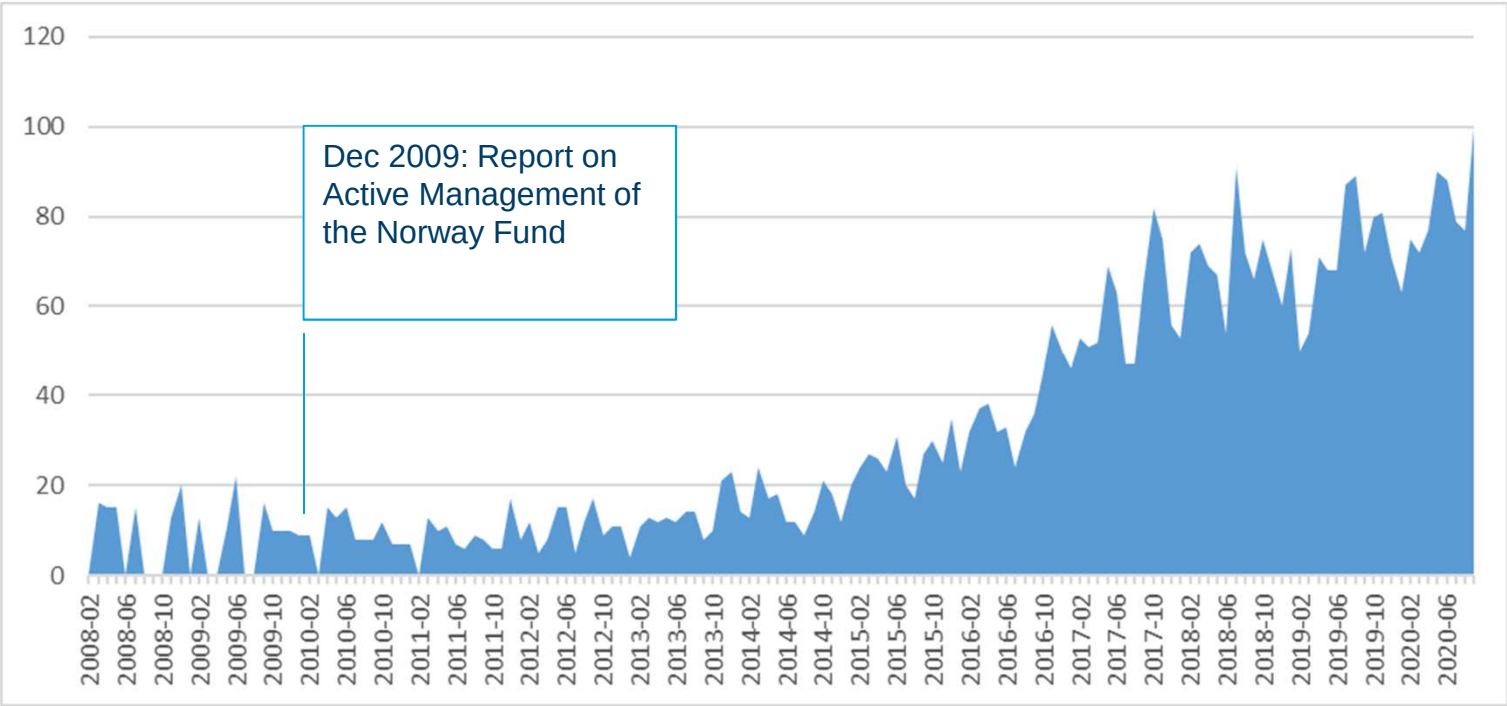
Factor Investing: Diversification Benefits and Transaction Costs

Marie Brière
Amundi, Paris Dauphine University, Université Libre de Bruxelles
marie.briere@amundi.com

Factor Investing: A Lively Field

– Google Trends for « Factor Investing »



Source: Google Trends, Sept 2020

A Short History of Risk Factors…

- For many years, only one factor
  - Sharpe-Lintner-Mossin-Treynor CAPM (1964): **the market is the key risk factor** (at least for equities)

- Early additions to the market factor
  - Ross (1976) Arbitrage Pricing Theory: other risk factors exist
  - Fama and French (1992) introduce the **size and value factors**
  - Jegadeesh and Titman (1993) and Carhart (1997) add **the momentum factor**

- Many new factors
  - **Quality** (Piotroski, 2000), **Low Beta** (Black et al., 1972 ; Frazzini and Pederson, 2014)
    - Fama and French (2014) add **two quality (profitability and investment) factors**
  - **> 300 factors** have been proposed in the equity market (Harvey et al., 2015)
  - **Other asset classes** (ex: Maio and Barroso, 2019 ; Vatanen and Suhonen, 2019)

Amundi
ASSET MANAGEMENT

… and Factor Investing

- Ang, Goetzmann and Schaefer (2009): report to the Norwegian Sovereign Wealth Fund
  - A substantial part of active returns can be explained by exposure to risk factors
  - Recommend to allocate portfolio risks among these factors
  - Started a new conversation about asset allocation
- Using risk factors for asset allocation
  - Aggregate securities by their exposure to pre-defined factors
  - Asset allocation based on “factor indices“ (rebalancing actively securities)
  - Factor-based investment: "new paradigm for long term investment" (Ang, 2014)

… and Factor Investing

– Key players moved from traditional to factor asset allocation: creation of factor indices (MSCI, Russell, etc.), ETFs

AQR FUNDS

AQR Large Cap Momentum Style Fund

SPDR Russell 1000® Low Volatility ETF

– Large investors moved part of their asset allocation to factors

- The Norwegian fund monitors the risk factor exposures of its asset allocation
- Dutch fiduciary manager PGGM applies factor tilts in their portfolio construction
- Danish Pension Fund ATP implements both factor tilts and factor optimization

Amundi ASSET MANAGEMENT

Key Questions for Practical Implementation

– Which factors?

