# Champagne leverage on a beer budget:

## *Rethinking leveraged ETFs for the retail investor*

**Pieter Van Staden**, Peter Forsyth, Yuying Li

ICCF 2026

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# What is a Leveraged ETF (LETF)?

- VETF = Standard/Vanilla ETFs: **Replication** of (1x) *daily* returns before costs:

$$\frac{dF_v(t)}{F_v(t^-)} = \frac{dS(t)}{S(t^-)} - c_v \cdot dt$$

- LETF = Leveraged ETF: **Replication of $\beta$-times** *daily* returns before costs:

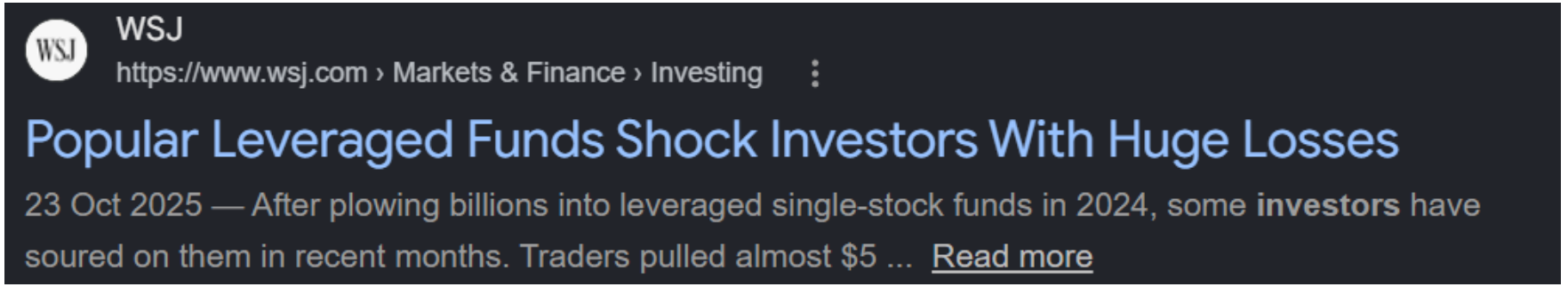
$$\frac{dF_\ell(t)}{F_\ell(t^-)} \simeq \beta \frac{dS(t)}{S(t^-)} - [(\beta - 1)\, r + c_\ell]\, dt.$$

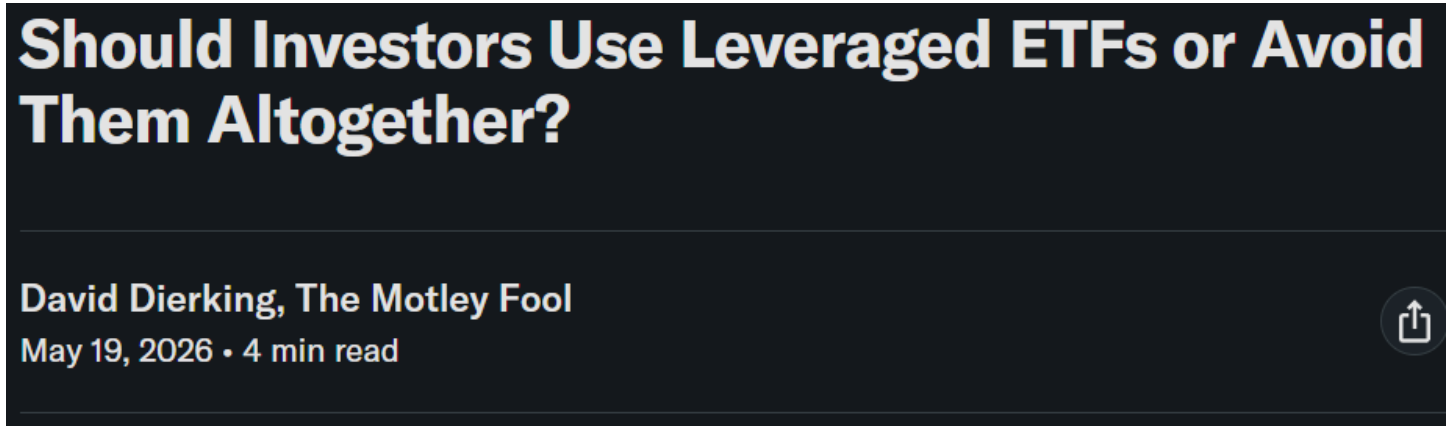
Approximation!
[Exact only if GBM]

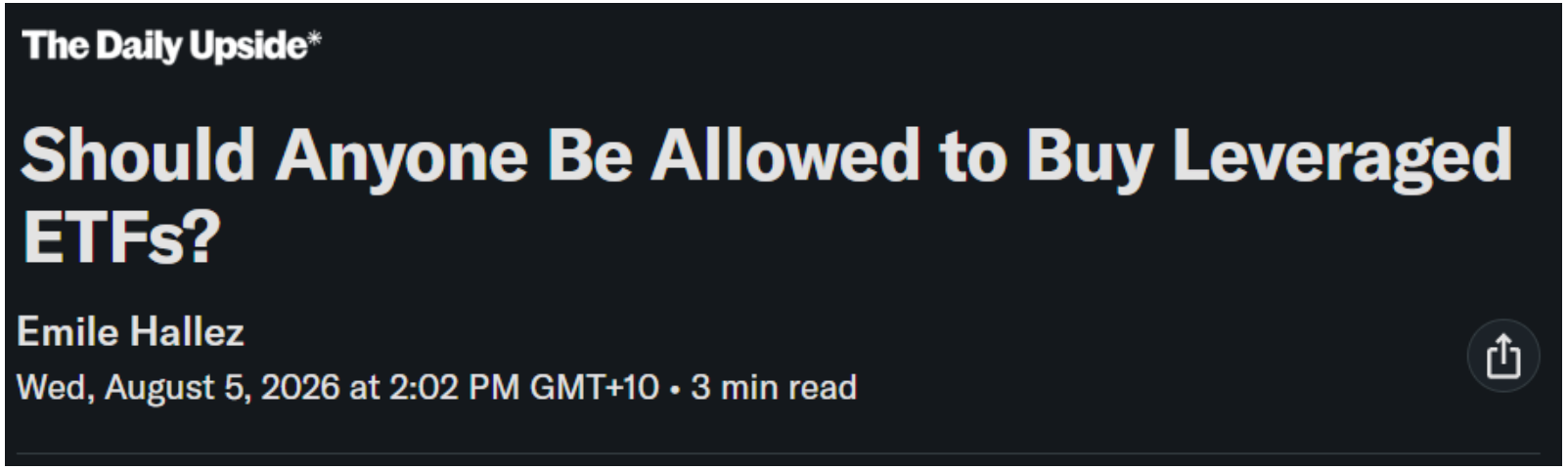
  - Bull/long LETFs ($\beta > 1$) e,g, 2x or 3x are common.
  - Inverse/Bear LETFs ($\beta \leq -1$): -1x, -2x are common.

  - Warning: Obviously multiplying *daily* returns is not the same as multiplying e.g. *monthly* returns. So LETF does not replicate e.g. 2x annual VETF returns!

