A TAIL INDEX TOUR ACROSS FOREIGN EXCHANGE RATE REGIMES IN TURKEY

Abstract

It is by now generally accepted that foreign exchange returns exhibit “heavy tails” as measured by the well-known tail index. Applications of extreme value analysis typically assume the tail index to be constant. However, numerous switches in foreign exchange regimes in recent history - especially within emerging markets such as Turkey- raises doubts over this constancy assumption. The purpose of this paper is three-fold: first, using the Turkish exchange rate returns, the tests developed by Quintos, Fan and Phillips (2001) are applied to both full sample covering all regimes and separately to subsamples representing fixed and float regime periods for testing and dating the breaks in tail index. Second, signaling capacity of these tests for predicting crises is investigated. Third, estimated tail index values and test statistics under fixed and float regimes is compared against their theoretical behavior. The estimation results reject the constancy assumption of the tail index both for the full sample and subsamples separately, indicating time varying behavior not only across but also within the fixed and float regime periods. However, there is weak support for any association of the change in tail behavior with any exchange regime switch. At least one of the tests successfully signals the increasing risk preceding the two financial crises. On the other hand, tail index plots generally support the theorized behavior under fixed and float regimes.

Key words: Tail index, exchange rate regimes, and structural breaks.

JEL Classification: F31, G15, G19, C49.

The purpose of this study is to investigate the behavior of the Turkish exchange rate returns by focusing exclusively on their extreme movements across various exchange rate regimes. Extreme theory incorporates specialized techniques to measure the probability of occurrence of large jumps in financial time series. Since extreme observations are concentrated in the tails of the distribution from which these observations come from, a method frequently applied is the tail index. Empirical studies of extreme movements using tail index in foreign exchange markets are numerous. Among them, notably Koedjik et al. (1990), Hols and de Vries (1991), Koedijk, et al. (1992), Koedijk and Nieuwland (1995) have investigated the tail behavior of the empirical distribution of foreign exchange rate returns and also analyzed the stability of the distributions across different exchange rate regimes. Dacarogna et al. (1998), on the other hand, conducted similar work using high frequency or tick-by-tick foreign exchange series. The general finding from these papers is that exchange rate returns are fat tailed but also exhibit different tail behavior under fixed and float exchange rate regimes. All these studies suggest that any empirical study covering different exchange rate regime periods should take the tail behavior differences into consideration.

Despite numerous theoretical and empirical investigations about the exchange rate tail behavior made for both developed and emerging markets, the studies exclusively dealing with the statistical properties of the Turkish foreign exchange returns are rather limited to the study of Akgiray (1990). Although, his work is unique, it is by now dated and did not make use of the tail index. Frequently investigated issues about the exchange rate behavior about the Turkish experience have generally been related with either its volatility behavior and/or its relationship with the fundamentals. Some examples include Aysoy et al. (1996), which studied the daily volatility in the Turkish foreign exchange market. The study by Berument (2002) investigated the link between exchange rate movements and the inflation dynamics. Guimaraes and Karacadag (2004) studied the empirics of foreign exchange rate intervention in Turkey, particularly in terms of its effect on volatility. Duttagupta, Fernandez and Karacadag (2004) discussed the operational aspects of moving from pegged to floating exchange rate citing Turkey among other countries used in their study. A recent treatment is by Selçuk and Ardıç (2004), which examine the interaction between the exchange rate and its volatility and the Central Bank policies in the float period.

The present study attempts to provide substantial further evidence on the effects of changes in foreign exchange rate regimes, for several reasons. First, by concentrating on the overall characterization of the tail of the return distribution rather than on volatility measures, the results are focused on extreme events; we are able to examine the evolution of this measure of extreme behavior over time and across different foreign exchange rate regimes. Second, by conducting these tests first for the whole historical sample without dividing it in subsamples and then using subsamples of fixed and float regime periods separately, we not only address the issues of pre-testing problems and sample splitting but also separate tail behavior under the float and fixed periods to better trace the effects of the economic developments within these regimes at the same time. Tail index, just like volatility, can be a risk indicator. However, unlike volatility, which uses all of the observations, tail index is constructed from the observations in the tails of the distribution as noted above. Under the assumption of time varying tail index, the values of the tail index can be used as a useful early warning tool for an increasing likelihood of an approaching currency crisis.[1] Therefore a second objective of this study is to asses to which extent tail index could be utilized in predicting the two currency crises in Turkey. A third question of interest is that whether we can detect attenuating influences on extreme behavior during the float period that followed the 2001 crisis.

The paper proceeds as follows: In the next section the description of the tail index, Hill estimator and QFP tests are presented. This will be followed by a tabular chronology of the foreign exchange rate regimes and related developments. The data, descriptive statistics of foreign exchange returns, estimation results and their interpretation are given in the fourth section. Section five concludes.

Inferential Methods

A well-known measure of the tail index is the Hill estimator. This is based on the *m* largest order statistics of the sample. Following the notation of Quintos et al., define the order statistics from the original sample $\{X_1, X_2, \ldots X_T\}$ as $\{X^T_{(1)}, X^T_{(2)}, \ldots X^T_{(T)}\}$, such that $X^T_{(1)}<X^T_{(2)}< <X^T_{(T)}$. In the present problem {Xi} = {Fx}, the set of daily TL/USD returns. Choose the largest m_T of these, $X^T_{(T-mT+1)}$ to $X^T_{(T)}$, for estimation on the right tail of the distribution (for the left tail, multiply the smallest m_T values by -1). The Hill estimator of *α* is then

$$\hat{\alpha}_{\mathbf{T}} = \left[\mathbf{m}_{\mathbf{T}}^{-1} \sum_{\mathbf{j}=1}^{\mathbf{m}_{\mathbf{T}}} (\ln \mathbf{X}_{(\mathbf{T}-\mathbf{j}+1)} - \ln \mathbf{X}_{(\mathbf{T}-\mathbf{m}_{\mathbf{T}}+1)} \right]^{-1} \tag{3}$$

Estimation of the tail index parameter generally requires a relatively large sample, because only a small proportion of the sample occurs, by definition, in the tails; it is common in estimation to use a proportion such as 10% of the sample size, following DuMouchel (1983) who suggested that m_T be a fixed proportion not exceeding 0.1T. All sequences of tail index estimates in the present paper are based on the Hill estimator, and vary only in the definition of the sample used for estimation.

