WHITE PAPER #6

Systematic Fair Value: Choosing Among the Available Aids

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March 19, 2003
Revised: November 14, 2003

Background

In two letters, dated December 8, 1999 and April 30, 2001, the staff of the Securities and Exchange Commission ("SEC") has commented on mutual funds' obligations to fair value their portfolio securities.

Fair value pricing is the process by which a mutual fund establishes prices of portfolio holdings for which market quotations are not "readily available". This includes international securities whose prices would be affected by market events that have occurred since the local market closed but before the funds' daily Net Asset Value ("NAV") calculation, typically, at 4:00 p.m. Eastern Time ("ET"). The two letters make clear that a mutual fund cannot simply adopt as its fair values the evaluated prices of a third-party pricing service. Pricing service evaluations can, however, properly be one input into a fund's exercise of its fair valuation obligations. To utilize a pricing service's data as part of its fair value deliberations, a mutual fund will of course want to understand the models and mechanisms that the pricing service employs in arriving at its evaluated prices.

Fair value pricing also serves to deter "time zone arbitrage". While some mutual fund industry participants consider short-term trading fees, monitoring, and delayed exchanges to be adequate deterrents, fair value pricing has several advantages over these methods. First, while the other solutions all have limited effectiveness, properly implemented fair value pricing removes the arbitrage opportunity. Second, while other methods may have a selective application (or non-application), fair value pricing automatically impacts all investors equally. Last, and most importantly, only fair value pricing allows all purchases and redemptions, whether from a long-term investor redeeming retirement assets or from an arbitrageur, to occur at prices that are not systematically different from those that would prevail in a liquid market.

Most mutual funds are closely studying tools that can assist them in meeting their fair value obligations. We sampled 200 of the largest international funds and used the methods described in Zitzewitz (2002) to determine whether the funds were adequately fair valuing their portfolios in the second half of 2002.[1] We found that about 15 funds were "fully" on target (i.e., close enough that we could not statistically distinguish an arbitrage opportunity) and another 35 funds were "partially" successful (i.e., making on average at least 20 percent of the necessary full adjustments). Some of the mutual funds that we looked at are using the Interactive Data Pricing and Reference Data Fair Value Information Service as an input into their fair value processes. Other mutual funds are using either competing third-party services or self-developed models.

[1] See "Another Kind of 'Weekend Effect' in Financial Markets," available on Eric Zitzewitz's web site: http://faculty-gsb.stanford.edu/zitzewitz.

Choosing a Fair Value Approach

Mutual funds, which opt to use an external service to provide fair value input, can choose among several different methodologies. A fund will want to understand the approach of any tool that it decides to utilize as part of its fair valuation process.

Ad-hoc vs. systematic. The 2001 SEC staff letter stresses a mutual fund's obligation regularly to review the effectiveness of the methods used to fair value its portfolio securities. One easily applied test of the efficacy of a fund's efforts is whether the next day's opening prices move in the same or the opposite direction as the fair value adjustments. Mutual funds which adjust in the wrong direction may be subject to (often unfair) criticism (see Barron's August 10, 2002 "Gaming International Funds"). When a fund is required to defend its pricing methodology, it will obviously be easier for the fund to justify fair value pricing practices that make use of a systematic rather than an ad-hoc model.

Top-down vs. bottom-up. Our White Paper #2[2] discusses the advantages of using a bottom-up methodology, which looks at each security in a portfolio, rather than applying broad changes across sectors, countries or entire portfolios in a top-down approach. While top-down adjustments to entire mutual funds portfolios are less costly to make, they are fundamentally problematic because they do not result in individual price adjustments to only those securities for which market quotations are not (due to the occurrence of a post-market closing significant event) "readily available". Moreover, top-down adjustments do not take into account changes in portfolio composition, which occur rapidly for actively managed mutual funds portfolios. A top-down approach has the additional disadvantage of limiting the number of factors that can be considered.

Single vs. multi-factor. This white paper explains why a multi-factor approach is of greater utility to a fund which decides that it must fair value some or all of its portfolio securities. Interactive Data Pricing and Reference Data's Fair Value Information Service uses multiple factors, including, where applicable, relevant sector indices, ADRs, U.S. general equity futures, the Nikkei future, and in some cases the iShare (ETF) for a security's home market. We know of two single-factor approaches that compete with Interactive Data Pricing and Reference Data's multi-factor approach. One single-factor model focuses on a general index, and the other focuses on the "Mark to ADR" approach of substituting ADR prices for local closing prices of equities with shares traded in the U.S. As shown below, testing demonstrates that, if a mutual fund relies too heavily on a single-factor model in its fair valuation processes, its fair value prices will differ predictably from the next day's opening prices.

