Profitability of Momentum Strategies in the International Equity Markets

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Abstract

This paper examines the profitability of momentum strategies implemented on international stock market indices. Our results indicate statistically significant evidence of momentum profits. The momentum profits arise mainly from time-series predictability in stock market indices, and very little profit comes from predictability in the currency markets. We also find higher profits for momentum portfolios implemented on markets with higher volume in the previous period, indicating that return continuation is stronger following an increase in trading volume. This result confirms the informational role of volume and its applicability in technical analysis.

I. Introduction

An extensive body of recent finance literature documents that stock returns are predictable based on past price history. Numerous studies examine the profitability of trading strategies that exploit interdependence of time-series returns and show that these strategies could lead to abnormal returns. For example, Jegadeesh and Titman (1993) document that over a horizon of three to twelve months, past winners on average continue to outperform past losers by about one percent per month, showing that there is "momentum" in stock prices. There are two possible explanations for the momentum effect. First, stock prices underreact to information. Chan, Jegadeesh and Lakonishok (1996) show that stock prices respond gradually to earnings news and that a substantial portion of the momentum effect is concentrated around subsequent earnings announcements. Hong, Lim, and Stein (1999) find that underreaction of stock prices depends on analyst coverage, which is pronounced with bad news. Second, investors tend to "flock" together. The herding behavior is documented by several studies. For example, Grinblatt, Titman, and Wermers (1995) find that the majority of mutual funds purchase stocks based on their past returns, namely by buying past "winners", and that funds showing the greatest tendency to buy past winners also tend to invest more intensely "with the crowd" than other funds do. Also, Lakonishok, Shleifer, and Vishny (1992) find evidence of pension fund managers either buying or selling in herds, with slightly stronger evidence that they herd around small stocks.

Several recent studies evaluate the profitability of the strategy for international equities. Rouwenhorst (1997) finds that momentum strategies are profitable for equities in 12 European markets, and Rouwenhorst (1999) also reports that emerging market stocks exhibit momentum. On the other hand, Bekaert, Erb, and Harvey, and Viskanta (1997) find that momentum strategies are not consistently profitable for emerging markets, although they perform better when the investable indexes are examined.

In this paper, we extend the analysis of momentum strategies to the global equity markets, and contribute to the literature as follows. First, we implement the momentum strategies based on individual stock market indices. As a growing number of international

equity funds gain access to foreign equity markets, portfolio managers have to make top-down decisions on international asset allocations. In fact, Keppler (1990) and Macedo (1995) document the potential benefits of style investment strategies applied to country selection. By analyzing momentum strategies based on stock market indices, this paper examines whether these strategies are useful for country selection.

Second, we examine how the profitability of international momentum strategies is affected by exchange rate movements. Profits from international momentum investment portfolios depend on the interrelationship between the currency and equity markets. Consider a U.S. investor who implements a momentum strategy that involves buying British stocks when the value of British stocks increases (in terms of U.S. dollars). The value of her portfolio depends on how the equity and currency markets affect each other. If, for example, British pounds tend to appreciate following a rise in the British equity market, the U.S. investor profits when she liquidates the British stock portfolio and converts back to U.S. dollars. Similarly, if the value of British stocks tends to increase following British pound appreciation, the U.S. investor also profits. In both cases, the momentum profits do not come from return continuation in the equity market, but from the interdependence between the currency and equity markets. In this paper, we analyze whether international momentum profits are attributable to this interdependence.

Third, we investigate whether trading volume information affects the profitability of momentum strategies. Volume has long received attention from technical analysts who believe that volume data provides important information about future price movements. There is a common belief that "it takes volume to move prices". Without sufficient trading volume, stock prices may underreact to information. Thus, if a country underreacts to information on low trading activity, the momentum strategy applied to this country will be profitable. Several theoretical papers also show that traders can learn valuable information about securities from past volume information (Grundy and McNichols (1990), Blume, Easley, and O'Hara (1994), and Campbell, Grossman, and Wang (1993)). A few empirical papers also document that trading volume does contain information about future stock prices. Conrad, Hameed, and Niden (1994) find that high-volume securities

experience price reversals, while low-volume securities experience price continuations. Gervais, Kaniel, and Mingelgrin (1998) show that individual stocks whose trading volumes are unusually large (small) tend to experience large (small) subsequent returns. Lee and Swaminathan (1998) illustrate that past trading volume predicts both the magnitude and persistence of future price momentum and, over intermediate horizons, price momentum strategies work better among high volume stocks. Nevertheless, as these studies are on individual stocks, it is unclear if similar results will hold for our momentum strategies that are implemented on stock market indices.

The paper is organized as follows. Section II presents the framework of analysis of momentum strategies. Section III presents the empirical results. Section IV presents robustness tests, and Section V concludes the paper.

II. Analysis of Momentum Strategies

A. Basic Momentum Strategies

The formulation of the trading strategies is similar in spirit to the strategies formulated by Lehmann (1990), Lo and MacKinlay (1990) and Conrad and Kaul (1994). The portfolio weights for the trading strategies are determined by the past performance of the asset relative to the average performance of all assets being considered. However, in contrast to previous studies that consider buying or selling individual stocks, our strategies are to long or short individual stock market indices. Therefore, we assume that there is no restriction for investors in trading portfolios of stocks in individual markets worldwide. Investors who do not have positions in individual markets might not be able to implement such strategies because, in some markets, short-selling of equities is prohibited or stock index futures are not available. These strategies are, however, useful to international money fund managers who need to reallocate funds across different markets.

We consider, from the perspective of a U.S. investor, the trading strategies for N equity markets in period t. Since our strategies are implemented on foreign stock indices, the profit from investing in foreign markets has to be converted into U.S. dollars.

Consequently, exchange rate movements will also be considered explicitly in the determination of portfolio weights.

If R_{it} denotes the U.S. dollar return from investing in stock index i at time t, r_{it} denotes the local currency return at time t, and e_{it} denotes the percentage rate of change of local currency price (relative to U.S. dollars) at time t, then $R_{it} \cong r_{it} + e_{it}$. We consider an investor who buys or sells stocks at time t, based on their performance at time t-1. Let $w_{it}(k)$ denote the fraction of the momentum portfolio devoted to stock index i at time t, where k is the number of weeks between time t-1 and t. The momentum portfolio is constructed by evaluating the performance of stock index i with the other stock indices at time t-1:

$$(1) \qquad w_{it}(k) = \frac{1}{N}[R_{it-1} - R_{mt-1}] ,$$

where R_{mt-1} $(=\frac{1}{N}\sum_{i=1}^{N} R_{it-1})$ is the cross-sectional average of stock index returns across N markets at time t-1. The portfolio weights are consistent with the philosophy of momentum strategies whereby an investor in period t will long the winner countries and short the loser countries of the period t-1. Since the portfolio weights are proportional to the differences between the individual stock market returns and the cross-sectional averages, countries that deviate more from the average at time t-1 will have greater (absolute) weight in the time t portfolio.