From the formula in (3) it can be the easily inferred that higher values of α imply low risk and lower values imply high risk. The general finding from the papers mentioned in the previous section is that exchange rate returns are fat tailed but with $\alpha<4$ and, during a variety of fixed exchange rate regimes, have tail indices that are in the region $1<\alpha < 2$. For floating rate regimes, however, α tends to exceed 2, which is interpreted as suggesting that a float lets exchange rates adjust more smoothly than regimes that involve some amount of fixity. Therefore, empirical studies involving a variety of regimes should allow time varying behavior and structural breaks across different exchange rate regimes. The tests developed by Loretan and Phillips (1994), typically assume for example, that the breakpoint is known a priori.

A practical problem frequently encountered is the unequal number of observations across different regimes if sample is divided in subsamples to allow structural change with unknown breakpoints. In case of no sample splitting to circumvent the problem, the constancy of tail index is implicitly assumed and may lead to erroneous results by not allowing time varying behavior if it exists. In case of sample splitting, this implies exogenously determining time(s) of structural changes. Sample splitting however, apart from imposing a known breakpoint, has the risk of introducing pre-testing bias and is subject to known critics (Christiano, 1992). Using the tail index of returns on foreign exchange rate as a summary measure of extreme behavior, recently-developed tests for the null of constancy of the tail index, versus the alternative of a change at an unknown date, permit inference on changes in extreme behavior over a long time period while allowing for second-moment dependence in the return data. The recursive, rolling and sequential tests developed by Quintos, Fan and Phillips (2001) is one popular example. A major advantage of the QFP tests for structural change is that as they do not require a priori specification of a break point, they allow possible structural breaks in the Hill estimator by endogenizing the break dates, therefore pre-testing bias can be eliminated. Further, these tests can be modified to incorporate Hsing's (1991) results to allow for the ARCH-type dependence present in such data.

The structural change tests of Quintos et al. (2001) are based on the sequences of tail index estimates. The null hypothesis is that the tail index has the constant value α over the real interval $t \in [t_0, T - t_0]$, with alternative of departure from α at some point in the interval, and is tested with sequences of estimates defined over different sets of samples. Recursive estimates produce a sequence of estimates α_t using samples 1,.. t, for t = t_0, t_0 +1,.. T - t_0. Rolling estimates use samples 1+ (t-t_0), . . . t, with t indexed over the same values, for a constant sample size t_0 $\equiv\gamma T$. In other words, in recursive estimation, a sequence of estimators is presented in which the sample size is augmented at each date by the latest data point. In rolling estimation, a fixed sample size is maintained by dropping the earliest data point each time a new data point is added. The sequential tests use both a recursive set of estimates and a reverse recursive set, labeled $\alpha_t^{(-)}$, defined over samples 1, . . . t and t+1, . . .T respectively, where once again t indexes the values t_0, t_0 + 1, . . .T - t_0. The test statistics based on these estimates are given as (in a slightly modified notation):

$$Z_1^2(t) = \left(\frac{tm_t}{T}\right)\left(\frac{\hat{\alpha}_t}{\hat{\alpha}_T} - 1\right)^2 \tag{4}$$

$$Z_2^2(t) = \left(\frac{t_0 m_0}{T}\right)\left(\frac{\hat{\alpha}_{(t_0,t)}}{\hat{\alpha}_T} - 1\right)^2 \tag{5}$$

$$Z_3^2(t) = \left(\frac{tm_t}{T}\right)\left(\frac{\hat{\alpha}_t}{\hat{\alpha}_t^{(-)}} - 1\right)^2 \tag{6}$$

where $\hat{\alpha}_t$, $\hat{\alpha}_{(t_0,t)}$ and $\hat{\alpha}_t^{(-)}$ are the recursive, rolling and sequential tail index estimates with 't ' and 'm' being the corresponding sample size and truncation point respectively. The test statistics are sup Z^2_i (t), i = 1, 2, 3, and in the IID case have asymptotic distributions obtained and tabulated by Quintos et al. (2001).

There are several additional points to be considered for these foreign exchange data. First, the recursive test is consistent only against increases in tail thickness (decrease in α) beyond the breakpoint, and inconsistent in one direction. This is a consequence of the fact that a part of the sample with thick tails dominates in estimation of α. The rolling and sequential tests however, are consistent in both directions. There is no reason for us to hypothesize, a priori, a thick tail alternative across a variety of exchange rate regimes. Consequently recursive estimation is not utilized in this study.[3] Second, the foreign exchange returns data that we examine here is not IID, but displays second-moment dependence often modeled, for example, with GARCH processes. Quintos et al. provide modified versions of the test statistics using the results of Hsing (1991) for dependent processes, applying these to the squares of the logarithmic returns.[4]

Review of the Foreign Exchange rate regimes in Turkey

The table shown below is compiled from various sources which are, in no way, exhaustive . Among them, notably are Keyder (2000), Özatay and Sak (2002), Ertuğrul and Selçuk (2001), Selçuk (2003), Selçuk and Ardıç (2004), Bubula et al, (2003) and CBT press announcements. The dates given not only identify exchange rate regimes but also summarize important exchange rate related developments.

Date	Events
1980	Inception of financial liberalization program. Devaluation of TL by 48.6% and the determination of exchange rates by daily adjustments in parallel to the purchasing power parity[3].
1987	Increasing gap between official and black market foreign exchange rates due to negative real deposit interest rates in domestic currency resulting in a sharp depreciation of the TL vis-à-vis foreign currencies.
1988	The growing volume of transactions both in the stock exchange and foreign exchange markets creating liquidity surplus thus causing imbalances in the financial markets. Consequence: Mini crises by 1988.
1988	Abandonment of the daily adjustment system
1989	CBT switch to **managed float** system by changing its foreign exchange policy. The equilibrium exchange rate to be set according to demand-supply interactions and CBT would only intervene in the event of unexpected sharp swings[5]. This system remained in effect between 1991 and 1993.
1991	Gulf Crisis. Withdrawal of foreign exchange deposits from the banks
1992	Tight monetary policy and CBT's effort to contain volatility in the foreign exchange market and maintain the foreign exchange rate increases below inflation rate by intervening directly. Appreciation of the TL.