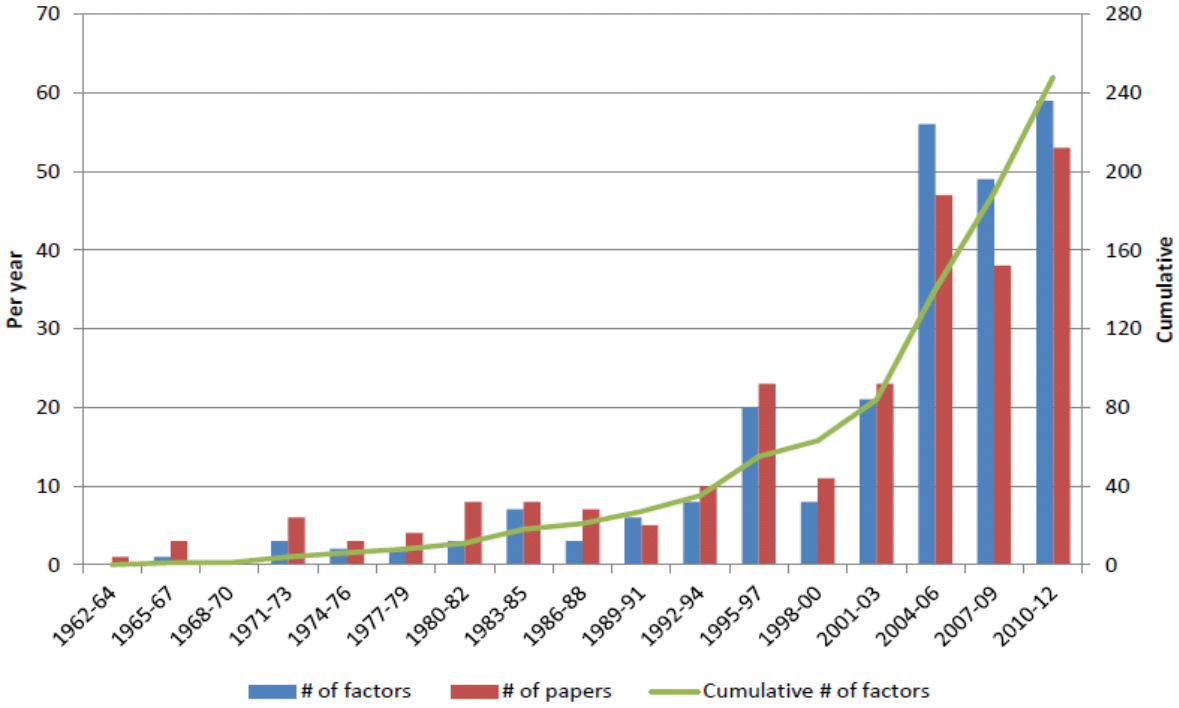
– Diversification benefits between selected factors

– Factors' transaction costs

Which Factors?

Factor Proliferation

- More than 300 discovered equity factors (Harvey et al., 2015)
  - Cochrane (2011) refers to a “zoo” of factors



Source: Harvey et al., 2015

Too Many Factors?

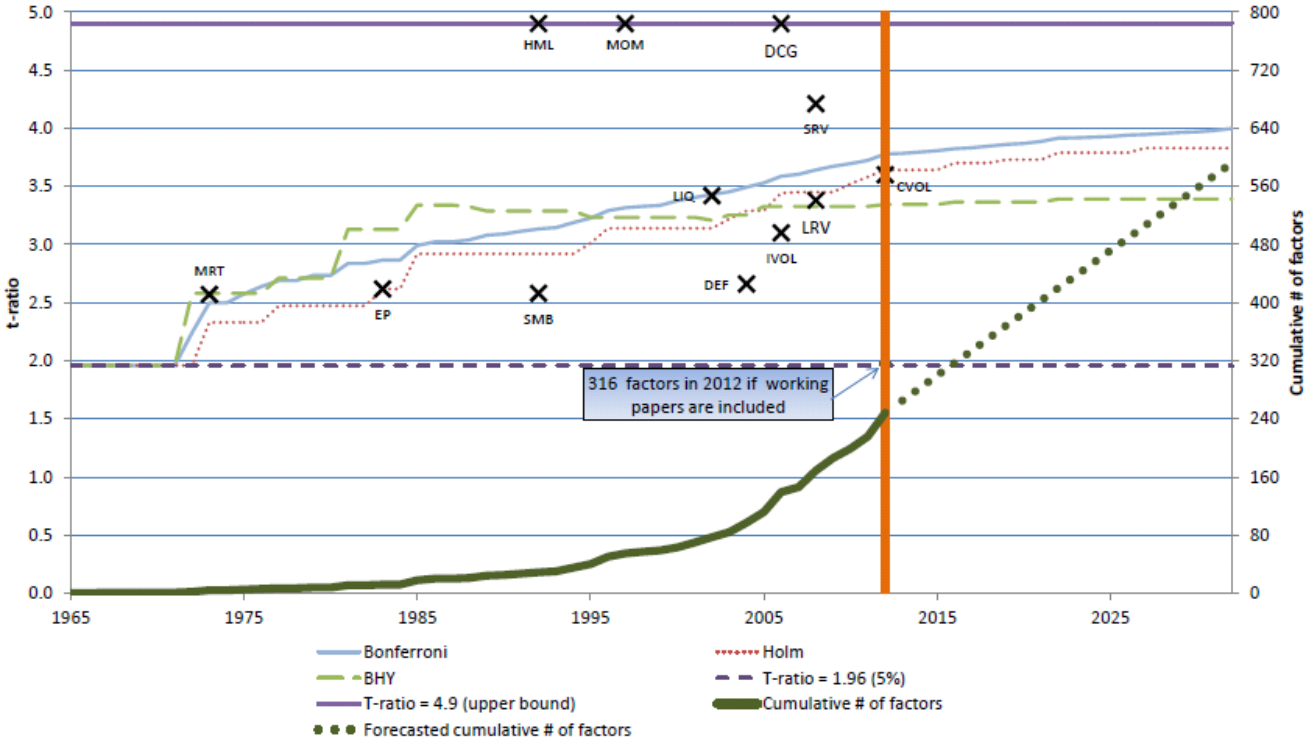
- Is the performance of factor strategies real?

