Wednesday, 19 February 2020

SUERF/UniCredit Foundation Workshop, Milano

Anomalies across the globe: Once public, no longer existent?

Heiko Jacobs, University of Duisburg-Essen
Sebastian Müller, TUM School of Management, TUM Campus Heilbronn

The paper in a nutshell

➢ **McLean/Pontiff (2016, JF): 97 anomalies in U.S. stock market: Mispricing, risk, data mining?**

- "Anomalies": Compare returns in-sample, post-sample, post-publication

- 58% post-publication decline: Mispricing corrected by informed arbitrage trading (+ some data mining)

➢ **This study: 241 anomalies in 39 stock markets (> 2 million anomaly months)**

1 **How?** Construct and analyze one of the largest anomaly data sets in the literature

2 **What?** Only U.S. with a strong post-publication decline

3 **Why?** Limits to arbitrage + cross-country barriers to arbitrage most promising

Why international stocks markets?

1 Economically important

- Non-U.S. countries: 58% of the world market capitalization
- Non U-S. countries: 73% of global GDP

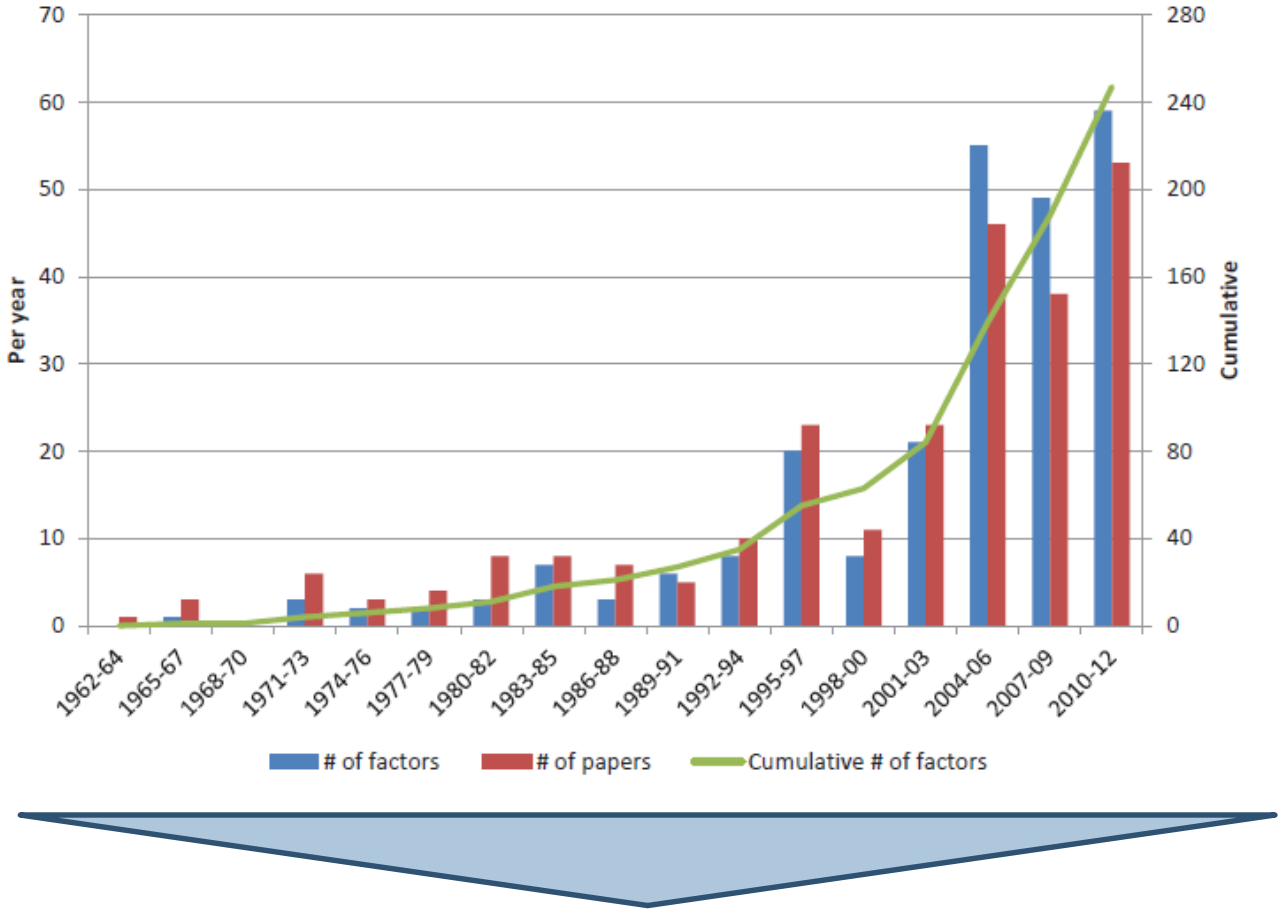
2 Academically important

- Karolyi (2016): “Large and persistent US (home) bias in academic research in Finance”
- Harvey/Liu/Zhu (2016): “(…) most claimed research findings in financial economics are likely false.”

3 Practically important

- Do markets become more efficient?
- How to optimize asset allocation?

