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Systematic Portfolio Allocation Based on Aggregate Insider Behavior

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Anthony Raimondo

"I pledge my honor I have not violated the Honor Code during this assignment"

I.   Executive Summary

This study develops a trading strategy based on the daily trading behavior of U.S. corporate insiders in aggregate. The consensus in the literature on this topic is that insiders are able to earn abnormal returns on their open market transactions of common stock in their firms, which most attribute to the superior information these individuals possess about their firm prospects. The trading strategy developed and tested here builds on the ideas of previous studies related to aggregate insider trading and the potential for outsiders to profit by replicating insider behavior.

I use daily Form 4 filings with the Securities and Exchange Commission over the past 18 years to conduct this study. Using only open market transactions, I compute a measure of net aggregate insider sentiment based on the buying and selling behavior of the collection of active insiders each day. This measure, adjusted for noise-inducing routine insider selling, translates directly into portfolio allocation decisions which are made each day. The intention of this approach is to forecast future equity market returns using the collective information of the most informed individuals across all public U.S. firms, which constitutes the market.

The returns generated by this trading strategy over 2-month holding periods are marginally positive, but they would shrink to near zero once accounting for transaction costs. As the holding periods increase, I find the performance to decline and become negative. These results are consistent across the entire population of Form 4 filers, as well as for subsets of insiders such as CEOs, CFOs, and directors. The trading strategy appears limited by explicit and implicit regulation/monitoring of insiders along with their own behavioral biases, and perhaps the strategy's own inability to disregard information-less transactions.

II.   Introduction

Many academic papers have concluded that insiders are able to profit from buying and selling shares of their firm on the open market. This has implications for outside investors who gather information from these events, and regulators because insiders are not allowed to profit from material non-public information. The topic of insider trading profitability is of interest to the study of behavioral finance because its existence is an argument against the strong form of the efficient market hypothesis; likewise, the existence of outsider profitability by predicting returns from observing insider behavior refutes the semi-strong form. There is conflicting evidence regarding the ability of outsiders to profit from the information provided by insider trading behavior. Lorie & Niederhoffer (1968) were among the first to show that prompt and proper analysis of insider transactions can be profitable for outsiders. However, Seyhun (1986) finds that outsiders cannot earn abnormal profits once transaction costs are accounted for.

The source of insider profits is not always clear and may be affected by several factors beyond superior insider information. Lakonishok & Lee (1998) find that insiders of value firms tend to be net buyers of their common shares, while insiders of growth firms are net sellers, as does Jenter (2005); this suggests insider profits may be in part attributable to the well-documented value anomaly. They also find that insiders can predict returns best in small firms, because large firms are priced more efficiently. Givoly & Palmon (1985) argue that insider transactions garner significant attention from news publications that cover financial markets, which influences outsiders to trade in the same direction and inflates the returns to insider transactions.

The perspective I take is that of an outsider observing insider transactions and thereby making portfolio allocation decisions. I back-test a trading strategy which uses aggregate insider trading data, similar to Seyhun (1988)**.** The data used here are similar to that of studies referenced above, but cover a longer, more recent time period. The

paper is organized as follows: Section III provides a brief summary of the data and how it was obtained. Section IV presents the model and trading strategy. Section V analyzes how the strategy performs on historical data. Section VI concludes.

III.   **Data**

The data used in this study are sourced directly from the Securities and Exchange Commission's EDGAR database. Using the SEC's API, I consumed all insider transactions from 6/1/2003 to 5/31/2021 by parsing each Form 4 filing in this time span; many filings are missing or incomplete in the API response for periods before 6/1/2003, hence they are not used. There are 2,185,913 open market transactions in the sample, 1,516,542 of which are sales (≈69%). Table 3 in the appendix breaks down the size and volume of open market transactions by Form 4 filer type. Some key values stored for each transaction include the shareholder title, number of shares transacted, and the resulting number of shares beneficially owned. The use of these values is described in section IV. Other data used to analyze returns include daily 1-month T-bill rates and daily equal-weight market returns, both sourced from CRSP.

The large number of insider sales relative to purchases is indicative of executives diversifying their risk and/or meeting their liquidity needs after earning shares as part of their compensation package. Section IV describes how this is accounted for when constructing the portfolio. There may also be deterrents to insider sales such as regulation, negative signaling to the market, tax implications – per Jin & Kothari (2008), and the potential erosion of firm value – as suggested by Masson & Madhavan (1991). Armstrong et al. (2021) argue CEOs have incentive to purchase common stock because it can prolong their tenure by showing their commitment to the firm. However, the data show these deterrents to selling and incentives to buy shares are outweighed by the need of insiders to diversify and have liquidity.

