

Reference Price Formation for Packaged Transactions

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ABSTRACT

This paper provides a new approach to determine the relevance of a reference price when investors decide if a security is to be kept or sold. We propose that the observed reluctance to crystallise losses and propensity to realise gains, a behavioural bias dubbed the disposition effect, may be a result of the reference investors apply to determine if an investments is in profit or at loss. We examine a comprehensive data set comprised of all trading records for investors within the Nasdaq OMX Helsinki market over a recent seven year period. We find that the disposition effect is statistically and economically significant in the short run for a sample of active individual investors that purchase shares at one price in one package. It appears that there can be significant reduction in the extent of the disposition effect by simply reducing the significance of the purchase price by spreading buy transactions across several trades and consequently across different market prices [packaging].

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1. Introduction

The disposition effect, or the tendency to sell winning investments too soon and hold losing investments too long, is one of the most robust behavioural biases that is evident in financial markets. The impact of the disposition effect has been explored in many different stock markets (the US, China, Israel, Finland, and Australia), in markets other than equities (futures markets, foreign currency markets, and housing markets), and both individual investors and institutional investors appear to be prone to riding losses.

The disposition effect is partly driven by an investor's propensity to engage in mental accounting, as well as their adherence to prospect theory type preferences. Mental accounting combined with prospect theory implies that disposition-prone investors will evaluate their decision to sell on a stock-by-stock basis, and by whether they are in the 'gain domain' or the 'loss domain', relative to some reference price.

Under prospect theory (or its cumulative variant, Tversky and Kahneman, 1992), the reference price is internally determined by the investor – if the investor 'feels' they have made a gain the disposition-prone investor will want to sell and crystallise their profit. On the other hand, if the investor 'feels' they have made a loss, they will prefer to hold the stock in the hope that it will rise in price up to, or above, the reference price so that they can sell the stock for a gain. Thus they will prefer to hold on to losing stocks. Kahneman (1992) make specific mention (p. 310) that "an important problem for future research is the study of how multiple reference points compete and combine".

In many applications, the reference price is taken as a given: the investor buys the stock for \$B and sells it for \$S, then evaluates whether or not they are in the domain of gains or losses by the sign of $(S - B)$, also known as a 'sign realisation preference' (Ben-David and Hirshleifer, 2012). However, in the situation where an investor purchases the stock in increments, there may be multiple candidates for the reference price. For example, an investor may choose an average purchase price, or engage in a process whereby they mentally account for the inventory of purchases using a First In First Out (FIFO) accounting system. In any case, when stocks are purchased in package, the purchase price is likely to be less salient in the investor's mind when making their decision to sell than when there is a single purchase price.

The aim of this paper is to investigate, using individual investor trading data on packaged purchases and sales, whether or not the disposition effect is reduced in magnitude for investors that have purchased stocks as part of a package compared with those that have not purchased as part of a package. For those investors

that have purchased as stocks in multiple transactions, we examine which of the plausible mental accounting systems (average purchase price, or FIFO) appears to reflect the most similar behaviour to the non-packaged transactions, given the holding periods of the stock. We aim to shed light on the likely mental accounting behaviour of individuals who have purchased in packages.

We find that the disposition effect is statistically and economically significant in the short run, and that the effect is stronger in the short term for investors that purchase shares at one price (disappearing for holding periods longer than two years) and persist longer for investors that purchase shares in several parcels at varying prices.

2. Literature

The disposition effect has been examined in an empirical setting by several authors. These empirical studies usually control for packaged purchases by choosing an accounting system such as the Volume Weighted Average Price (VWAP) or FIFO to evaluate the decision to sell by individuals. Feng and Seasholes (2005), in their study of individual investor trading in the Peoples' Republic of China, find that 69% of the trades in their sample are made as single purchases followed by sales. They take a volume-weighted average price to be the reference price for the 31% of sales that were a result of packaged purchases. They mention that their results are 'essentially unchanged' for different plausible candidates for reference prices, such as the highest purchase price, most recent purchase price, or first purchase price. However, Feng and Seasholes (2005) do not explicitly compare transactions made in packages against single purchases.

Shapira and Venezia (2001) examine the trades made by Israeli investors in both single and packaged purchases, and find that the average length of time taken for round-trip trades is shorter in magnitude for winning positions compared with losing positions in both cases. The extent of the disposition effect is decreased substantially for transactions made as part of a package; winning stocks acquired by individuals in a single transaction are held for on average 46.37 fewer days than losers, but only 34.99 fewer days for those purchased in increments. Shapira and Venezia, however, only have a small number of transactions made by 1642 clients from a single discount brokerage, and winning packages and losing packages are again evaluated only by comparing volume-weighted average purchase price with the sales price. Around 20% of their data set is made up of packaged purchases. Chen et al (2007) present a similar notion of 'simple' and

‘complex’ trades for investors in the People’s Republic of China, but find that ‘complex’ trades (those made in packages) typically exhibit a greater degree of disposition than ‘simple’ trades. Winning stocks are held for 11.85 fewer days than losing stocks when purchased as part of a package, compared with 7.42 days for simple transactions. Our study is partially motivated by these contradictory findings.

