Do limits to arbitrage explain the benefits of volatility-managed portfolios?

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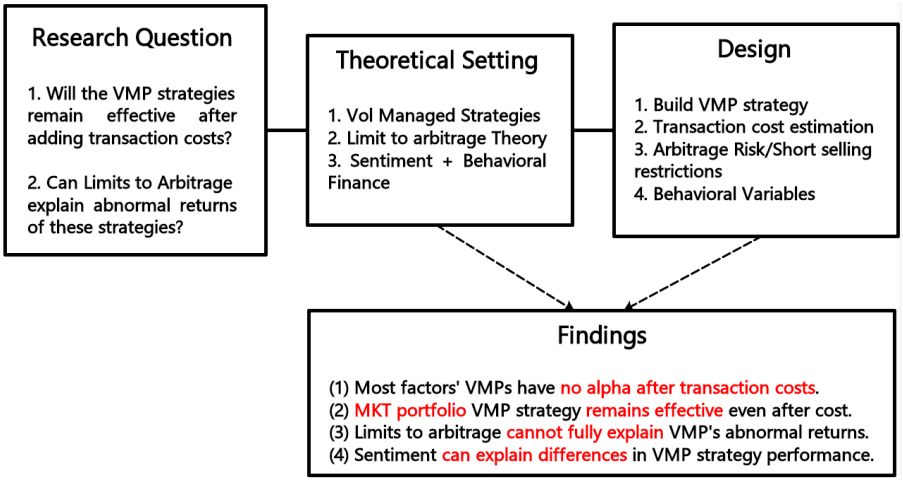
Framework


Research Question
1. Will the VMP strategies remain effective after adding transaction costs?
2. Can Limits to Arbitrage explain abnormal returns of these strategies?
Theoretical Setting
1. Vol Managed Strategies
2. Limit to arbitrage Theory
3. Sentiment + Behavioral Finance
Design
1. Build VMP strategy
2. Transaction cost estimation
3. Arbitrage Risk/Short selling restrictions
4. Behavioral Variables
Findings
(1) Most factors' VMPs have no alpha after transaction costs.
(2) MKT portfolio VMP strategy remains effective even after cost.
(3) Limits to arbitrage cannot fully explain VMP's abnormal returns.
(4) Sentiment can explain differences in VMP strategy performance.

Research Questions

1. Can Volatility Managed Portfolios (VMPs) still have significant abnormal returns after considering transaction costs?

- Namely, Can transaction costs explain why non-market factors' VMP generate alphas?
- Do seemingly useful strategies really make money?

2. Can Limits to Arbitrage (LTA) explain the performance of VMP strategies?

- If not, is there any alternative channel to explain such anomly?

Motivation

Moreira and Muir (2017) found that VMPs can generate significant abnormal returns.

- Most studies on VMP only evaluate **'ideal profits'** and **ignore costs**.
- VMP strategy(**high turnover rate and cost sensitivity**)is an ideal research object.

Contradictions between theoretical and empirical expectations:

- Classical financial theory holds that **the higher the risk, the higher the expected return**.
- Empirically, VMP reverses the use of VOL, and still brings excess rets.

This abnormal result may not necessarily mean that market is ineffective:

- Market participants are unable to execute effective arbitrage;(high costs)
- Market participants have 'behavioral biases';(slow to react during high volatility)

Contributions

1. Literature on VMPs and Their Abnormal Returns

Prior: VMP significantly improved return of various asset factors.(Moreira & Muir 2017)

Extend: Analyze actual feasibilit when adding transaction costs, turnover rates, etc.

2. Literature on the role of LTA in explaining abnormal returns

Prior: Higher arbitrage risk implied the stronger the abnormal returns. (Stambaugh et al. 2015)

Extend: Testing and discovering that LTA cannot explain the benefits of **VMP** strategy.

3. Literature on introduction of Sentiment Theory into Asset Pricing

Prior: The market responds slowly to negative information when sentiment is high.

Extend: Introducing sentiment interpretation pathway into interpretation framework of VMP.

Hypothesis

H1: VMPs for non-market factors achieve high excess returns after considering costs.

- Checking that if LTA explain for VMP alpha returns for non-market factors.
- High-return strategies (VMP) may not be profitable(arbitrage costs are too high)

H2: LTA explains the excess returns obtained by market portfolio VMP strategy.

- Many studies have shown that abnormal returns increase with increasing **IV** and decrease with increasing **IO** in the cross-section;
- Otherwise, LTAs fails to explain, and there may exist another channel(**Sentiment**).

Sample and Variables

Sample Range:

- Stock data: CRSP, Compustat
- Factor data: Kenneth French, AQR, Hou-Xue-Zhang
- Sample period: 1926–2015(Monthly)

Key Vairables:

- The **VMP returns**: $f_t^{\sigma} = \frac{c}{RV_{t-1}^2} \cdot f_t$

f_t: Monthly returns of raw factors (such as HML) at time t.

RV_{t-1}^2: Realized variance of the daily returns of the factor in period (t-1).

c: Normalizd coefficient: Managed portfolio has same vol as the original factor.