IV.   Methodology

Using aggregate insider transactions, I construct a portfolio of the equal-weighted market index, potentially with leverage, and the 1-month T-bill. Because the data contain insider transactions of all publicly traded U.S. firms, I treat these transactions as a measure of aggregate insider sentiment and use it as a proxy for the market outlook. I assume all inside information is equally as important, hence the choice to use the equal-weighted index in portfolio construction. The strategy is to overweight the equal-weighted index when net aggregate insider sentiment is positive, and underweight when it is negative by allocating a portion to the T-bill. I create a new slice each day based on that day's Form 4s consumed and add it to the portfolio. Holding periods for these slices are described in section V.

The implementation of the trading strategy requires computing a net aggregate sentiment score S_t based on all insider transactions for a given day t. This score determines the weights of the two assets in the portfolio, and is calculated as follows:

$$S_t = \frac{\sum_{i=1}^{I_{n,t}} \frac{\Delta v_{i,t}}{v_{i,t}}}{I_{n,t}}$$

Where $I_{n,t}$ is the number of insiders who bought or sold shares (net) of their firm on date t, $v_{i,t}$ is the volume of shares the insider beneficially owns at the beginning of date t, and $\Delta v_{i,t}$ is the change in the volume of shares owned by the insider on date t. Because the SEC filing provides the number of shares held following the transaction (i.e., $v_{i,t+1}$), I adjust by the number of shares bought or sold to determine $v_{i,t}$, which avoids the issue of dividing by $v_{i,t} = 0$ in the case of a complete liquidation. Using the change in the holdings of insiders, rather than simple dollar amounts, captures the magnitude of the transaction relative to each insider and is assumed here to represent the amount of information revealed by each transaction.

Insider sales account for most of their transactions but many are not informational, as mentioned in section III. Cohen et al. (2012) classify insiders as "routine" and "opportunistic" traders by analyzing their past trading history for patterns in the timing of trades. They find opportunistic insiders, those without consistent historical trading patterns, have significant abnormal returns while routine insiders have none. I take a simplified approach to help account for routine insider sales; I find the median daily sentiment from the 6/1/2003 to 5/31/2004 sample and subtract it from daily insider sentiment in subsequent years. Because S_t is distributed around zero for purchases and sales, subtracting the median value will adjust for this "information-less trade bias", and move future median S_t values closer to zero. The median S_t value ($\tilde{S}$) in this one-year sample is -0.081.

The range of possible values for S_t are [-1.0, ∞), because a complete portfolio liquidation for all insiders on a given day t would make $\Delta v_{i,t} = -v_{i,t} \; \forall \; I_{n,t}$, making $S_t = -1.0$, and there is no practical upper bound on the number of shares an insider could purchase beyond their current holdings. A large insider purchase from a small base of shares held could skew the net aggregate insider sentiment positive for that day, even if most other insiders sold shares of their firm on the same day. This right-skewness is similar to that described by Jaffe (1974). To deal with this potential issue, I scale S_t between -1 and 1 using the hyperbolic tangent function, which ensures these arbitrarily large numbers converge to 1.0. I then add 1 to the result to adjust the interval to (0.0, 2.0) for simplified interpretation when determining the allocation for each slice:

$$W_{m,t} = \tanh\left(S_t - \tilde{S}\right) + 1$$

Where $W_{m,t}$ denotes the slice weight in the equal-weighted index for date t. Adjusting the range of values between 0.0 and 2.0 allows for a straightforward allocation between the two assets: $W_m = 0.0$ represents a 0% allocation to the index, $W_m = 1.0$ represents a

100% allocation to the index, and $W_m = 2.0$ represents a levered 200% index allocation. I then determine the weight in the 1-month T-bill (W_{rf}):

$$
\begin{aligned}
W_{rf,t} &= 1 - W_{m,t}, \quad \forall\, W_{m,t} < 1.0 \\
W_{rf,t} &= 0, \qquad\qquad\ \forall\, W_{m,t} > 1.0
\end{aligned}
$$

V. Analysis

I analyze this strategy for holding periods of 2, 3, and 12 months for each slice. Each holding period was chosen for comparison with previous studies: Seyhun (1988) finds net aggregate insider trading activity in a given month is significantly positively correlated with the return to the market portfolio during the subsequent 2 months, and Seyhun (1986) shows that outsiders can earn abnormal returns, before transaction costs, over 100- and 300-day periods if they act on insider trades as soon as they are reported to the SEC. Conflicting evidence from Lakonishok & Lee (1998) indicates there is little explanatory power for predicting returns from insider transactions over 3-month periods.