If an arbitrageur is able to determine a fund's basis for its fair value adjustments, it can exploit that information. For example, by analyzing the publicly reported NAVs of a mutual fund with Japanese holdings, a day trader might be able to conclude that the fund's fair value adjustments were directly linked only to the S&P 500 Index. On days when the S&P 500 fell but the Nikkei future did not follow it down, the next-day expected returns on this fund would be positive. The arbitrageur could act accordingly. Alternatively, if the fund was heavily invested in Nokia, on days that the Nokia ADR was up significantly but the S&P 500 was not, the fund would be under-priced. An arbitrageur could then buy the fund cheaply and dilute long-term shareholders in the process.

The 1999 SEC staff letter mentions various factors that mutual fund boards might take into account in order to meet their fair value pricing obligations as to securities traded on foreign markets. Items referred to include the "value of foreign securities traded on other foreign markets, ADR trading, closed-end fund trading, foreign currency exchange activity, and the trading prices of financial products that are tied to baskets of foreign securities". The thesis of this white paper is that following this approach and using a greater number of such factors results in fair value pricing that is more precise measured against the tests set forth below.

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[2] *Fair Value Controversy, Top-Down versus Bottom-Up* (October 2001)

Testing Parameters

The 2001 SEC staff letter recommends that funds continuously "evaluate the appropriateness of their fair value methodology for foreign securities by reviewing next-day opening prices or actual sale of the securities on the foreign exchange or market". As we discuss in White Paper #5[3], two tests of fair value price appropriateness are arbitrage reduction (AR) and variance reduction (VR). Both tests allow a mutual fund to determine the effectiveness of its fair value pricing of portfolio securities.

Any AR quantification necessarily depends on the trigger strategy that arbitrageurs are assumed to use. An analysis of daily flow data suggests that changes to the S&P 500 is the trigger strategy that arbitrageurs currently most commonly use. We have therefore presented our AR results assuming a trading strategy based on the S&P 500.[4]

The VR test rationale is that fair value prices should be as close as possible to next-day opening prices. VR is defined as the variance of the fair value adjusted prices to the next day opening prices change divided by the variance of the Close-to-Open change. VR of 100 percent will never be possible, since invariably some news is revealed after 4:00 p.m. ET but before next-day foreign market openings (such as U.S. earnings announcements after the close). It is reasonable to expect that a sophisticated arbitrageur will look at VR and focus on those funds with lower VR percentages.

In summary, good performance on the AR test implies that arbitrage is removed for a specific arbitrage strategy. Optimal performance on the VR test implies that arbitrage opportunities are removed for any conceivable arbitrage strategy.[5]

Results

Table 1 presents the results of the AR and VR tests for different pricing methods. Using public information we created a hypothetical portfolio of the 250 largest market capitalized (European and Asian) securities. The region weightings are 76 percent European and 24 percent Asian; 101 of the 250 securities have ADRs. For each day of the twelve months February 15, 2002 through February 15, 2003, we calculated what the fair value adjustments would have been for each security using five different models ranging from the simplest single-factor model to Interactive Data Pricing and Reference Data's complex multi-factor model. To obtain the maximum number of days, we assumed that arbitrageurs would purchase whenever the S&P 500 rose and would redeem whenever it dropped. Results are quite similar (all models have proportionately higher VR) if we limit the sample to days with S&P 500 movements of at least, e.g., 75 basis points. We used the lower threshold simply to maximize the number of trading days.

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[3] *Testing Fair Value Prices* (June 2002)

[4] Note, however, that by choosing the same factor used in the single-factor model example as the arbitrage trigger, we are understating the benefits of a multi-factor pricing approach.

[5] Rather than VR, another accuracy test might be to count the number of times the fair value adjusted prices were closer to the next day's open than the local close was. Although this test is intuitive (one wouldn't want the fair value adjusted price estimates consistently to be further away from the open than the local closes), it's a less powerful measure statistically. Consider 3 days with local close of 100 and next day open of 101. If the fair value adjusted prices were 100.1, 100.1, and 105, the test score is 67%. Yet the $4 miss was so severe that the fair value adjusted prices were much worse than always using the local close. As an extreme model, consider a daily NAV adjustment of one penny in the direction of the S&P 500. This model achieves the best accuracy count score but almost no AR or VR.

Table 1: Comparison of Models[6]

Model	Style	Arbitrage Profit with Local Close	Arbitrage Profit with Fair Value	Standard Error	**Variance Reduction[7]**	**Information left out of fair value estimates relative to Interactive Data Pricing & Reference Data model**
"Mark to ADR"	Bottom up	54.1%	31.2%	10.0%	**44.2%**	**24%**
S&P-only	Top Down	54.1%	7.9%	10.3%	**48.5%**	**17%**
S&P-only	Bottom up	54.1%	7.9%	10.3%	**48.5%**	**17%**
S&P and Nikkei	Bottom up	54.1%	3.2%	10.1%	**51.2%**	**12%**
Interactive Data Pricing & Reference Data multi-factor	Bottom up	54.1%	1.1%	9.4%	**58.2%**	--

The worst performing model is the "Mark to ADR" model that substitutes ADR prices for local closing prices. While this approach eliminates some of the arbitrage opportunity, most ADRs are thinly traded in the U.S. and their prices include "noise" (e.g., from bid-ask bounce) and are less sensitive to current-day U.S. market movements. More significantly, this model suffers from the absence of fair value pricing for the 149 portfolio securities without ADRs.

