Appendix

Methodology for Calculating Shareholder Harm

I. Framework for the Analysis

1. The purpose of this analysis is to estimate harm to long-term shareholders that they may have suffered as a result of the market timing activities discussed in the SEC Order. To estimate harm to shareholders, three possible but-for worlds were initially considered: (1) a but-for world in which the timer would not have been present; (2) a but-for world in which timer would be present, but would pay a fair price when entering or leaving the fund, with the 'fair' price measured as either a 'fair' NAV for the timer given the information the timer used in making its decision at the time or the next-day NAV; and (3) a but-for world in which the timer simply disgorges its profits.

2. Greene and Ciccotello (2004)[1] have shown that neither the second but-for world (fair NAV), nor the third (disgorgement of profits) guarantee that the shareholders will be adequately compensated for the harm they have actually suffered as a result of the timing activity.

3. Shareholders of mutual funds in which timing activity takes place are diluted to the extent that the actual returns they earn are less than the returns they would have earned had the timing activity not occurred. Timer activity may adversely affect the returns to non-timer shareholders if it (1) disrupts the investment style of the fund ("style drift"); and/or (2) generates non-optimal cash balances, therefore causing cash drag; and/or (3) causes the fund to incur additional transaction costs in response to the timing activity.

4. The extent to which Canary's timing activities adversely affected the returns to non-timer shareholders is estimated in Section II below by analyzing the behavior of each Fund's tracking error over the period when the timing activity occurred. The analysis of tracking error indicates no statistical change in investment style and only modest disturbance caused by the cash positions of the funds as a consequence of timer activity. The general methodology for calculating dilution is described in Section III; this methodology

requires a measure of the extent of cash disruption, described in Section IV. The application of the model to estimate dilution is described in Section V.

5. The methodology described can be viewed as an extension of Greene and Ciccotello (2004), with two features added. First, the necessary condition of disruption of the funds' tracking error is verified. And second, an empirical methodology to estimate cash imbalances resulting from timing activities is developed.

II. Portfolio Style versus Cash Position Disruption

6. The behavior of tracking error is analyzed to determine whether there is statistical evidence of any perturbation that can be attributed to any style change or excess cash caused by the timer. If there is no statistical evidence that the activity disrupted the portfolio manager's ("PM") investment style, disruption to tracking error, if any, is assumed to result from non-optimal levels of cash caused by the timer activity.

7. To examine whether the timer activity disrupted portfolio style and/or the Funds' cash positions, a model of mutual fund returns is estimated using the return on each Fund's best-fit index.[2] The implicit assumption behind this formulation is that the factor-loadings represent the manager's style in a risk-return setting. For a period of time before the timing activities begin (75 trading days), the model estimates:

$$R_{pt} = \alpha^{b} + \beta_1^{b} R_{bt} + \varepsilon_t \tag{1}$$

where R_{pt} is the mutual fund return, R_{bt} is the return on the best-fit index, and the superscript b indicates the time period before the start of timing activity.

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1 Greene, Jason T. and Conrad S. Ciccotello, "Mutual Fund Dilution from Market Timing Trades," *Journal of Investment Management*, v. 4, no. 1, 2006, pp. 1-24.

2 The best-fit index is determined by Morningstar. Morningstar regresses a fund's monthly excess returns against the monthly excess returns of several well-known market indexes. Best fit signifies the index that provides the highest R-squared when the fund is regressed against it. For the Growth Fund, the best-fit index is the Russell 1000 Growth; for the Target Fund, the best-fit index is the Russell Mid-cap Growth; and for the Opportunity Fund, the best-fit index is the Russell 2000 Growth. The best-fit index for the Innovation Fund is PSE Tech Growth, but since there is only one round trip in this fund, one cannot estimate a meaningful relationship; losses for the Innovation Fund are calculated based on the parameters for the Growth Fund.