1993	Fall in the interest rates curbing attractiveness of the TL. Reversal of the Capital flows.
1994	Failure of the three devaluations in the first half of the 1994 to stop the short-term capital flight leading to a substantial exchange rate crisis in early 1994. On March 1994, CBT abandons its interventionalist policy and gradually devalue the Turkish Lira[6]
1995	Adoption of the crawling band regime. The predetermined foreign exchange rate was to be kept under the inflation rate with monthly adjustment ensuring this.
1997	**The Asian Financial Crisis**
1998	Abandonment of the foreign exchange interventions as a policy tool in controlling money supply in favor of targeting the growth rate of net domestic assets.
1998	**Financial Crisis in Russia**
1999	Launch of a stand-by agreement with the IMF aiming at reducing inflation. The main tool of disinflation program has been adoption of a crawling peg regime; i.e., the percent change in the TL value of a basket of foreign exchanges (1 US dollar plus 0.70 euro) was fixed for a year and half period.
2000	In January 2000, launch of a new system based on the pre-announcement of the foreign exchange band. The new practice is based on the follow-up of the net domestic assets within the framework of the exchange rate policy while maintaining an upper limit for net domestic assets and at the same time, a lower limit for net international reserves. Thus CBT commits itself into purchasing all the foreign currencies on offer at the pre-announced rate.
2000	The second crisis was preceded by a financial turmoil that burst in the second half of November 2000 just at the midst of an exchange rate based stabilization program.
2001	The prime minister announced that there was a severe political crisis that ignited a crisis in the highly alerted markets due to what had happened at the end of the preceding year. On that day the overnight rates jumped to unprecedented levels of 6200 percent in uncompounded terms. Three days later, the exchange rate system collapsed and Turkey declared that it was going to implement a floating exchange rate system from that time onwards.[7]
Post 2001	CBT stressed that it would stick to the floating exchange rate system and the volatility of the nominal exchange rate will be of concern rather than its level of direction. Central Bank conducted several selling auctions. In fact, during the early stages of the float regime between March 29, 2001 and November 30, 2001, all interventions were in the form of selling auctions. All other episodes of preannounced interventions had been in the form FX buying auctions. [8]

Data and Empirical Results

Tail index estimation is usually based only on data from the tails of the empirical density, thus very large samples are typically required in order to obtain reliable estimates. As far as the availability of abundant data is concerned, the full historical sample and fixed regime subsample present no problem. The float regime subsample, although contains much less observations, can also be used separately with QFP tests.

Figure 1a-1b-1c here

The foreign exchange return is calculated as log (p_t/p_{t-1}) from the daily TL buying price of the U.S dollar taken from Central Bank of Turkey data dissemination server. The full historical sample period covers the period between 28.01.1980 - 14.10.2004 spanning various variants of the pegged foreign exchange regime as well as the float period in effect since 2001 February. The fixed regime subsample covers 28.01.1980 - 21.02.2001 periods. The float regime covers 23.02.1980 - 14.10.2001 period.

Table 1a-1b-1c here

Prior to tail index estimation some descriptive statistics and plots of the foreign exchange returns for the full sample and subsamples are presented. As expected, the distribution of the returns are nonnormal, highly leptokurtic and skewed, although with varying degree over the full sample and subsamples (Table 1a-1b-1c). The plots of the full sample as well as fixed and float period subsamples are shown in figures 1a-1b-1c. The largest jump in the returns that occurred in February 23, 2001 is quite visible. This date also marks the switch to the floating exchange rate regime. Another large jump observed represents the 1994 devaluation of the Lira. The plot for the float period indicates that the upswings in the exchange returns persist some time after the date of switch.

Table 2a - 3a   Figure 2a - 3a

The first set of empirical results concerns the hypothesis of constancy of the tail index on the full historical sample including both fixed and floating period. The results, for rolling tests using various sample proportions and for the sequential tests, are presented in Table 2a. The base results reported in the tables take 'm' to be 10% of the relevant sample size (Dumouchel, 1983) and Quintos et al (2001). These results are easily summarized: On all tests, the null of constancy of the tail index is rejected at a test level of both 0.01 and 0.05; that is, each of the test statistics exceeds (by a substantial margin) the 95 and 99th percentiles of the null distribution. Thus, substantial evidence of a break is detected by both sequential and rolling test statistics. The large February 2001 jump is captured as the supremum of the statistics for smaller window sizes while for the larger window sizes the breakpoint dates slide back to September 1988. These dates seem close to the abandon of the daily exchange rate adjustment system (Table 3a).

The rolling tail indices and tests at 15 and 20 percent window sizes are given in Figure 2a. The rolling tail index graphs show that for smaller window sizes, the tail index is moving between 1 -1.6 range until 1994 during which it falls down 0.6 to remain close to that value until 1998. The test statistic plots, however, are not significant from 1988 until late 1998. The insignificance of the tests may be attributed to the foreign exchange returns taking close values in that segment. The rebound in the statistics after 1998 can be attributed to the impact of the Asian and Russian crises. On the other hand, sequential test plot depicts a jagged rising trend until 1994 following which it falls only to rise again in the year 2000 (Figure 3a). Thus, sequential tests signal rising risk in the periods preceding both crises as opposed to rolling test, which fail to capture the tail thickness, increase prior to 1994. In spite of the conflict between sequential and rolling test plots in terms of significance in the period preceding first financial crisis, all test statistic plots signal rising risk close to 2001 period.

Table 2b - 3b Figure 2b - 3b

The next set of results concerns inference on the fixed exchange rate regime era. The large jump in February 21 is not included in the fixed period subsample[9], to ensure robustness of the estimations. The null hypothesis of constancy of Hill estimator is again rejected for this subsample as well (Table 2b). Interestingly, despite the exclusion of the large jump, the breakpoint dates for the window sizes .15 and .20 again point to February 2001 as in the full sample, albeit with few days earlier (Table 3b). The rolling tail index plots show that the tail index is below the value of 2, thus it is consistent with similar studies. The plots show that tail index is rising until 1988 then drops afterwards (Figure 2b). The test statistics are also highly significant in that period; however they follow the drop in the tail value and become insignificant thereafter. Starting in the early 1999, the test statistics stabilize slightly above significance level. This low value period is also captured by the rolling tail tests of varying window sizes[9]. Interestingly, even when the subsample is insulated from the effect of the largest jump in February 2001, the second largest jump in April 1994 is still not captured as a breakpoint by any of the tests. On the other hand, the plot of the sequential test statistic behaves much like in the full sample.i.e; with a jagged rising trend until 1994 and sharply falling thereafter. Once again, as for the full period, sequential test performs better than its rolling counterpart in signaling the approaching crisis in 1994 (Figure 3b). To summarize, both test plots capture the rising risk in the period just before the second crisis of February 2001, however the sequential test plots, being also statistically significant in the period preceding 1994, clearly act as early warning signal for the risk of crisis.