Once a slice matures it is rebalanced based on that day's measure of S_t. Regardless of holding period length, the T-bill rate is set to the prevailing rate on the 1-month T-bill every month after the slice was created. I assume a constant 4% borrowing rate for any amount of leverage used. The returns over these holding periods for all Form 4 filers during the 06/01/2004 through 05/31/2021 period are shown in table 1.

Table 1 – Returns Using All Insider Transactions

	Holding Period (months)		
	2	3	12
Cumulative	6.72%	-0.04%	-6.31%
Annual	0.38%	0.00%	-0.38%
Monthly	0.03%	0.00%	-0.03%

06/01/2004 through 05/31/2021

The 2-month holding period yields the best results across all insiders, which is consistent with Seyhun (1988). Using a 3-month holding period appears to have no predictive power, as Lakonishok & Lee (1998) argue, and the strategy performs worse as the holding period increases.

To test for differences in information amongst insiders, I create ten subsets of Form 4 filers: directors, officers, officer-directors, CEOs, CFOs, CEOs and CFOs, chairperson, CEO and chairperson, all excl. large shareholders, and 10% Owners. Several academic papers previously referenced find that large shareholders trade on less valuable information than managers. It is accepted in the literature that CEOs and board members especially are able to earn profits from trading the firm's common stock for a variety of reasons. Contreras (2020) shows that insider transactions after the Sarbanes-Oxley Act of 2002 are concentrated in the period immediately following earnings announcements. The most profitable trades occur within 5 days post-announcement, when the market has under- or over-reacted to the news. Hillier et al. (2015) claim abnormal returns earned by CEOs and CFOs are attributable to their superior skills as opposed to their special information. Table 2 shows the returns for select groups, and table 4 in the appendix shows how the trading strategy performs for all ten groups.

Table 2 – Returns Using Select Groups of Insider Transactions

	Cumulative Holding Period (months)			Annual Holding Period (months)			Monthly Holding Period (months)		
	2	3	12	2	3	12	2	3	12
Directors	12.40%	5.20%	-4.18%	0.69%	0.30%	-0.25%	0.06%	0.02%	-0.02%
Officers	0.64%	-6.22%	-8.64%	0.04%	-0.38%	-0.53%	0.00%	-0.03%	-0.04%
CEOs	8.40%	1.24%	-5.20%	0.48%	0.07%	-0.31%	0.04%	0.01%	-0.03%
CFOs	6.45%	0.43%	-2.69%	0.37%	0.03%	-0.16%	0.03%	0.00%	-0.01%
10% Owners	4.56%	-2.09%	-8.34%	0.26%	-0.12%	-0.51%	0.02%	-0.01%	-0.04%

06/01/2004 through 05/31/2021

Observing the behavior of directors appears to be the most profitable using this strategy. Large shareholders do in fact seem to have less information than directors and top managers. However, the group of all officers performs the worst. The most reasonable explanation I can offer is that many officers filing their transactions with the SEC are one or more levels removed from direct interaction with top executives. Comingling the returns to transactions by these less-informed insiders is diluting the returns earned by individuals at the very top. The CEO and CFO subsets perform much better than the general Officer group, but not as well as the subset of directors. This could be due to greater scrutiny from the media and outsiders who recognize and pay close attention to these individuals, which prevents them from fully exploiting their special information, whereas board members might get less attention and therefore have fewer constraints. Again, the returns for each subset decrease as the holding period grows.

VI.   Conclusions

The trading strategy developed and analyzed here has little ability to generate abnormal returns. The most useful way to employ this strategy is with a 2-month holding period for board member transactions only. This approach would return just 3bps above the equal-weighted index per month, and once transaction costs are accounted for it would likely be indistinguishable from zero. The trading strategy's performance declines as the holding period for each slice increases, but transaction costs will affect the shorter holding period strategies more due to higher turnover.

In terms of risk, the combinations of subsets and holding periods all have market betas above 1.0, see table 5 in the appendix for all beta estimates. Over the course of the trading period studied, the levered positions increase the overall portfolio's exposure to systematic risk, yet the returns do not show adequate compensation for this risk. This

indicates inaccurate timing and/or magnitude of levered positions using this strategy. Finally, whenever leverage is being used there is risk of a margin call. I found there to be < 5 daily slices constructed in the 17-year period in which the leverage was above 50%, thus I do not consider the implications of a margin call on returns for this strategy.