- **Publication bias due to agency problems** (Harvey, 2017)
  - Journal editors compete for impact factors, tend to publish papers with the most significant results
  - Authors engage in datamining, selecting test procedures until results become significant
  - The more scrutiny a collection of data is subjected to, the more likely will interesting (spurious) patterns emerge (Lo and MacKinlay, 1990)

- **Robustness checks / new statistical tests are needed**
  - Out of sample and sensitivity analysis (sample period, investment universe etc.)
  - More restrictive statistical tests

Robust Factors

– **Keep the factors that pass the adjusted statistical thresholds… controlling for false discovery rate**



MRT: market beta (Fama and McBeth, 73) ; EP : earnings-price ratio (Basu, 83) ; DCG: durable consumption good (Yogo, 2006) ; DEF: default likelihood (Vassalou and Xing, 2004) ; LRV : long run volatility (Adrian and Rosenberg, 2008) ; CVOL : consumption volatility (Boguth and Kuehn, 2012)

 Source: Harvey et al. (2015)

Amundi ASSET MANAGEMENT

Robust Factors

– ... But also that have economic underpinning !

- Chordia et al. (2017) compute the performance of **2.1 million** factor strategies
  - Impose significance level of 5%, false discoveries tolerance of 5%, significant alpha, Fama-MacBeth coefficient, Sharpe ratio higher than the market.
- The **17 surviving factors have** no relationship with published anomalies!

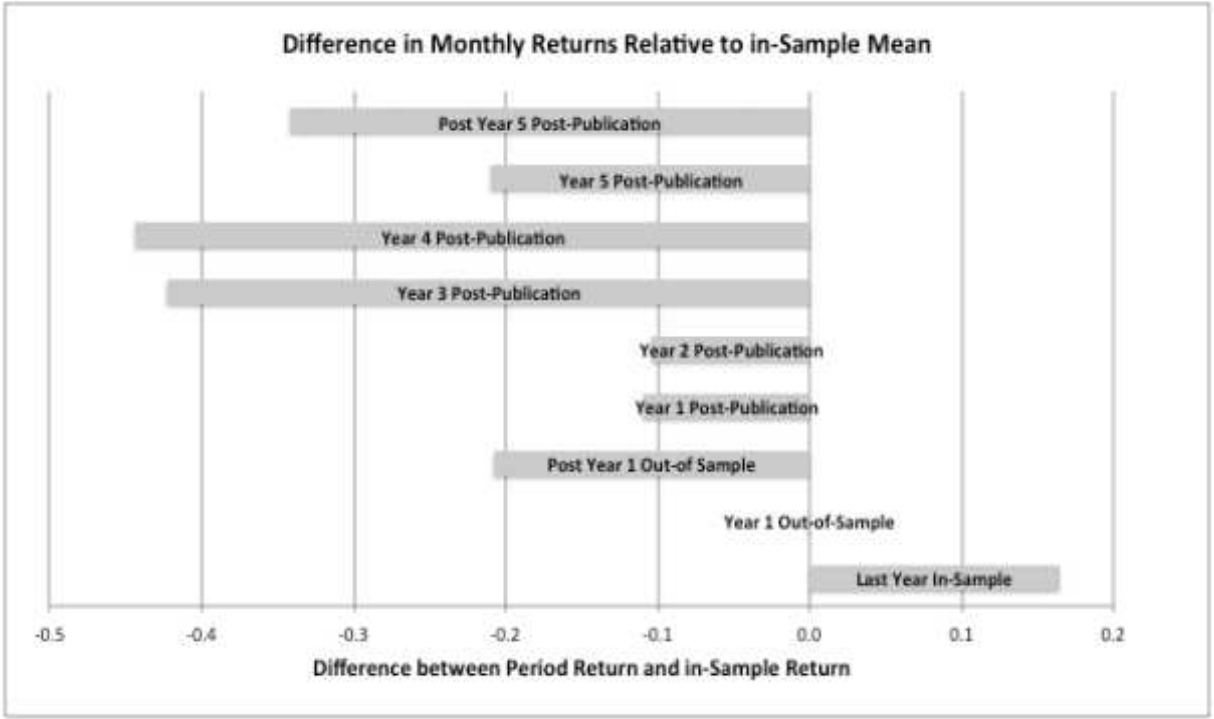
Table A8: 17 strategies that survive hurdles

(cstk – reajo) / xad	(Common-Ordinary Stock (Capital) – Retained Earnings Other Adjustments) / Advertising Expense
(lo – sppe) / tstkn	(Liabilities Other Total – Sale of Property) / Treasury Stock Number of Common Shares
(ap – txfed) / dvc	(Accounts Payable Trade – Income Taxes Federal) / Dividends Common-Ordinary
(csho – xsga) / xint	(Common Shares Outstanding – Selling, General and Administrative Expense) / Interest and Related Expense Total
(cshpri – xsga) / dd3	(Common Shares Used to Calculate Earnings Per Share Basic – Selling, General and Administrative Expense) / Debt Due in 3rd Year

Amundi ASSET MANAGEMENT

Robust Factors

- **Keep the factors that survive post-publication**
  - Alpha Decay: portfolio returns are 58% lower post-publication (97 factors, McLean and Pontiff, 2016)



 Source: McLean and Pontiff (2016)

Amundi
ASSET MANAGEMENT

Robust Factors

- **Keep the factors that resist practical implementation**
  - Factors' exposure to microcap stocks (Hou, Xue, and Zhang, 2017)
    - 60% stocks number, 3% market cap
    - Equal-weight or NYSE-Amex-NASDAQ breakpoints **outweight microcaps**
  - Due to **high transaction costs**, anomalies in microcaps are more apparent than real
    - With value-weight or NYSE breakpoints, **64% of 447 tested factors insignificant** at 5% level (85% at critical value of 3)