Contribution to the Literature: Harvey/Liu/Zhu (2016, RFS): Number of published anomalies in academic journals



Tremendous growth of the anomaly literature

We contribute with a global perspective

Data

- **Stock market/Accounting/Analyst data**
  - U.S.: CRSP, Compustat
  - International: Datastream (extensive screens), Worldscope
  - All: IBES
  - Exclude stocks < 10 Mio USD, countries <20,000 anomaly months
- **(Baseline) Sample period: 1/1980-12/2015**
- **Final Sample:**
  - 39 countries, ~ 59,000 firms,
  - 241 anomalies,
  - 7,072 (anomaly, country) pairs,
  - 2.14 million anomaly months

Anomalies: Some general remarks

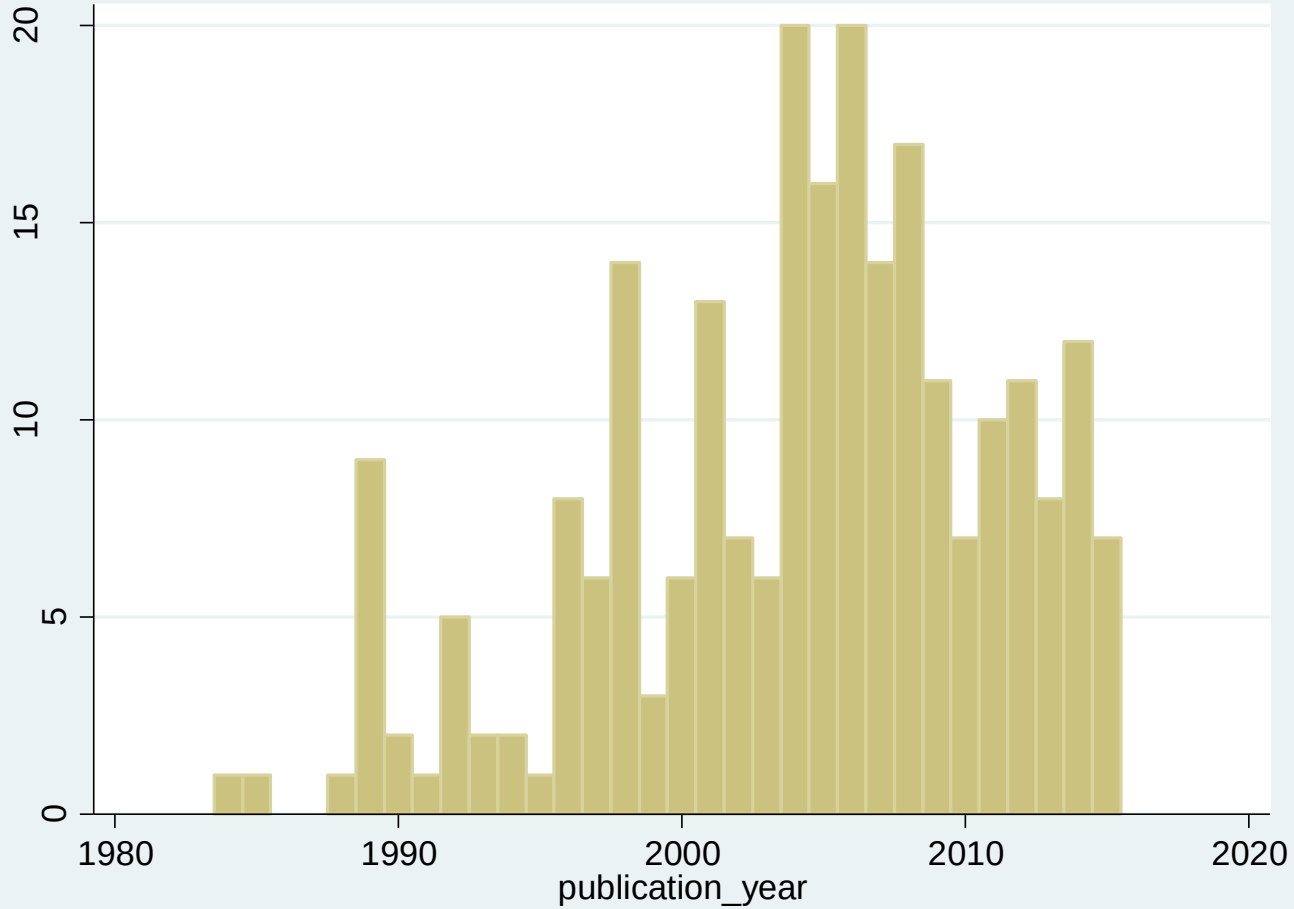
- Selection of anomalies: based on reference studies on meta-anomalies
- Goal: **Include all anomalies / return predictors**

- Subrahmanyam (2010, p. 28) “(...) disparate methodologies are used by different researchers (…). This is another reason why the picture remains murky and suggests a need for clarifying studies.”

- Goal: **Common framework for all anomalies, not exact replication**

- Long/short quintiles, both equally weighted and value-weighted returns

Anomalies: A closer look



Anomaly types:

- 64 Event
- 67 Fundamental
- 69 Market
- 41 Valuation

Descriptive statistics (1/2)