Idea: Less/More weights during high/Low volatility periods for risk adjusted returns.

H1: Non-market Factors' VMP don't remain effective after adding costs

Panel A: Full sample

	MKT	SMB	HML	MOM	RMW	CMA	ROE	IA	BAB
α	4.81	−0.46	1.74	12.53	2.68	0.36	5.03	1.41	6.83
	(3.05)	(−0.50)	(1.64)	(8.06)	(3.06)	(0.50)	(5.15)	(2.06)	(6.85)
β	0.61	0.61	0.57	0.47	0.58	0.68	0.65	0.70	0.58
	(25.17)	(25.23)	(22.71)	(17.36)	(17.97)	(22.94)	(20.62)	(23.51)	(22.95)
N	1073	1073	1073	1068	629	629	587	587	1020

Estimation method for transaction costs: two-step modeling

Step1: Adopting Hasbrouck's (2009) Effective Spread measurement method;

Step2: Adding up individual stock costs as factor portfolio cost(Novy Marx 2016).

Panel A: Whole sample factor performance and transaction cost statistics

	SMB	HML	MOM	RMW	CMA	ROE	IA	BAB
$E(f^{\alpha}_{net})$	−5.56	4.48	1.33	3.13	4.43	0.85	2.25	6.67
α_{net}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$t(\alpha_{net})$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

H1(further): Introducing six cost mitigation mechanisms is of no help

Panel A: 150% maximum leverage constraint

		SMB	*HML*	*MOM*	*RMW*	*CMA*	*ROE*	*IA*	*BAB*
1926 to 2015	α_{net}	0.00	0.00	1.27	0.00	0.00	0.17	0.00	0.00
	$t(\alpha_{\text{net}})$	0.00	0.00	1.26	0.00	0.00	0.24	0.00	0.00
	$z(SR(f^{\sigma}_{\text{net}}))$	5.72	3.97	1.65	3.79	6.66	0.52	4.27	6.23
1926 to 1955	α_{net}	0.00	0.00	0.00					0.00
	$t(\alpha_{\text{net}})$	0.00	0.00	0.00					0.00
	$z(SR(f^{\sigma}_{\text{net}}))$	3.62	3.73	0.45					3.94
1956 to 1985	α_{net}	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
	$t(\alpha_{\text{net}})$	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00
	$z(SR(f^{\sigma}_{\text{net}}))$	4.83	3.08	0.33	4.53	4.75	1.92	4.35	5.92
1986 to 2015	α_{net}	0.00	0.00	2.14	0.00	0.00	0.90	0.00	0.00
	$t(\alpha_{\text{net}})$	0.00	0.00	1.67	0.00	0.00	1.09	0.00	0.00
	$z(SR(f^{\sigma}_{\text{net}}))$	5.14	2.35	1.35	2.28	5.09	0.38	3.03	4.13

Panel D: Factors scaled by six-month volatility

1926 to 2015	α_{net}	0.00	0.39	5.01	0.00	0.00	1.92	0.09	1.23
	$t(\alpha_{\text{net}})$	0.00	0.61	2.88	0.00	0.00	3.20	0.22	1.77
	$z(SR(f^{\sigma}_{\text{net}}))$	−2.45	−0.27	5.09	−0.94	−1.93	2.86	−0.31	0.63

The cost mitigation strategy reduces liquidity demand through one of the following two techniques: **(i) slowing down trading speed** or **(ii) avoiding stocks with high trading costs**.

Proxies for Limits to Arbitrage, LTA

Idiosyncratic Volatility(IVOL) as the **arbitrage risk** proxy variable.

$$\text{IVOL}_{i,t} = \text{Std. Dev}(\epsilon_{i,t})$$

Among them, $\epsilon_{i,t}$ is the CAPM regression residual of stock i at time t.

Institutional Ownership(IO) measures the **short-selling restrictions**.

$$\text{IO}_{i,t} = \frac{\text{Number of shares held by the institution}}{\text{Total number of outstanding shares}}$$

Calculate the monthly **IVOL & IO** of all stocks and divide into three quartiles:

Low arbitrage risk group, **Medium** arbitrage risk group, **High** arbitrage risk group.

Supporting H1 & Rejecting H2

	Panel A: IV, 1926 to 2015			Panel B: IO, 1986 to 2015		
	IV1	IV2	IV3	IO1	IO2	IO3
β	0.56***	0.72***	0.83***	0.55***	0.65***	0.71***
	(11.19)	(11.47)	(10.89)	(12.24)	(13.23)	(13.48)
α	5.74***	5.29***	0.72	0.33	2.41	5.46***
	(3.81)	(2.71)	(0.27)	(0.13)	(1.13)	(2.63)
N	1072	1072	1072	360	360	360
R^2	0.35	0.34	0.27	0.29	0.43	0.48
$SR(rx)$	0.48	0.38	0.15	0.27	0.42	0.52
$SR(rx, rx^{\sigma})$	0.62	0.47	0.15	0.27	0.47	0.71
ΔCER	2.63	1.35	0.00	0.00	0.74	3.82

Rejecting H2: LTA cannot explain the abnormal returns of market portfolio VMP.