Back to Basics: Competing Factor Models

- Hou Xue and Zhang (2015) q-factor model
  - **Market, Size, Investment and Profitability** (ROE)

- Fama and French (2014) 5-factor model
  - **Market, Size, Value, Profitability and Investment**

- AQR's 6-factor model
  - Add the **Momentum** factor
  - Change the **Value** factor

    FF (2014) value (HML) is redundant to profitability and investment

    book value with 6M lag but price with no lag, monthly rebalancing (Asness and Frazzini, 2013)
  - They also propose a new **Quality** factor

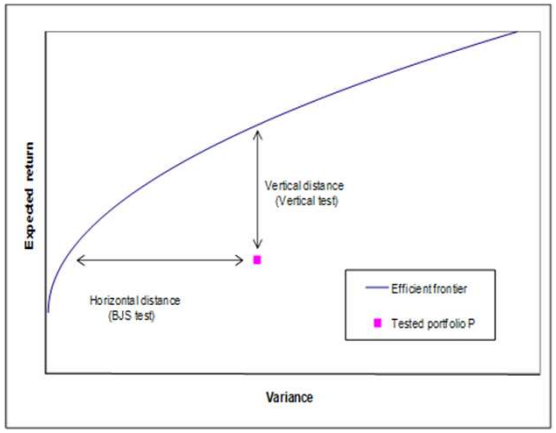
Factor diversification Benefits

Factor Diversification

- **Are the risks of individual factors diversified away by optimal diversification?**

- Brière and Szafarz (2017a) compare optimal portfolios of factors and sectors across multiple performance measures

  - **Vertical & horizontal distances** between the market and efficient frontier (Basak et al., 2002; Brière et al., 2013)



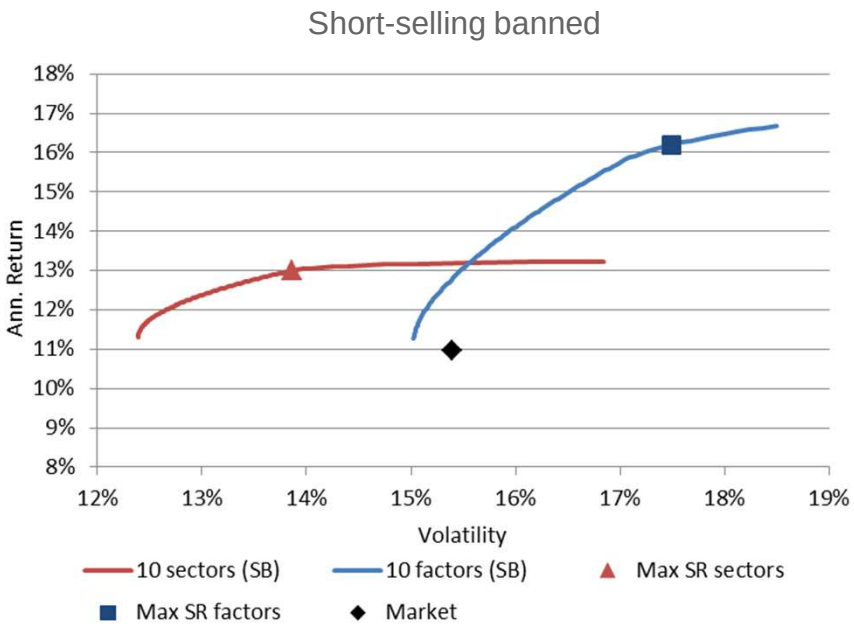
  - **Jensen's alphas and Sharpe ratios**
    Wald test (+Newey-West correction) of equality
    Ledoit and Wolf (2008) test of equality

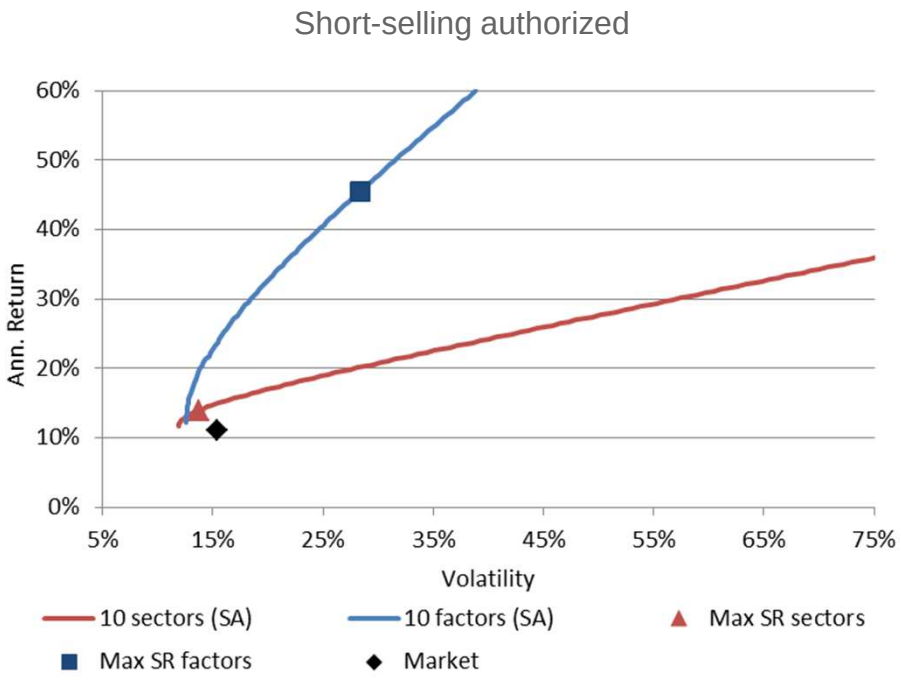
  - **Certainty Equivalent Returns (CER)**
    Christoffersen and Langlois (2013) bootstrapped test of equality, CRRA, CARA utility
    Manipulation-proof performance measure (Goetzmann et al., 2007)

