Multiple Birds, One Stone: Can Portfolio Rebalancing Contribute to Disposition-effect-related Trading Patterns?

Min Dai   Hong Liu   Jing Xu

National University of Singapore
Washington University in St. Louis, CAFR
Renmin University of China

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Disposition Effect: Background

- In contrast to the common investment advice "Cut your losses and let profits run," investors tend to quickly sell winning stocks and hold on to losing stocks
- This tendency is termed "Disposition Effect"
- Odean (1998) Measure

$$PGR = \frac{\#RealizedGains}{\#RealizedGains + \#PaperGains}$$

$$PLR = \frac{\#RealizedLosses}{\#RealizedLosses + \#PaperLosses}$$

Disposition effect: $DE \equiv PGR - PLR > 0$

Related Patterns

- Reverse disposition effect: investor is more likely to purchase losing stocks than winning stocks (Odean (1998))
- Volatility pattern: disposition effect is stronger for more volatile stocks (Kumar (2009))
- V-shape pattern: the probability of selling (or buying additional shares) increases with the magnitude of gains or losses (Ben-David and Hirshleifer (2012))
- Repurchase pattern: investors are reluctant to repurchase stocks previously sold for a loss, as well as stocks that have appreciated in price subsequent to a prior sale (Strahilevitz, Odean, and Barber (2011))

Existing Theories

- Prospect theory on general gains/losses: usually does not predict a DE (Barberis and Xiong (2009))
- Realization utility: utility on realized gains and disutility on realized losses (Barberis and Xiong (2012), Ingersoll and Jin (2013))
  - Doubt on whether RU causes DE has been casted (He and Yang (2019))
  - In RU models, investor realizes losses to reset reference points. However, investors do not seem to reset their reference points upon many loss realizations (Frydman, Hartzmark, and Solomon (2018))
- Return extrapolation (Peng (2017)): investors may overly extrapolate past return to form beliefs
- No unified theory on disposition-effect-related patterns

Learning and Portfolio Rebalancing

- Portfolio rebalancing
  - Household-level evidence of active rebalancing by retail investors in Sweden (Calvet, Campbell, and Sodini (2009))
  - Japanese investors tend to conduct contrarian trades, as predicted by standard portfolio rebalancing models (Komai, Koyano, and Miyakawa (2018))
- Learning
  - past returns and historical price patterns affect trading decisions (Grinblatt and Keloharju (2001))
  - investors learn about information contained in asset prices and revise their trading strategy accordingly (Kandel, Ofer, and Sarig (1993), and Banerjee (2011))

Preview of Results

Table: **Comparison with existing papers**

	D.E.	R.D.E.	Volatility	V-shape	Repurchase
BX (2009)	Yes	No	No	No	No
IJ (2013)	Yes	No	No	Yes	No
Peng (2017)	Yes	No	No	Yes	No
This paper	Yes	Yes	Yes	Yes	Yes

The Model: Asset Market

- One risk-free asset with a constant interest rate r
- N risky assets (stocks). The ith stock price S_{it} follows

$$\frac{dS_{it}}{S_{it}} = \mu_i dt + \sigma_i dB_{it}^S,$$

  where $\mathbf{B_t} = (B_{1t}, ..., B_{Nt})'$ is a standard N-dimensional Brownian motion process.
- Trading any of the stocks incurs proportional transaction costs

Learning

- Merton (1980) and Jorion (1986): the first moment of stock returns is difficult to estimate from finite sample; Consequently, we assume that μ_i may not be observed
- Learning about μ_i: $N(z_{i0}, V_i(0)) \rightarrow N(z_{it}, V_i(t))$ where

  $$z_{it} = E[\mu_i|\mathcal{F}_t], \quad V_i(t) = E[(\mu_i - z_{it})^2|\mathcal{F}_t]$$

  We assume that the prior is independent of $\mathbf{B_t}$
- Learning effect:

  $$dz_{it} = \frac{V_i(0)}{\sigma_i^2 + V_i(0)\,t}\left(\frac{dS_{it}}{S_{it}} - z_{it}dt\right).$$

  Implication: upward (downward) adjustment after large positive (negative) returns

Preference and Objective

- The investor chooses the optimal trading policy to maximize
$$E\left[\frac{1}{1-\gamma}W_T^{1-\gamma}\right],$$
  - $W_t = X_t + \sum_{i=1}^{N}(1-\alpha_i)Y_{it}$: the time t net wealth
  - X_t: the dollar amount in the risk free asset
  - Y_{it}: the dollar amount invested in Stock i
- No-short-sale constraint is imposed (retail investors rarely short sell)

Solution Strategy

- Challenge: the HJB PDE is of high dimension ($2 \times N$ dimensions if there are N stocks), which makes the numerical solution very difficult $\rightarrow$ We rely on an approximate solution for the CRRA utility case