Table 2c -3c Figure 2c - 3c

Table 2c presents the float period results. Here again, the null of the constancy of the tail index is rejected by rolling tests under different window sizes indicating time-varying tail behavior within that period. On the other hand, sequential test is significant at 5% but not at 1% level. In this subsample, the rolling test breakpoint dates are quite close under varying window sizes. Moreover, the sequential test breakpoint date is also very close to those of rolling tests (Table 3c). Since the detected breakpoint date is not associated with any situation related to domestic economy in that period, the tail thickness change might be linked with an external development.[11]

The tail index in float period subsample, contrary to findings in the early studies, exhibit a value less than 2 initially, then rises over that value for a while, then falls back below and remains at that level until around October 2003 (Figure 2c). Following that date, the index starts to increase considerably and generally is greater than 2. Rolling test statistics become highly significant in that segment and this is also confirmed by the rising value of the sequential tests statistic. This inconsistency can be explained as follows: The exit from the pegged exchange system did not occur in a pre-announced way, but by the outbreak of a crisis. Since the transition was not smooth, some time had to elapse before economic agents adjusted to the change so that they could revise their expectations accordingly. For a lengthy period after February 2001 switch, the foreign exchange also showed substantial volatility until the upswings and downswings finally settled down thanks to the interventions of CBT in the form of selling auctions. Uncertainty linked to the political environment such as collapse of the coalition government and the upholding of early elections all may be responsible, at least to some extent, for the indices lying below their anticipated values.

Conclusion

This paper used the tests of parameter constancy to asses whether the probability of observing sharp swings in the USD/TL returns has been the same across different exchange rate regimes. There is strong evidence of a change in the tail index not only for the whole historical sample, but also within the fixed and float regime subsamples as well. Then it follows that the span of Turkish foreign exchange rate returns should not be treated as a sample from a single distribution, particularly when considering the extreme tails of the distribution. On the other hand, considering that variants of exchange regime changes are concentrated mainly in the fixed regime period, there is scant support for the association of breakpoints with changes in regimes. When the full sample is used, the large jump coinciding with the date of the abandonment of the pegged regime is detected as the major breakpoint. This is to be expected. However, in the fixed regime subsample, which does not include the date of switch, breakpoint dates are still clustered in the early days of February 2001, which is in the period just preceding the switch to float regime. In other words, the tail behavior preceding the second crisis is dominating the tail behavior preceding the first crisis. This suggests that accumulated internal problems such as delayed structural reforms such as privatization and the adverse effects of capital inflows and outflows- which had already been substantial by then- coupled with the contagion effects of the external developments such as Asian and Russian crises are found to be more influential in affecting extreme values than the prevailing factors in early 1994. Plots of test statistics – particularly sequential type- rise substantially during the pre-crisis periods and reach the maximum at the time of the outbreak. The slow but gradual increase of the tail index in the float period particularly after October 2003 point to the success of the CBT auctions not only in terms of reducing volatility but also in terms of reducing the riskiness. This may be thought of the first signs of successful attempts of CBT to stabilize the economy and ease the conduct of its monetary policies in the float period. On the other hand, the breakpoint dates captured in the float period subsample underlines the role of political events in affecting extreme movements in foreign exchange returns regardless of the exchange regime adopted.

FOOTNOTES

[1] A well-known paper about predicting crises is Kaminsky et al., (1998).

[2] Recently, Candelon and Straetmans (2003) and Quintos (2004) generalized Quintos et al (2001) method towards an analysis of multiple breaks for emerging market currency returns.

[3] Recursive estimation results are available on request. For the sake of preserving space only rolling tests at 15 and 20 percent window sizes will be presented here. Results for other window sizes are close.

[4] Details are not shown here for space consideration. Interested reader may refer to original paper or Quintos et al (2001).

[5] There is no consensus as to the type of exchange rate regime after that period. For instance, according to Bubula and Otker-Robe (2003) the regime is described as 'backward looking crawling peg'. Berument (2002) on the other hand, defines the period up to January 2000 as an 'intermediate exchange rate regime being neither of crawling peg nor of fixed exchange rate regime' type.

[6] Bubula and Otker-Robe (2003) identify the period as forward-looking crawling peg.

[7] We identify the period until the second crisis as fixed regime despite the implementation of a short-lived managed float system within that period.

[8] CBT Press Announcement No: 2002-25, March 2002.

[9] When it is included the captured breakpoint dates are similar to those in the full sample. The exclusion of this date implies that the endpoint of the fixed period subsample is pulled back one day.

[10] These are not provided here to preserve space however they are not markedly different.

[11]There was a referandum in April 24,2004 in Cyprus. The tension buildup reflected in all domestic markets.

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Table 1a. Descriptive statistics for full sample (January 28, 1980-October 11, 2004).

Number of observations	6236
Mean	0.0015957
Std.Devn.	0.010279
Skewness	12.255
Excess Kurtosis	396.37
Minimum	-0.12564
Maximum	0.33473
Asymptotic test: Chi^2(2)	4.0977e+007 [0.0000]**
Normality test: Chi^2(2)	13430. [0.0000]**

** Significant at 1% level.

Table 1b. Descriptive statistics for fixed period subsample (January 28, 1980-February 21, 2001).

Number of observations	5324
Mean	0.0017232
Std.Devn.	0.0084073
Skewness	14.151
Excess Kurtosis	549.46
Minimum	-0.11537
Maximum	0.32851
Asymptotic test: Chi^2(2)	6.7150e+007 [0.0000]**
Normality test: Chi^2(2)	10303. [0.0000]**

** Significant at 1% level.

Table 1c. Descriptive statistics for float period subsample (February 21, 2001-October 11, 2004).