Seru, Shumway, and Stoffman (2010) examine the trading behaviour of Finnish investors over the period 1995-2003. They measure the returns as either the holding period return, or the return that the investor made in the first 30 days from holding the stock, which is similar to the median holding period for their sample of active households. This largely circumvents the problem of comparing returns across different holding periods, but may not be appropriate when considering an investor’s actual decision to liquidate their position, especially when our sample consists of all individuals, not only extremely active ones.

Kaustia (2010) also explores the disposition effect in Finland. He uses the FIFO methodology for stocks purchased as part of a package, due to the fact that this is how capital gains tax is actually calculated in Finland. Kaustia finds that the impact of the disposition effect is weakened for longer holding periods; the propensity to sell winners as opposed to losers is far greater for holding periods less than 12 months than it is for longer time horizons. The analysis presented by Kaustia also shows that stocks that have had large deviations from their purchase price within the holding period are not more likely to be sold at a loss than those stocks which have had small deviations from the purchase price over the holding period. In other words, it appears unlikely that observed prices (rather than purchase prices) do not loom in investors’ minds when making the decision to sell. We aim to extend this analysis by considering those stocks purchased as part of a package to those purchased individually.

The findings of Kaustia (2010) present some interesting challenges to the literature on reference price formation. For example, Kliger and Kudryavtsev (2008) find that reference prices are typically updated with firms’ earnings announcements, particularly for those that were unanticipated by analysts, and for those firms with low market capitalization and high betas (i.e. those firms for which information frictions are likely to exist). The Kliger and Kudryavtsev (2008) study does not examine the behaviour of individual investors and uses abnormal volume as a proxy for the updating of investors’ reference prices.

Thaler (1999) suggests that investors frequently “reset their reference price.” Heath, Huddart and Lang (1999) study stock option exercise decisions by over 50,000 employees at seven corporations. They find that

reference levels depend on the extreme values in the past. In particular, employee exercise activity roughly doubles when the stock price exceeds the maximum price attained during the previous year. Experimental evidence producing similar findings was conducted by Gneezy (2005), who finds that the last purchase price seems to be the most likely candidate for a reference price. These papers would tend to suggest that a simple choice of “first purchase price” or “average purchase price” as the reference price is not appropriate, but again do not consider the behaviour of individual investors or study the disposition effect along the lines of the papers of Odean (1998) or Feng and Seasholes (2005).

More recently, Baucells, Weber, and Welfens (2011) use an experimental setting to find that the best fit for subjects’ reference prices is some weighted average of the first and last prices observed in a time series of prices. Therefore, reference prices are expected to move upward following a gain, and downward following a loss. Similar experimental findings were made by Arkes et al (2008, 2010), who find that reference points adapt asymmetrically; subjects adapt to good news faster than bad news. Jung Grant, Xie, and Soman (2010) attribute the asymmetric updating partially to memory and investor attention (e.g. Karlsson et al, 2009), and partially due to an increased motivation for investors to sell following a price increase. However, none of these studies consider the actual trading behaviour by individual investors.

The extent to which the disposition effect actually drives the investor decision to sell stocks has been questioned by Ben-David and Hirshleifer (2012). They examine very closely the data set of Strahilevitz, Odean, and Barber (2011), which is similar to the data set of Odean (1998). They find that for stocks with short holding periods (1-20 days), which one would presumably expect to have the greatest motivation to sell at a gain relative to the purchase price, there is no increase in the probability of a sale around the zero return point. Ben-David and Hirshleifer (2012) suggest that the motivation to sell is more driven by a ‘profit magnitude realisation preference,’ where stocks are more likely to be sold at a large gain than a small gain, and more likely to be sold for a large loss than a small loss, with the impact being greater on the gain side. The impact is particularly strong for short trading horizons. This leads to a ‘V-shaped’ pattern of profit realisation, and Ben-David and Hirshleifer (2012) attribute this selling preference mainly to overconfidence or the speculative motivation for trade. Ben-David and Hirshleifer (2012) state that it is difficult to measure the disposition effect cleanly because of confounding effects with other trade motivations.

To complement the literature this paper is to investigate, using individual investor trading data on packaged purchases and sales, whether or not the disposition effect is reduced in magnitude for investors that

have purchased stocks as part of a package compared with those that have not purchased as part of a package. We expect the disposition effect to be stronger for investors that have purchased shares in one trade at one price as they are more likely to anchor their purchase to this one price. The between-groups comparison that we employ is useful because it allows us to compare explicitly traders with similar trade motivations. We expect that the disposition effect may last longer for investors that have purchased shares as a package as they are also likely to sell off the shares gradually and hence the reference price for a position in a certain stock has a more lasting effect.

For those investors that have purchased shares in multiple transactions, we examine which of the plausible mental accounting systems (average purchase price or FIFO) appears to reflect the most similar behaviour to the non-packaged transactions, given the holding periods of the stock. For those investors that purchase shares in one trade and one price the reference the mental accounting system is naturally irrelevant as the purchase price remains the same under both accounting systems. For those investors that purchase shares in several lots at different prices alternative accounting systems will lead to different reference prices. FIFO would be justified as this is the way the taxation of capital gains are calculated in the investigated market, average purchase price or VWAP would be justified as a natural way to treat purchases at several prices. We expect the reference price to lie close the VWAP as this is a common technique of calculating purchase price for traders.