# LETFs are bad...

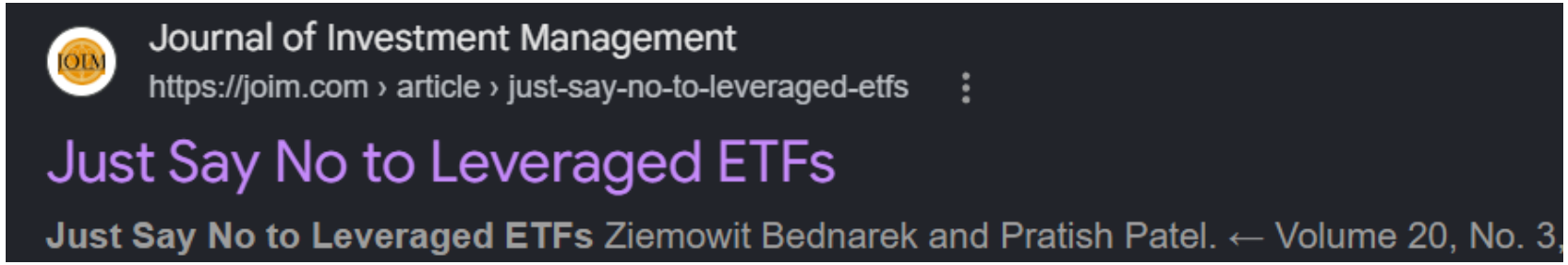


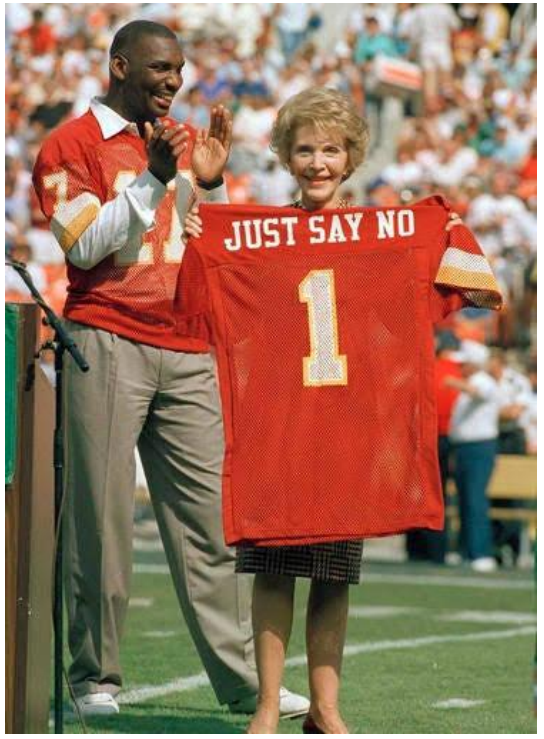



# “Just say no”

- Academia (mostly) agrees - my favourite example is this 2022 paper title:



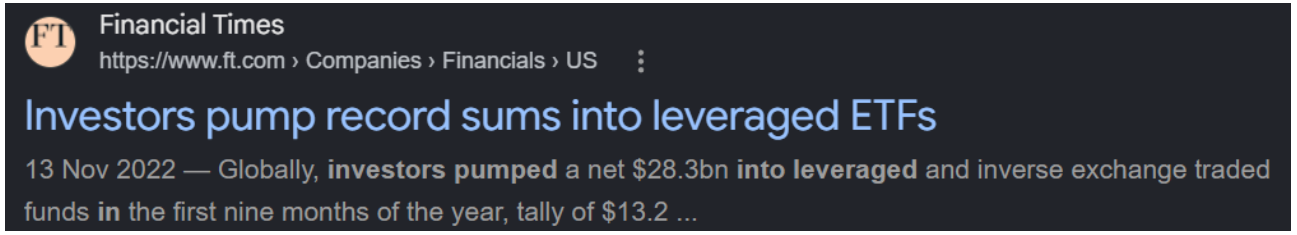

- 1980s: (Same vibes, not LETFs)

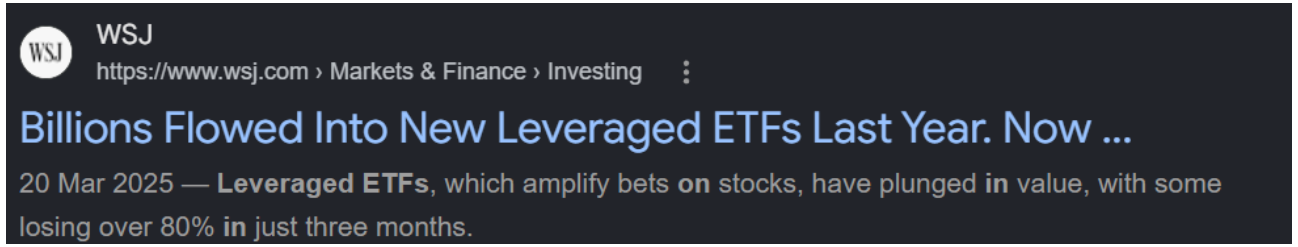

# “Just say no” seems to be winning hearts and minds… or not…

- 2022 article:


- 2024 article:




- 2025 article:




- 2026 article:

# What's going on?

- Could just be crazy speculation?
  - Remember Justin Bieber's "Bored Ape NFT"?


- If it is just speculation, then:
  1. Why do we see this massive popularity of LETFs year after year?
  2. Why do institutional investors also have LETF positions?

Research article Get rights and content ↗

Blessing or curse? Institutional investment in leveraged ETFs

Luke DeVault [a], H.J. Turtle [b], Kainan Wang [c] Show more

Journal of Banking & Finance

**Date:** August 2021
**Article:** 106169
**Volume:** Volume 129

- Or… could the academic literature be missing something?
  - ➢ And could this "missing something" explain the Retail investor enthusiasm for LETFs?

# Retail investors: The (careful) case *for* LETFs

1. All LETFs are ***not* the same**
   - *Generic* warnings about *generic* LETFs are not very helpful.

2. The academic literature on LETFs is ***not wrong*** **–** it provides all the ***right answers*****, but to the *wrong questions***
   - Especially for Retail investors.

3. LETFs provide **cheap leverage for Retail investors** → systematically missed in the literature
   - Leverage is risky → LETFs are risky.
   - But the leverage provided by LETFs is also cheap, convenient.

4. Using **LETFs cleverly** in investment strategies: **Reduce LETF exposure after gains**.
   - Quarterly rebalancing is enough.

5. **No free lunch**.
   - Leverage is still leverage (even if it is cheap and convenient!)

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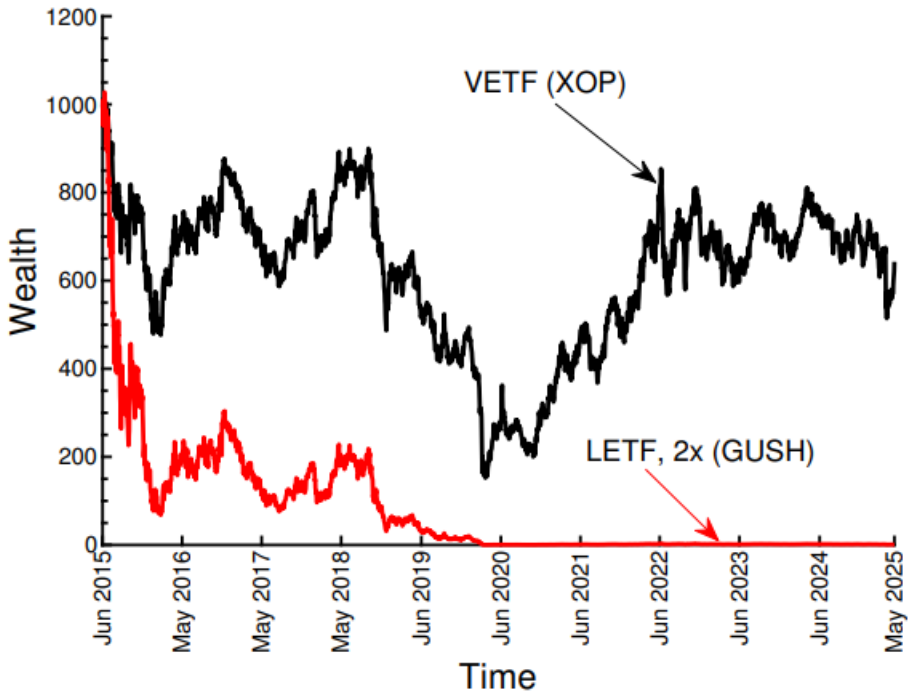
# 1. All LETFs are not the same

- **Bad news: Single stock LETFs:**
  - Example – recent drama in South Korea.