The excess returns of VMP strategy are concentrated in stocks with "low arbitrage restrictions" (i.e. low-risk, high short selling stocks).

New Channel: Behavioral finance –Sentiment

The BW Sentiment Index:

Constructed by Baker and Wurgler (2006), is one of the most classic and widely cited market sentiment measures(behavioral finance).

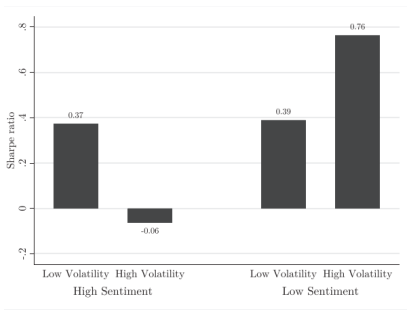
Selecting 6 market variables that represent the level of investor optimism:

Return on the First Day of IPO; Number of IPOs; Closed-end fund discount; Equity Issuance; Turnover; Changes in PE,PB;

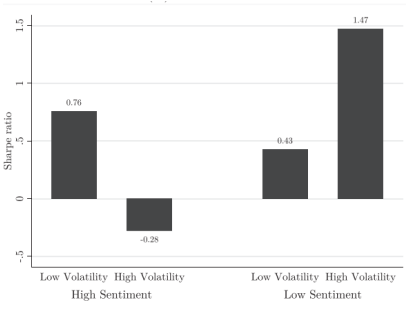
Using PCA to extract the first PC from them as overall market sentiment factor.

Adopting a regression residual version, which is the **"pure sentiment component"** after **controlling for macroeconomic variables** such as inflation, interest rates, etc.

H2(further): Sentiment explains performance of market portfolio VMP



(A) 1966 to 2015



(B) 1986 to 2015

When market **sentiment is low**, volatility has a **positive predictive effect** on market returns, while it has a **negative predictive effect** when **sentiment is high**.

研究结论如何回应研究假设

研究假设	是否被支持	说明
H1：VMP 策略在成本后仍有效	不支持	除市场组合和少数例外（如 MOM）外，多数策略在交易成本后无 alpha
H2：套利限制解释 VMP 超额收益	不支持	VMP 收益集中在套利限制小的股票中，违背套利限制理论预期
H3：情绪驱动解释 VMP 收益	支持	高情绪时期 VMP 策略表现显著更好，符合行为金融理论解释

维度	套利限制理论（LTA）	行为金融情绪理论
理论出发点	理性套利者面临摩擦或风险	投资者非理性、存在行为偏差
假设核心	“不能套利”导致错误持续存在	“错误定价 + 迟钝反应”形成可预测收益
文中检验方式	分组套利限制变量（IVOL、IO）	分组情绪指数变量（BW 情绪指数）
实证结果支持	不支持	支持
研究意义	驳斥传统“摩擦”路径解释	强化行为金融在资产定价中的解释力

研究局限性与未来展望

局限性:

(1). 样本范围主要基于美国市场数据：时间跨度虽然长（1926–2015），但缺乏国际样本。

- 研究结论的外部有效性有限，在其他国家市场（特别是新兴市场或制度差异显著的市场）是否成立仍需检验。

(2). 交易成本估计基于模型推导，非真实交易数据：虽然作者使用 Hasbrouck (2009) 与 Novy-Marx & Velikov (2016) 的方法进行交易成本建模，但这些仍是**“模型估算”**，并非基于真实交易账户执行成本。

未来研究方向:

(1). 可将 VMP 策略在不同国家（如欧洲、新兴市场）、不同监管环境下检验；

- 可进一步拓展至其他资产类别。验证 VMP 策略的普适性与套利限制/情绪理论的跨市场有效性。

(2). 构建多因子下的最优杠杆动态策略：

- 当前 VMP 策略基于单因子波动率，未来可基于多因子协方差矩阵动态调整组合杠杆（风险平价）；

或结合机器学习，进行多维特征条件下的策略优化。

Appendix– 交易成本的估算方法-两步法建模

第一步：个股交易成本的估算

采用 Hasbrouck (2009) 的**有效价差 (Effective Spread)** 度量方法：

有效价差 = 成交价格与中间报价（midquote）之间的差值；

衡量投资者实际承担的买卖滑点成本；

使用高频数据估算每只股票的单位交易成本。

第二步：组合层面的交易成本建模

使用 Novy-Marx and Velikov (2016) 的方法将个股成本汇总为因子组合成本：

计算组合的月度换手率（Turnover）；

按照权重分配和换手金额，对个股交易成本加权求和；

得到组合月度总交易成本；

从组合收益中减去交易成本 → 得到净收益（Net Return）。

Appendix–2

项目	市场组合 MKT	一般因子（如MOM、SMB）
VMP调仓对象	整体市场权重	个股之间大幅换仓
是否需要借券	否	是（某些因子需做空）
换手率	低	极高（动量类尤甚）
成本可控性	非常好（可用ETF、期货）	非常差（个股价差 + 冲击成本）
成本后收益	仍显著为正	多数为负或为零