Amundi
ASSET MANAGEMENT

Factor Diversification

- Combining factors improves on the market
  - Optimal factor and sector portfolios, full sample 1963-2015

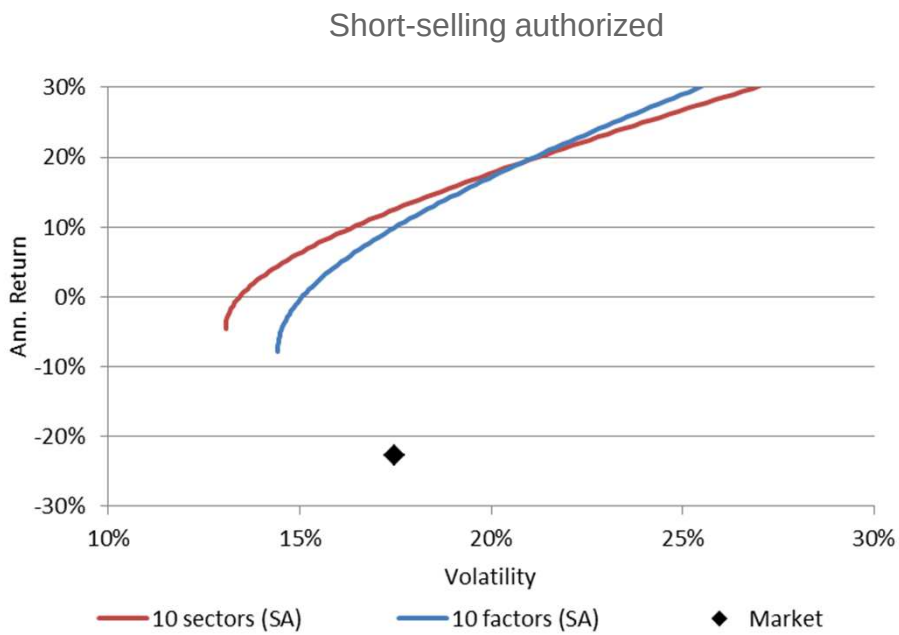




Source: Brière et Szafarz (2017a)

Factor Diversification

- Be careful with crises times
  - Optimal factor and sector portfolios, bear markets



Source: Brière et Szafarz (2017a)

Factor Diversification

- Factors: return improvement, sectors: risk reduction
  - Vertical and horizontal distance to the market portfolio

short-selling banned

Sample	Panel A: Vertical distance (exp. returns)	
	Sectors	Factors
Full sample	0.0017*	0.0014***
Bear markets	-	0.0394***
Bull markets	0.0006	0.0003*
Recessions	0.0069***	-
Expansions	0.0013	0.0017***
	Panel B: Horizontal distance (variance)	
Full sample	-	-
Bear markets	-	-
Bull markets	0.0001***	0.00002*
Recessions	-	-
Expansions	0.0005***	0.00004

short-selling authorized

Sample	Panel A: Vertical distance (exp. returns)	
	Sectors	Factors
Full sample	0.0032**	0.0106***
Bear markets	0.0303	0.0272***
Bull markets	0.0007	0.0037***
Recessions	0.0282***	0.0323***
Expansions	0.0019*	0.0076***
	Panel B: Horizontal distance (variance)	
Full sample	-	-
Bear markets	-	-
Bull markets	0.0001***	0.0003***
Recessions	-	-
Expansions	0.0005***	0.0004***

Source: Brière et Szafarz (2017a)

Amundi ASSET MANAGEMENT

Factor Diversification

– Accounting for extreme risks, factors have significantly higher CER only when short-selling authorized

short-selling banned

Portfolio	Panel A: Low risk aversion (γ=5)		
	CER (CRRA)		Bootstrapped equality t-test
	Sectors	Factors	
In-sample estimation			
LOmaxSR	0,67	0,65	0.05
LOminvol	0,62	0,45	0.69
Equalweight	0,52	0,36	0.53
Out-of-sample estimation, M=60 months			
LOmaxSR	0,36	0,51	-0.47
LOminvol	0,61	0,47	0.54
Equalweight	0,48	0,26	0.67
Out-of-sample estimation, M=120 months			
LOmaxSR	0,33	0,66	-0.93
LOminvol	0,70	0,56	0.50
Equalweight	0,56	0,39	0.46

short-selling authorized

Portfolio	Panel A: Low risk aversion (γ=5)		
	CER (CRRA)		Bootstrapped equality t-test
	Sectors	Factors	
In-sample estimation			
LOmaxSR	**0,77**	**2,07**	**-3,09*** **
LOminvol	0,68	0,67	0,05
Out-of-sample estimation, M=60 months			
LOmaxSR	-	-	-
LOminvol	0,66	0,78	-0,5
Out-of-sample estimation, M=120 months			
LOmaxSR	-	-	-
LOminvol	0,75	0,82	-0,3