3. Data and Methodology

The analysis is conducted using all transactions by a sample of 15,911 household investors that make on average at least one roundtrip trade per year. This subsample is taken from the Euroclear Finland Ltd database that includes all transactions in the share depository for all 1.061 million investor accounts (classified into 994,937 households, 722 domestic institutions, 96 foreign investor nominee accounts and 65,010 others) with holdings in 210 unique common stock listed on Nasdaq OMX Helsinki Exchange, Finland. This database has been used in several papers e.g. Kaustia (2010) and Seru et al (2010).

4. Results

4.1 Descriptive Statistics

Table 1 reports descriptive statistics for our first sample of 17,056 trades by household investors. These are all trades where the purchase occurs in one trade. Only investors that make an average roundtrip per year during the investigated period 2003 to 2010 are included. The average number stocks the investors that make purchases in one trade hold is 8.7 and the average portfolio value for these investors is EUR 6,394. These investors make an average of 14.3 sales over this time period. Their sales may occur as part of a package, but the median number of trades in a sale transaction for unpackaged stocks is 1.25. The turnover rate is 0.70, relatively high due to smaller portfolio size, while the average holding period of a stock position is 146 days or about half a year. Realized profits are positive and larger on average than unrealised profits for these portfolios.

**Table 1 Descriptive statistics for sample 1:
Trades where all shares are purchased in one trade.**

This table reports descriptive statistics for our first analysed sample of 17,056 trades purchased as one transaction by a group of active household investors that make on average at least one roundtrip trade per year in one of the continuously traded 151 different stocks during the period 2003 to 2010. This subsample is taken from the Euroclear Finland Ltd database that includes all transactions in the share depository for all 1.061 million investor accounts (classified into 994,937 households, 722 domestic institutions, 96 foreign investor nominee accounts and 65,010 others) with holdings in 210 unique common stock listed on Nasdaq OMX Helsinki Exchange, Finland. The statistics are computed per day per investor and aggregated. Portfolio values are computed as of purchase price and profits on transactions when a part or all of a position is sold.

	Mean	Median	Max	Min	StDev	n
No Stocks	8.7	6	105	1	8.9	17,056
No Sells	14.3	8	457	1	19.5	17,056
Parcels in purchases	1	1	1	1	0	17,056
Parcels in sales	1.5	1.25	15.7	1	0.92	17,056
Portfolio Value EUR	6,394	2,638	5,573,568	90	29,488	17,056
Turnover Rate	0.6985					17,056
Days Held	147	53				17,056
Real. Profit_VWAP %	0.1003	0.0598				17,056
Real. Profit FIFO %	0.0981	0.0598				17,056
Unreal. Profit VWAP %	0.0259	0				17,056
Unreal. Profit_FIFO %	0.0259	0				17,056

Table 2 reports similar descriptive statistics to Table 1, but for the 16,930 trades where stocks are purchased as part of a package. The investors that typically buy in parcels hold on average 12.2 stocks in their portfolio (3.5 more on average than the non-packaged sample) and are also slightly more likely to make sales as part of a package than the non-packaged purchase investors from Table 1. The portfolio values of the investors that make package purchases are larger – the average portfolio is 40,517 EUR for the package-purchase sample, which is about four times larger on average than the unpackaged-purchase sample. The choice of trading strategy is hence impacted by the size of the portfolio. The turnover rate is 0.23 relatively low due larger portfolio size, while the average holding period of a stock position is 140 days or only slightly less than half a year.

**Table 2 Descriptive statistics for sample 2:
Trades where all shares are purchased as a package of several trades - FIFO accounting.**

This table reports descriptive statistics for our second analysed sample of 16,930 trades purchased in several parcels by a group of active household investors that make on average at least one roundtrip trade per year in one of the continuously traded 151 different stocks during the period 2003 to 2010. This subsample is taken from the Euroclear Finland Ltd database that includes all transactions in the share depository for all 1.061 million investor accounts (classified into 994,937 households, 722 domestic institutions, 96 foreign investor nominee accounts and 65,010 others) with holdings in 210 unique common stock listed on Nasdaq OMX Helsinki Exchange, Finland. The statistics are computed per day per investor and aggregated. Portfolio values are computed as value of sales + the inventory value of the stock left in the portfolio when a part of a position is sold.

	Mean	Median	Max	Min	StDev	n
No Stocks	12.2	6	241	1	18.4	16,930
No Sells	31.1	10	7,412	1	86.2	16,930
Parcels in purchases	2.25	1.72	53.2	1	1.84	16,930
Parcels in sales	2.20	1.67	63.7	1	1.96	16,930
Portfolio Value EUR	40,517	6,576	137,382,000	160	594,647	16,930
Turnover Rate	0.2257					16,930
Days Held	140	36				16,930
Real. Profit_VWAP %	0.5276	0.0155				16,930
Real. Profit FIFO %	0.0770	0.0167				16,930
Unreal. Profit VWAP %	0.5543	0				16,930
Unreal. Profit_FIFO %	0.0538	0				16,930