Country	MSCI group	N anomaly months	N anomalies	% Macap	Start year	N firms	Equally weighed long/short return		Value weighed long/short return	
Australia	DM	71,861	214	1.8%	1980	2,504	0.735***	(11.51)	0.591***	(8.99)
Austria	DM	44,897	157	0.2%	1986	166	0.408***	(5.83)	0.263***	(3.72)
Belgium	DM	54,025	174	0.6%	1980	221	0.480***	(7.26)	0.303***	(3.94)
Brazil	EM	23,317	113	0.8%	1994	246	0.429***	(3.87)	0.255**	(2.07)
Canada	DM	78,468	224	2.4%	1980	2,857	0.555***	(7.66)	0.431***	(5.34)
Chile	EM	42,566	162	0.4%	1989	251	0.317***	(4.95)	0.294***	(4.26)
China	EM	37,128	157	4.7%	1992	2,814	0.215***	(3.18)	0.170**	(2.31)
Denmark	DM	61,678	197	0.4%	1982	298	0.547***	(8.71)	0.462***	(6.20)
Finland	DM	42,903	162	0.4%	1988	196	0.435***	(4.75)	0.348***	(2.83)
France	DM	81,970	227	3.9%	1980	1,512	0.506***	(8.63)	0.341***	(5.85)
Germany	DM	80,274	224	3.4%	1980	1,300	0.514***	(7.73)	0.410***	(6.25)
Greece	EM/DM	48,014	176	0.2%	1988	394	0.462***	(4.35)	0.569***	(4.17)
Hongkong	DM	54,950	182	1.3%	1982	204	0.289***	(3.00)	0.270***	(3.02)
India	EM	46,975	182	1.7%	1990	3,360	0.579***	(6.97)	0.428***	(4.10)
Indonesia	EM	46,319	175	0.4%	1990	539	0.413***	(3.36)	0.392***	(2.74)
Ireland	DM	25,045	102	0.2%	1987	98	0.487***	(3.94)	0.386***	(2.85)
Israel	EM/DM	33,540	133	0.3%	1986	674	0.504***	(6.83)	0.448***	(4.63)
Italy	DM	69,272	210	1.4%	1980	512	0.429***	(7.22)	0.293***	(4.72)
Japan	DM	87,644	237	12.5%	1980	4,786	0.219***	(4.87)	0.188***	(3.82)
Korea	EM	63,595	205	1.5%	1984	2,606	0.548***	(5.66)	0.395***	(4.66)

Descriptive statistics (2/2)

Country	MSCI group	Total anomaly months	Total number of anomalies		Start year	Number of firms	Equally weighted long/short return		Value-weighted long/short return	
Malaysia	EM	66,948	207	0.7%	1984	1,131	0.416***	(4.92)	0.345***	(4.37)
Mexico	EM	42,869	166	0.6%	1989	219	0.418***	(4.85)	0.386***	(4.91)
Netherlands	DM	66,373	199	1.1%	1980	254	0.556***	(7.84)	0.272***	(3.42)
New Zealand	DM	31,144	127	0.1%	1988	234	0.626***	(8.95)	0.336***	(4.44)
Norway	DM	56,060	190	0.4%	1982	399	0.523***	(5.78)	0.414***	(3.97)
Pakistan	EM/FM	33,737	144	0.1%	1992	274	0.408***	(3.37)	0.461***	(4.10)
Philippines	EM	37,389	151	0.2%	1990	253	0.344***	(2.65)	0.287**	(2.11)
Poland	EM	24,166	120	0.2%	1995	697	0.528***	(6.48)	0.370***	(3.81)
Portugal	EM/DM	34,899	125	0.1%	1988	137	0.533***	(5.93)	0.479***	(5.51)
Singapore	DM	62,825	196	0.6%	1983	889	0.476***	(5.67)	0.359***	(4.48)
South Africa	EM	64,398	198	0.9%	1980	758	0.727***	(12.95)	0.568***	(8.26)
Spain	DM	57,547	195	1.5%	1987	239	0.367***	(4.34)	0.375***	(4.35)
Sweden	DM	60,850	202	1.0%	1982	792	0.642***	(6.09)	0.435***	(4.01)
Switzerland	DM	70,058	210	2.4%	1980	412	0.428***	(7.72)	0.304***	(5.15)
Taiwan	EM	49,685	187	1.5%	1987	2,097	0.288***	(4.26)	0.178**	(2.41)
Thailand	EM	54,010	193	0.4%	1987	812	0.373***	(2.94)	0.370***	(3.10)
Turkey	EM	44,749	170	0.4%	1988	422	0.230***	(3.00)	0.118	(1.19)
UK	DM	88,919	238	6.8%	1980	3,260	0.552***	(11.98)	0.365***	(6.76)
USA	DM	99,214	241	42.5%	1980	20,026	0.559***	(9.65)	0.359***	(6.43)