8. Then, the observed fund returns during the period of timing are used to estimate a more general form of equation (1):

$$R_{pt} = (1-c)\left(\alpha^a + \beta_1^a R_{bt}\right) + cR_{t-1} + (1-c)\varepsilon_t \tag{2}$$

where R_{t-1} is the interest rate on cash, c is the amount of excess cash as a percentage of total assets in the fund, and the superscript a indicates the time period when the timer is active. The following hypotheses are then tested: $H_0 : c = 0$ and $H_0 : \beta_1^b = \beta_1^a$ and $\alpha^b = \alpha^a$. Under this specification, c will provide an estimate of average excess cash during the timing period. If the hypothesis that $c = 0$ can be rejected, then one can infer that excess cash caused some disturbance to the portfolio. Similarly, if the hypothesis that $\beta_1^b = \beta_1^a$ and $\alpha^b = \alpha^a$ can be rejected, one can infer that the timing activity altered the portfolio style. Conversely; if $\beta_1^b = \beta_1^a$ and $\alpha^b = \alpha^a$ cannot be rejected, i.e., the portfolio beta and alpha did not significantly change during the timing period, then one can infer that the only disturbance to the portfolio is the presence of excess cash levels.

9. For the Growth Fund, the results of the estimation equation indicate that c is greater than zero, but is not statistically significant. If equation (2) is estimated constraining c to be equal to zero, the hypothesis that portfolio style changed during the timing period cannot be rejected, meaning that the hypothesis that excess levels of cash caused disturbances to the portfolio cannot be rejected. Failure to properly account for this cash disturbance could lead to a false conclusion that the portfolio style changed. Therefore, the slight disturbance is treated as caused by excess cash.

10. In the Opportunity Fund, there is no evidence of style change or cash disruption.

11. In the Target Fund, the hypothesis of style change cannot be rejected. However, c is positive, but not significant, indicating some possible level of cash disturbance. Rejecting the hypothesis of "no style change" may be due to the fact that the pre-timer period includes observations shortly after the events of 9/11. If the 75-day period

following the timer activity is used instead, there is again no evidence of a style change during the timing period; *c* continues to be positive, but not significant.

12. Based on the foregoing, the IDC concludes that, to the extent there is any disruption, it is due to excess cash.

III. Methodology for Estimation of Dilution

13. The analysis above indicates that portfolio performance is adversely, though moderately, affected by the excess cash caused by the timer activity. Dilution to fund shareholders can be computed directly from a measure of cash disruption. Note, however, that excess levels of cash held in the fund which are attributable to timer activity may either harm or benefit other shareholders depending on the period return on invested assets. That is, timer-related perturbations in tracking error can either be positive (adding to returns) or negative (reducing returns). Dilution is defined as negative perturbations to tracking error caused by the timer.

14. Dilution resulting from a timer round trip starting at time t=0 can be expressed as:

$$\prod_{t=0}^{T+N}\left(1+r_t^*\right)NA_0-\prod_{t=0}^{T+N}\left(1+r_t\right)NA_0 \qquad (3)$$

where *T* is the duration of the roundtrip and *N* is the duration (number of days) of cash disturbance after the end of the roundtrip. Equation (3) states that dilution is equal to the difference between the return shareholders would have received in the absence of the timer (the "but-for return") and the actual return on the fund, applied to the fund's net assets at the beginning of the timer's round trip. The period T+N for calculating dilution is defined as the period during which the round trip disrupts returns.

15. Assuming, as warranted by the evidence that timing did not perturb fund style, that when the PM invests the timer cash, he invests that cash 'in the portfolio,'[3] i.e., that timer activities do not change the investment strategy, as shown above, the observed return on the fund can be written as:

[3] Investing 'in the portfolio' implies that the portfolio manager holds 'the normal' level of cash.