- **Bad news: Sector-specific LETFs:**
  - Example: S&P Oil and Gas Exploration and Production Select Industry Index.
    - VETF = XOP
    - 2x LETF = GUSH

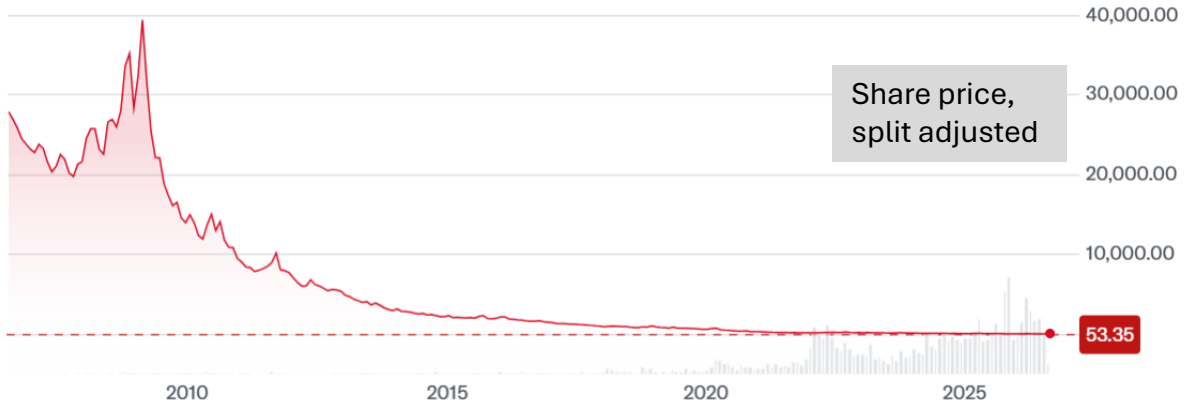
Illustrative buy-and-hold portfolio values from investing all hypothetical initial wealth of $1000 in each VETF and LETF from June 2015 until May 2025



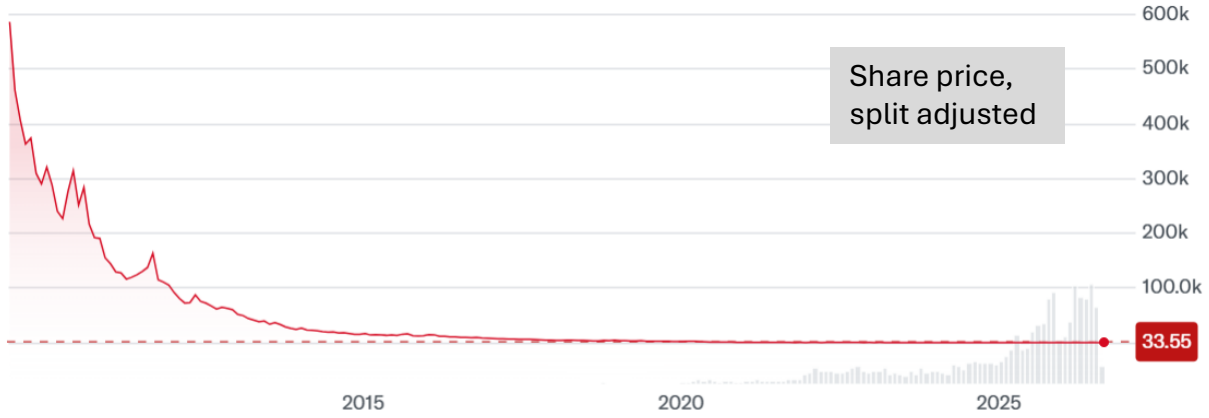
# 1. All LETFs are not the same

- **Bad news:** Inverse/bear LETFs ($\beta < 1$):
  - Example ETFs on S&P 500:
    - -2x LETF = SSO
    - -3x LETF = UPRO
  - Inverse LETFs are leveraged bets *against* positive drift…. in addition to *other* LETF risks we will discuss.

**-2x LETF: ProShares UltraShort S&P500 (SDS)**




**-3x LETF: ProShares UltraPro Short S&P500 (SPXU)**



# 1. All LETFs are not the same

- **Broad equity, long LETFs ($\beta > 1$)**:
  - Example ETFs on S&P 500:
    - VETF = IVV
    - 2x LETF = SSO
    - 3x LETF = UPRO

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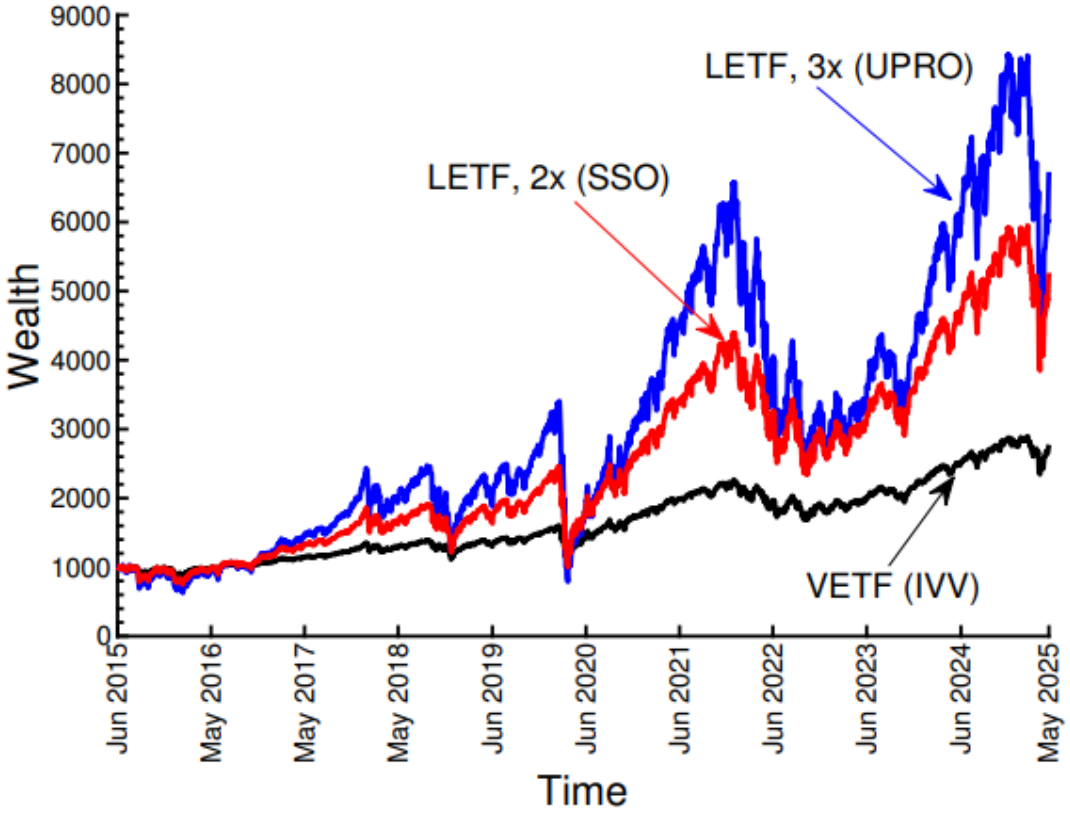
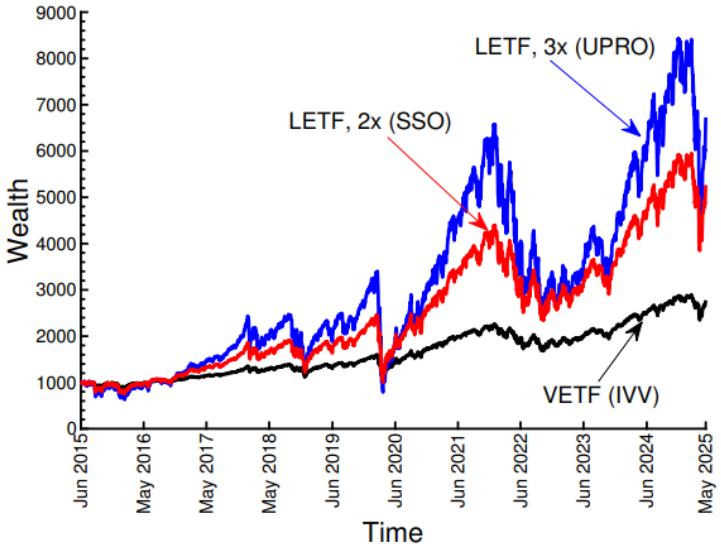



**All LETFs are *not* the same, especially for a Retail investor:**

- **Bad news ("just say no!"):** inverse LETFs, single sector LETFs, single stock LETFs
- **More promising: Broad equity, long LETFs only ($\beta > 1$):** We will use $\beta = 2$ in examples
  - ✓ Underlying diversification
  - ✓ Moderate volatility
  - ✓ Long-term positive drift
  - → payoff convexity [will discuss!]

# Aside: Data

- But wait… isn't this optimistic picture missing the point?
  - Good last 10 years ≠ Good in next 10 years!




- Problem: LETFs were only introduced in 2006.