First look at publication effects

2 ways to aggregate markets

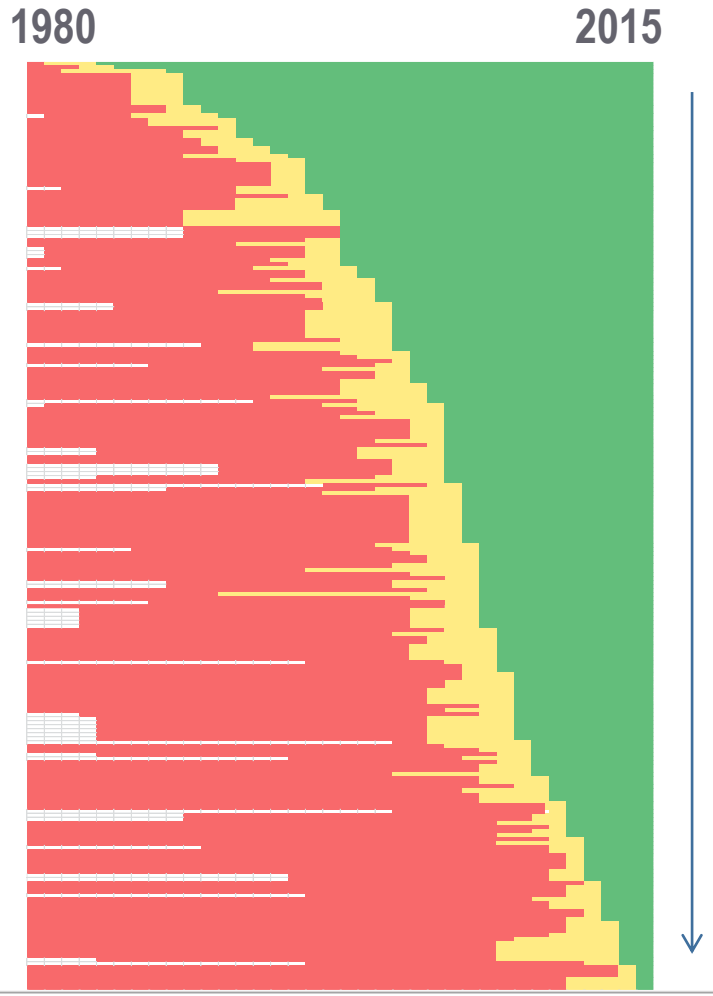
Country universe	USA		International markets (Pooled)			International markets (Composite)			
		All	Developed	Large markets	G7+Australia	All	Developed	Large markets	G7+Australia
N	99,214	2,041,067	1,246,763	1,075,133	558,408	92,806	92,750	92,788	92,692
Panel A: Equally weighted returns									
In-sample returns	0.742***	0.413***	0.453***	0.465***	0.476***	0.367***	0.379***	0.374***	0.373***
	(12.52)	(9.16)	(9.05)	(8.76)	(6.94)	(10.90)	(10.27)	(10.12)	(9.72)
Post-sample returns	0.466***	0.498***	0.532***	0.597***	0.562***	0.452***	0.454***	0.477***	0.444***
	(5.23)	(8.65)	(7.45)	(8.40)	(6.60)	(9.50)	(7.96)	(8.65)	(7.68)
Post-publication returns	0.292***	0.523***	0.514***	0.555***	0.498***	0.438***	0.419***	0.446***	0.403***
	(3.69)	(9.08)	(7.98)	(8.89)	(6.29)	(9.97)	(7.94)	(8.97)	(7.29)
Panel B: Value-weighted returns									
In-sample returns	0.489***	0.347***	0.365***	0.372***	0.382***	0.254***	0.255***	0.259***	0.262***
	(8.27)	(8.24)	(7.62)	(7.70)	(6.55)	(5.98)	(5.76)	(5.93)	(5.72)
Post-sample returns	0.310***	0.383***	0.391***	0.431***	0.425***	0.242***	0.275***	0.295***	0.287***
	(3.45)	(6.62)	(5.29)	(5.86)	(5.20)	(4.12)	(4.47)	(4.89)	(4.55)
Post-publication returns	0.163**	0.371***	0.336***	0.370***	0.333***	0.198***	0.199***	0.222***	0.210***
	(2.07)	(6.02)	(5.19)	(5.92)	(4.59)	(4.44)	(4.25)	(4.87)	(4.30)

U.S. anomality profitability declines: In sample<post-sample<postpublication

No clear patterns for international markets

Econometric approach

$$R_{i,t} = \alpha_i + \beta 1 * Post - Sample\ Dummy_{i,t} + \beta 2 * Post - Publication\ Dummy_{i,t} + \epsilon_{i,t}$$