$$r_t = \left(1 - \frac{C_{t-1}}{NA_{t-1}}\right) r_t^* + \frac{C_{t-1}}{NA_{t-1}} r_t^C \qquad (4)$$

where r_t^C is the return on cash[4] and C_{t-1} is the excess cash[5] held because of the timer activity. If no excess cash is held, the but-for return will be equal to the actual portfolio return. The return on the normal level of cash is embedded in the portfolio's normal return. When excess cash is held, but no other disruption is caused to the portfolio, the observed return is a weighted average of the normal return (which is also the but-for return) and the return on cash. The but-for return can therefore be expressed as:

$$r_t^* = \frac{r_t - \frac{C_{t-1}}{NA_{t-1}} r_t^C}{1 - \frac{C_{t-1}}{NA_{t-1}}} \qquad (5)$$

16. Equation (5) implies that the but-for return at time t is simply the actual return corrected for the excess cash from the timer the day before and for the return on that excess cash. The calculation of the but-for return in Equation (5) requires a measure of the relationship between timer activity and portfolio cash, described below.

IV. The Dynamics of Timing and Cash

17. Any disruption to portfolio performance caused by timer activity is most likely related to large cash imbalances. In order to calculate shareholder dilution, a model of the dynamics of cash in the fund before, during, and after a timer roundtrip needs to be developed that will provide an estimate of the magnitude of those cash imbalances.

a. Model

18. The following models are estimated using end-of-day cash:

$$\frac{Cash}{NetAssets_{f,t}} = \alpha + \sum_{i=1}^{5} \beta_i \frac{Cash}{NetAssets_{f,t-i}} + \sum_{j=0}^{5} \gamma_j \frac{TimerFlow}{NetAssets_{f,t-j}} \qquad (6)$$

4 For the return on cash, the daily overnight repurchase rate is used, as reported in the data received from Respondents.

5 Excess cash is defined as the departure from the optimal cash position caused by the timer activity.

19. This model allows one to measure how timing activity causes a divergence of portfolio cash holdings from optimal cash holdings. The γ's measure the extent to which cash brought in by the timer directly affects the fund's cash balance – this impact can last up to five days. The β's can be interpreted as measuring the decay rate, or the speed of adjustment to any cash imbalance.

20. For example, when the timer enters the portfolio, a positive value is recorded for the *TimerFlow* variable. When the timer leaves the portfolio, a negative value is recorded for that same variable. To the extent that these flows systematically disturb the cash position of the portfolio, the estimated γ's will be positive and significant. Note also that if the γ's are positive and significant, the timer's entry will affect the portfolio's cash balance. This will create a cash imbalance over time which is reflected in the β's.

21. This specification of cash and timer flows was chosen for several reasons. First, the number of lags chosen (five) is appropriate since lag structures longer than five do not improve the explanatory power of the model. Second, non-timer flows do not have any significant impact on fund cash positions and therefore have been excluded from the regression. Third, the use of more complex error terms structures (such as GARCH) does not significantly improve the explanatory power of the model.

b. Results

22. For the Growth Fund, the estimation shows that the cash adjustment to inflows and outflows took about three days (lags longer than three days for both lagged cash and inflows are insignificant). The model could not be estimated for the Innovation Fund because there was only one round trip in this fund. To calculate dilution, if any, for the Innovation Fund, the parameters estimated for the Growth Fund were used.

23. Results for the Target Fund indicate that the cash adjustment might have been slightly slower (lag four coefficients being marginally significant in some instances). The Opportunity Fund appears to have had a much faster cash adjustment process. No lagged variable for flows is significant beyond lag two.

V. Use of the Model to Estimate Dilution

a. Accounting Considerations

24. Although the logic behind equation (5) is quite simple, some adjustments to the equation must be made to account for fund accounting rules.

- On day 1 of a round trip, timer cash must be included as uninvested cash and added to the fund's net assets, as it does not appear in the fund's accounting at day 0.
- On day 2 of the trip, the timer cash, which appears now as a receivable, must be included as uninvested cash.
- To calculate the but-for return on T+1 (the day after the timer exits), the cash payable to the timer must be subtracted from uninvested cash on day T and from the fund's net assets on day T.

b. Measuring Excess Cash

25. Uninvested, or excess, cash is measured as the departure from the steady-state cash position caused by timer activity, as described in equation (6) above. Assuming that the dynamics of investment by the PM when timing occurs are always the same, dilution can be measured by substituting into equation (3) the but-for return determined by equation (5) incorporating the excess cash as measured using the cash dynamics model in Section B.IV.

c. Correction for Transaction Costs

26. Investment of some of the timer money by the PM also results in excess transaction costs – both when purchasing the securities and when selling them to fund the timer's redemption. Some of the transaction costs of purchasing securities are actually borne by the timer, but all of the transaction costs of selling the securities are borne exclusively by the other shareholders.