Number of observations	912
Mean	0.00085169
Std.Devn.	0.017584
Skewness	7.8084
Excess Kurtosis	148.39
Minimum	-0.12564
Maximum	0.33473
Asymptotic test: Chi^2(2)	8.4603e+005 [0.0000]**
Normality test: Chi^2(2)	1589.8 [0.0000]**

** Significant at 1% level.

Table 2a. Full-sample rolling and sequential tests of USD/TL log returns, January 28, 1980-October 11, 2004.

Test	5% c.v.	1% c.v.	$\text{Sup}(Z_i^2(t))$
Rolling, $\gamma = 0.15$	1.46	1.90	15.29
Rolling, $\gamma = 0.20$	1.75	2.30	23.22
Rolling, $\gamma = 0.25$	1.98	2.55	24.25
Rolling, $\gamma = 0.30$	2.12	2.86	29.45
Sequential, $t_0 = 500$	18.31	28.82	89.37

Critical values recorded are taken from Quintos, Fan, and Phillips (2001).

Table 2b. Subsample rolling and sequential tests of USD/TL log returns, January 28, 1980-February 21, 2001.

Test	5% c.v.	1% c.v.	$\text{Sup}(Z_i^2(t))$
Rolling, $\gamma = 0.15$	1.46	1.90	8.92
Rolling, $\gamma = 0.20$	1.75	2.30	11.74
Rolling, $\gamma = 0.25$	1.98	2.55	13.59
Rolling, $\gamma = 0.30$	2.12	2.86	15.14
Sequential, $t_0 = 500$	18.31	28.82	80.15

Critical values recorded are taken from Quintos, Fan, and Phillips (2001).

Table 2c. Subsample rolling and sequential tests of USD/TL log returns, February 23, 2001-October 11, 2004.

Test	5% c.v.	1% c.v.	$\text{Sup}(Z_i^2(t))$
Rolling, $\gamma = 0.15$	1.46	1.90	14.55
Rolling, $\gamma = 0.20$	1.75	2.30	19.98
Rolling, $\gamma = 0.25$	1.98	2.55	26.68
Rolling, $\gamma = 0.30$	2.12	2.86	26.98
Sequential, $t_0 = 500$	18.31	28.82	15.71

Critical values recorded are taken from Quintos, Fan, and Phillips (2001).

Table 3a. Full Sample Breakpoint Dates

Day	Month	Year	Test
1	8	2002	SupSeq
21	2	2001	Roll15
20	2	2001	Roll20
5	9	1988	Roll25
28	9	1988	Roll30

Table 3b. Fixed Regime Subsample Breakpoint Dates

Day	Month	Year	Test
23	2	1999	SupSeq
15	2	2001	Roll15
20	2	2001	Roll20
4	8	1988	Roll25
23	5	1988	Roll30

Table 3c. Float Regime Subsample Breakpoint Dates

Day	Month	Year	Test
11	2	2004	SupSeq
27	4	2004	Roll15
22	4	2004	Roll20
22	4	2004	Roll25
22	4	2004	Roll30

Notes: SupSeq is the Supremum Sequential test. All others are rolling tests at window sizes shown by the suffixes.

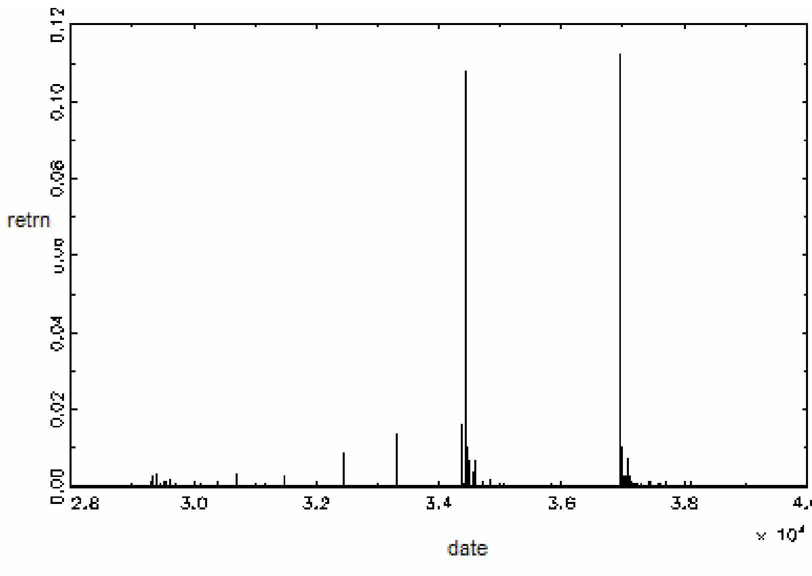

Figure 1a. Full Sample USD/TL exchange returns.

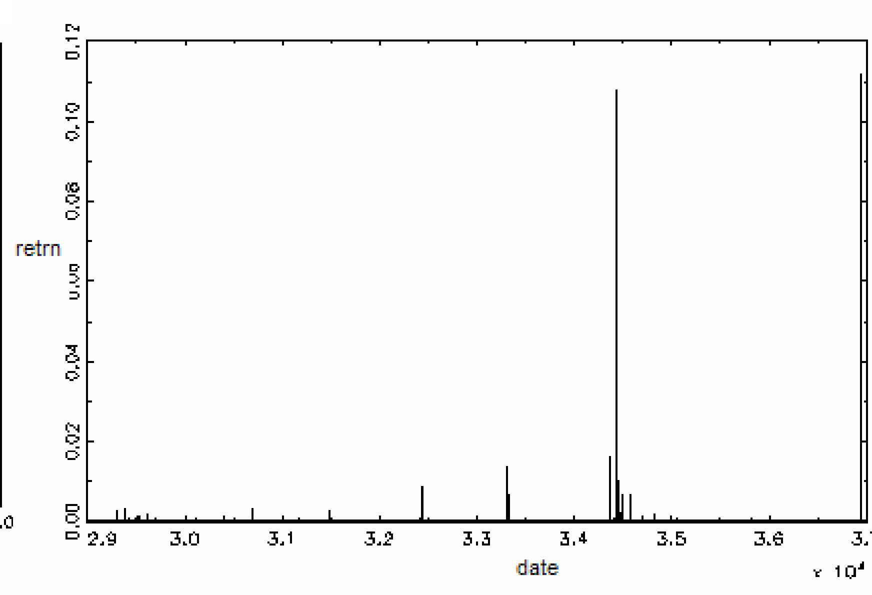

Figure 1b. Fixed Period USD/TL exchange returns.