Red = In-Sample Period

Yellow= Post-sample Period

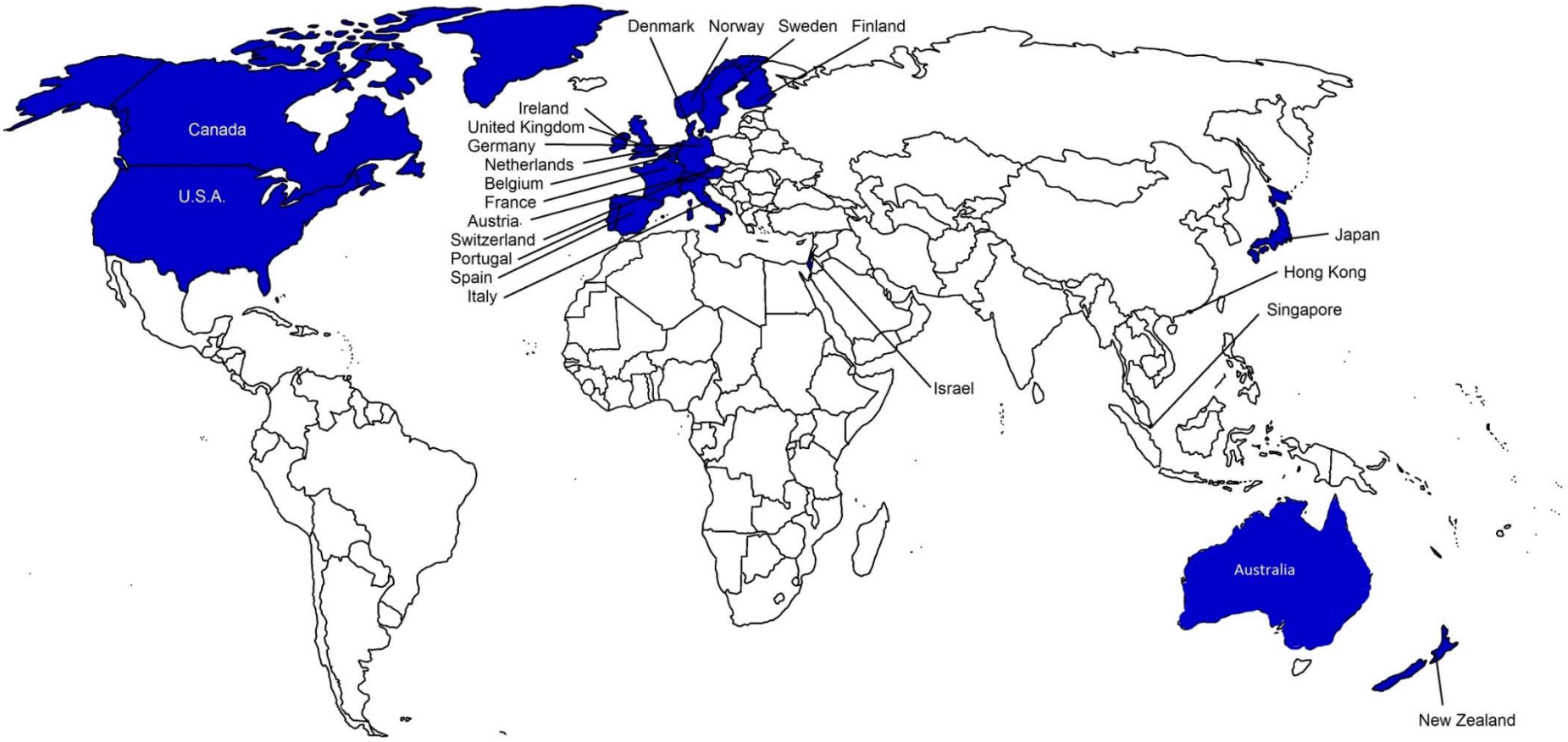
Green=Post-Publication Period

Baseline results: Aggregate findings

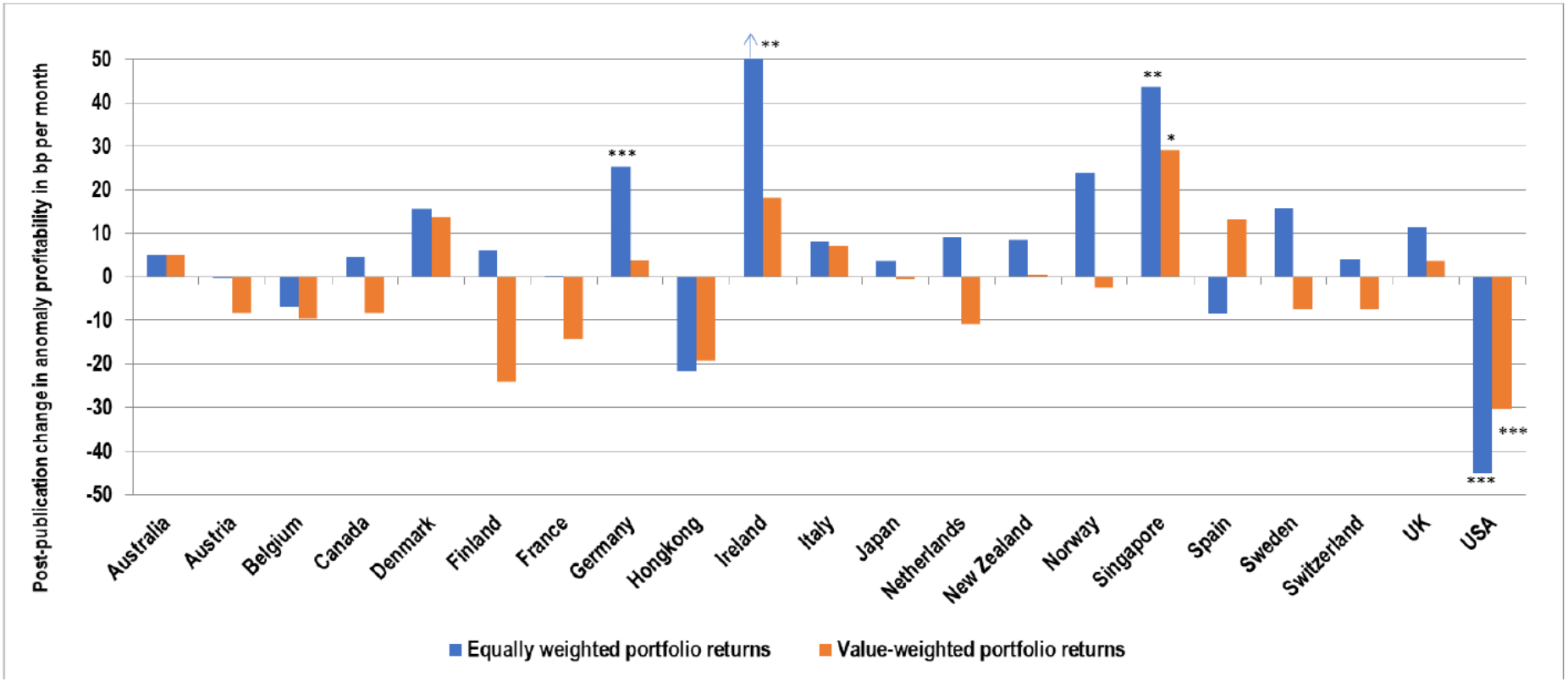
Country universe	USA	International markets (Pooled)				International markets (Composite)			
		All	Developed	Large	G7+Australia	All	Developed	Large	G7+Australia
N	99,214	2,041,067	1,246,763	1,075,133	558,408	92,806	92,750	92,788	92,692
Panel A: Regression coefficients, equally weighted long/short returns									
Post-sample	-0.276***	0.103**	0.094*	0.153***	0.108*	0.113**	0.108**	0.142***	0.104*
	(-3.43)	(2.41)	(1.81)	(3.07)	(1.95)	(2.59)	(2.09)	(2.85)	(1.95)
Post-publication	-0.450***	0.132*	0.093	0.138**	0.083	0.128**	0.106	0.146**	0.098
	(-4.75)	(1.88)	(1.26)	(2.00)	(1.14)	(2.11)	(1.48)	(2.13)	(1.29)
Panel B: Implied relative changes in anomaly profitability, equally weighted long/short returns									
Mean in-sample return	0.724	0.41	0.450	0.459	0.463	0.340	0.352	0.345	0.343
Post-sample change	-38%	25%	21%	33%	23%	33%	31%	41%	30%
Post-publication change	-62%	32%	21%	30%	18%	38%	30%	42%	29%
Panel C: Regression coefficients, value-weighted long/short returns									
Post-sample	-0.173**	0.047	0.029	0.064	0.053	-0.007	0.033	0.053	0.039
	(-2.02)	(0.94)	(0.47)	(1.08)	(0.82)	(-0.11)	(0.51)	(0.82)	(0.59)
Post-publication	-0.305***	0.044	-0.010	0.022	-0.006	-0.046	-0.032	-0.008	-0.024
	(-2.96)	(0.57)	(-0.12)	(0.29)	(-0.08)	(-0.66)	(-0.45)	(-0.12)	(-0.32)
Panel D: Implied relative changes in anomaly profitability, value-weighted long/short returns									
Mean in-sample return	0.464	0.331	0.356	0.372	0.362	0.245	0.247	0.250	0.249
Post-sample change	-37%	14%	8%	17%	15%	-3%	13%	21%	16%
Post-publication change	-66%	13%	-3%	6%	-2%	-19%	-13%	-3%	-10%