4.2 Analysis of differences in profit and loss distributions

Figure 1 shows the histogram of realised profits from the purchase price in percentage for investors who purchase all shares as part of a single transaction, with observations ranging between -50% and +50%

returns, clustered into 1% return bins. There is a clear discontinuity in the return distribution around the zero return bin (which contains a large spike). This is consistent with the graphical evidence presented in Grinblatt and Keloharju (2001) and Ben-David and Hirshleifer (2012). The asymmetry in returns on the gain side compared with the loss side is strong evidence that these investors prefer to realise gains rather than losses, relative to the purchase price. This is consistent with the disposition effect. Interestingly, there is a slight drop in the realisation of gains around the (0, -1%) bin, which we interpret as consistent with transaction costs for the retail investors. We contrast this with the price-discreteness argument of Ben-David and Hirshleifer (2012), as the Finnish market over this time period was completely decimalised.

Figure 1: Distribution of realised profits: Trades where all shares are purchased in a single transaction.

Observations are clustered at 1% return bins, in the range of -50% to +50% returns.

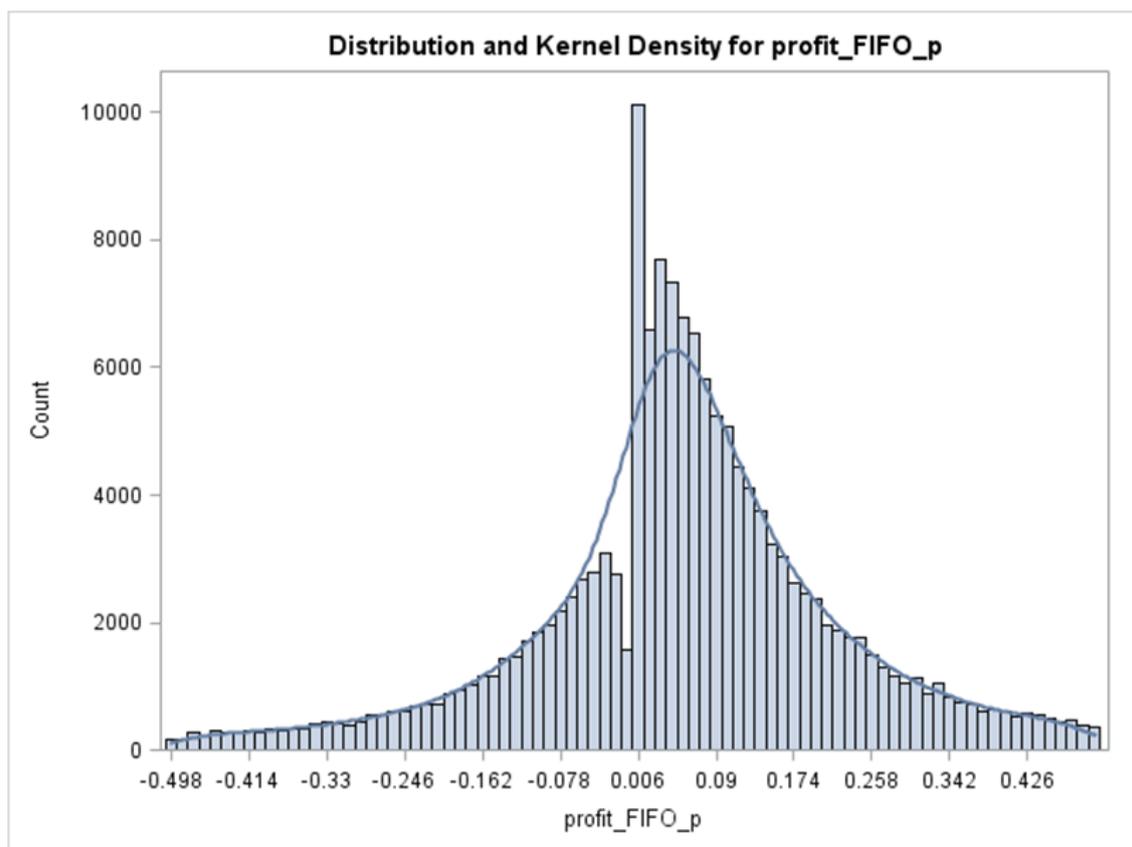
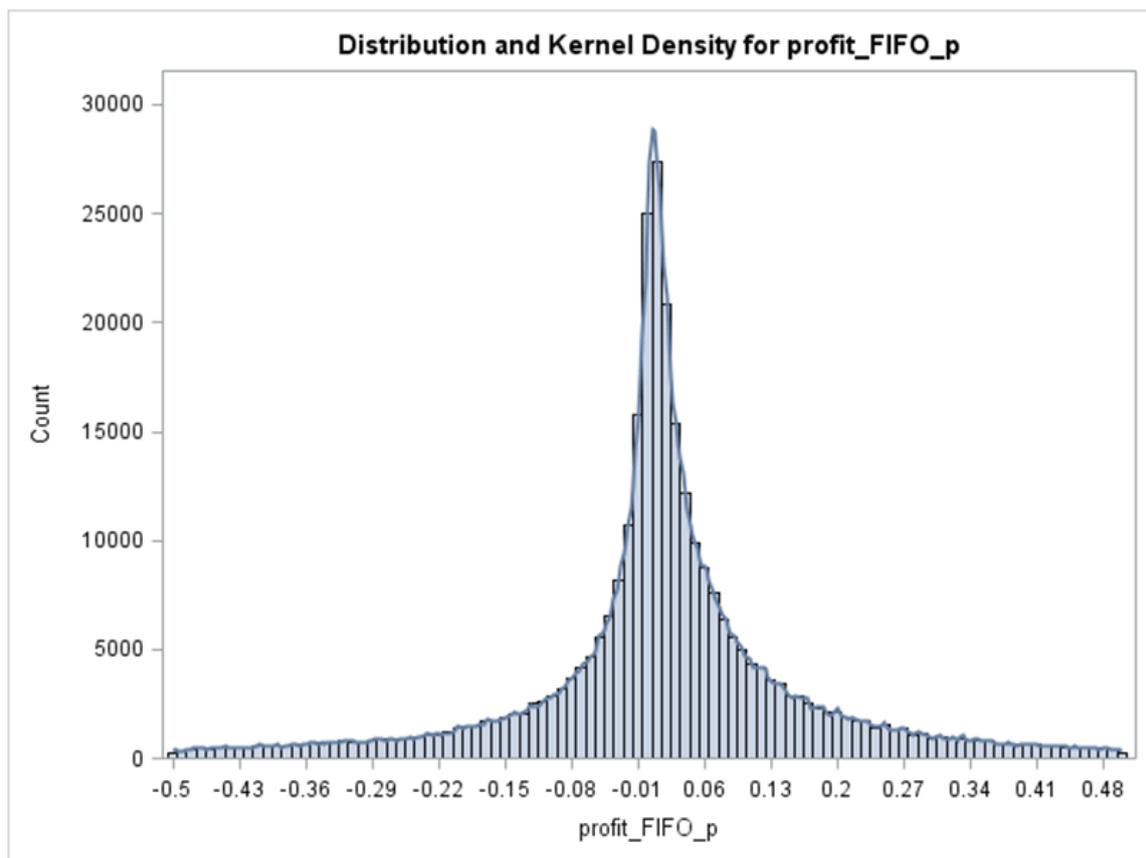