The single-factor S&P top-down model performs reasonably well on AR but poorly on VR. Its real world performance would be weaker if there were changes in portfolio composition. Hence we have assumed the portfolio stayed constant throughout our test period. The single-factor S&P bottom-up model performed almost exactly the same as the top-down version. We nonetheless view the bottom-up model more favorably because in the event of portfolio changes, the bottom-up model would not degrade as the top-down model would.

Performance improves when we add the Nikkei future as a second factor. This is the model used in Zitzewitz (2002).

The best performance, however, is obtained with the multi-factor model. It eliminates more of the arbitrage opportunity (although within a standard error, it's equivalent to all models except the "Mark to ADR") but, more importantly, gets substantially closer to the next day opening prices.

[6] Each of these models was optimized as best as we could determine. For instance, we used the S&P 500 in the one-factor model so we could use its liquid future price to measure the change between foreign closes at 2:00 or 3:00 a.m. and 4:00 p.m. For comparability, we used a rolling 12-month historical sample to estimate the model each day. We do find slightly better performance when we use more than 12 months of history and we will be increasing our historical database over time.

[7] This table shows VR at the portfolio level, because this is the level at which prices are publicly viewed. At the individual security level, the VR advantage of a multi-factor model is even greater.

Fair Value in a World with 24-hour Trading

Some industry observers have argued that 24-hour trading means that, eventually, "every security will have an ADR" (i.e., will be tradable, but perhaps not have liquidity, 24 hours a day). As a preview of how the models will perform in such a world, we can examine the performance of a hypothetical portfolio including only the 101 securities that have ADRs.[8]

Table 2: Results for ADR-Only Portfolio

Model	Arbitrage Profit with Local Close	Arbitrage Profit with Fair Value	Standard Error	Variance Reduction	**Information left out of fair value estimates relative to Interactive Data Pricing & Reference Data model**
"Mark to ADR"	59.8%	18.8%	9.6%	59.4%	**5%**
S&P-only	59.8%	6.7%	10.9%	51.4%	**17%**
S&P and Nikkei	59.8%	1.9%	10.7%	53.7%	**14%**
Interactive Data Pricing & Reference Data multi-factor	59.8%	-1.8%	9.6%	62.5%	**--**

One observation from Table 2 is that the ADR-only model, unsurprisingly, performs relatively better on the ADR-only portfolio with regard to Variance Reduction, but a multi-factor model still outperforms it by 3.1%. The non-ADR factors correct for the bid-ask bounce and low liquidity which cause some ADR prices to be stale by several minutes to several hours.) Second, with regard to Arbitrage Reduction, the "Mark to ADR" approach still fails to come within one standard error of zero. In summary, the advantage of a multi-factor approach over other approaches even exists for ADR securities. Thus, when an ADR is available, it contributes significant information and so makes sense to use, but it should be used in combination with other information-rich factors.

Conclusion

Given the intuitive appeal and demonstrably superior performance of a multi-factor model, why are some industry players advocating less effective approaches? One reason is probably that it takes much more work to construct a multi-factor model. For instance, it requires at least one year of intra-day prices at the closing times of every foreign exchange to develop data for approximately 800 ADRs, sector indices, ETFs and futures. Another reason is that selection of a correct set of factors is not a trivial exercise. This is especially true in selecting futures and sector indices. There is no easy answer as to whether, with respect to the financial securities industry, a banking index, the Treasury yield curve, or both, is the "best" factor to include.

One reason we advocate using the VR test is its ability to detect noise. Our initial models added some "noise" to fair value prices when we applied them out of sample. Over the past two years, we have refined the model and eliminated much of this noise. The noise was unacceptable, in part because, to the extent it was predictable by an outside party, it was adding a source of NAV predictability that could have been exploited by smart arbitrageurs using complex strategies. (As we show above, AR against a simple trading strategy is reasonably easy to achieve with almost any model.) Another reason is that the VR test is a sensitive means of measuring closeness, that is, for comparing the "appropriateness" of fair value estimates against the next day's opening prices.

[8] Due to our selection of large cap portfolio securities, the corresponding ADRs are also large capitalization issues. Based on tests not reported here, the relative advantage of a multi-factor model would be greater when applied to smaller cap ADRs.

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