Large differences between U.S. and international markets

In the following, (mostly) focus on developed markets



Baseline results: Absolute post-publication change



Large differences between U.S. and international markets

Overview of explanation attempts

1. Anomaly universe

2. Time effects

3. Asset pricing models

4. Database issues

5. Limits to arbitrage:

   - In-sample profitability

   - Firm size

1. The impact of the anomaly universe

- Qualitatively similar findings for all anomaly groups (market, fundamental, valuation, event)
- Qualitatively similar findings for original McLean/Pontiff (2016) anomalies and alternative set:

Country universe	USA	G7+Australia		USA	G7+Australia	
		Pooled	Composite		Pooled	Composite
Return weighting	Equally weighted returns			Value-weighted returns		
Panel A: Event-based anomalies						
Post-sample	-0.238***	0.062	0.059	-0.173**	0.001	-0.036
	(-3.84)	(1.37)	(1.14)	(-2.17)	(0.02)	(-0.49)
Post-publication	-0.443***	0.011	0.044	-0.265***	-0.046	-0.076
	(-6.28)	(0.20)	(0.78)	(-2.78)	(-0.66)	(-1.06)
N	24,883	125,641	22,359	24,883	125,641	22,359
Panel B: Fundamental-based anomalies						
Post-sample	-0.131*	0.208***	0.141**	-0.021	0.185***	0.139
	(-1.91)	(3.46)	(2.30)	(-0.24)	(2.82)	(1.55)
Post-publication	-0.366***	0.269***	0.225***	-0.158*	0.129*	0.139*
	(-4.58)	(4.21)	(3.68)	(-1.77)	(1.96)	(1.79)
N	27,736	156,114	25,649	27,736	156,114	25,649
Panel C: Market-based anomalies						
Post-sample	-0.414**	0.083	0.096	-0.321*	-0.016	0.017
	(-2.29)	(0.86)	(0.91)	(-1.78)	(-0.13)	(0.13)
Post-publication	-0.473***	-0.004	0.035	-0.396**	-0.051	-0.094
	(-2.96)	(-0.04)	(0.26)	(-2.32)	(-0.38)	(-0.65)
N	29,356	179,434	28,525	29,356	179,434	28,525
Panel D: Valuation-based anomalies						
Post-sample	-0.332	0.076	0.142	-0.138	0.050	0.053
	(-1.58)	(0.66)	(1.16)	(-0.56)	(0.34)	(0.33)
Post-publication	-0.540***	0.039	0.077	-0.445***	-0.083	-0.088
	(-3.76)	(0.37)	(0.64)	(-2.80)	(-0.66)	(-0.60)
N	17,239	97,219	16,159	17,239	97,219	16,159

No explanatory power for differences between U.S. and other markets

2. The impact of time effects

Country	USA	G7+Australia		USA	G7+Australia	
universe		Pooled	Composite		Pooled	Composite
Return weighting	Equally weighted returns			Value-weighted returns		
Panel A: Linear time trend						
Post-sample	-0.188***	0.042	0.051	-0.161**	0.020	0.027
	(-2.68)	(0.74)	(1.01)	(-2.06)	(0.31)	(0.43)
Post-publication	-0.299***	-0.035	0.003	-0.285**	-0.065	-0.045
	(-2.62)	(-0.39)	(0.04)	(-2.27)	(-0.66)	(-0.49)
Time trend	-0.063	0.055**	0.042	-0.009	0.027	0.010
	(-1.39)	(2.01)	(1.56)	(-0.18)	(0.84)	(0.28)
N	99,214	558,408	92,692	99,214	558,408	92,692
Panel B: Month-fixed effects						
Post-sample	-0.119**	0.059	0.058	-0.116*	0.044	0.031
	(-2.18)	(1.34)	(1.35)	(-1.79)	(0.83)	(0.55)
Post-publication	-0.168**	0.056	0.061	-0.189**	0.030	0.026
	(-2.18)	(1.03)	(1.04)	(-2.50)	(0.48)	(0.37)
N	99,214	558,408	92,692	99,214	558,408	92,692

Little explanatory power for differences between U.S. and other markets

3. The impact of asset pricing models

Country	USA	G7+Australia		USA	G7+Australia	
universe		Pooled	Composite		Pooled	Composite
Return weighting	Equally weighted returns			Value-weighted returns		
			Panel C: CAPM alphas			
Post-sample	-0.278***	0.131***	0.122***	-0.180**	0.080	0.040
	(-4.02)	(2.99)	(2.65)	(-2.51)	(1.48)	(0.64)
Post-publication	-0.424***	0.106*	0.115*	-0.280***	0.018	-0.026
	(-5.14)	(1.72)	(1.82)	(-3.19)	(0.26)	(-0.36)
N	99,214	558,408	92,692	99,214	558,408	92,692
			Panel D: Three-factor model alphas			
Post-sample	-0.204***	0.125***	0.169***	-0.124*	0.065	0.106*
	(-3.13)	(2.90)	(3.65)	(-1.83)	(1.24)	(1.76)
Post-publication	-0.373***	0.080	0.155***	-0.239***	-0.020	0.037
	(-5.37)	(1.58)	(2.79)	(-3.24)	(-0.35)	(0.56)
N	99,214	553,584	91,692	99,214	553,584	91,692