Figure 2 shows the histogram of realised profits from the purchase price (calculated using FIFO accounting) in percentage for investors who purchase all shares as part of a single transaction, with observations ranging between -50% and +50% returns, clustered into 1% return bins. In sharp contrast to Figure 1, we note the clear disparity between realisation of gains and losses has disappeared almost entirely. Investors who

purchased shares as part of a package appear approximately as likely to sell for a gain or a loss, and therefore do not exhibit the realisation-type preferences seen in the non-packaged sample. This is consistent with the idea that the purchase price is not as salient in investors' minds when making the decision to sell stocks that were purchased as part of a package.

Figure 2 Distribution of realised profits: Trades where all shares are purchased as a package of several trades - FIFO accounting.

Observations are clustered at 1% return bins in the range of -50% to +50% returns.



4.3 Formal tests of differences in profit and loss distributions

The observed differences in distributions between un-packaged and packaged purchases and between negative and positive unrealised profits are statistically significant using the Kolmogorov-Smirnoff distance test, Friedman (1977), Gordon and Olshen (1978) and Rounds (1980), and reported in Table 3. When the distance between the class-conditional probability density functions for purchases in one trade and purchases in several trades is the highest, this difference is significant on with p-value less than 0.0001. When the probability density functions differ the least, this difference is significant on 5% level with p-value of 0.0241.

Table 3: Test of difference in profit distributions between trades where all shares are purchased in one trade vs. when all shares are purchased as a package of several trades

Panel A	Kolmogorov-Smirnoff	Number of Observations	EDF at max	Dev from Mean at Max
Realised Profits	Purchases as Package	333,987	0.6138	36.82
	Purchases One Trade	165,269	0.4213	-52.35
		D = max [F1 - F2]	0.1925	
		Pr > D	<.0001	
		D+ = max [F1 - F2]	0.1925	
		Pr > D+	<.0001	
		D- = max [F2 - F1]	0.0041	
		Pr > D-	0.0241	
Panel B	Kolmogorov-Smirnoff	Number of Observations	EDF at max	Dev from Mean at Max
Unrealised Profits	Purchases as Package	336,005	0.6221	-41.91
	Purchases One Trade	167,042	0.8400	59.44
		D = max [F1 - F2]	0.2177	
		Pr > D	<.0001	
		D+ = max [F1 - F2]	0.1787	
		Pr > D+	<.0001	
		D- = max [F2 - F1]	0.2177	
		Pr > D-	<.0001	

The differences in distributions between realised and unrealised profits for un-packaged and packaged purchases respectively are statistically significant using a Kolmogorov-Smirnov test reported in Table 4. The difference between realised and unrealised profits is greater for un-packaged purchases as expected, indicating that for these trades the reference price has a greater weight and hence create behavioural biases.