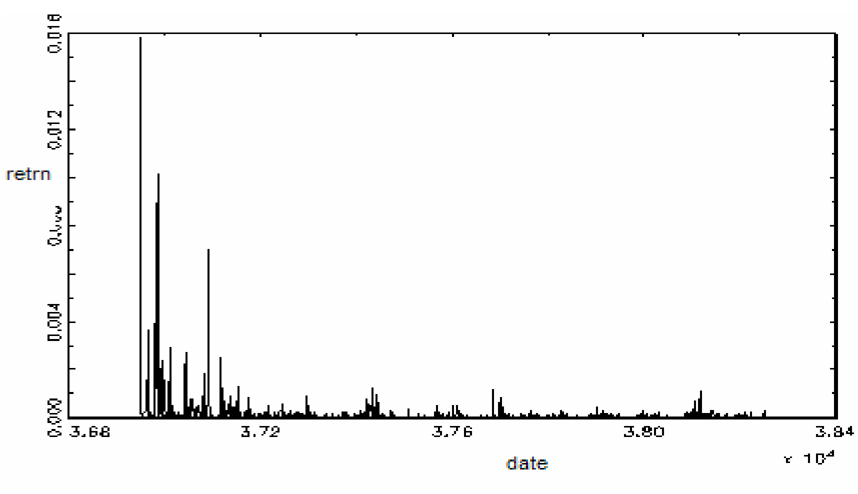

Figure 1c. Float Period USD/TL exchange returns.

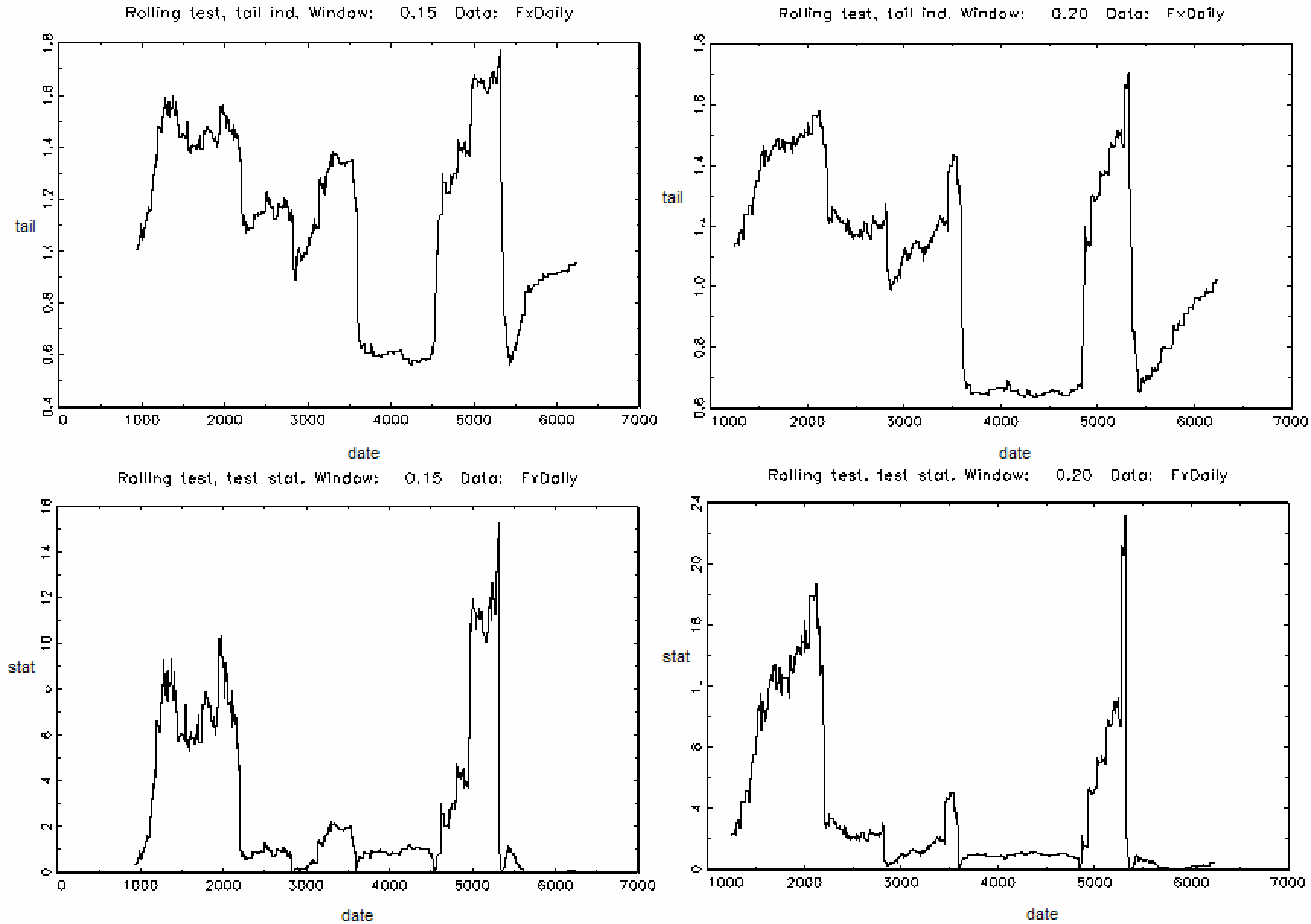

Figure 2a. Full Sample. Upper panels are tail indexes and lower panels are test statistics at 15% and 20% window sizes.