No explanatory power for differences between U.S. and other markets

4. The impact of different databases

- **Can limited international data availability explain our results?**
  - Datastream/Worldscope leading data provider
  - Similar results during 1995-2015 and with controls for time effects
  - Similar findings for developed markets and stock market data
  - U.S. findings qualitatively unchanged when conditioning on Datastream/Worldscopre availability

Only modest evidence for database issues

5. The impact of limits to arbitrage

Limits to arbitrage has many facets:

- In-sample anomaly profitability
- Firm characteristics (most notably: firm size) [has only limited effect when isolated]

Match anomalies on these characteristics

⇒ Condition on anomalies with in-sample profitability of at least 50 bp and less than 25 bp difference

⇒ Compute anomalies using large firms only (> 20th NYSE percentile, > 50th NYSE percentile)

5. The impact of limits to arbitrage

Country universe	USA	G7+Australia Pooled	Difference to USA	USA	G7+Australia Composite	Difference to USA
Panel A: Matched in-sample profitability, equally weighted returns						
Matched strategies		29			22	
Mean in-sample return	1.14	1.09		0.86	0.81	
N	11,804	68,812		8,953	8,185	
Post-sample	-0.538***	-0.118	-0.420***	-0.245*	-0.159	-0.085
	(-2.63)	(-0.83)	(-2.69)	(-1.87)	(-1.51)	(-0.66)
Post-publication	-0.672***	-0.120	-0.552***	-0.428***	-0.183*	-0.245*
	(-3.28)	(-0.72)	(-3.54)	(-3.40)	(-1.78)	(-1.84)
Panel B: Matched in-sample profitability, value-weighted returns						
Matched strategies		26			18	
Mean in-sample return	0.80	0.88		0.71	0.65	
N	10,908	64,182		7,443	6,905	
Post-sample	-0.476*	-0.089	-0.387*	-0.580***	-0.263	-0.317
	(-1.73)	(-0.44)	(-1.86)	(-2.72)	(-1.49)	(-1.52)
Post-publication	-0.624**	-0.177	-0.447*	-0.493**	-0.159	-0.334*
	(-2.08)	(-0.76)	(-1.94)	(-2.47)	(-0.94)	(-1.70)

Some explanatory power for differences between U.S. and other markets

Suggestive of cross-country barriers to investment management

5. The impact of limits to arbitrage

Country universe	USA	G7+Australia Pooled	Difference to USA	USA	G7+Australia Composite	Difference to USA
Panel E: Matched in-sample profitability, firms larger than 50th NYSE size percentile, equally weighted returns						
Matched strategies		19			16	
Mean in-sample return	0.75	0.79		0.71	0.72	
N	7,672	33,258		6,521	6,136	
Post-sample	-0.398	-0.202	-0.197	-0.527***	-0.097	-0.430**
	(-1.33)	(-1.24)	(-0.70)	(-2.79)	(-0.60)	(-2.37)
Post-publication	-0.615*	-0.199	-0.416*	-0.538***	-0.275*	-0.263
	(-1.90)	(-0.86)	(-1.82)	(-3.21)	(-1.66)	(-1.60)
Panel F: Matched in-sample profitability, firms larger than 50th NYSE size percentile, value-weighted returns						
Matched strategies		16			17	
Mean in-sample return	0.69	0.70		0.70	0.68	
N	6,650	29,345		7,090	6,550	
Post-sample	-0.514*	-0.438*	-0.321	-0.402*	-0.338	-0.064
	(-1.96)	(-1.73)	(-1.54)	(-1.78)	(-1.48)	(-0.29)
Post-publication	-0.750***	-0.137	-0.435**	-0.667***	-0.386**	-0.281
	(-2.70)	(-0.67)	(-2.33)	(-3.27)	(-2.01)	(-1.37)

Some explanatory power for differences between U.S. and other markets

Suggestive of cross-country barriers to investment management

Limits to arbitrage within markets

- So far: Limits to arbitrage between markets
- What about limits to arbitrage within markets
  - Could help to understand underlying mechanism:
  - Mispricing view: More limits to arbitrage => Higher long/short returns
  - Data mining view: More limits to arbitrage => no clear implication

Compute average firm characteristics for each anomaly (in-sample period):

- Firm size
- Idiosyncratic volatility
- Dollar trading volume
- Amihud (2002) illiquidity
- Bid-ask spread
- Composite proxy

Limits to arbitrage within markets

Regress anomaly returns

on

- Post-publication dummy
- Limits to arbitrage proxy
- Interaction effect

Country universe	USA	G7+Australia Pooled	G7+Australia Composite
Panel A: Idiosyncratic volatility, equally weighted returns			
Post-publication (P)	-0.372***	0.023	0.025
	(-5.06)	(0.41)	(0.44)
P*Idiosyncratic volatility	-0.136***	-0.030	-0.043
	(-3.52)	(-0.83)	(-1.19)
Idiosyncratic volatility	0.241***	0.199***	0.117***
	(8.27)	(7.99)	(4.72)
Constant	0.677***	0.384***	0.383***
	(11.48)	(8.65)	(10.09)
Arbitrage + (P x Arbitrage)	0.105	0.169	0.074
p-value	0.001***	0.000***	0.014**
Panel B: Idiosyncratic volatility, value-weighted returns			
Post-publication (P)	-0.274***	-0.038	-0.048
	(-3.52)	(-0.61)	(-0.87)
P*Idiosyncratic volatility	-0.172***	0.016	-0.016
	(-3.62)	(0.38)	(-0.35)
Idiosyncratic volatility	0.218***	0.175***	0.092***
	(6.75)	(5.98)	(2.82)
Constant	0.443***	0.488***	0.263***
	(7.63)	(11.31)	(6.15)
Arbitrage + (P x Arbitrage)	0.046	0.191	0.077
p-value	0.242	0.000***	0.029**

Anomalies with higher limits to arbitrage have higher long/short returns

Summary and conclusion

- Exceptionally rich anomaly data set suggests that anomalies are (unconditionally) a global phenomenon and are related to arbitrage costs
- But: Large differences between U.S. and international markets
- At least partly related to limits to arbitrage. But also: Cross-country barriers!
- Implications for literature on arbitrage trading, data mining, market segmentation, and meta analysis of market anomalies

Thank you for your attention!