By holding the position in period t, the investor will earn a profit equal to $\pi_t(k) = \sum_{i=1}^{N} w_{it}(k)\, R_{it}(k)$. Since $\sum_{i=1}^{N} w_{it}(k) = 0$, this strategy will lead to a zero cost portfolio. The aggregate investment long and short in the zero-cost strategies at time t, $I_t(k)$, is given by

$$(2) \qquad I_t(k) = \sum_{i=1}^{N} |w_{it}(k)| .$$

Since the arbitrage strategies are zero-cost ones, the portfolio weights can be arbitrarily scaled to obtain any level of profits in a frictionless world. Therefore, we need to assess the economic significance of the profits, beyond the statistical significance. We will

calculate a "return" measure, which is to divide the expected profits by the length of the holding period and by the amount of investment in the long or short position, i.e., $E(\pi_t(k))/(0.5*k*I_t(k))$. This "return" could be interpreted as the per-period profits for every dollar invested in the long or short position for the arbitrage strategy. It could also be interpreted as the difference in per-period returns between the winner and loser portfolios.

B. Decomposition of Momentum Profits

We could decompose the profits from the momentum strategies into the equity component, the currency component, and some interaction components.

Since $R_{it} \cong r_{it} + e_{it}$, $w_{it}(k) = \frac{1}{N}[(r_{it-1} + e_{it-1}) - (r_{mt-1} + e_{mt-1})]$, where $r_{mt-1} = \frac{1}{N}\sum_{i=1}^{N} r_{it-1}$ and $e_{mt-1} = \frac{1}{N}\sum_{i=1}^{N} e_{it-1}$, the profit from the momentum strategy in period t can be expressed as:

(3)
$$\pi_t(k) = \sum_{i=1}^{N} w_{it}(k)\, R_{it}(k)$$

$$\cong \frac{1}{N}\{\sum_{i=1}^{N} [(r_{it-1} + e_{it-1}) - (r_{mt-1} + e_{mt-1})]\,[r_{it} + e_{it}]\}$$

$$= \frac{1}{N}\{\sum_{i=1}^{N} (r_{it-1} - r_{mt-1})\, r_{it} + \sum_{i=1}^{N} (r_{it-1} - r_{mt-1})\, e_{it} +$$

$$\sum_{i=1}^{N} (e_{it-1} - e_{mt-1})\, r_{it} + \sum_{i=1}^{N} (e_{it-1} - e_{mt-1})\, e_{it}\} .$$

Taking expectations of both sides, the expected profit to the momentum strategy $E(\pi_t(k))$ can be decomposed into four components:

(4)
$$E(\pi_t^1(k)) = \frac{1}{N}\sum_{i=1}^{N} E\{(r_{it-1} - r_{mt-1})\, r_{it}\}$$

$$E(\pi_t^2(k)) = \frac{1}{N}\sum_{i=1}^{N} E\{(r_{it-1} - r_{mt-1})\, e_{it}\}$$

$$E(\pi_t^3(k)) = \frac{1}{N} \sum_{i=1}^{N} E\{(e_{it-1} - e_{mt-1})\, r_{it}\}$$

$$E(\pi_t^4(k)) = \frac{1}{N} \sum_{i=1}^{N} E\{(e_{it-1} - e_{mt-1})\, e_{it}\}.$$

The first component, $E(\pi_t^1(k))$, reflects profits due to predictability of equity returns based on past equity performance. The component is positive if the equity market, which performs better than average in period t-1, is expected to rise further in period t. The second component, $E(\pi_t^2(k))$, reflects profits due to predictability of exchange rate returns based on past equity performance. The component is positive if a country whose equity market performs better than average in period t-1 experiences currency appreciation in period t. The third component, $E(\pi_t^3(k))$, reflects profits due to predictability of equity returns based on past exchange rate performance. The component is positive if a country whose currency appreciates (relative to a basket of currencies) in period t-1 experiences a rise in the equity market in period t. The fourth component, $E(\pi_t^4(k))$, reflects profits due to predictability of exchange rate returns based on their past performance. The component is positive if a country whose currency appreciates (relative to a basket of currencies) in period t-1 experiences further currency appreciation in period t.

C. Market Capitalization-Weighted Momentum Strategies

In the previous momentum strategies, the amount invested (or shorted) in one market depends on how much the individual stock market out-performed (or under-performed) the world market. For some small and illiquid markets, the size of the position (long or short) could be unrealistic and not in proportion to the capitalization of the markets. To overcome this problem, we construct another set of momentum strategies that take into account the market capitalization weights. The portfolio weight for country i is computed as:

(5) $$w^M_{it}(k) = h_{it-1}\,[R_{it-1} - R_{mt-1}]\,,$$

where h_{it-1} is the market capitalization weight of country i at time t-1, with $\sum_{i=1}^{N} h_{it-1} = 1$.

Since the portfolio weights depend on h_{it-1}, an investor will not take a very large long or short position in the small markets even if they out-perform or under-perform the world market significantly. Since $\sum_{i=1}^{N} w^{M}_{it}(k) = 0$, these new weights will also lead to a zero cost momentum investment portfolio.

III. Empirical Results

A. Data

We obtain from PACAP datatape, the equity market indices for Thailand, Taiwan, Malaysia and Indonesia while the remaining equity indices are taken from Datastream. Table 1 lists the 23 sample countries, along with their equity market indices and the length of the sample period. Of the 23 countries, nine are from the Asia-Pacific (Australia, Hong Kong, South Korea, Japan, Singapore, Thailand, Taiwan, Malaysia, Indonesia), eleven are from Europe (Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, Switzerland, UK), two are from North America (Canada and U.S.), and one from Africa (South Africa). Except for Austria, South Africa and Indonesia, the sample period is from 80/1/1 to 95/6/30, a span of more than 15 years. The analyses are conducted based on stock indices denominated in U.S. dollars. The index values are converted from foreign currencies to U.S. dollars based on daily exchange rates retrieved from Datastream. In addition, we collect trading volume for these countries. Except for six countries (Belgium, Denmark, Italy, S. Africa, Spain, and Switzerland), we are able to obtain volume measures in terms of either turnover or dollar volume.

Given that these stock markets operate in different time zones with different trading hours, their rates of return on a given calendar day may, in fact, represent the returns realized over different time periods. However, since we conduct the analysis using weekly data or data sampled less frequently, this reduces the potential estimation biases arising from non-synchronous data. To reduce further the non-synchronous data bias, the weekly

interval is defined differently for the evaluation period and holding period. For the evaluation period, a week is taken to begin on Wednesday and end on Wednesday. For the holding period, a week is taken to begin on Thursday and end on Thursday.[1] Since the evaluation period ends before the holding period starts, this guarantees that the trading strategies do not use price information of any countries from the holding period.