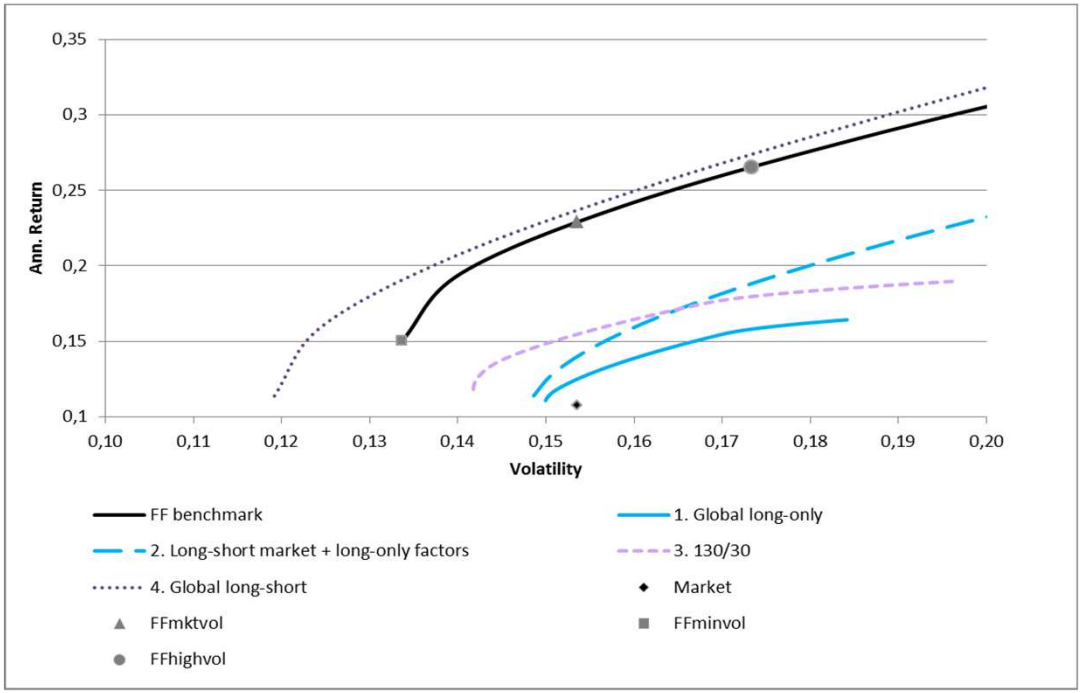
risk-free rate that would make the investor indifferent between holding the risky portfolio made of factors/sectors and earning the CER (CRRA Utility)

Source: Brière et Szafarz (2017a)

Amundi ASSET MANAGEMENT

Factors Long-Only or Long-Short?

- Long-short multi-factor extensions are attractive
  - Efficient Frontiers (1963-2015)



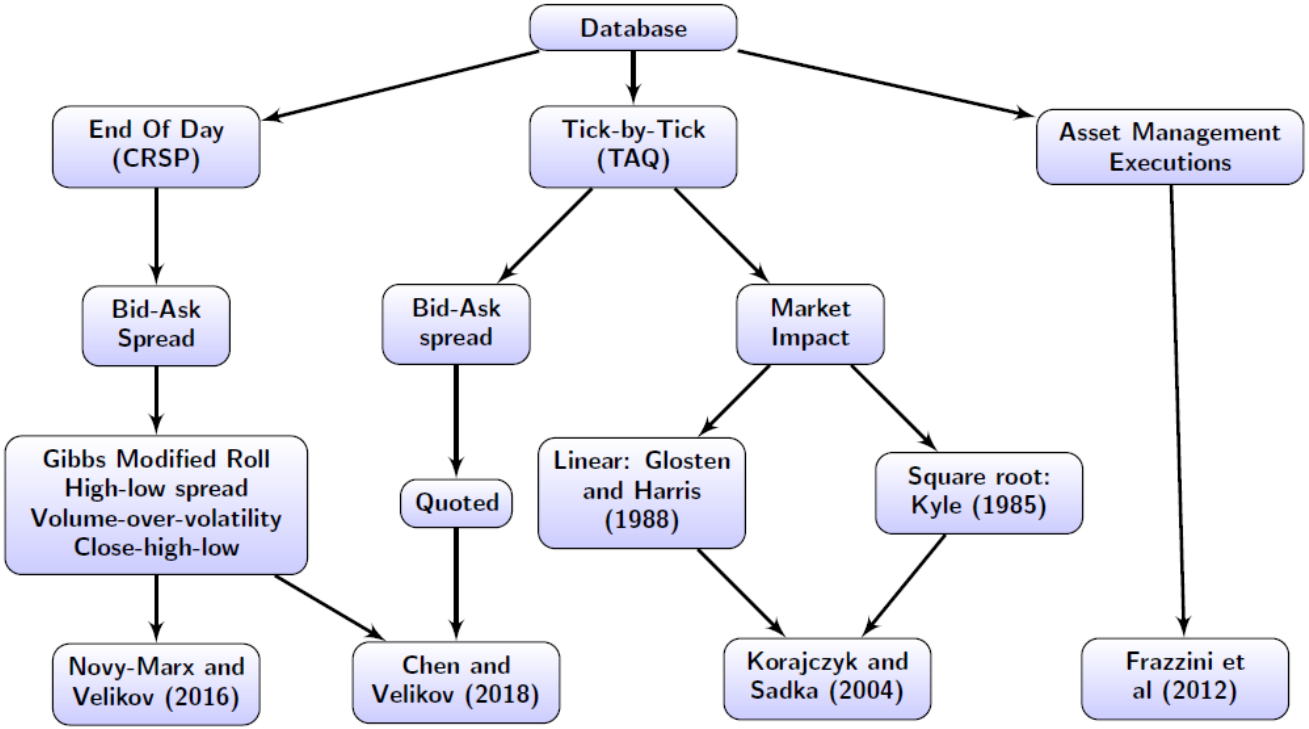
  - But be carefull of **shorting costs** (Huij et al., 2014)

Source: Brière et Szafarz (2017b)

Factor Transaction Costs

Factor Transaction Costs

- No consensus on trading costs estimation
  - Explicit trading costs (bid-ask spreads, commissions) are easily measured but full costs are dominated by price impact



48, 60, 780 bp for size, value, momentum

61 bp in sample (average of 120 anomalies)