- **Solution**: **Construct synthetic LETF returns** for a broad US equity market index **starting January 1926**. Rough steps:
  1. CRSP capitalization-weighted index consisting of all US stocks.
  2. Multiply daily returns by multiplier $\beta = 2$.
  3. Adjust daily LETF returns with the annual LETF expense ratio c = 0.89%
  4. Adjust daily LETF returns with the observed T-bill* rate $r$
  5. Inflation-adjust the time series

*LETFs are managed by large institutional fund managers who typically achieve leverage more efficiently through total return swaps. Due to their significant scale and high creditworthiness, these institutions can negotiate swap agreements priced at levels very close to the risk-free (T-bill) rate.

$$\frac{dF_\ell(t)}{F_\ell(t^-)} \simeq \beta \frac{dS(t)}{S(t^-)} - [(\beta - 1)r + c_\ell]\,dt.$$

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# 2. LETFs are risky: Academic literature is not wrong

- Dynamics: T-bills and Broad stock market index:

$$\frac{dB(t)}{B(t)} = r \cdot dt,$$

$$\frac{dS(t)}{S(t^-)} = (\mu - \lambda\kappa_1^s)\,dt + \sigma \cdot dZ + d\left(\sum_{i=1}^{\pi(t)} (\xi_i^s - 1)\right)$$

- Dynamics – VETF:

$$\frac{dF_v(t)}{F_v(t^-)} = \frac{dS(t)}{S(t^-)} - c_v \cdot dt$$

$$= (\mu - \lambda\kappa_1^s - c_v) \cdot dt + \sigma \cdot dZ + d\left(\sum_{i=1}^{\pi(t)} (\xi_i^s - 1)\right)$$

- Dynamics – LETF:

$$\frac{dF_\ell(t)}{F_\ell(t^-)} \simeq \beta\frac{dS(t)}{S(t^-)} - [(\beta - 1)\,r + c_\ell]\,dt$$

**Approximation! [Exact only if GBM]**

**LETF jumps: Limited liability**

$$\xi^\ell = \begin{cases} \xi^s & \text{if } \xi^s > (\beta - 1)/\beta, \\ \frac{(\beta - 1)}{\beta} & \text{if } \xi^s \leq (\beta - 1)/\beta. \end{cases}$$

$$\frac{dF_\ell(t)}{F_\ell(t^-)} = [\beta(\mu - \lambda\kappa_1^s) - (\beta - 1)\,r - c_\ell] \cdot dt + \beta\sigma \cdot dZ + \beta \cdot d\left(\sum_{i=1}^{\pi(t)} (\xi_i^\ell - 1)\right)$$

# 2. LETFs are risky: Academic literature is not wrong

- Simple illustration: Buy-and-hold over $[0, \Delta t]$

$$\frac{dF_v(t)}{F_v(t^-)} = (\mu - \lambda\kappa_1^s - c_v)\cdot dt + \sigma \cdot dZ + d\left(\sum_{i=1}^{\pi(t)}(\xi_i^s - 1)\right)$$

$$\frac{dF_\ell(t)}{F_\ell(t^-)} = [\beta(\mu - \lambda\kappa_1^s) - (\beta - 1)r - c_\ell]\cdot dt + \beta\sigma \cdot dZ + \beta \cdot d\left(\sum_{i=1}^{\pi(t)}(\xi_i^\ell - 1)\right)$$

- VETF payoff at $\Delta t$ :

$$\frac{F_v(\Delta t)}{F_v(0)} = \exp\{-c_v \cdot \Delta t\} \cdot \left(\frac{S(\Delta t)}{S(0)}\right)$$

**A little bit of Cost drag... but basically just replication**

- LETF payoff at $\Delta t$ :

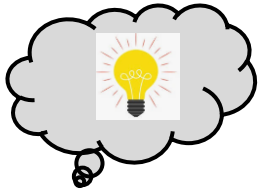
⚠ **A lot more cost drag** $0 < c_v \ll c_\ell$

$$\frac{F_\ell(\Delta t)}{F_\ell(0)} = \exp\{-c_\ell \cdot \Delta t\} \cdot f_\ell(\Delta t;\beta) \cdot \widetilde{Y}_\ell(\Delta t;\beta) \cdot \left(\frac{S(\Delta t)}{S(0)}\right)^\beta$$

⚠ **Volatility decay:** $\lim_{\sigma\to\infty} f_\ell(\Delta t;\beta) = 0$

⚠ **Time decay:** $\lim_{\Delta t\to\infty} f_\ell(\Delta t;\beta) = 0$

⚠ **Jump decay:** $\widetilde{Y}_\ell(\Delta t;\beta) \le 1$



Great opportunity to write lots of papers warning about each of these (valid) concerns with LETFs!

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# 3. What's missing? LETFs can provide cheap leverage

- LETF payoff at $\Delta t$ :

$$\frac{F_\ell(\Delta t)}{F_\ell(0)} = \exp\{-c_\ell \cdot \Delta t\} \cdot f_\ell(\Delta t;\beta) \cdot \widetilde{Y}_\ell(\Delta t;\beta) \cdot \left(\frac{S(\Delta t)}{S(0)}\right)^{\beta}$$

**What about this term?**
Remember: We are looking at broad equity index LETFs

- **LETFs can provide cheap leverage for Retail investors** – systematically missed in the literature.

  Missing counterfactual: What are the actual options available for Retail investor?

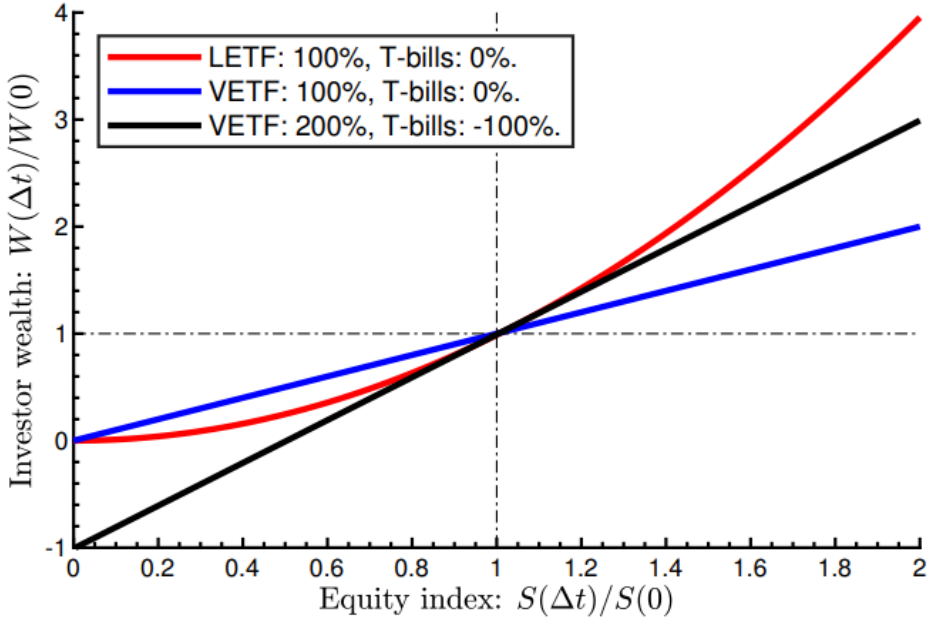
  - **Option 1 – Standard borrow-to-invest**: Inconvenient, expensive for a Retail investor
    - ⚠ Retail margins are **enormous** (even small institutional investors pay margins >5%)
    - ⚠ No downside protection, margin calls, active management.

  - **Option 2 – Use LETFs**: If you want leverage (and leverage is risky!), then for the (cheap) expense ratio ~90bps you get:
    - ✓ Limited liability
    - ✓ No active management of leverage position needed
    - ✓ Payoff is call-like (floored at zero)

**Missing counterfactual**
- We are *not* comparing: LETFs vs. No leverage
- We *are* comparing: **Getting leverage via LETFs** vs. **getting leverage another way**.

# 3. What's missing? LETFs can provide cheap leverage

- Payoff charts:




Basic illustration (GBM, no borrowing margins)

<u>If you want leverage</u>, then:

- **Black line** = Option 1: Standard borrow-to-invest
- **Red line** = Option 2**:** Use LETFs

**Blue line**: No leverage, standard vanilla ETF.

- LETF payoff:
  - ✓ Limited liability
  - ✓ No active management of leverage position needed
  - ✓ Payoff is call-like (floored at zero)

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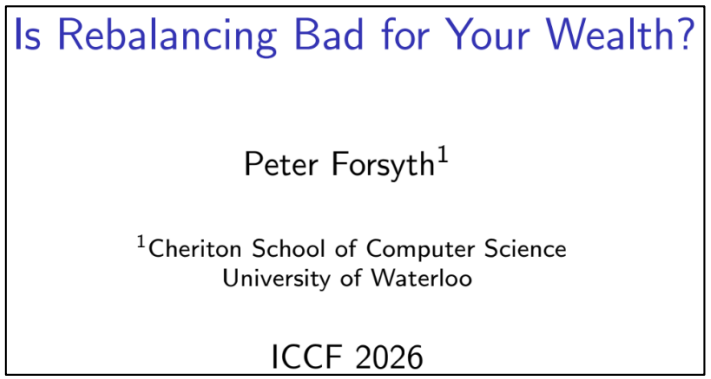
# 4. Using LETFs cleverly: Reduce LETF exposure after gains

- Rebalancing can be costly for a Retail investor


Is Rebalancing Bad for Your Wealth?