Table 4: Test of difference in realised vs. un-realised profit distributions between trades where all shares are purchased in one trade vs. when all shares are purchased as a package of several trades

Panel A	Kolmogorov-Smirnoff	Number of Observations	EDF at max	Dev from Mean at Max
Purchases One Trade	Realised Profits	165,269	0.3116	-107.94
	Unrealised Profits	167,042	0.8398	107.37
		D = max [F1 - F2]	0.5282	
		Pr > D	<.0001	
		D+ = max [F1 - F2]	0.2012	
		Pr > D+	<.0001	
		D- = max [F2 - F1]	0.5282	
		Pr > D-	<.0001	
Panel B	Kolmogorov-Smirnoff	Number of Observations	EDF at max	Dev from Mean at Max
Purchases as Package	Realised Profits	333987	0.3737	-72.01
	Unrealised Profits	336005	0.6221	71.79
		D = max [F1 - F2]	0.2484	
		Pr > D	<.0001	
		D+ = max [F1 - F2]	0.1222	
		Pr > D+	<.0001	
		D- = max [F2 - F1]	0.1222	
		Pr > D-	<.0001	

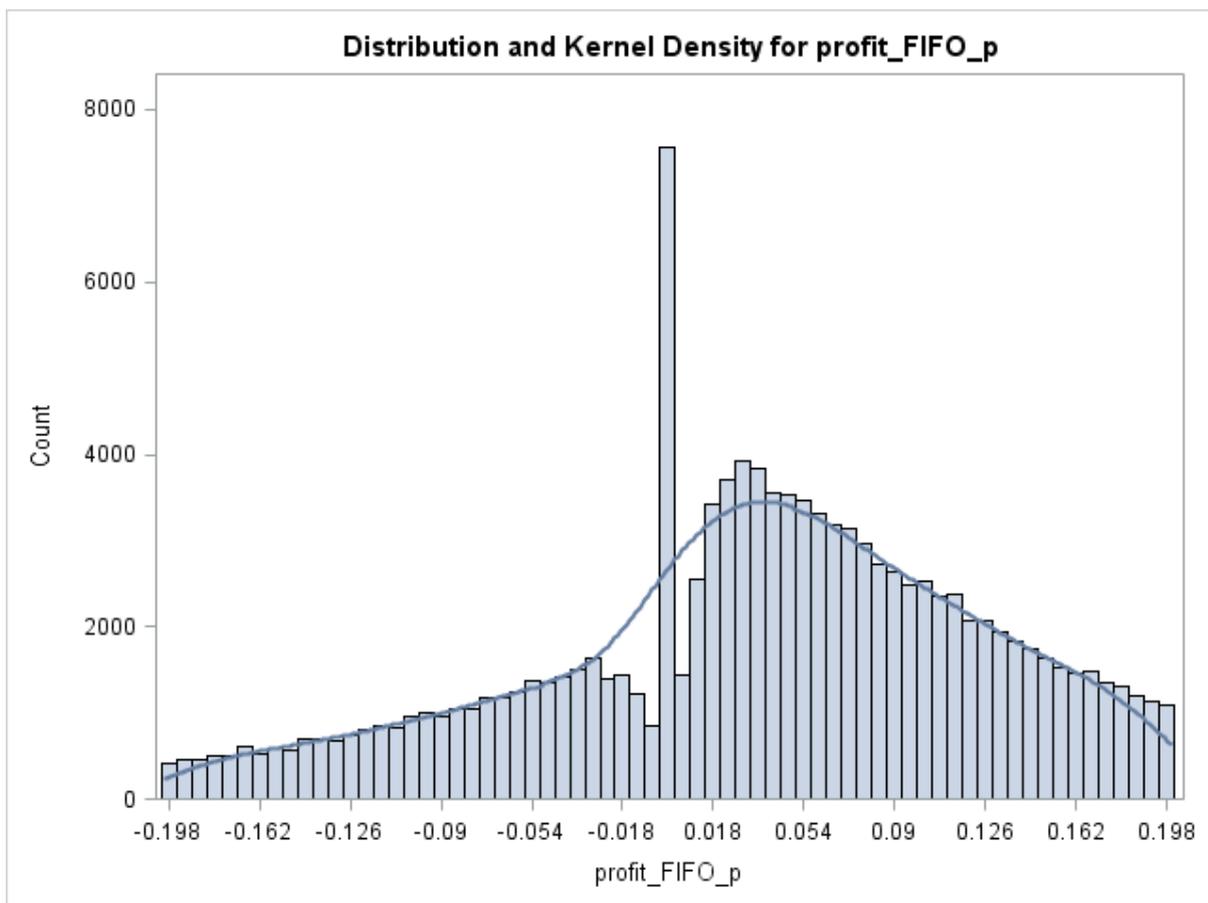
4.4 A closer look at the profit and loss distribution for stock purchased in a single transaction.

Figure 3 presents a zoomed in version of Figure 1, for investors making a sale of stocks purchased in a single transaction, for the range -20% to +20% returns. The asymmetry between realised gains and losses is still evident. However, we do note the quite clear trend of decreasing selling propensity around zero, with the remaining spike at zero. Transaction costs and price discreteness play the joint role of there being fewer observations at these points (slightly below zero, and slightly above zero) as pointed out in Ben-David and Hirshleifer (2012). In contrast with their findings, the evidence presented shows quite clearly that, even without considering the exact zero returns, there appears to be a preference for gains compared to losses, even at these very small magnitudes. Comparing the shape of the distributions on either side of zero shows

that investors are more than twice as likely to sell in the region (0.5%, 1%) as compared with (-1%, -0.5%). Even considering that there may be a degree of price-discreteness, it appears unlikely that this would only be present in stocks trading at a small loss as opposed to a small gain (unless investors prefer to sell lower priced stocks only at a gain).