200 bp for momentum

154, 146, 351 bp for size, value, momentum

Amundi ASSET MANAGEMENT

Factor Transaction Costs

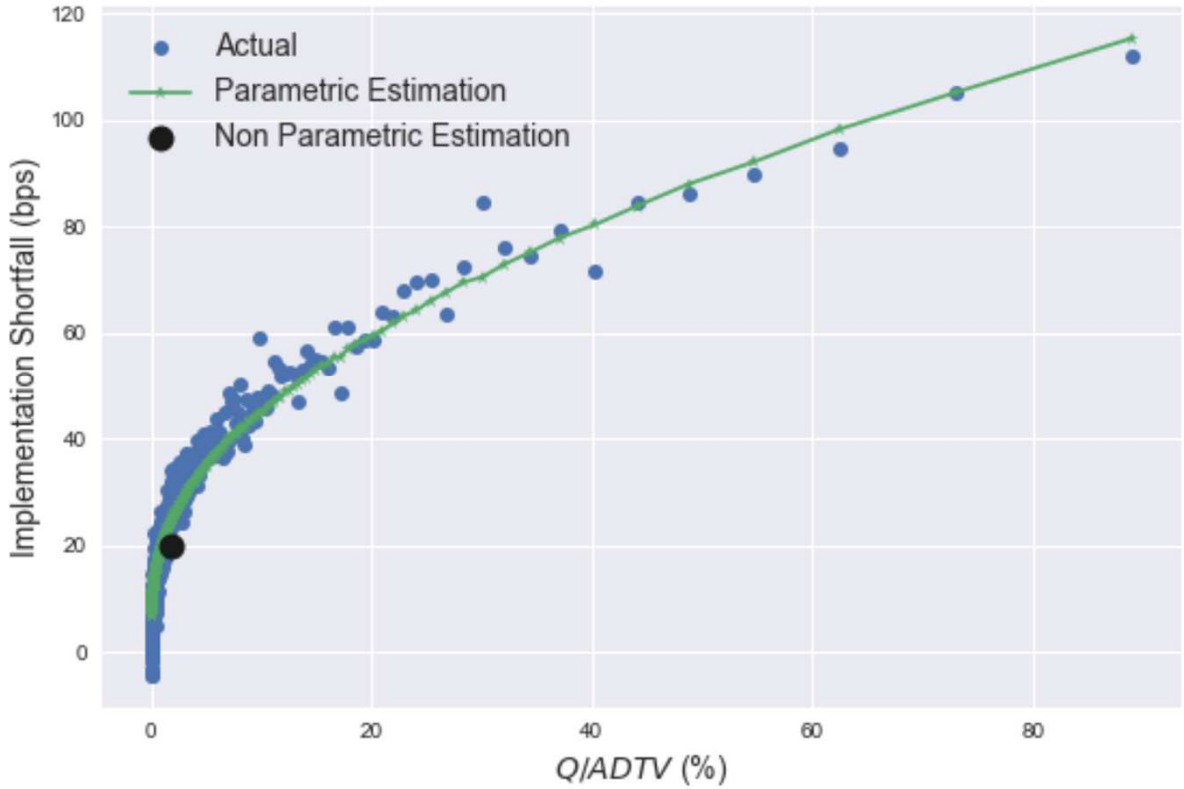
- Trading costs estimation on Institutional Investors' Trades, ANcerno
  - 10% of institutional trades, 5% of market volume, $ 41.8 trn transactions, 10000 stocks
  - **Meta-order information** (split between child tickets)

	# Institutions	# Funds, Managers or Accounts	# Brokers	# Stocks	Amount traded ($ billions)	Amount traded (% of market volume)
Full Sample	1078	148621	1488	10044	51310	5.44
1999	381	6153	657	6291	2060	2.28
2000	374	6390	669	6239	3181	2.46
2001	401	13654	716	5396	3026	3.37
2002	428	16847	765	4935	3096	5.00
2003	405	26861	751	4930	2667	6.03
2004	408	23112	716	4126	4122	8.28
2005	379	18928	761	4912	3930	6.17
2006	403	22081	753	4773	4232	5.98
2007	381	28999	738	4941	4506	5.35
2008	338	26600	701	4507	4187	3.95
2009	303	41848	650	4207	2875	3.70
2010	258	43227	632	3951	2508	3.69
2011	-	-	675	3884	1828	5.96
2012	-	-	723	3715	2596	8.30
2013	-	-	647	3755	2714	9.39
2014	-	-	531	3809	2742	7.12
June 2015	-	-	392	2753	1033	3.64

 Source: Brière, Lehalle, Nefedova, Raboun (2019)

Factor Transaction Costs

- Implementation shortfall can be large for sizeable meta-orders
  - measures the difference between closing price in t-1 and an actual traded price, in % of the close



Source: Brière, Lehalle, Nefedova, Raboun (2019)

Factor Transaction Costs

– Average transaction costs including implementation shortfall, 1999-2015

	Portfolio				Long Leg				Short Leg			
	μ_{Gross} (%)	σ (%)	Turn (%)	Tcost (bps)	μ_{Gross} (%)	σ (%)	Turn (%)	Tcost (bps)	μ_{Gross} (%)	σ (%)	Turn (%)	Tcost (bps)
Size (SMB)												
CRSP	4.8	12.4	0.5	-	12.0	20.6	0.3	-	-7.2	15.4	0.2	
ANCR	4.5	11.1	0.5	15.7	11.5	20.4	0.4	13.7	-7.1	15.4	0.2	2.0
Value (HML)												
CRSP	2.9	12.0	0.8	-	10.6	18.4	0.4	-	-7.7	18.9	0.3	
ANCR	2.2	12.2	0.7	22.5	10.1	18.8	0.4	2.6	-7.8	18.4	0.3	20.0
Profitability (RMW)												
CRSP	4.2	10.8	0.7	-	9.8	15.5	0.3	-	-5.6	21.8	20.4	
ANCR	4.8	10.4	0.8	30.4	10.6	15.4	0.3	13.9	-5.8	21.7	0.4	16.7
Investment (CMA)												
CRSP	3.1	6.4	1.3	-	10.0	17.8	0.7	-	-6.9	18.7	0.6	
ANCR	3.0	7.0	1.2	31.4	10.5	17.6	0.6	12.4	-7.5	18.6	0.6	19.0
Momentum (UMD)												
CRSP	5.2	18.2	7.3	-	11.7	18.5	3.3	-	-6.6	24.5	4.0	
ANCR	5.1	18.5	8.3	222.5	11.7	18.6	3.8	93.3	-6.6	24.8	4.5	129.2

Source: Brière, Lehalle, Nefedova, Raboun (2019)