B. Profits to Momentum Strategies

We first implement the basic momentum strategies. In period t, we long the winner countries and short the loser countries, and the portfolio weights are constructed based on equation (1). We use five different holding periods k, where k equals 1 week, 2 weeks, 4 weeks, 12 weeks and 26 weeks. [2]

We calculate the aggregate momentum profits across all countries at time t as $\pi_t(k) = \sum_{i=1}^{N} w_{it}(k) R_{it}(k)$, where N is the number of countries. In addition to calculating the total profits to the momentum strategies, we decompose them into the four profit components as discussed in Section II.

1. Whole Sample Period

Table 2 reports the results for the whole sample period. The average of total momentum profits (π_t) is 0.0024 cents for 1-week interval, 0.012 cents for 2-week interval, 0.020 cents for 4-week interval, 0.035 cents for 12-week interval, and 0.195 cents for 26-week interval. The table also contains the z-statistics that are asymptotically distributed as N(0,1), under the null hypothesis that the "true" profits are zero, and are corrected for

[1] For the evaluation period, if the beginning (ending) Wednesday is a holiday, then the weekly interval begins (ends) on Thursday (Tuesday). For the holding period, if the beginning (ending) Thursday is a holiday, then the weekly interval begins (ends) on Friday (Wednesday).

[2] The length of the evaluation period is the same as the holding period. For example, for a 4-week holding period strategy, we form momentum portfolios based on the past 4-week performance of the countries. We have also done sensitivity tests by varying the holding period, while keeping the length of the evaluation period constant. In general, we find that the momentum profits decrease with the length of the holding period.

heteroskedasticity and autocorrelation based on Newey-West adjustment (1987). In general, the first profit component (π_t^1) is much higher than the other profit components - it contributes more than 90% of total profits for the 1-week holding period, and more than 80% for the 2-week and 26-week holding periods. This indicates that predictability within the equity markets is the most significant source of momentum profits. In contrast, the contribution of the second component (π_t^2) and the fourth component (π_t^4) to the momentum profits is relatively small. Finally, the third profit component (π_t^3) has a negative contribution to the momentum profits for the 12-week and 26-week holding periods, indicating a negative relationship between lagged exchange rate returns and equity returns. Therefore, the evidence indicates that even taking into account exchange rate fluctuation does not add much to momentum profits.

To assess the economic significance of profits, we calculate the weekly "returns" by dividing total profits by the length of the holding period and by the total investment long or short, i.e., $\pi_t(k) /(0.5*k*I_t(k))$. One way to interpret the weekly "returns" is that they represent the difference between the weekly returns of the winner portfolios and loser portfolios. Table 2 shows that the weekly "returns" are statistically significant (with z-statistics of bigger than two) except for the 12-week holding period, and the magnitudes are quite high for short holding periods. For example, the average of weekly "returns" is 0.48% for the 2-week holding period, and 0.25% for the 4-week holding period. In other words, the difference between the returns of winner and loser portfolios is at least 0.25% per week. Therefore, an active global asset allocation strategy that reallocates an equity investment from loser countries to winner countries in accordance with our momentum strategies for every 2 to 4 weeks will outperform a passive buy-and-hold strategy by at least 1% per month.

To gauge whether the significance tests are sensitive to the assumption of N(0,1) for the test statistics, we also conduct bootstrap simulations in which the returns of stock market indices are "scrambled" simultaneously, in an attempt to eliminate any time-series relations, while maintaining cross-market correlations. We implement momentum strategies on 2000 boostrap samples, and calculate the p-values which measure the

proportion of times the simulated profits are greater than the actual profits. The bootstrap results are even stronger. For example, the p-values are 0.1%, 0%, 0%, 7.3% and 1.3% for the "weekly" returns of the 1-week, 2-week, 4-week, 12-week, and 26-week holding periods. The momentum returns remain statistically significant (at 5% level) for all except the 12-week holding period.

2. Post-1985 Period

If the success of momentum strategies is due to market segmentation, we would expect the momentum strategies to be less profitable in a more recent sample period when many countries allowed more foreign investors to access their stock markets. For instance, Japan abolished some capital market restrictions in the 1980s (see Bosner-Neal, Brauer, Neal and Wheatley (1990) and Gultekin, Gultekin, and Pentai (1989)), and a number of emerging markets removed or relaxed restrictions on foreign equity ownership in the 1990s (see Bekaert (1995)). To check the sensitivity of our results, we implement momentum strategies using the data after January 1, 1985. The choice of the post-1985 period is ad-hoc, and simply reflects our intention to keep a reasonably long sample period in order to maintain the power of the test. As there may be concern that the emerging markets were still segmented in late 1980s, we will perform additional robustness tests by excluding emerging markets from the analysis [see Section IV below].

The post-1985 results are reported in Table 3. They are generally comparable to those for the whole sample period. The first profit component (π_t^1) remains the most important in the contribution to the overall profits. There is no evidence that the momentum strategies are less profitable for a more recent sample period. On the contrary, the overall profits and weekly returns in the post-1985 period are slightly higher for holding periods from 2 weeks to 26 weeks than in the full-sample period.

3. Risk Adjustment for Individual Countries' Profits

In this section, we examine whether all countries earn significant momentum profits after adjusting for world beta risk. First, we compute the momentum profit for country i at

time t as $\pi_{it}(k) = w_{it}(k)\, R_{it}(k)$. We then normalize the momentum profit by dividing it by the aggregate investment long or short in the zero-cost strategies ($I_t(k)$). The normalized momentum profits (π^*_{it}) are then regressed on the excess world market return (R'_{mt}):

$$\pi^*_{it} = \alpha_i + \beta_i R'_{mt} + \varepsilon_{it} \quad . \tag{6}$$

The estimate of α_i from the regression measures abnormal profits of country i. By stacking the above regression equation for all countries, we have a multivariate regression model system where we assume the disturbances (ε_{it}) to be independent and identically distributed within each equation, but allow them to be heteroskedastic and contemporaneously correlated across equations. The system of regressions is estimated with generalized least squares. To allow comparability across countries, we use the post-1985 period when all 23 countries have data observations.

Results are reported in Table 4. To save space, only abnormal profits (alphas) are reported. For the 1-week holding period, the alphas are small and close to zero for most of the countries. The joint test that alphas are zero for all countries cannot be rejected at the 5% significance level. The alphas become higher for the 2-week and 4-week holding periods - 19 and 17 countries have positive alphas - and the joint test that alphas are zero can be rejected at the 1% significance level. For the 12-week and 26-week holding periods, the abnormal profits disappear, and quite a number of countries have negative alphas. Therefore, our evidence indicates that simple beta risk adjustment could explain most of the profits at long horizons, but not at short horizons (2 and 4 weeks).

C. Profits to Market Capitalization-Weighed Momentum Strategies

To implement market capitalization-weighted strategies, we obtain the year-end market capitalization for the 23 countries during the 1980-1994 period from a factbook published by the International Finance Corporation. Ideally, we would like to construct momentum portfolio weights in accordance with equation (5) and based on market capitalization weights in the previous year. However, since we do not have market capitalization data for 1979, we will use the market weights at the end of 1980 to construct

the portfolio weights during 1980. Since the market capitalization weights do not change dramatically within a year, we think that using the ex-post market capitalization data for only one year (1980) will not bias the results substantially.