Peter Forsyth[1]

[1]Cheriton School of Computer Science
University of Waterloo

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- But "buy-and-hold" for LETFs has risks of its own!

⚠ Holding LETF ≈ holding leveraged position without rebalancing…
… and that is a completely different proposition than was just discussed.

- LETFs also have their real, idiosyncratic issues:
  - ⚠ Cost drag.
  - ⚠ Volatility decay.
  - ⚠ Time decay.
  - ⚠ Jump decay.

# 4. Using LETFs cleverly: Reduce LETF exposure after gains

- What would the *optimal, dynamic* LETF-based strategy look like (T = 10 years)?
  - **Goal**: Beat a given, standard constant proportion benchmark (stocks, bonds).
  - One example – using dynamic **Information Ratio** as optimization objective:

**Maximize:** $\mathcal{IR}_{\mathcal{P}}^{t_0,w_0} = \dfrac{E_{\mathcal{P}}^{t_0,w_0}\left[W(T) - \hat{W}(T)\right]}{Stdev_{\mathcal{P}}^{t_0,w_0}\left[W(T) - \hat{W}(T)\right]}.$

**Investor** wealth

**Benchmark** wealth

**Strategies:**
- **Benchmark**: Equity index and T-bills
- **VETF investor**: Uses VETF and T bills.
- **LETF investor**: Uses LETF and T-bills

  - Can be solved via embedding:

$$(IR(\gamma)): \quad \inf_{\mathcal{P}\in\mathcal{A}} E_{\mathcal{P}}^{t_0,w_0}\left[\left(W(T) - \left[\hat{W}(T) + \gamma\right]\right)^2\right], \qquad \gamma > 0,$$

**Embedding parameter:** Implicit target for benchmark outperformance at T

  - **Basis for comparison**:
    - Investor strategies all have **same outperformance target**, whether the investor uses **LETF** or **VETF**. What can we learn from the LETF-based strategy?

# 4. Using LETFs cleverly: Reduce LETF exposure after gains

- **Warm-up for intuition**: Closed-form optimal strategies under continuous rebalancing, assumed parametric asset dynamics, unrealistic assumptions.

| Underlying assets | | | Benchmark | Investor candidate assets | |
|---|---|---|---|---|---|
| Label | Value | Asset description | | Using VETF | Using LETF |
| T30 | $B(t)$ | 30-day Treasury bill | 30% | ✓ | ✓ |
| Market | $S(t)$ | Market portfolio (broad equity market index) | 70% | - | - |
| VETF | $F_v(t)$ | Vanilla or standard/unleveraged ETF (VETF) replicating the returns of the market portfolio $S(t)$, with expense ratio $c_v = 0.06\%$ | 0% | ✓ | - |
| LETF | $F_\ell(t)$ | Leveraged ETF (LETF) with daily returns replicating $\beta = 2$ times the daily returns of the market portfolio $S(t)$, with expense ratio $c_\ell = 0.89\%$ | 0% | - | ✓ |

**Strategies:**
- **Benchmark**: Equity index and T-bills
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Investor strategies all have **same outperformance target**, whether the investor uses **LETF** or **VETF**.
What can we learn from the LETF-based strategy?

**Benchmark** wealth

$$\begin{aligned} d\hat{W}(t) &= \left\{\hat{W}(t^-)\cdot[r+\hat{\varrho}_s(t)(\mu-\lambda\kappa_1^s-r)]+q\right\}\cdot dt \\ &\quad +\hat{W}(t^-)\,\hat{\varrho}_s(t)\,\sigma\cdot dZ(t)+\hat{W}(t^-)\,\hat{\varrho}_s(t)\cdot d\left(\sum_{i=1}^{\pi(t)}(\xi_i^s-1)\right) \end{aligned}$$

**VETF investor** wealth

$$\begin{aligned} dW_v(t) &= \left\{W_v(t^-)\cdot\left[r+\varrho_v\left(t,\boldsymbol{X}_v(t^-)\right)\{(\mu-\lambda\kappa_1^s-r)-c_v\}\right]+q\right\}\cdot dt \\ &\quad +W_v(t^-)\,\varrho_v\left(t,\boldsymbol{X}_v(t^-)\right)\sigma\cdot dZ(t)+W_v(t^-)\,\varrho_v\left(t,\boldsymbol{X}_v(t^-)\right)\cdot d\left(\sum_{i=1}^{\pi(t)}(\xi_i^s-1)\right) \end{aligned}$$

**LETF investor** wealth

$$\begin{aligned} dW_\ell(t) &= \left\{W_\ell(t^-)\cdot\left[r+\varrho_\ell\left(t,\boldsymbol{X}_\ell(t^-)\right)\{\beta(\mu-\lambda\kappa_1^s-r)-c_\ell\}\right]+q\right\}\cdot dt \\ &\quad +W_\ell(t^-)\,\varrho_\ell\left(t,\boldsymbol{X}_\ell(t^-)\right)\beta\sigma\cdot dZ(t)+W_\ell(t^-)\,\varrho_\ell\left(t,\boldsymbol{X}_\ell(t^-)\right)\beta\cdot d\left(\sum_{i=1}^{\pi(t)}(\xi_i^\ell-1)\right) \end{aligned}$$

# 4. Using LETFs cleverly: Reduce LETF exposure after gains

- **Warm-up for intuition**: Closed-form optimal strategies under continuous rebalancing, assumed parametric asset dynamics, unrealistic assumptions.
  - ➢ Can get nice closed-form results…

**Proposition 3.2.** *(IR-optimal investment strategy using the LETF) Let $\gamma > 0$ be fixed. Suppose that Assumption 3.2 and wealth dynamics (3.22) and (3.24) apply. Let $W_\ell^*(t)$ denote the LETF investor's wealth process (3.24) under the optimal strategy $\varrho_\ell^*$, and let $\boldsymbol{X}_\ell^*(t) = \left(W_\ell^*(t), \hat{W}(t), \hat{\varrho}_s(t)\right)$. Then the IR-optimal fraction of the investor's wealth invested in the LETF, $\varrho_\ell^*$, satisfies*

$$\begin{aligned}
&\varrho_\ell^*\left(t, \boldsymbol{X}_\ell^*(t^-)\right) \cdot W_\ell^*(t^-) \\
&= \left(\frac{\beta\left[\mu + \lambda\left(\kappa_1^\ell - \kappa_1^s\right) - r\right] - c_\ell}{\beta^2\left(\sigma^2 + \lambda\kappa_2^\ell\right)}\right) \cdot \left[h_\ell(t) + \gamma e^{-r(T-t)} - \left(W_\ell^*(t^-) - g_\ell(t) \cdot \hat{W}(t^-)\right)\right] \\
&\quad + \frac{1}{\beta} g_\ell(t) \left(\frac{\sigma^2 + \lambda\kappa_\chi^{\ell,s}}{\sigma^2 + \lambda\kappa_2^\ell}\right) \cdot \hat{\varrho}_s(t) \hat{W}(t^-),
\end{aligned}$$

**IR-optimal strategy for LETF investor**: Uses LETF and T-bills

*where $g_\ell$ and $h_\ell$ are the following deterministic functions,*

$$g_\ell(t) = \exp\left\{K_\beta^{\ell,s} \cdot \int_t^T \hat{\varrho}_s(u)\, du\right\},$$

$$h_\ell(t) = -\frac{q}{r}\left(1 - e^{-r(T-t)}\right) + q e^{-r(T-t)} \cdot \int_t^T \exp\left\{r(T-y) + K_\beta^{\ell,s} \cdot \int_y^T \hat{\varrho}_s(u)\, du\right\} dy,$$

*with constant $K_\beta^{\ell,s}$ given by*

$$K_\beta^{\ell,s} = \mu - r - \frac{\left(\beta\left[\mu + \lambda\left(\kappa_1^\ell - \kappa_1^s\right) - r\right] - c_\ell\right)\left(\sigma^2 + \lambda\kappa_\chi^{\ell,s}\right)}{\beta\left(\sigma^2 + \lambda\kappa_2^\ell\right)}.$$

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Investor strategies all have **same outperformance target**, whether the investor uses **LETF** or **VETF**.
What can we learn from the LETF-based strategy?