27. Transaction costs can be estimated as:

$$f\,\frac{NA_0 - T_0}{NA_0}(C^{SS} - C_{T+1}) \tag{7}$$

for securities purchases, and:

$$f\,(C^{SS} - C_{T+1}) \tag{8}$$

for securities sales.

T_0 is the total amount of money brought in by the timer; *f* is the transaction fee for each dollar purchase or sale of securities;[6] C^{SS} is the steady-state level of cash;[7] and C_{T+1} is the predicted level of cash after the timer's money has left the portfolio.

28. Transaction costs are assessed by looking at the dip in cash following the timer's departure. The share of the timer's money actually invested in securities by the PM is approximated as C^{SS}-C_{T+1}. This methodology has the advantage of accounting for all the timer's cash activities over the trip.[8]

29. When the timer enters, the amount of cash in the fund is at its steady-state level, and if the PM does not invest any of the timer's cash, cash during the round trip should never fall bellow the steady-state level. If cash does fall below the steady-state level, this means that the PM does not have enough cash to meet the redemption of the timer.

30. Appendix Exhibit 1 provides summary statistics for the market timer's activity in the Funds. Appendix Exhibit 2 shows the distribution of roundtrips by number of days.

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6 The transaction fee used in the calculation is 25 basis points per dollar traded.

7 C^{SS} is defined as $\alpha/(1-\Sigma\beta_i)$; see Equation (6).

8 Some roundtrips are complex in that the timer cash may enter and/or exit the fund in two or more transactions.

Appendix Exhibit 1
Descriptive Statistics for Subscriptions and Redemptions (inclusive of Exchanges)

	Growth	Target	Opportunity	Innovation	Total
Timer Descriptive Statistics:					
Date of First Trade	11-Apr-02	8-Feb-02	11-Apr-02	8-Feb-02	8-Feb-02
Date of Last Trade	21-Nov-02	21-Nov-02	3-Apr-03	21-Feb-02	3-Apr-03
Number of Subscriptions	31	46	45	1	123
Number of Redemptions	35	53	46	2	136
Value of Subscriptions	$ 886,964,213	$ 1,185,888,663	$ 185,899,886	$ 23,857,947	$ 2,282,610,710
Value of Redemptions	887,945,282	1,184,319,679	185,537,368	22,694,419	2,280,496,747
Average Size of Subscription	28,611,749	25,780,188	4,131,109	23,857,947	18,557,811
Holding Period Profit	981,069	(1,568,985)	(362,518)	(1,163,529)	(2,113,963)
Non-Timer Descriptive Statistics:					
Value of Subscriptions During Timing Period	$ 46,608,895	$ 118,224,066	$ 76,359,982	$ 11,962,438	$ 253,155,380
Value of Redemptions During Timing Period	201,396,701	306,051,095	117,800,397	23,372,878	648,621,071
Net Non-timer Flow	(154,787,806)	(187,827,030)	(41,440,415)	(11,410,440)	(395,465,691)
Average Daily Subscription	208,075	413,371	213,894	920,188	604,189
Average Daily Redemption	899,092	1,070,109	329,973	1,797,914	1,548,022
Total Dilution to Diluted Shareholders [1]	$ 1,682,329	$ 79,999	$ 99,086	$ 1,866	$ 1,863,281

Note: [1] These numbers reflect dilution only to those shareholders who suffered dilution with no offset for shareholders who had negative dilution.

Appendix Exhibit 2
Distribution of Number of Holding Period Days
Timer Transactions
Growth, Innovation, Opportunity, and Target Funds