We do not report the market capitalization weights here. However, it should be noted that several countries dominate the world stock market capitalization. Throughout the whole sample period, the five largest stock markets (U.S., Japan, United Kingdom, France, and Germany) account for about 75% of the world market capitalization. The market capitalization weights of the remaining countries are therefore quite small. For example, in 1994, the ten smallest stock markets (Austria, Belgium, Denmark, Indonesia, Italy, Norway, Spain, Singapore, South Korea and Thailand) accounted for only 10% of the world market capitalization. If momentum profits arise mainly from the small and illiquid markets, then the momentum strategies that take into account market capitalization weights could become unprofitable.

Table 5 reports profits to market capitalization-weighted momentum strategies. The overall profits are generally smaller than the profits of previous momentum strategies that are not based on market capitalization weights. Nevertheless, the returns from the market capitalization-weighted strategies remain statistically significant for the short holding periods. We also analyze the profits from buying winners and selling losers separately. We find that buying winner portfolios yields significant profits consistently, but selling loser portfolios creates either insignificant profits or losses.

D. Effects of Trading Volume on Momentum Profits

In this section, we examine the role of trading volume in momentum strategies. Several theoretical papers conjecture that there is a relation between trading volume and predictable patterns in short-horizon security returns. Blume, Easley and O'Hara (1994) show that volume provides information that cannot be deduced from the price statistic and demonstrate that traders who use information contained in the volume statistic will do "better" than traders who do not. Campbell, Grossman and Wang (1993) argue that because the variations in the aggregate demand of the liquidity traders also generate large

levels of trade, volume information can help distinguish between price movements that are due to fluctuating demands of liquidity traders and those that reflect changes in expected returns. An implication of the model is that price changes accompanied by large trading volumes tend to be reversed. Wang (1994) examines the link between the nature of heterogeneity among investors and the behavior of trading volume and its relation to price dynamics. In the model, uninformed investors trade against informed investors and will revise their positions when they realize their mistakes. When the return is high in the previous period, it could be due to private information of informed investors or simply buying pressure for non-informational reasons. If it is due to private information, the high realized return accompanied by high volume in the past will be followed by high future returns. If it is due to non-informational reasons, the high realized return will be followed by low future returns. Conrad, Hameed and Niden (1994) provide empirical evidence on these relations. They find that high-transaction securities experience price reversals, while the returns of low-transactions securities are positively autocorrelated, a result that seems to be consistent with Campbell, Grossman, and Wang (1993).

Since the predictability of short-term returns might be affected by trading volume, we examine whether the volume information could affect the momentum profits. For period t, we construct momentum portfolios, and for each equity market, we compare the market trading volume in period t-1 and t-2. The momentum portfolios are divided into portfolios of countries with high and low lagged trading volume. Following Conrad, Hammed, and Niden (1994), the trading volume of a country is defined as high (low) if the volume in period t-1 is higher (lower) than the volume in period t-2. While such a definition seems to be ad-hoc, but since the length of the time interval varies from 1 week to 26 weeks, we already consider the information contents of trading volume over different holding periods.

The momentum profits to the high and low lagged volume groups are reported in Table 6. It must be noted that our analysis covers only 17 countries, as we do not have trading volume data for six countries (Belgium, Denmark, Italy, S. Africa, Spain, and Switzerland). Except for the 26-week holding period, the profits and weekly returns are

higher for the portfolios of countries with high lagged trading volume than for the portfolios of countries with low lagged trading volume. This indicates that price continuation is stronger following an increase in trading volume. This result is not consistent with the conjecture that momentum profits arise from underreaction to information due to insufficient trading. It also contradicts the prediction of Campbell, Grossman and Wang (1993) and the empirical evidence in Conrad, Hameed, and Niden (1994). Finally, the evidence also suggests that price continuation could not be explained by nonsynchronous trading. According to the nonysnchronous trading hypothesis, when trading volume is high at time t-1, most of the information should already be incorporated into the prices at t-1, so that there will be less return continuation at time t. We further examine the effects of nonsynchronous trading in the next section.

IV. Robustness Tests

A. Nonsynrchronous Trading

One possible explanation for momentum profits is the presence of nonsynchronous trading. When there is nonsynchronous trading, index returns are likely to be autocorrelated, so that the momentum strategies that exploit return continuation might seem to be profitable. To mitigate the effect of nonsynchronous trading, we implement momentum strategies with a lag of one week, that is, buying winner countries and selling loser countries one week after we evaluate the past performance. If all component stocks underlying stock indices trade at least once a week, this procedure will be adequate in eliminating any spurious momentum profits due to nonsynchronous trading. Certainly, if the stocks trade much more frequently and momentum builds up within a week, this correction procedure will over-adjust for the nonsynchronous trading bias and then the momentum profits will be understated.

Table 7 reports the results. Except for the 1-week holding period, the profits are smaller than those generated without the implementation lag. Nevertheless, all profits remain statistically significant. Therefore, not all of the momentum profits can be

explained by nonsynchronous trading.

B. Exclusion of Emerging Markets

Our previous results show that a significant portion of momentum profits comes from emerging markets. This is also consistent with the evidence in Harvey (1995) and Bekaert, Erb, Harvey, and Viskanta (1997) who document that emerging market returns have higher autocorrelation and are more predictable. Given the low liquidity of these emerging markets, there are questions about the momentum profits being spurious. To examine this possibility, we implement the strategies on a subset of markets, discarding six emerging markets from our sample (S. Korea, S. Africa, Thailand, Taiwan, Malaysia, and Indonesia).

Table 8 reports the results of implementing the strategies on only the non-emerging markets. The evidence indicates that the momentum profits become smaller than those obtained when all 23 countries are included. For example, the average weekly returns decrease to 0.14% for the 1-week horizon and to 0.28% for the 2-week horizon. Nevertheless, the profits remain statistically significant.

C. Different Betas in the Up and Down Markets

Another explanation for the momentum profits is that the simple beta adjustment in Section III.B is not adequate in reflecting compensation for risks. As reported by Rouwenhorst (1998), the winners and losers could have different betas in up and down markets. To evaluate this possibility, we regress excess U.S. dollar returns (in excess of the U.S. risk-free rate) of the momentum portfolios on the excess U.S. dollar returns of the Morgan Stanley Capital International (MSCI) world index, but allow for different betas in the up and down markets as follows:

$$(7) \qquad R_{pt} - r_{ft} = \alpha + \beta^{+} D_t (R_{mt} - r_{ft}) + \beta^{-} (1 - D_t)(R_{mt} - r_{ft}) + \varepsilon_{pt} \ ,$$

where R_{pt} is the return of the momentum portfolio at time t, r_{ft} is the U.S. risk-free rate at

time t, [3] R_{mt} is the return of the MSCI market index at time t, and D_t is a dummy variable that is one if the MSCI return is positive at time t and zero otherwise. We estimate the above regression for returns for winner portfolios, loser portfolios, and the winner minus loser portfolios for different holding periods. To save space, only results for the winner minus loser portfolios are reported.