We learn two basic things:

1. **Balance sheet buffering**:
   - For same outperformance target, you need much less % of wealth in LETF than you would have needed in the VETF.
2. **De-risk after gains**:
   - Not a mean reversion bet.
   - Payoff convexity means outperformance increases effective leverage
   - Cutting exposure to LETF just puts risk back where you wanted it.

# 4. Using LETFs cleverly: Reduce LETF exposure after gains

- **Warm-up for intuition**: Closed-form optimal strategies under continuous rebalancing, assumed parametric asset dynamics, unrealistic assumptions.
  - Investor strategies all have **same outperformance target**, whether the investor uses **LETF** or **VETF**. What can we learn from the LETF-based strategy?

We learn two basic things:

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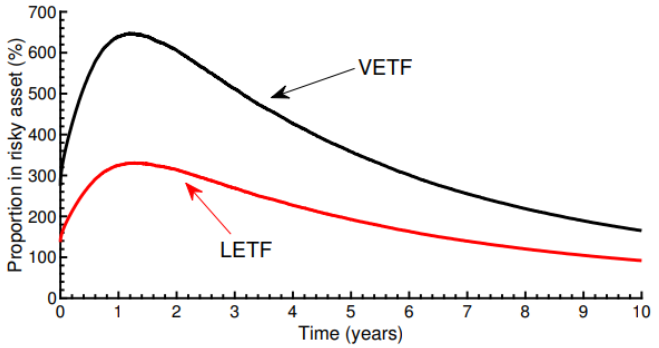
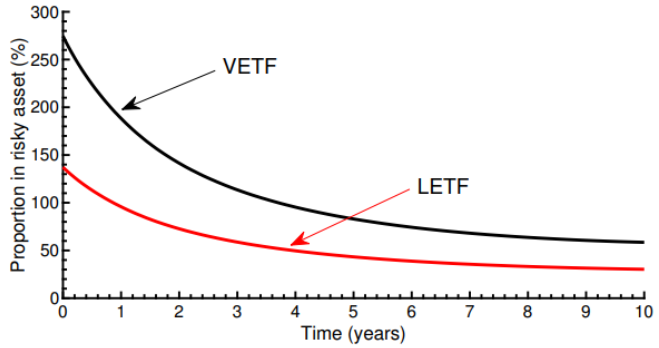
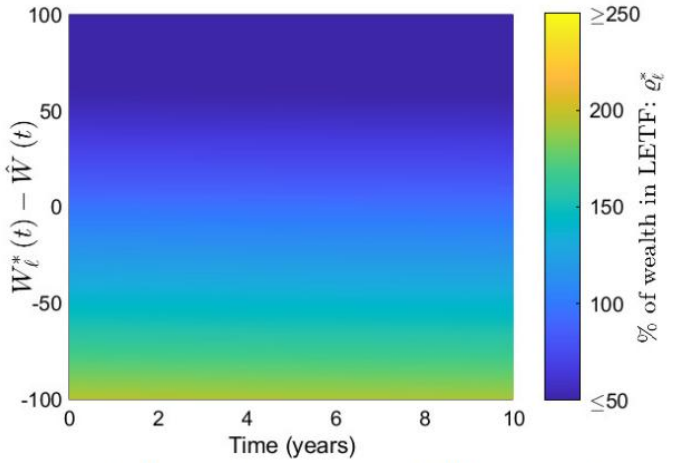


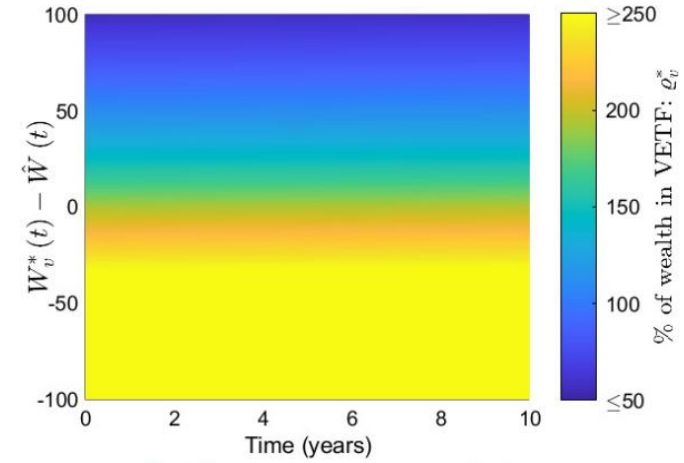

(a) $\varrho_\ell^*$ and $\varrho_v^*$: 95th percentiles over time




(b) $\varrho_\ell^*$ and $\varrho_v^*$: 50th percentiles over time




(a) IR-optimal investment in LETF ($\beta = 2$), $\varrho_\ell^*$




(b) IR-optimal investment in VETF, $\varrho_v^*$

# 4. Using LETFs cleverly: Reduce LETF exposure after gains

- More realistic scenario, T = 10 years:
  - ✓ **For the VETF investor using leverage**, there are:

| | |
|---|---|
| (i) | Restrictions on the maximum leverage |
| (ii) | Limitations on short-selling |
| (iii) | Borrowing premium applicable when short-selling an asset. |
| (iv) | Prohibition of trading in insolvency. |

**Strategies:**
- Benchmark: Equity index + bonds.
- **VETF + bonds, no leverage.**
- **Leveraged VETF + bonds.**
- **LETF + bonds.**

Investor strategies all have **same outperformance target**, whether the investor uses **LETF** or **VETF**.
What can we learn from the LETF-based strategy?

  - ✓ **For LETF investor**: **No portfolio-level leverage at all** – i.e. no borrowing to fund a leveraged LETF position. LETF is used as an alternative to a leveraged VETF position.

  - ✓ **Both the VETF and LETF investors**: **Infrequent (discrete) portfolio rebalancing**.

- We have to use **numerical solutions** to find optimal strategy:
  - ➢ Neural network-based approach.

# 4. Using LETFs cleverly: Reduce LETF exposure after gains

- More realistic scenario – results from numerical solutions:

**Strategies:**
- Benchmark: Equity index + bonds.
- **VETF + bonds, no leverage.**
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We learn ~~**two**~~ **three** basic things:

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2. **Reduce LETF exposure after gains**:
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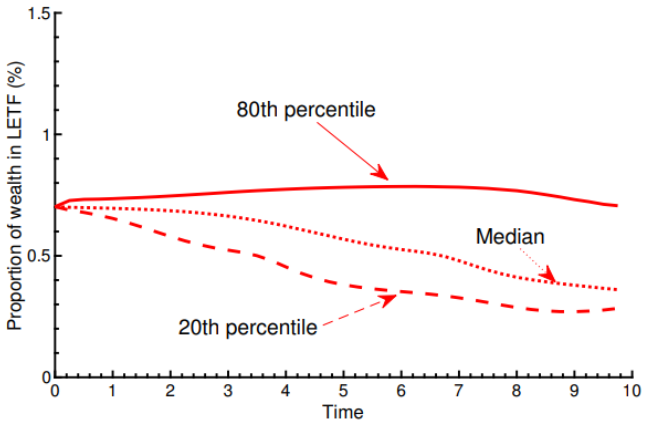
   - Payoff convexity means outperformance increases effective leverage
   - Cutting exposure to LETF just puts risk back where you wanted it.
3. **Quarterly rebalancing of LETF position is enough**:
   - [Broad equity market LETFs].
   - Great news for Retail investors.