Contribution to the literature

1

(U.S.-based) literature on data snooping

- E.g., Fama (1998), Schwert (2003), Harvey et al. (2016), Harvey (2017), Hou et al. (2018), Linnainmaa/Roberts (2018), Wahal (2018), Yan/Zheng (2017), Engelberg et al. (2018)…

→ **The average anomaly is unlikely to be the result of data mining**

2

(U.S.-based) literature on growth of the arbitrage industry and its implications

- E.g., Hanson/Sunderan (2014) vs. Israel/Moskowitz (2013) or Chordia et al. (2014) vs. Haugen/Baker (1996)...
- Green et al. (2017), Hou et al. (2018), McLean/Moskowitz

→ **Arbitrage trading seems to affect price formation primarily in U.S. market only**

3

Literature on international stock market integration

- E.g., Bekaert et al. (2014), Froot and Dabora (1999), Hau (2011), Rapach et al. (2013),…

→ **Seemingly strong geographic stock market segmentation**

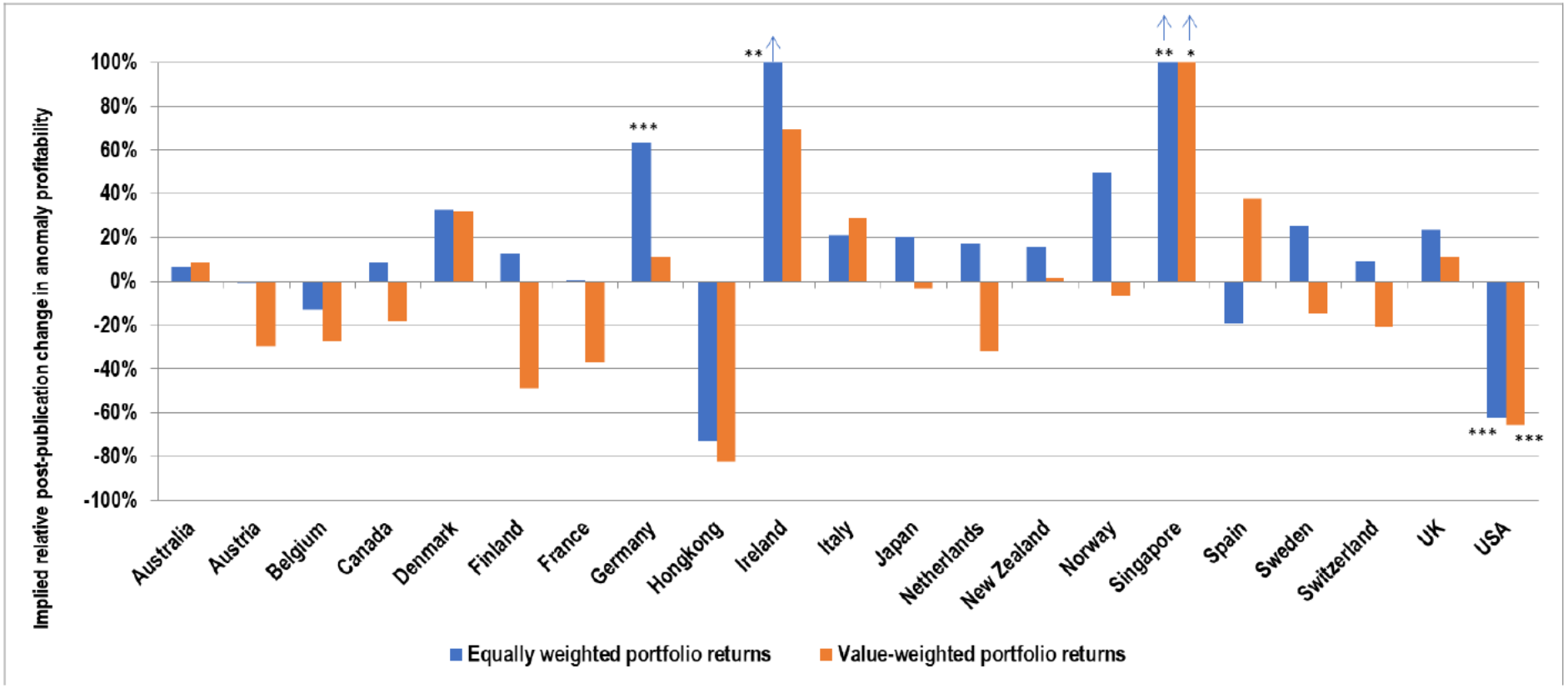
4

(U.S.-based) literature on the meta-analysis of market anomalies

- E.g. Engelberg et al. (2016), Fama and French (2016), Green et al. (2013, 2017), Hou et al. (2015, 2018), Jacobs (2016), Keloharju et al. (2016), Novy-Marx and Velikov (2016), Stambaugh (2012, 2014, 2015), Stambaugh and Yuan (2016),…

→ **Global perspective matters**

Baseline results: Implied relative post-publication change



Large differences between U.S. and international markets