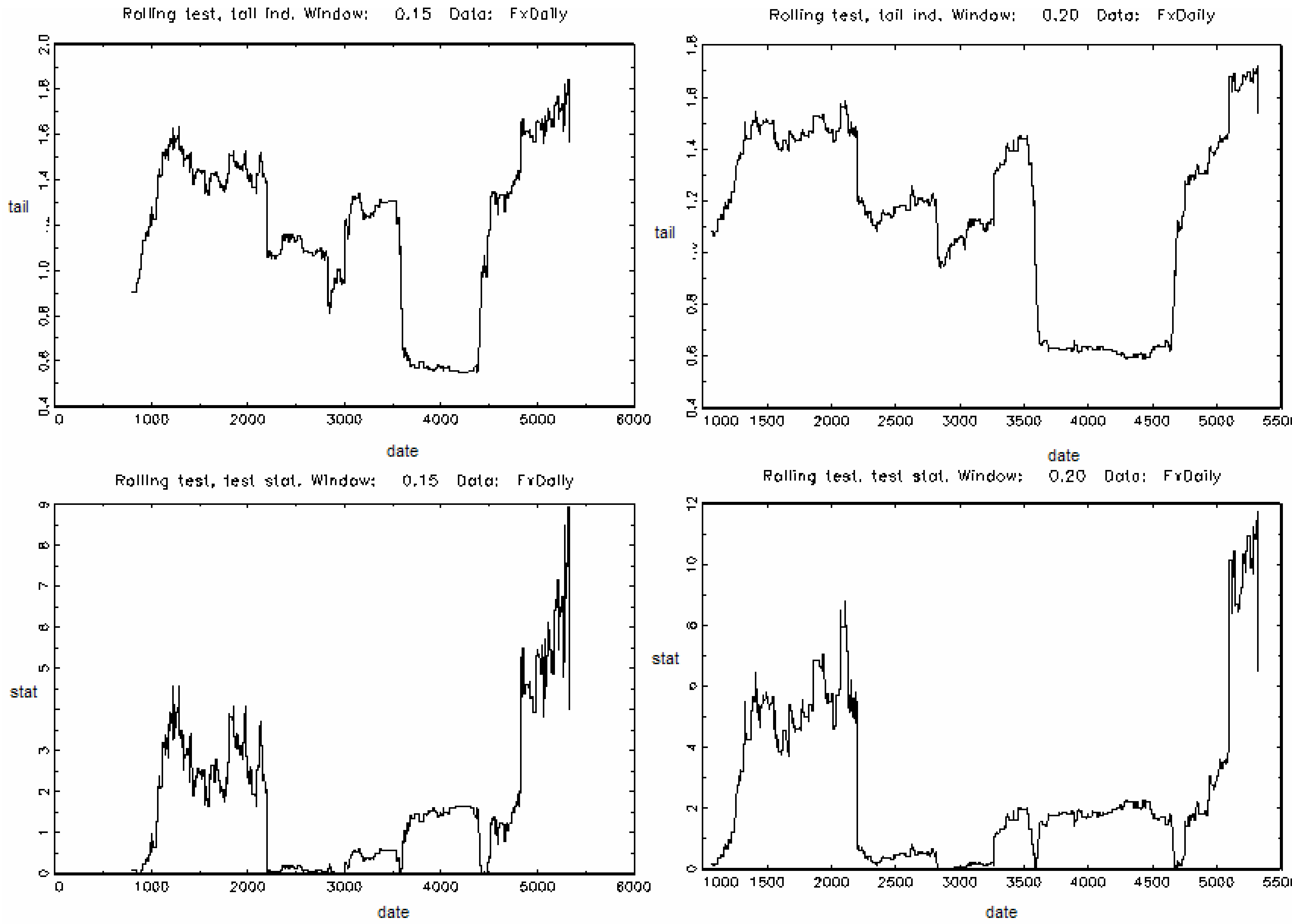

Figure 2b. Fixed period. Upper panels are tail indexes and lower panels are test statistics at 15% and 20% window sizes.