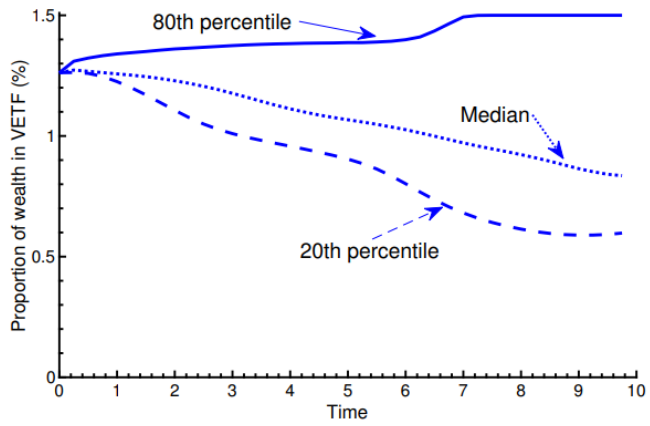
To achieve same outperformance target:

**LETF strategy**
(No portfolio-level leverage)




(a) Proportion of wealth in LETF (no leverage)

**Leveraged VETF strategy**
(Max 1.5x leverage)




(b) Proportion of wealth in VETF ($p_{max} = 1.5, b = 0.03$)

# 4. Using LETFs cleverly: Reduce LETF exposure after gains

- More realistic scenario – results from numerical solutions:

**Strategies:**
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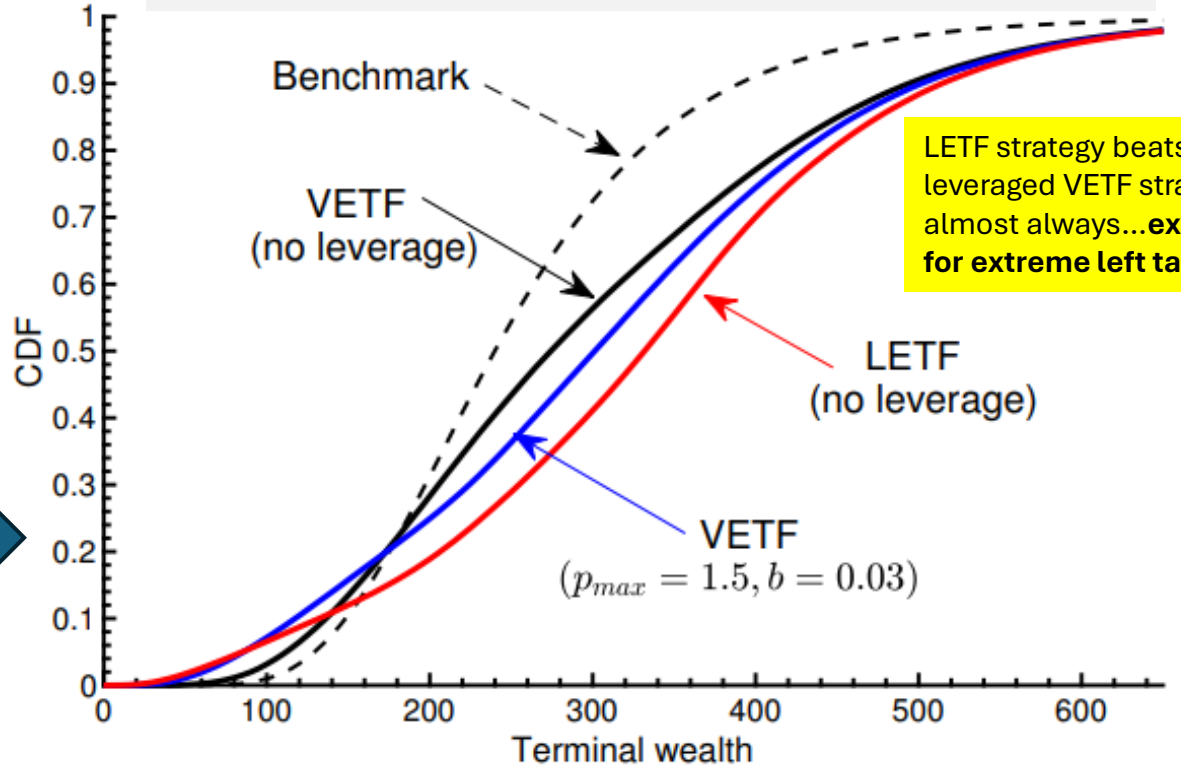
CDF of terminal wealth, same outperformance target, quarterly rebalancing




LETF strategy beats leveraged VETF strategy almost always…**except for extreme left tail**.

**(a)** CDFs of $W^*(T), W_k^*(T), k \in \{v, \ell\}$

# Retail investors: The (careful) case *for* LETFs

1. All LETFs are ***not* the same**
   - *Generic* warnings about *generic* LETFs are not very helpful.

2. The academic literature on LETFs is ***not wrong*** – it provides all the ***right answers*, but to the *wrong questions***
   - Especially for Retail investors.

3. LETFs provide **cheap leverage for Retail investors** → systematically missed in the literature
   - Leverage is risky → LETFs are risky.
   - But the leverage provided by LETFs is also cheap, convenient.

4. Using **LETFs cleverly** in investment strategies: **Reduce LETF exposure after gains**.
   - Quarterly rebalancing is enough.

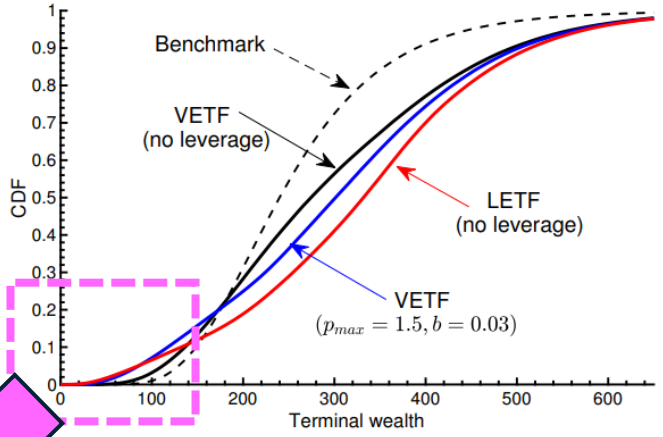
5. **No free lunch**.
   - Leverage is still leverage (even if it is cheap and convenient!)

# 5. No free lunch: Leverage is still leverage

Numerically-derived, realistic, quarterly-rebalanced IR-optimal investment strategies: **Terminal wealth distributions**.

CDF of terminal wealth, same outperformance target, quarterly rebalancing

LETF strategy beats leveraged VETF strategy almost always…**except for extreme left tail.**

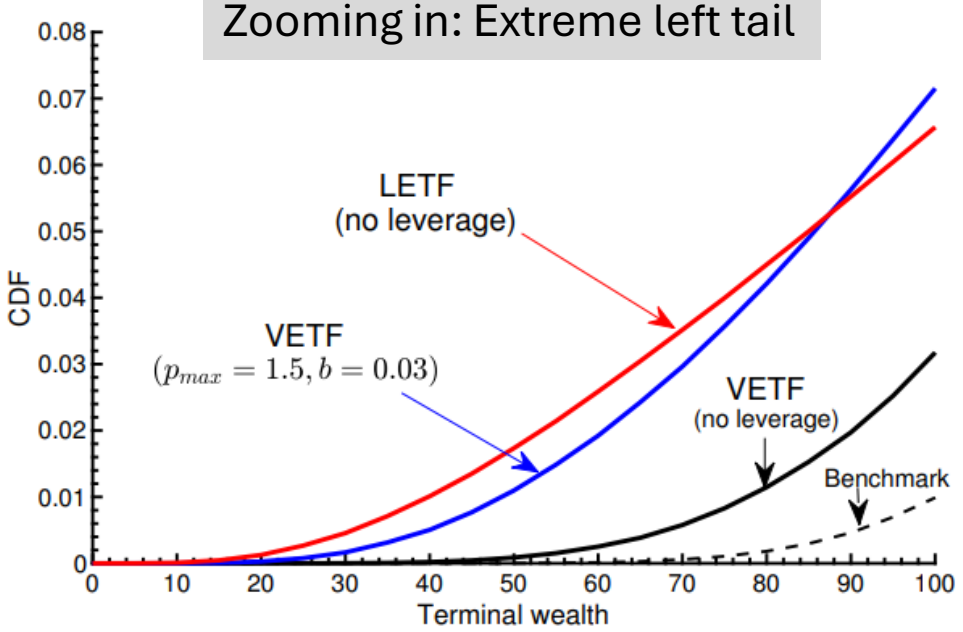



(a) CDFs of $W^*(T), W_k^*(T), k \in \{v, \ell\}$

IR optimal strategies: Investor strategies have same benchmark outperformance target.

- Benchmark: Equity index + bonds.
- **VETF + bonds using no leverage.**
- **Leveraged VETF + bonds.**
- **LETF + bonds.**

Zooming in: Extreme left tail




(b) Extreme left tail: CDFs of $\hat{W}(T)$, $W_k^*(T), k \in \{v, \ell\}$

- LETF limited liability protects you against one catastrophic quarter.
- But the extreme left tail isn't made of one catastrophic quarter: many mediocre quarters compound the LETF's time decay, vol drag, cost drag, jump decay.