For the momentum effect to be consistent with market dependent betas, winners will have higher betas in an up market and lower betas than losers in a down market. The evidence in Panel A of Table 9 is partially consistent with this explanation. Except for the 1-week holding period, the coefficient β^+ is positive, suggesting that the winner countries have higher betas than the loser countries during the up market. On the other hand, the coefficient β^- is negative for the 1-week, 2-week, and 4-week holding periods, indicating that winner countries have lower betas than the loser countries during the down market. After adjustment for the changing betas in the up- and down-market, the risk-adjusted returns (alphas) become smaller and are statistically significant only for the 2-week holding period.

We also perform similar risk adjustment for returns of momentum portfolios partitioned by high and low past trading volume. Results are reported in Panel B of Table 9. For the momentum portfolios with low past trading volume, the risk-adjusted returns are generally insignificant. However, for the momentum portfolios with high past trading volume, the risk-adjusted returns remain high and statistically significant for short horizons. Therefore, even though the beta risks could account for the returns to momentum strategies under low trading volume, they do not fully explain the observed returns to momentum strategies when trading volume is high.[4]

[3] Although the risk-free rate is realized for time t, the investors already observe the interest rate at time t-1.

[4] Besides the betas, we also calculate the variance of high volume and low volume momentum portfolios. We find the variance of high volume portfolios is lower than the variance of low volume portfolios and therefore refute the conjecture that the profits to high volume portfolios are due to higher total risks.

V. Concluding Remarks

This paper examines the profitability of momentum strategies formed based on past returns of country indices in the global equity markets. Our results indicate evidence of momentum profits that are statistically and economically significant, especially for short holding periods (less than 4 weeks). Although the momentum profits could be increased by exploiting exchange rate information, the major source of momentum profits arises from price continuations in individual stock indices. Evidence also indicates that the momentum profits cannot be completely explained by nonsynchronous trading and are not confined to emerging markets, although it seems that they diminish significantly after adjusting for beta risk.

An interesting result is that when we implement the momentum strategies on markets that experience increases in volume in the previous period, the momentum profits are higher. This indicates that return continuation is stronger following an increase in trading volume. This result seems to contradict the hypothesis of underreaction and price reversals of liquidity-related trades as predicted by Campbell, Grossman, and Wang (1993), but is consistent with the herding behavior theory, in which investors tend to follow the crowd in buying and selling securities. We must point out that our evidence is different from Conrad, Hameed, and Niden (1994), who document that the price changes accompanied by higher trading volume tend to be reversed in the following period. One difference between our study and Conrad, Hameed, and Niden is that we study individual stock indices in the international equity markets while they study individual securities in the U.S. market. This seems to suggest that the relation between trading volume and price continuation (or price reversal) is different between individual stocks and the market. This could be an interesting topic for future work.

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Table 1

Sample countries, stock market indices, trading volume, and sample periods

Country	Index Name	Market Trading Volume Available	Currency	Sample Period
Australia	AUSTRALIA ALL ORDINARY INDEX	Yes	Australian Dollar	80/1/1 - 95/6/30
Austria	AUSTRIA GZ ALLSHARE INDEX	Yes	Austrian Schilling	81/1/1 - 95/6/30
Belgium	BRUSSELS SE GENERAL INDEX	No	Belgium Franc	80/1/1 - 95/6/30
Canada	TORONTO SE (300) COMPOSITE INDEX	Yes	Canadian Dollar	80/1/1 - 95/6/30
Denmark	COPENHAGEN SE GENERAL INDEX	No	Danish Kroner	80/1/1 - 95/6/30
France	FRANCE-DS MARKET INDEX	Yes	French Franc	80/1/1 - 95/6/30
Germany	FAZ GENERAL INDEX	Yes	Deutsche Mark	80/1/1 - 95/6/30
Hong Kong	HANG SENG INDEX	Yes	Hong Kong Dollar	80/1/1 - 95/6/30
S. Korea	KOREA SE COMPOSITE (KOSPI) INDEX	Yes	Korean Won	80/1/1 - 95/6/30
Italy	MILAN BANCA COMM.ITAL. INDEX	No	Italian Lire	80/1/1 - 95/6/30
Japan	NIKKEI STOCK AVERAGE (225) INDEX	Yes	Japanese Yen	80/1/1 - 95/6/30
Netherlands	CBS ALL SHARE GENERAL INDEX	Yes	Dutch Guilder	80/1/1 - 95/6/30
Norway	OSLO STOCK EXCHANGE INDUSTRY INDEX	Yes	Norwegian Kroner	80/1/1 - 95/6/30
S. Africa	JOHANNESBURG SE INDUSTRIALS INDEX	No	S. African Rand	84/2/1 - 95/6/30
Spain	MADRID S.E. INDEX	No	Spanish Peseta	80/1/1 - 95/6/30
Singapore	SINGAPORE-STRAITS T. INDUSTRIAL INDEX	Yes	Singapore Dollar	80/1/1 - 95/6/30
Switzerland	CREDIT SUISSE GENERAL INDEX	No	Swiss Franc	80/1/1 - 95/6/30
U.K.	FT ORDINARY SHARE INDEX	Yes	Sterling Pound	80/1/1 - 95/6/30
U.S.	DOW JONES INDUSTRIALS INDEX	Yes	U.S. Dollar	80/1/1 - 95/6/30
Thailand	BANGKOK S.E.T. INDEX	Yes	Thailand Baht	80/1/1 - 95/6/30
Taiwan	TAIWAN WEIGHTED INDEX	Yes	Taiwan Dollar	80/1/1 - 95/6/30
Malaysia	KUALA LUMPUR COMPOSITE INDEX	Yes	Malaysian Ringgit	80/1/1 - 95/6/30
Indonesia	JAKARTA COMPOSITE INDEX	Yes	Indonesian Rupiah	85/1/1 - 95/6/30

Table 2
Profits to Momentum Strategies
Implemented on Stock Market Indices of 23 Countries in the Full-Sample Period

The table contains the decomposition of profits to international momentum strategies that long winner stock indices and short loser stock indices. All indices are denominated in U.S. dollars. The sample period is from 80/01/01 to 95/06/30. We form momentum portfolios (buy winners and sell losers) based on past performance of stock market indices. The weight of each index is based on the deviation of its return in the previous period from the cross-sectional average return. We use five different holding periods, ranging from 1 week to 26 weeks. All profit estimates and aggregate investment weights are multiplied by 1,000. π_t are average profits overall; π_t^1 are profits attributed to predictability of equity returns based on past equity returns; π_t^2 are profits attributed to predictability of exchange rate returns based on past equity returns; π_t^3 are profits attributed to predictability of equity returns based on past exchange rate returns; π_t^4 are profits attributed to predictability of exchange rate returns based on past exchange rate returns. Aggregate investment weight is defined as $I_t(k) = \sum_{i=1}^{N} |w_{it}(k)|$, where w_{it} is the weight of index i at time t, and $R_t(k)$, the weekly return, is equal to $\pi_t(k) /(0.5*k*I_t(k))$. The numbers in parentheses are z-statistics that are asymptotically N(0,1) under the null hypothesis that the relevant parameter is zero, and are corrected for heteroskedasticity and autocorrelation based on Newey-West adjustment (1987).

