggests that the end of the year effect was only operative during the last 2 weeks of the year, n is set to the value of 2. By subtracting the estimates of $\hat{\beta}_1 d_1 + \hat{\beta}_2 d_2$ from the logarithm of the cash market turnover, we can adjust the data to control for the part due to the approaching of the end of the year.

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[11] For example, the first week from the year-end refers to the last five trading days of the year while the second week refers to the period of the last sixth trading day up to the tenth trading day of the year.

<div align="right">**Annex III**</div>

<div align="center">**Exponential Smoothing**</div>

The presence of transient noise in financial data complicates the understanding of the underlying relationships among financial variables. In this study, a simple exponential smoothing method based on Cogley (2002) is employed for filtering both the open interest and the cash market turnover to remove the transient noise.[12]

Technically, the exponential smoothing method used to reduce noise in the data is based on the following algorithm:

$$d_t^a \;=\; d_{t-1}^a + g_0 * \left(d_t - d_{t-1}^a \right)$$

where d_t^a is the adjusted data at time t after smoothing and d_t is the actual data at time t. The smoothing parameter (g_0) governs the rate at which the algorithm adapts to the shift in the data. In this study, the parameter is set at 0.23 (i.e. ln(2)/3), so that it will take approximately 3 periods (i.e. days) to complete half of the adjustment for any unit shift in the data.

Despite its simplicity, this method is found to have some desirable properties. First, the exponential smoother well approximates an ideal low-pass filter for suitable choices of g_0 as the filter removes high-frequency components of the data and passes those at low frequencies. Second, unlike many other approximations to low-pass filters, this filter is one-sided into the past and thus can be implemented in real time when new data is available.

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[12] Cogley, Thomas (2002), "A Simple Adaptive Measure of Core Inflation", *Journal of Money, Credit, and Banking,* 34, 94-113.

Empirical Tests of the Causal Relationship between
Open Interest and Cash Market Turnover

The Granger (1969) approach to the question of whether x causes y is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation.[13] y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on the lagged x's are statistically significant. Note that two-way causation is frequently the case; x Granger causes y and y Granger causes x.

It is important to note that the statement "x Granger causes y" does not imply that y is the effect or the result of x. Granger causality measures precedence and information content of the two variables. In other words, it tests if the past value of one variable has explanatory power to the present value of the other variable. It does not by itself indicate that one variable causes the other variable in the common use of the term. It uses the lagged value of both variables as independent variables when the regression is run.

Table A1 reports the results of the Granger causality test. The test is performed on the non-adjusted data of open interest (as measured by the number of contracts outstanding) and the cash market turnover (as measured by the number of shares).[14] For the daily percentage change, no Granger causality in either direction is found with one lag. However, Granger causality appears to happen in both directions when the number of lags increase to three. The results show that it is not clear that the high volume of cash market turnover can explain the high volume of open interest in the futures market, and vice versa.

TABLE A1: GRANGER CAUSALITY TESTS

Variables:	Percentage Change of Open Interest (Open Interest)		
	Percentage Change of Cash Market Turnover Volume (Turnover)		

	1 lag	p-value 2 lags	3 lags
Null Hypothesis			
Open Interest does not Granger Cause Turnover	0.38	0.00*	0.00*
Turnover does not Granger cause Open Interest	0.21	0.28	0.04*

Note: Sample period spans from 9 August 1994 to 28 September 2004.
     * denotes coefficient significant at the 5% level.

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[13] Granger, C. W. J. (1969), "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods", *Econometrica,* 37, 424-438.
[14] The test with the adjusted data shows similar results.

Table A2 reports the results of the first regression. It is initially run with open interest as the dependent variable, the cash market turnover and the HSI as independent variables. All data are transformed to daily percentage change to take into account the non-stationary in open interest series and HSI. The estimated coefficient of the change of HSI is not significant. Then the regression is re-run with the HSI variable dropped, the estimated coefficient of the change in cash market turnover has a positive sign and is significant, although its magnitude is only 0.02.

Table A2: Regression Results

Dependent Variable: Percentage Change of Open Interest

Explanatory Variable

Constant	0.00
	(0.76)
Percentage Change of Cash Market Turnover Volume	0.02*
	(3.66)
Adjusted R-squared	0.01
S.E. of regression	0.05

Notes: Sample period spans from 9 August 1994 to 28 September 2004.
             t values are in brackets.
             * denotes coefficient significant at the 5% level.

To confirm that the causality is not clear in either direction, another regression is run with the cash market turnover as the dependent variable, the open interest as the independent variable. Again daily percentage changes of both variables are used. The estimated coefficient of open interest is significant with a positive sign (see Table A3).

Table A3: Regression Results

Dependent Variable: Percentage Change of Cash Market Turnover Volume

Explanatory Variable

Constant	0.00
	(0.33)
Percentage change of Open Interest volume	0.34*
	(3.75)
Adjusted R-squared	0.01
S.E. of regression	0.23

Notes: Sample period spans from 9 August 1994 to 28 September 2004.
             t values are in brackets.
   * denotes coefficient significant at the 5% level.