# 5. No free lunch: Leverage is still leverage

Numerically-derived, realistic, quarterly-rebalanced IR-optimal investment strategies implemented on actual historical paths:

IR optimal strategies: Investor strategies have same benchmark outperformance target.

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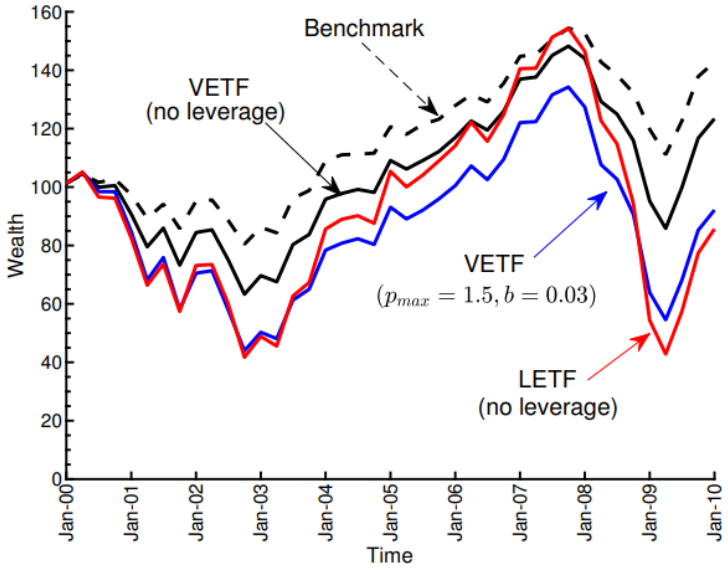
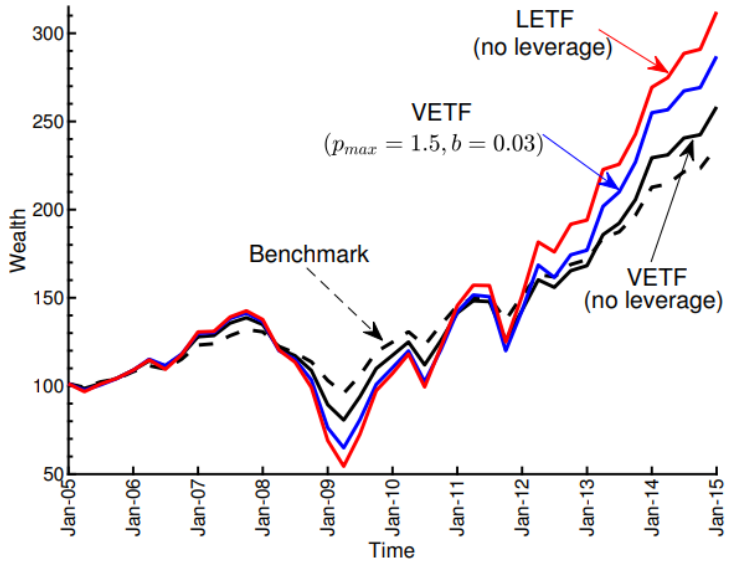
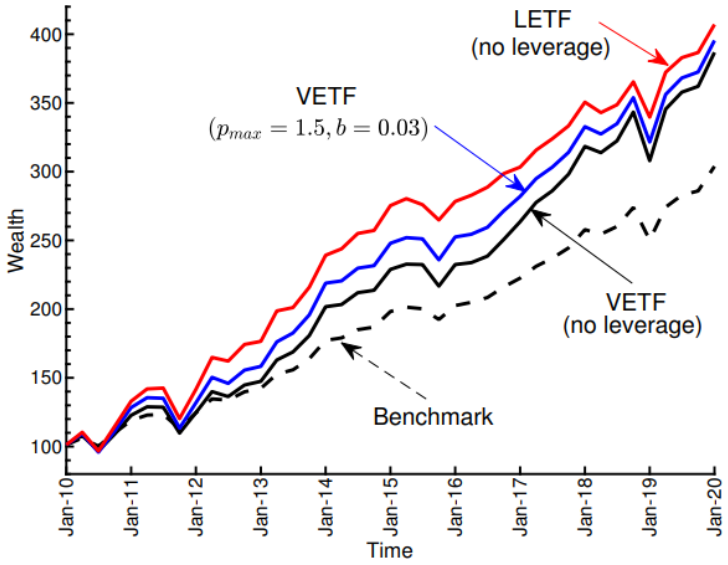


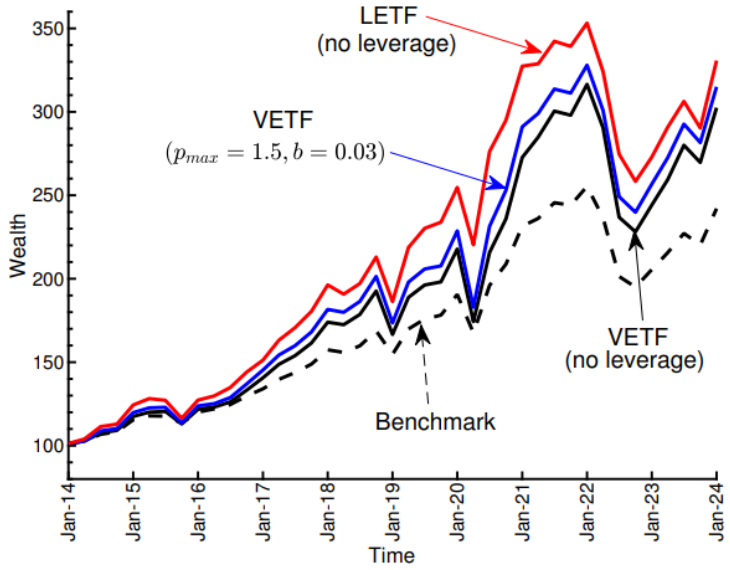

(a) Investing Jan 2000 - Dec 2009




(b) Investing Jan 2005 - Dec 2014




(c) Investing Jan 2010 - Dec 2019




(d) Investing Jan 2014 - Dec 2023

# Conclusion: Champagne leverage on a beer budget

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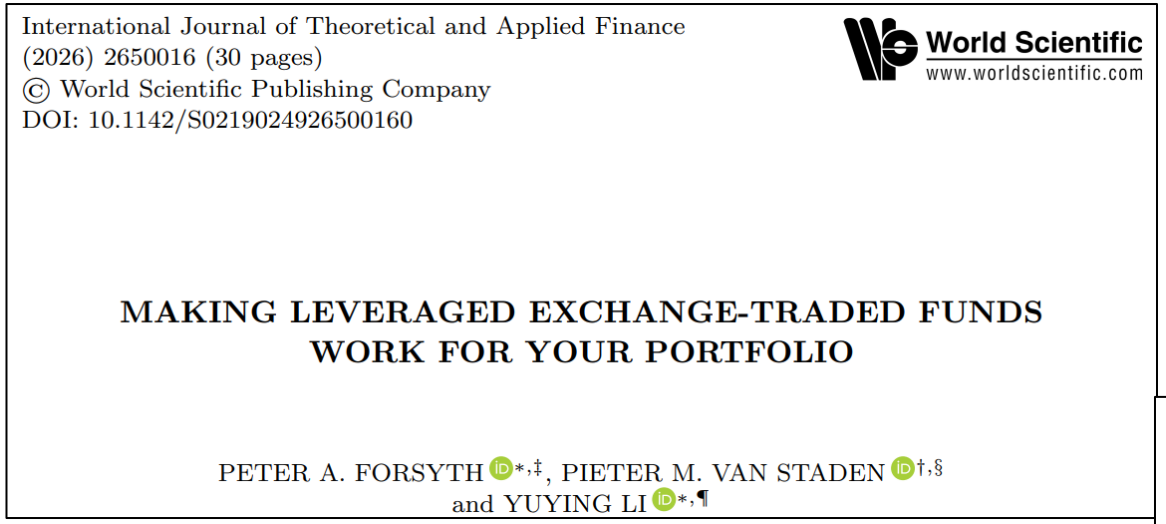
# More information

- Further reading: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MAKING LEVERAGED EXCHANGE-TRADED FUNDS WORK FOR YOUR PORTFOLIO

PETER A. FORSYTH *,‡, PIETER M. VAN STADEN †,§
and YUYING LI *,¶


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**Smart leverage? Rethinking the role of Leveraged Exchange Traded Funds in constructing portfolios to beat a benchmark§**

PIETER M. VAN STADEN †, PETER A. FORSYTH ‡ and YUYING LI *‡