	1-week	2- week	4-week	12-week	26-week
π_t^1	0.023286	0.104034	0.154635	0.151245	1.6481
	(2.07272)	(4.77357)	(2.37499)	(0.53314)	(2.42505)
π_t^2	0.002997	0.015619	0.033848	0.173832	0.469455
	(1.18537)	(2.70056)	(2.12104)	(2.25263)	(2.07631)
π_t^3	0.001082	0.005815	-0.01281	-0.09791	-0.6057
	(0.48264)	(1.14298)	(-0.76844)	(-1.14518)	(-3.266)
π_t^4	-0.00258	0.004503	0.028817	0.132817	0.439519
	(-1.03485)	(0.95182)	(2.32403)	(2.12386)	(2.6466)
π_t	0.024785	0.12997	0.204487	0.359984	1.9513
	(1.91507)	(5.46304)	(2.72098)	(0.97656)	(2.38621)
Aggregate Investment	18.7814	27.1927	40.4157	74.3342	114.0949
Weekly Return (in %)	0.27743	0.48303	0.25371	0.0940992	0.1159
	(2.87784)	(6.30818)	(3.34746)	(1.31099)	(2.34978)

Table 3
Profits to Basic Momentum Strategies
Implemented on Stock Market Indices of 23 Countries in the Post-1985 Period

The table contains the decomposition of profits to international momentum strategies that long winner stock indices and short loser stock indices. All indices are denominated in U.S. dollars. The sample period is from 85/01/01 to 95/06/30. We form momentum portfolios (buy winners and sell losers) based on past performance of stock market indices. The weight of each index is based on the deviation of its return in the previous period from the cross-sectional average return. We use five different holding periods, ranging from 1 week to 26 weeks. All profit estimates and aggregate investment weights are multiplied by 1,000. π_t are average profits overall; π_t^1 are profits attributed to predictability of equity returns based on past equity returns; π_t^2 are profits attributed to predictability of exchange rate returns based on past equity returns; π_t^3 are profits attributed to predictability of equity returns based on past exchange rate returns; π_t^4 are profits attributed to predictability of exchange rate returns based on past exchange rate returns. Aggregate investment weight is defined as $I_t(k) = \sum_{i=1}^{N} |w_{it}(k)|$, where w_{it} is the weight of index i at time t, and $R_t(k)$, the weekly return, is equal to $\pi_t(k) /(0.5*k*I_t(k))$. The numbers in parentheses are z-statistics that are asymptotically N(0,1) under the null hypothesis that the relevant parameter is zero, and are corrected for heteroskedasticity and autocorrelation based on Newey-West adjustment (1987).

	1-week	2-week	4-week	12-week	26-week
π_t^1	0.02615	0.10836	0.16566	0.19465	1.8878
	(1.6964)	(3.8576)	(1.8713)	(0.5426)	(2.2241)
π_t^2	0.00156	0.0167	0.0364	0.24708	0.75487
	(0.4582)	(2.2398)	(1.9196)	(2.3926)	(2.4918)
π_t^3	-0.0011	0.00356	-0.0126	-0.0955	-0.336
	(-0.3921)	(0.5693)	(-0.6024)	(-0.9140)	(-1.4237)
π_t^4	-0.0046	0.00542	0.03862	0.10727	0.40442
	(-1.3749)	(0.8491)	(2.3522)	(1.3191)	(1.7966)
π_t	0.02206	0.13403	0.22806	0.45354	2.7112
	(1.2336)	(4.3839)	(2.2415)	(0.9883)	(2.6959)
Aggregate Investment	18.9972	27.389	40.9606	76.0427	117.2
Weekly Returns (in %)	0.2615	0.5018	0.2708	0.0968	0.1545
	(2.0526)	(5.0853)	(2.6950)	(1.0895)	(2.5665)

Table 4
Risk-Adjusted Momentum Profits on Individual Countries

This table reports risk-adjusted profits (alphas) from a multivariate regression of normalized profits of individual countries on excess returns of MSCI world market. We buy winner countries and sell loser countries based on past performance of stock market indices. We use five different holding periods, ranging from 1 week to 26 weeks. Profits of individual countries are normalized by dividing them by aggregate investment long or short in the momentum strategies. The numbers in parentheses are the t-statistics, which are adjusted for heteroskedastic disturbances of individual countries. The last row contains the p-values for the joint tests that alphas for all countries are equal to zero.

	1-week	2- week	4- week	12- week	26- week
Australia	-0.0959	0.61	0.03447	-2.101	-4.853
	(-0.5760)	(2.3640)	(0.4030)	(-3.7180)	(-6.1890)
Austria	0.473	0.674	0.166	3.324	6.358
	(1.9180)	(2.1360)	(1.1520)	(3.6120)	(4.6840)
Belgium	-0.0718	0.318	0.154	-0.31	-1.164
	(-0.7390)	(2.7530)	(3.2380)	(-1.0890)	(-2.4110)
Canada	0.03599	-0.0642	-0.101	-0.55	0.267
	(0.4130)	(-0.5800)	(-2.5080)	(-2.4070)	(0.8360)
Denmark	0.01949	0.282	0.03792	-0.99	-0.883
	(0.1630)	(2.1160)	(0.6720)	(-2.9880)	(-1.9200)
France	0.265	0.313	0.08939	0.568	0.266
	(2.2630)	(1.6820)	(1.1780)	(1.1230)	(0.4940)
Germany	0.196	0.211	0.09649	1.214	0.423
	(1.5740)	(1.3020)	(1.6090)	(2.9520)	(0.6030)
Hong Kong	-0.0766	-0.0154	-0.189	1.916	7.495
	(-0.2410)	(-0.0440)	(-1.8490)	(2.9270)	(7.3360)
S. Korea	0.07859	0.705	0.07612	1.83	9.006
	(0.2790)	(2.3480)	(0.7230)	(2.5160)	(7.7210)
Italy	-0.261	0.433	0.06313	2.27	4.191
	(-1.0710)	(1.2560)	(0.5120)	(2.7680)	(2.9000)
Japan	0.594	0.755	0.216	-0.799	0.835
	(2.1740)	(2.4340)	(1.9910)	(-1.2490)	(1.0590)
Netherlands	0.02127	0.06132	0.02516	-0.0882	-0.417
	(0.3510)	(0.7180)	(0.8570)	(-0.4670)	(-1.6070)
Norway	0.01877	0.169	-0.0887	-3.258	-3.452
	(0.1060)	(0.8550)	(-1.2780)	(-5.7990)	(-4.9800)
S. Africa	0.09949	0.07277	0.169	-2.598	-1.931
	(0.4040)	(0.2540)	(1.7020)	(-3.4590)	(-2.0110)
Spain	0.08056	-0.0184	-0.0132	-0.687	1.928
	(0.3180)	(-0.0670)	(-0.1440)	(-1.0130)	(2.2690)
Singapore	-0.0916	0.315	0.226	0.393	-0.525
	(-0.4660)	(1.2860)	(3.1140)	(0.7570)	(-0.5730)
Switzerland	0.06727	0.151	0.05792	-0.414	1.304
	(0.6810)	(1.2370)	(1.2150)	(-1.0010)	(2.5070)
U.K.	-0.0082	0.254	-0.0319	-1.529	-2.66
	(-0.0660)	(1.8190)	(-0.6150)	(-4.3750)	(-4.8150)
U.S.	-0.15	-0.113	-0.0296	-0.276	-0.667
	(-1.7250)	(-1.0780)	(-0.8930)	(-1.4920)	(-2.5070)
Thailand	0.466	0.512	0.346	-0.765	-5.636
	(1.3880)	(1.2400)	(2.3120)	(-0.6910)	(-3.3500)
Taiwan	1.793	3.981	0.954	5.238	5.399
	(1.8300)	(3.2580)	(1.9820)	(1.4280)	(1.4710)
Malaysia	-0.133	0.321	0.05158	0.978	-1.211
	(-0.5580)	(1.0940)	(0.5210)	(1.3770)	(-0.9510)
Indonesia	1.767	2.649	0.661	2.904	18.215
	(2.0330)	(3.9280)	(2.9160)	(2.0470)	(5.6340)
Testing alphas are equal to zero (p-values)	0.0651	0.0001	0.0001	0.0001	0.0001