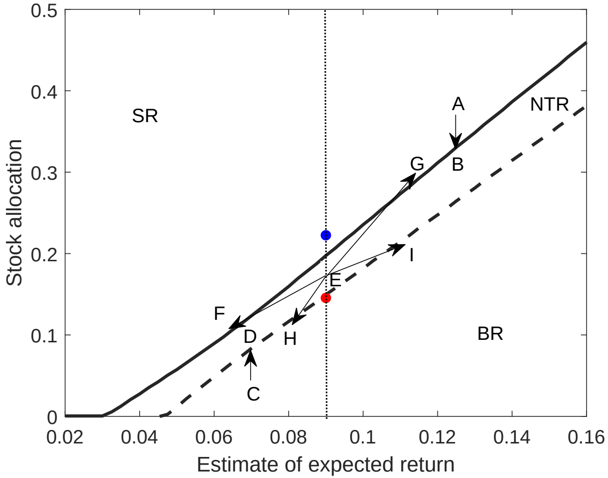
Proposition

(Decomposition of risk exposure without transaction cost) Suppose that there is no transaction cost for any stock, i.e., $\alpha_i = \theta_i = 0$ for $i = 1, 2, ..., N$. Then, the optimal fraction of total wealth W_t invested in Stock i in the model with N stocks equals the optimal fraction when the investor can only invest in the risk-free asset and Stock i.

Solution Strategy

- When there are small transaction costs, we also solve the model for one stock and one risk-free asset to obtain the tolerable risk exposure for that stock
- Remarks:
  - Independence assumption is crucial in obtaining this result
  - Fluctuations in other stocks' prices do affect rebalancing strategy (i.e. no narrow framing)
  - We have also solved a case with CARA utility, in which the risk exposure decomposition is optimal, and qualitatively similar results are obtained
- Calibrations:
  - 4 stocks (the median number of stockholding in Odean (1998)'s sample) with typical return parameters
  - unbiased prior estimate
  - a proportional transaction costs rate of 50 bps

Rebalancing Strategy for One Stock



Disposition Effect Measures

Table: **Disposition effect measures**

	A1: Full sample	B1: No-new purchase	C1: Complete sale
		Observable case	
PGR	0.338	0.333	N.A.
PLR	0.097	0.099	N.A.
DE	0.241***	0.234***	N.A.
DER	3.486***	3.364***	N.A.
PGL	0.859	0.859	N.A.
		Unobservable case	
	A2: Full sample	B2: No-new purchase	C2: Complete sale
PGR	0.343	0.346	0.173
PLR	0.122	0.126	0.353
DE	0.221***	0.220***	-0.179***
DER	2.823***	2.750***	0.491***
PGL	0.783	0.767	0.351

Remark: DE can arise in the subsample of complete sales if a stock with mean-reverting expected return is added

Disposition Effect and Volatility

- Kumar (2009): disposition effect is stronger for stocks with higher volatility.
- Our model:

Table: **The disposition effect and volatility**

	$\sigma = 0.35$	$\sigma = 0.3$
Average duration between sales	0.141	0.154
PGR	0.384	0.343
PLR	0.038	0.122
DE	0.346***	0.221***
$\Delta(DE)$	0.125***	

- Mechanism: learning is slower for more volatile stocks, and the exposure effect becomes stronger

Reverse Disposition Effect

- Odean (1998):

$$PGPA = \frac{\#\text{Gains Purchased}}{\#\text{Gains Purchased} + \#\text{Gains Potentially Purchased}},$$
$$PLPA = \frac{\#\text{Losses Purchased}}{\#\text{Losses Purchased} + \#\text{Losses Potentially Purchased}}.$$

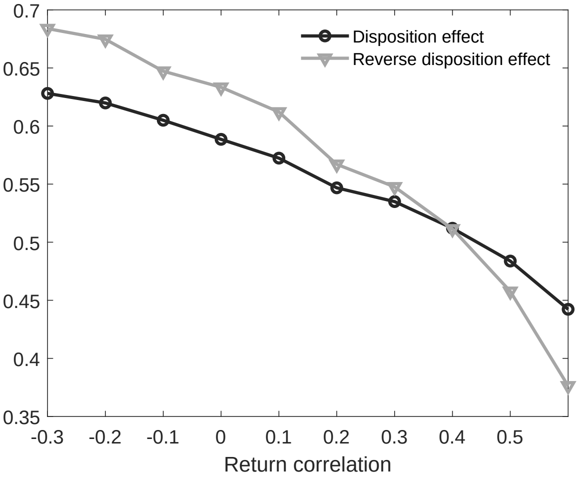
with $PLPA > PGPA$

- Our model:

Table: **The reverse disposition effect**

Observable case		**Unobservable case**	
PLPA	0.404	*PLPA*	0.353
PGPA	0.130	*PGPA*	0.201
RDE	0.274***	*RDE*	0.152***

Correlated Returns



After-Sale Return

- Odean (1998): Winners sold have higher after-sale returns than losers held
- Our model:

Table: ***Ex-post* returns**

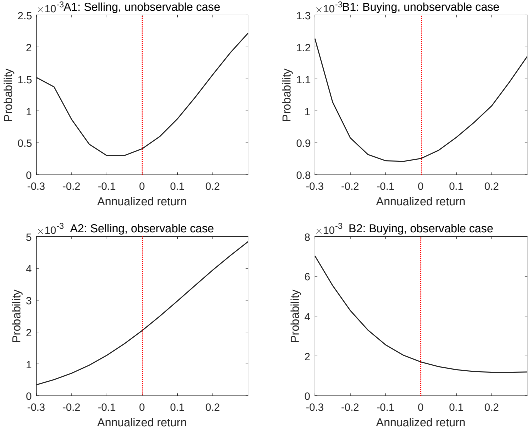
	in 84 trading days	in 252 trading days
Winners sold	4.53%	13.89%
Losers held	3.75%	11.38%
Difference	0.77%***	2.51%***

Remark: We increase stock 3 and 4's expected returns to 14% when generating these results

- Mechanism: stocks with higher expected return are more likely to reach the sell boundary

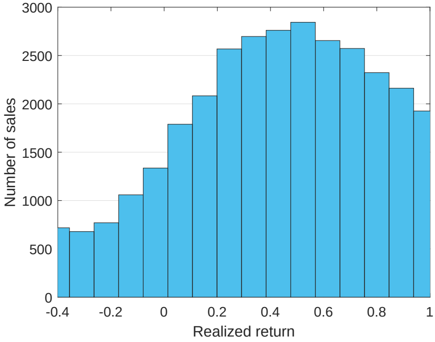
V-Shape Results

- Ben-David and Hirshleifer (2012): the plots of these probabilities against paper profit exhibit V-shaped patterns
- Our model:



Realized Returns

- Ben-David and Hirshleifer (2012): the distribution of realized returns is hump-shaped with a maximal value in the domain of gains
- Our model:



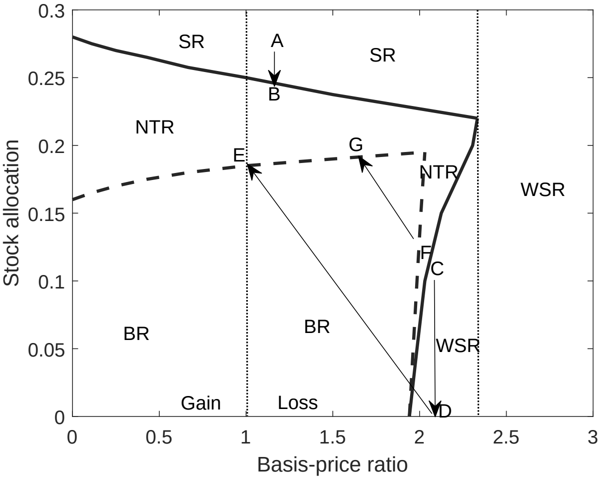
Repurchase Effect

- Strahilevitz, Odean, and Barber (2011): investors are reluctant to repurchase stocks previously sold for a loss, as well as stocks that have appreciated in price subsequent to a prior sale
- Our model:

Table: **Repurchase effect measures**

Unobservable case			
A1: Previous winners or losers		B1: Winners or losers since last sale	
PLRP	0.343	*PDR*	0.478
PWRP	0.393	*PUR*	0.247
Difference	-0.050***	Difference	0.231***
Observable case			
A2: Previous winners or losers		B2: Winners or losers since last sale	
PLRP	0.268	*PDR*	0.424
PWRP	0.279	*PUR*	0.004
Difference	-0.011	Difference	0.420***

Capital Gains Tax



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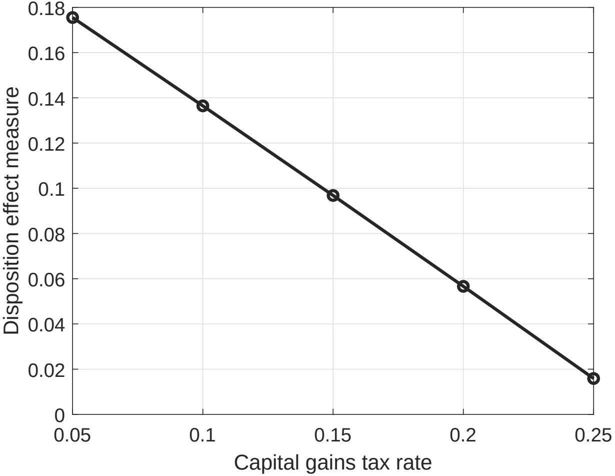

Conclusion

- Rational rebalancing motivation could generate a large portion of the main findings related to the disposition effect
- Although behavioral biases are likely to exist among some investors, there can well be a rational component in the disposition-effect and the related trading patterns
- How to separate the rational portfolio rebalancing and behavioral components constitutes an interesting empirical question for future studies