Figure 3 Distribution of realised profits: Trades where all shares are purchased in a single transaction.

Observations are clustered at 0.5% return bins in the range of -20% to +20% returns.



Considering the very large portfolios included in the sample, and the largest are in the group of packaged purchases it is justified to investigate if the results are driven by outliers or indeed represent the average trader in the respective group of trading styles. In Figures 4 and 5 winsorized samples omitting observations outside of +/- 3 standard deviations from the mean are used to create histograms of realised profits for purchases in one trade and packaged purchases respectively.

Figure 4 Distribution of winsorized realised profits: Trades where all shares are purchased in a single transaction.

Observations are clustered at 1% return bins in the range of -50% to +50% returns.

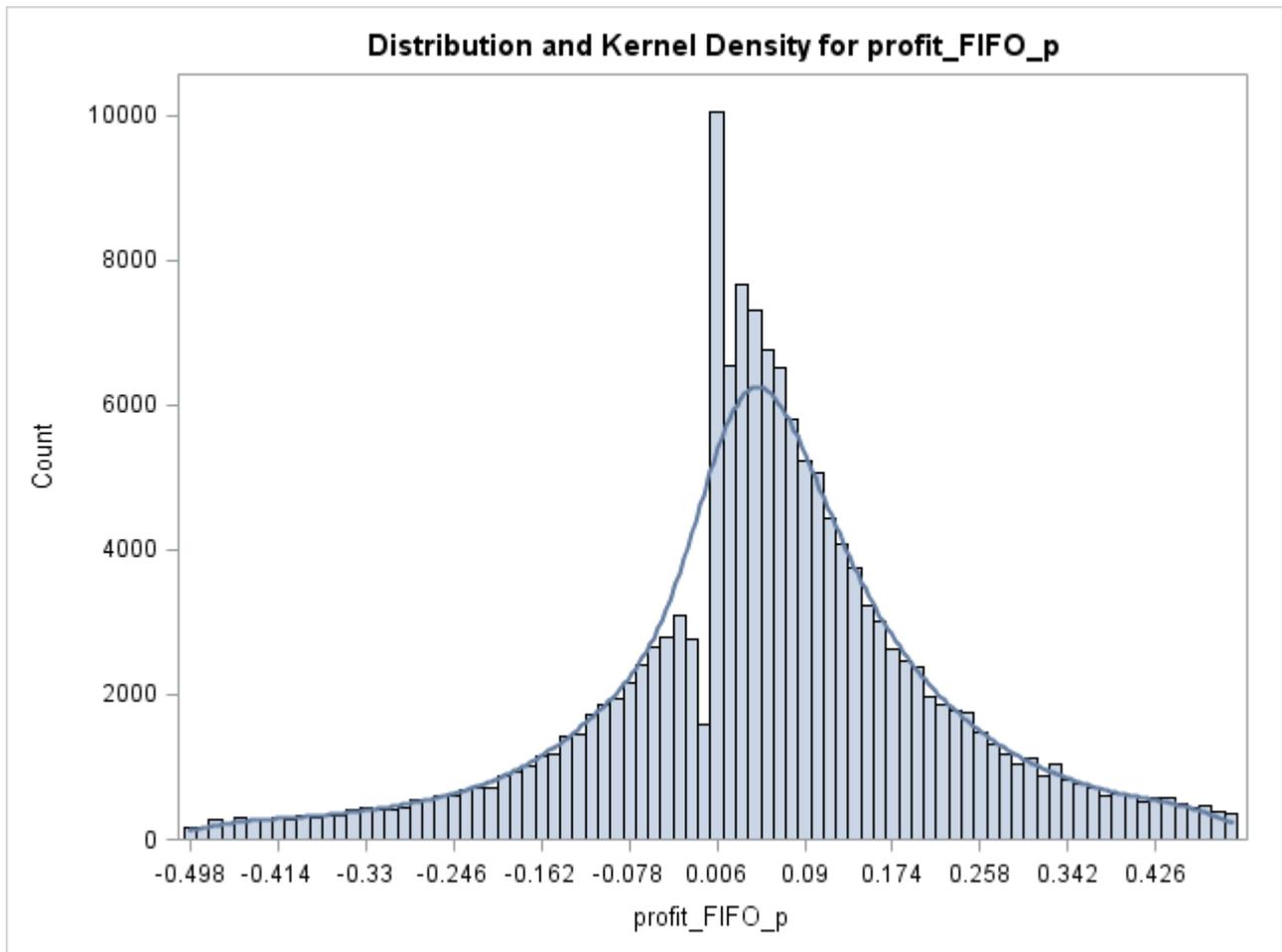
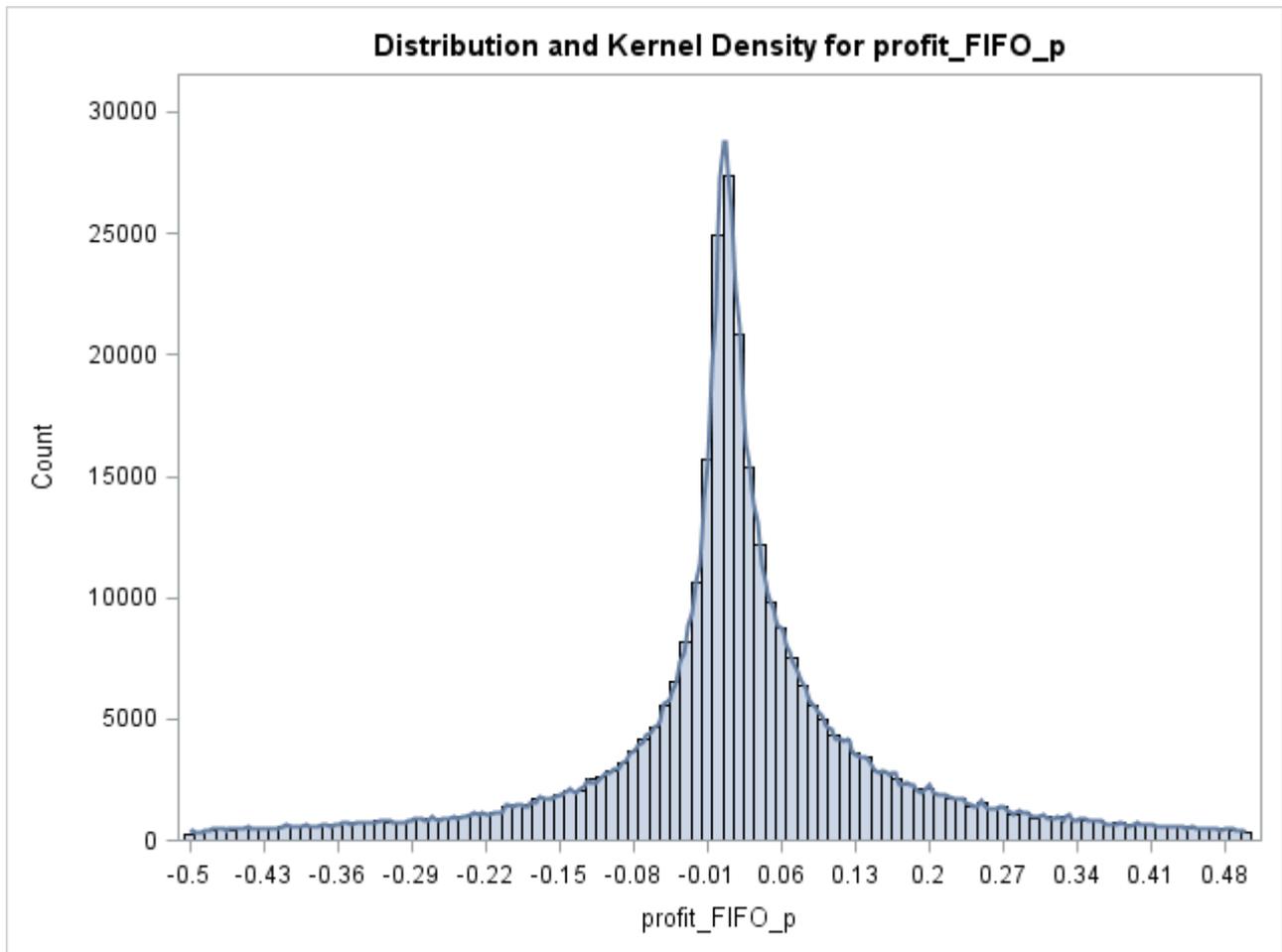