Table 5
Profits to Market Capitalization-Weighted Momentum Strategies
Implemented on Stock Market Indices of 23 Countries in the Full-Sample Period

The table contains the decomposition of profits to international momentum strategies that long winner stock indices and short loser stock indices. All indices are denominated in U.S. dollars. The sample period is from 80/01/01 to 95/06/30. We form momentum portfolios (buy past winners and sell past losers) based on past performance of stock market indices and the market capitalization weights of the previous year. We use five different holding periods, ranging from 1 week to 26 weeks. All profit estimates and aggregate investment weights are multiplied by 1,000. Aggregate investment weight is defined as $I_t(k) = \sum_{i=1}^{N} |w^M_{it}(k)|$, where w^M_{it} is the weight of index i at time t, and $R_t(k)$, the weekly return, is equal to $\pi_t(k) / (0.5*k*I_t(k))$. The numbers in parentheses are z-statistics that are asymptotically N(0,1) under the null hypothesis that the relevant parameter is zero, and are corrected for heteroskedasticity and autocorrelation based on Newey-West adjustment (1987).

	1-week	2-week	4-week	12-week	26-week
Loser Portfolios	0.00699	0.01582	-0.0915	-0.6021	-1.9847
	(0.3423)	(0.5001)	(-1.3810)	(-2.0186)	(-2.1343)
Winner Portfolios	0.02007	0.07736	0.193	1.0673	4.4134
	(2.2010)	(3.2829)	(2.9938)	(2.8942)	(4.1731)
Loser + Winner Portfolios	0.02706	0.09317	0.10147	0.46517	2.4287
	(1.6492)	(3.6987)	(1.7879)	(1.3303)	(2.2720)
Aggregate Investment	16.6701	24.3707	36.2423	66.1335	103.568
Weekly Return (in %)	0.1401	0.3045	0.1052	0.0802	0.1732
	(1.6065)	(4.2294)	(1.6629)	(1.0755)	(2.8167)

Table 6
Profits to Momentum Portfolios With
High and Low Lagged Trading Volume

This table contains the profits to momentum strategies that long winner stock indices and short loser stock indices, and divides the portfolios into groups of high-volume and low-volume countries. We form momentum portfolios (buy winners and sell losers) based on past performance of stock market indices. The weight of each index is based on the deviation of its return in the previous period from the cross-sectional average return. The trading volume of a country is defined as high (low) if the volume in period t-1 is higher (lower) than volume in period t-2. We use five different holding periods, ranging from 1 week to 26 weeks. The sample period is from 80/01/01 to 95/06/30. All profit estimates and aggregate investment weights are multiplied by 1000. Aggregate investment weight is defined as $I_t(k) = \sum_{i=1}^{N} |w_{it}(k)|$, where w_{it} is the weight of index i at time t, and $R_t(k) = \pi_t(k)\ (0.5*k*/I_t(k))$. The numbers in parentheses are z-statistics that are asymptotically N(0,1) under the null hypothesis that the relevant parameter is zero, and are corrected for heteroskedasticity and autocorrelation based on Newey-West adjustment (1987).

	High Volume					Low Volume				
	1-week	2-week	4-week	12-week	26-week	1-week	2-week	4-week	12-week	26-week
Loser Portfolios	0.01701 (0.9299)	0.032666 (0.8886)	-0.028375 (-0.3284)	-0.426763 (-1.1194)	-3.4878 (-3.9095)	-0.012392 (-0.8896)	0.024025 (0.6340)	-0.098492 (-0.9471)	-0.69795 (-1.3400)	-2.6183 (-2.6935)
Winner Portfolios	0.01475 (0.6220)	0.113748 (2.6713)	0.285103 (2.8442)	0.566228 (1.2771)	3.7609 (3.3008)	0.033398 (1.6624)	0.064229 (2.0271)	0.11853 (1.6582)	0.86121 (2.6431)	3.0761 (3.8468)
Loser +Winner Portfolios	0.03176 (1.1218)	0.146415 (3.3599)	0.256728 (2.2030)	0.139465 (0.3690)	0.273096 (0.3154)	0.021007 (0.8521)	0.088253 (2.7072)	0.020038 (0.2623)	0.16326 (0.3709)	0.45784 (0.5527)
Aggregate Investment	17.6008	25.5806	38.2106	67.7373	104.5007	15.4193	22.4052	32.4668	60.1726	86.296
Weekly Returns (in %)	0.41255 (3.6905)	0.51676 (5.3162)	0.28171 (3.0940)	0.07080 (0.9134)	0.01791 (0.3076)	0.1554 (1.0934)	0.32295 (3.3397)	0.06466 (0.7945)	0.01285 (0.1502)	0.08122 (1.3437)

Table 7
Profits to Momentum Strategies
Implemented on Stock Market Indices with One-Week Lag

The table contains the decomposition of profits to international momentum strategies, which are implemented on stock market indices one week after the evaluation period. All indices are denominated in U.S. dollars. The sample period is from 80/01/01 to 95/06/30. We form momentum portfolios (buy winners and sell losers) based on past performance of stock market indices. The weight of each index is the deviation of its return in the previous period from the cross-sectional average return. We use five different holding periods, ranging from 1 week to 26 weeks. All profit estimates and aggregate investment weights are multiplied by 1,000. π_t are average profits overall; π_t^1 are profits attributed to predictability of equity returns based on past equity returns; π_t^2 are profits attributed to predictability of exchange rate returns based on past equity returns; π_t^3 are profits attributed to predictability of equity returns based on past exchange rate returns; π_t^4 are profits attributed to predictability of exchange rate returns based on past exchange rate returns. Aggregate investment weight is defined as $I_t(k) = \sum_{i=1}^{N} |w_{it}(k)|$, where w_{it} is the weight of index i at time t, and $R_t(k)$, the weekly return, is equal to $\pi_t(k) / (0.5*k*I_t(k))$. The numbers in parentheses are z-statistics that are asymptotically N(0,1) under the null hypothesis that the relevant parameter is zero, and are corrected for heteroskedasticity and autocorrelation based on Newey-West adjustment (1987).