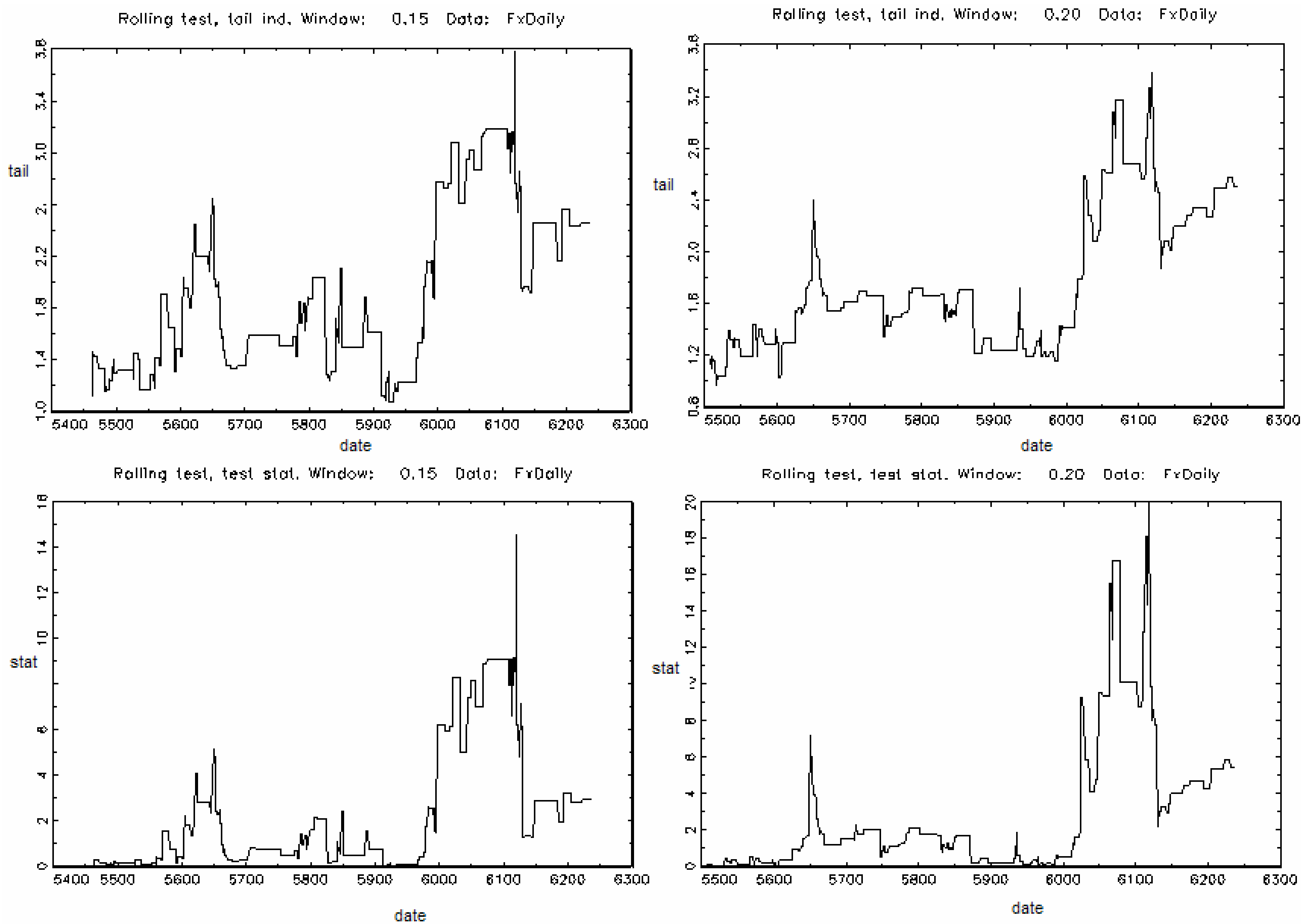

Figure 2c. Float period. Upper panels are tail indexes and lower panels are test statistics at 15% and 20% window sizes).

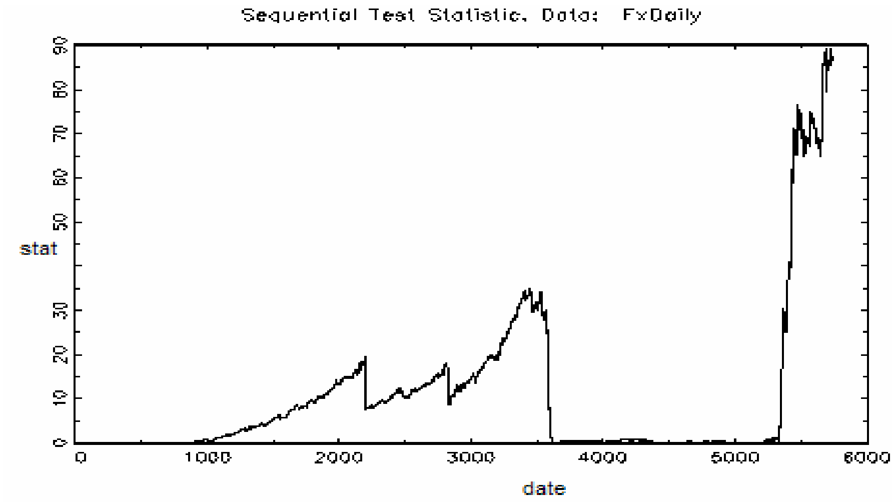

Figure 3a. Full sample sequential test plot.

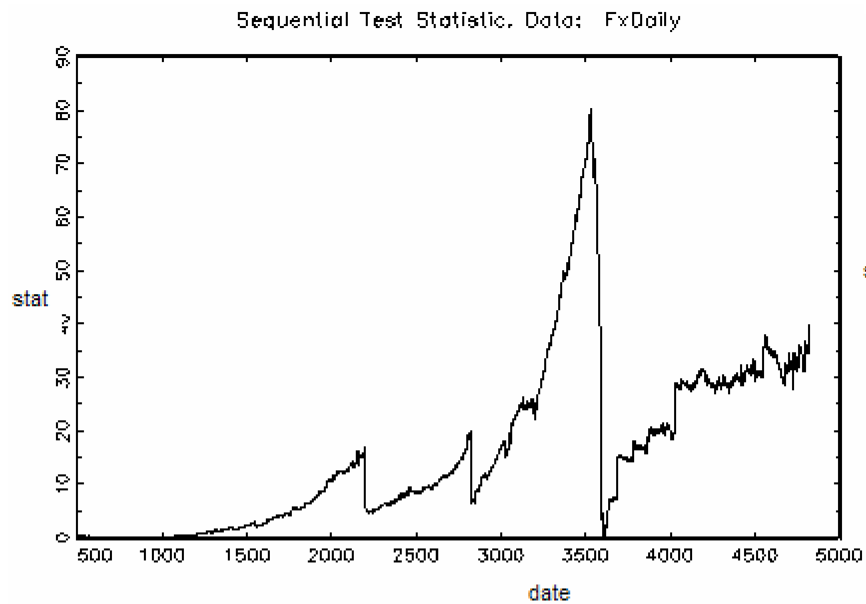

Figure 3b. Fixed period sequential test plot

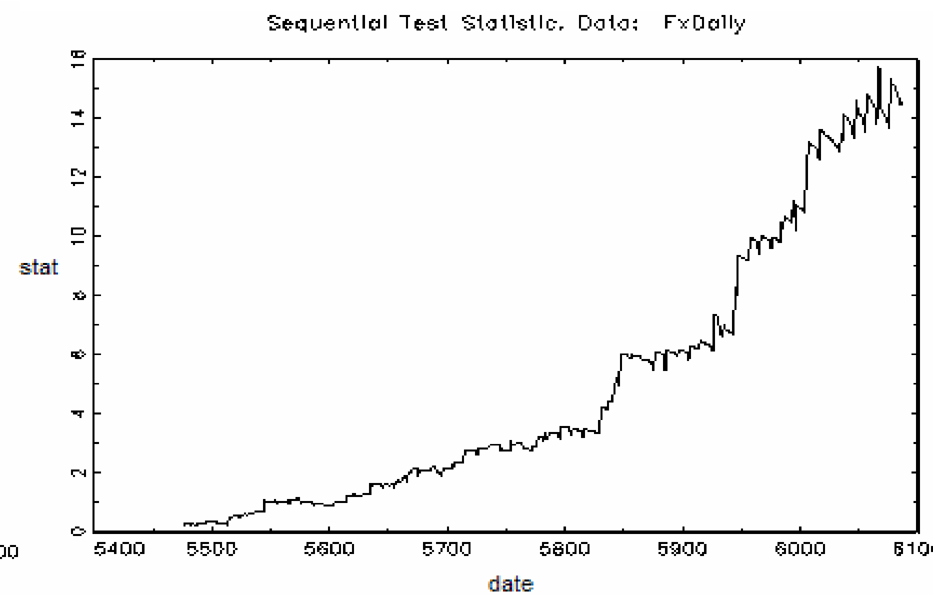

Figure 3c. Float period sequential test plot