There are a few major limitations to trading on insider activity as an outsider. The data are noisy for reasons such as routine sales for diversification and liquidity purposes, which makes it difficult to determine the informational content of transactions. There exists explicit and implicit regulation on executives who presumably have the most information. For example, Huddart et al. (2006) and Contreras (2020) show that top executives do not trade before earnings announcements, when their inside information is arguably most valuable. Givoly & Palmon (1985) point out how well-covered are the actions of CEOs, which could induce sub-optimal trading decisions to avoid negative market reaction. Even if we ignore these limitations of insider transactions to provide outsiders with reliable and actionable information, it is not a given that insiders will make optimal decisions. Malmendier & Tate (2005) assert that CEOs often exhibit overconfidence and make sub-optimal decisions related to exercising their stock options, and Lee & Piqueira (2019) find insiders have anchoring biases around 52-week highs, where they are reluctant to purchase stocks and instead more likely to sell stocks.

Insiders have consistently been able to profit from tractions of common stock in their firm, but evidence of outsiders' ability to profit by responding remains disputed. The trading strategy tested in this paper shows little support for abnormal returns to outsiders after considering transaction costs. An interesting use of this model would be to apply it to only small firms or value companies, rather than the entire market, because there is strong evidence of insider trades being more informative in these firms. Another interesting application would be to only consider open market purchases or place disproportionate weight on these events; Lakonishok & Lee (1998) find that purchases

are more informative than sales because, "insiders have many reasons to sell shares but the main reason to buy shares is to make money." A direct alteration to the model that could prove beneficial would be to use more sophisticated ways to account for routine transactions, such as Cohen et al. (2012). Doing so would help reduce the noisiness in the data by focusing solely on opportunistic insiders, whose actions have the most informational content.

Appendix

Table 3 – Insider Trades by Transaction Type

Filer Type	Total Trades	Number of Purchases	Number of Sales	Average Size of Purchase	Average Size of Sale
All	2,185,913	669,371	1,516,542	$617,010	$239,426
Directors	636,008	241,286	394,722	$18,266	$744,942
Officers	531,144	98,637	432,507	$10,644	$1,570
Officer-Directors	577,745	132,399	445,346	$2,984	$6,800
10% Owners	357,678	155,706	201,972	$2,009,179	$155,857
Others	83,338	41,343	41,995	$537,971	$26,167

Note: This was motivated by Jaffe (1974) – Table 2

Table 4 - Returns Using Select Groups of Insider Transactions

	Cumulative Holding Period (months)			Annual Holding Period (months)			Monthly Holding Period (months)		
Insider Group	2	3	12	2	3	12	2	3	12
All Filers	6.72%	-0.04%	-6.31%	0.38%	0.00%	-0.38%	0.03%	0.00%	-0.03%
Directors	12.40%	5.20%	-4.18%	0.69%	0.30%	-0.25%	0.06%	0.02%	-0.02%
Officers	0.64%	-6.22%	-8.64%	0.04%	-0.38%	-0.53%	0.00%	-0.03%	-0.04%
Officer-Directors	7.49%	0.71%	-5.37%	0.43%	0.04%	-0.32%	0.04%	0.00%	-0.03%
CEOs	8.40%	1.24%	-5.20%	0.48%	0.07%	-0.31%	0.04%	0.01%	-0.03%
CFOs	6.45%	0.43%	-2.69%	0.37%	0.03%	-0.16%	0.03%	0.00%	-0.01%
CEOs and CFOs	8.06%	1.15%	-5.02%	0.46%	0.07%	-0.30%	0.04%	0.01%	-0.03%
Chair	3.97%	-2.64%	-7.10%	0.23%	-0.16%	-0.43%	0.02%	-0.01%	-0.04%
CEO and Chair	7.31%	0.23%	-5.66%	0.42%	0.01%	-0.34%	0.03%	0.00%	-0.03%
Excluding Large Shareholders	6.89%	0.16%	-6.07%	0.39%	0.01%	-0.37%	0.03%	0.00%	-0.03%
10% Owners	4.56%	-2.09%	-8.34%	0.26%	-0.12%	-0.51%	0.02%	-0.01%	-0.04%

06/01/2004 through 05/31/2021

Table 5 - Beta Estimates by Grouping and Holding Period

	Holding Period (months)		
Insider Group	2	3	12
All Filers	1.08	1.09	1.10
Directors	1.13	1.13	1.15
Officers	1.04	1.04	1.06
Officer-Directors	1.09	1.09	1.09
CEOs	1.09	1.09	1.10
CFOs	1.09	1.10	1.10
CEOs and CFOs	1.09	1.10	1.10
Chair	1.07	1.07	1.08
CEO and Chair	1.09	1.09	1.09
Excluding Large Shareholders	1.08	1.09	1.10
10% Owners	1.07	1.07	1.07

06/01/2004 through 05/31/2021

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