The Correlation between Open Interest and Short Selling Turnover

Rolling correlation coefficients of the adjusted open interest (in value terms) and the short selling turnover are computed under a 30-day, 60-day and 250-day window, respectively, over the period from January 1998 to September 2004. In all cases, the pattern of resulting rolling correlation is not clear (see Charts A5 to A7).

**Chart A5: 30-day Rolling Correlation Coefficient between
Open Interest (in value) and Short Selling Turnover**
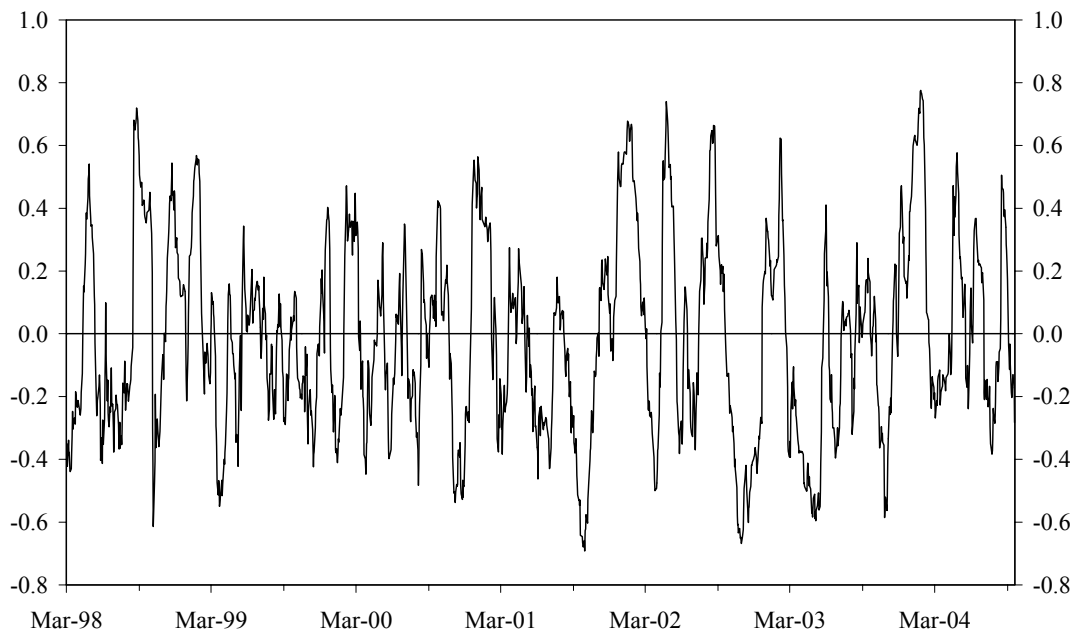
**Chart A6: 60-day Rolling Correlation Coefficient between
Open Interest (in value) and Short Selling Turnover**
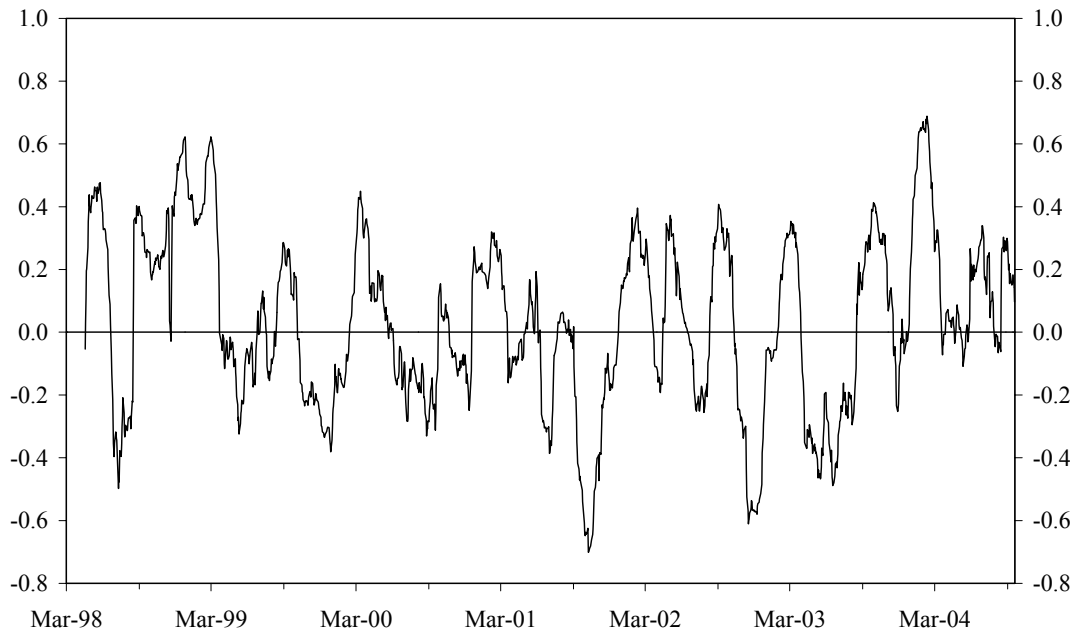
**Chart A7: 90-day Rolling Correlation Coefficient between
Open Interest (in value) and Short Selling Turnover**