Figure 5 Distribution of winsorized realised profits: Trades where all shares are purchased as a package of several trades - FIFO accounting.

Observations are clustered at 1% return bins in the range of -50% to +50% returns.



Inspecting the probability density functions without outliers we can see that the same patterns emerge and trades where purchases are executed as one trade are still much more likely to be followed by sales at a profit between 1 and 10% than by sales at a loss of -1 to -10%. For these trades sales at slightly above zero return are very common while sales at a small loss are highly unlikely and less common than sales at larger losses. Purchases in a package of several trades at different prices are almost equally likely to be followed by sales at a profit and a loss.

5. Conclusions

This paper provides an in depth analysis of the reference price investors apply when they decide if a security is to be kept or sold. We find specific evidence that investors who purchase stocks as part of a package are able to attenuate the disposition effect markedly compared with those who purchased stocks as part of a single transaction. There is a considerable jump in the frequency with which investors sell stocks trading at a profit compared to stocks trading at a loss for the non-packaged purchase group, but not for the package-

purchase group. This is consistent not only with the magnitude realisation hypothesis presented in Ben-David and Hirshleifer (2012), but also the sign-realisation preference from the disposition effect based on prospect theory.

These findings may be of interest to investors who are seeking to reduce the impact of behavioural biases on their trades. It appears that there can be significant reduction in the extent of the disposition effect, which was shown to be costly to investors by Seru et al (2010) in the Finnish data set, by simply reducing the significance of the purchase price by packaging buy transactions.

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