	1-week	2-week	4-week	12-week	26-week
π_t^1	0.03867 (4.76231)	0.05649 (2.61193)	0.07258 (1.22021)	0.07685 (0.2663)	1.7102 (2.49368)
π_t^2	0.0045 (1.71294)	0.01289 (2.20673)	0.02831 (1.65729)	0.1617 (2.09664)	0.46662 (2.0462)
π_t^3	0.00161 (0.86546)	-0.00044 (-0.08291)	-0.01725 (-0.99876)	-0.08829 (-1.04866)	-0.61468 (-3.28058)
π_t^4	0.0037 (1.87681)	0.0082 (1.54072)	0.02874 (2.28944)	0.12406 (1.97415)	0.45832 (2.70514)
π_t	0.04849 (5.518)	0.07714 (3.1634)	0.11238 (1.5744)	0.27431 (0.73679)	2.0205 (2.46977)
Aggregate Investment	18.777	27.1901	40.4214	74.3496	114.174
Weekly Returns (in %)	0.47211 (6.11125)	0.28295 (3.71398)	0.13059 (1.75742)	0.073668 (1.01479)	0.12046 (2.44747)

Table 8
Profits to Momentum Strategies
Implemented on Stock Market Indices Excluding Emerging Markets

The table contains the decomposition of profits to international momentum strategies that long winner stock indices and short loser stock indices. The countries excluded are South Korea, Taiwan, Malaysia, South Africa, Indonesia, and Thailand. All indices are denominated in U.S. dollars. The sample period is from 80/01/01 to 95/06/30. We form momentum portfolios (buy past winners and sell past losers) based on past performance of stock market. The weight of each index is the deviation of its return in the previous period from the cross-sectional average return. We use five different holding periods, ranging from 1 week to 26 weeks. All profit estimates and aggregate investment weights are multiplied by 1,000. π_t are average profits overall; π_t^1 are profits attributed to predictability of equity returns based on past equity returns; π_t^2 are profits attributed to predictability of exchange rate returns based on past equity returns; π_t^3 are profits attributed to predictability of equity returns based on past exchange rate returns; π_t^4 are profits attributed to predictability of exchange rate returns based on past exchange rate returns. Aggregate investment weight is defined as $I_t(k) = \sum_{i=1}^{N} |w_{it}(k)|$, where w_{it} is the weight of index i at time t, and $R_t(k)$, the weekly return, is equal to $\pi_t(k) / (0.5*k*I_t(k))$. The numbers in parentheses are z-statistics that are asymptotically N(0,1) under the null hypothesis that the relevant parameter is zero, and are corrected for heteroskedasticity and autocorrelation based on Newey-West adjustment (1987).

	1-week	2- week	4-week	12-week	26-week
π_t^1	0.00036	0.00116	-0.00040	-0.00715	-0.0430
	(0.738)	(1.918)	(-0.413)	(-1.123)	(-2.673)
π_t^2	0.000349	0.00089	0.00155	0.01058	0.03269
	(2.079)	(1.646)	(0.723)	(1.441)	(1.658)
π_t^3	0.000011	0.00058	0.00189	0.00387	0.01765
	(0.126)	(2.035)	(2.181)	(1.088)	(1.328)
π_t^4	0.000092	-0.00006	-0.00015	0.00386	0.00432
	(0.965)	(-0.223)	(-0.178)	(1.103)	(0.390)
π_t	0.00173	0.00774	0.00758	0.00925	0.06707
	(1.859)	(4.327)	(1.440)	(0.337)	(1.092)
Aggregate Investment	1.654	2.376	3.482	6.231	9.436
Weekly Return (in %)	0.1432	0.282	0.104	0.0430	0.0563
	(1.938)	(4.530)	(1.629)	(0.688)	(1.326)

Table 9
Risk-Adjusted Returns of Winner minus Loser Portfolios

This table reports risk-adjusted returns of momentum strategies implemented on the stock market indices. The sample period is from 80/01/01 to 95/06/30. We form momentum portfolios (buy past winners and sell past losers) based on past performance of stock market indices. We use five different holding periods, ranging from 1 week to 26 weeks. Excess returns (in excess of the U.S. risk-free rate) of winner portfolios, loser portfolios, and winner minus loser portfolios are regressed on excess returns of the MSCI world index. Only the results of winner minus loser portfolios are reported to save space.

Panel A: Whole sample

	1 Week	2 Weeks	4 Weeks	12 Weeks	26 Weeks
Alpha	0.002178	0.005838	0.00544	0.011553	0.022874
	(1.3814)	(2.6076)	(1.3775)	(1.0862)	(1.5170)
Beta in the up market	-0.032772	0.139853	0.190473	0.315918	0.367446
	(-0.2797)	(1.1696)	(1.6011)	(2.0901)	(2.6382)
Beta in the down market	-0.130358	-0.241278	-0.115813	0.431002	0.365632
	(-1.3111)	(-2.7355)	(-1.3472)	(2.5067)	(1.8569)

Panel B: Partitioned By High and Low Past Trading Volume

	High Past Trading Volume					Low Past Trading Volume				
	1 Week	2 Weeks	4 Weeks	12 Weeks	26 Weeks	1 Week	2 Weeks	4 Weeks	12 Weeks	26 Weeks
Alpha	0.004738	0.011138	0.00315	0.006956	0.008554	0.002256	0.005081	-0.000552	-0.00897	0.005773
	(2.5604)	(4.0235)	(0.7445)	(0.5628)	(0.3703)	(0.9693)	(1.7249)	(-0.1249)	(-0.6714)	(0.2680)
Beta in the up market	-0.095956	-0.020057	0.306412	0.282142	0.194791	-0.056475	-0.046667	0.06148	0.07061	0.091532
	(-0.6533)	(-0.1455)	(1.8975)	(1.6461)	(1.1850)	(-0.3931)	(-0.3532)	(0.4391)	(0.3493)	(0.4744)
Beta in the down market	-0.009088	0.062501	-0.228743	0.308428	0.411637	0.039377	-0.196788	-0.157092	-0.344756	-0.28054
	(-0.0498)	(0.6618)	(-2.0906)	(2.0220)	(1.7536)	(0.2818)	(-1.7590)	(-1.3595)	(-1.0934)	(-1.3578)