Amundi ASSET MANAGEMENT

Factor Transaction Costs

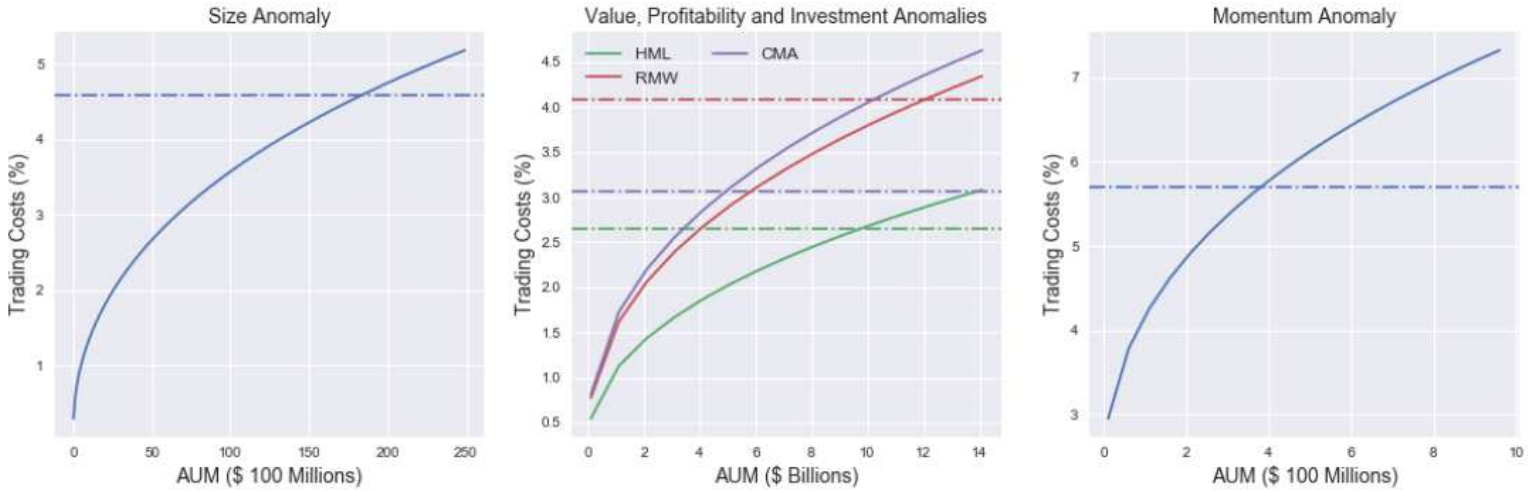
- Transaction costs estimation for large orders
  - Parametric estimation postulates squared root relationship between implementation shortfall and size of the trade

AUM	Size		Value		Profitability		Investment		Momentum	
AUM	μ_{Net} (%)	Tcost (bp)	μ_{Net} (%)	Tcost (bp)	μ_{Net} (%)	Tcost (bp)	μ_{Net} (%)	Tcost (bp)	μ_{Net} (%)	Tcost (bp)
$1M	4.46	19.2	2.11	30.8	4.24	42.6	3.78	43.8	2.46	253.4
$100M	4.35	30.1	1.88	54.2	3.89	77,0	3.40	81.1	0.93	417.4
$1Bn	4.09	56,0	1.33	108.8	3.10	156.4	2.55	166.6	-2.03	741.1

Source: Brière, Lehalle, Nefedova, Raboun (2019)

Breakeven Capacity

– Maximal fund size attainable before price impact eliminates profits



Anomalies	Size (SMB)	Value (HML)	Profitability (RMW)	Investment (CMA)	Momentum (UMD)
Capacity ($ Bn)	184	38	17	14	0.41
Trading Cost (%)	4.84	2.94	4.20	3.08	5.15

Source: Brière, Lehalle, Nefedova, Raboun (2019)

Conclusion

Key Takeaways

- Factors should be combined
- Be careful to crises: factors are for low to moderate risk-averse investors
- They should ideally be played long-short
- Factors resist transaction costs if low rebalancing

Further Questions

- Factor crowding
  - Capital devoted to factor strategies increased since the 1990s (Hanson and Sunderam, 2011)
  - Mutual funds flows (“dumb money”) **exacerbate stock return anomalies**, while hedge funds flows (“smart money”) attenuates them (Akbas et al., 2014).
  - Crowding explains **negative skewness** in momentum returns (Lou and Polk, 2013 ; Huang, 2015) and **negative returns** (Barroso et al., 2017)

References

- Brière M. and A. Szafarz (2020), "Good Diversification is Never Wasted: How to Tilt Factor Portfolios with Sectors", *Finance Research Letters*, 33.

- Brière M., Lehalle C.A., Nefedova, T. and A. Raboun (2019), "Stock Market Liquidity and the Trading Costs of Asset Pricing Anomalies", SSRN Working Paper N°3380239.

- Brière M. and A. Szafarz (2017), "Factors vs. Sectors in Asset Allocation: Stronger Together?", "Advances in the practice of public investment management: Portfolio modelling, performance attribution and governance" Palgrave Macmillan, SSRN Working Paper N°2965346.

- Brière M. and A. Szafarz (2017), "Factor Investing: the Rocky Road from Long Only to Long Short", in *Risk-Based and Factor Investing*, Ed. E. Jurczenko.

- Brière M. and A. Szafarz (2015), "Factor Investing: Risk Premia v. Diversification Benefits", SSRN Working Paper N°2615703, 2015.

Amundi
ASSET MANAGEMENT

– MENTIONS LEGALES

Société Anonyme au capital social de 1 086 262 605 euros
Société de Gestion de Portefeuille agréée par l'AMF sous le n° GP 04000036
Siège social : 90, boulevard Pasteur - 75015 Paris - France
Adresse postale : 90, boulevard Pasteur CS21564 - 75730 Paris Cedex 15 - France
Tél. +33 (0)1 76 33 30 30
Siren : 437 574 452 RCS Paris
Siret : 43757445200029
Code APE : 6630 Z
N° Identification TVA : FR58437574452

Amundi
ASSET MANAGEMENT