### Publication Bias and the Cross-Section of Stock Returns

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Disclaimer: The views expressed herein are those of the author and do not necessarily reflect the position of the Board of Governors of the Federal Reserve or the Federal Reserve System



















#### The Cross-Sectional Asset Pricing Lit





#### p-hacking

- data-mining, data-snooping
- suspicion and ambition
- collective re-use of data



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- robustness tests
- theoretical motivations
- supporting results
- a scientific, ethical culture

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The Cross-Sectional Asset Pricing Lit

**Our Question: Which Side is Winning?** 

(1) Focus: replications of 172 published cross-sectional predictors

- Excludes non-predictive and aggregate factors in Harvey, Liu, Zhu 2016
- Excludes un-published predictors in Chordia, Goyal, Saretto 2017

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Result:

- ► Journal review dominates. Nearly all predictors were real!!
  - Consistent w/ McLean-Pontiff 2016, Jacobs-Müller 2016, Yan-Zheng 2017

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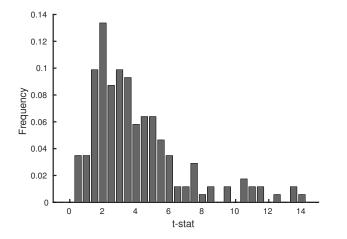
## Replications of 172 Published Predictors

## **Data: Replications of 172 Published Predictors**

- (1) Replicate McLean and Pontiff's (2016) 97 published cross-sectional predictors
- (2) Replicate 75 additional variables that were
  - shown to predict cross-sectional returns
  - published in "top-tier" journals

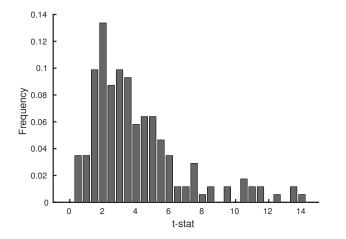
Data available at sites.google.com/site/chenandrewy/

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### **Distribution of Replicated t-stats**



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- ▶ But what explains the long right tail? ⇒ need model

## **Model and Estimation**

## A Statistical Model of Publication 1/2

### Motivating Story:

- 1. Anything that might be published is submitted to journals
  - Allows for p-hacking
- 2. Only portfolios with "narratives" are considered for publication
  - Allows for journal review: robustness tests, supporting results, ...
- 3. Only narratives with high t-stats are published
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- 3. Only narratives with high t-stats are published
  - Another **p-hacking** effect
- $\Rightarrow$  statistical model of publication similar to Harvey, Liu, and Zhu's (2016) model with correlations

## A Statistical Model of Publication 2/2

#### **Key equations**

▶ If portfolio *i* has a narrative,

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true return \mu_i \sim scaled student's t with \sigma_{\mu}, \nu_{\mu}
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• dispersion of true returns  $\sigma_{\mu}$  measures power of journal review

– large  $\sigma_{\mu}$   $\Rightarrow$  narratives find variation in true returns

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• In-sample returns are noisy and biased signals of  $\mu_i$ 

$$r_i = \mu_i + \epsilon_i$$

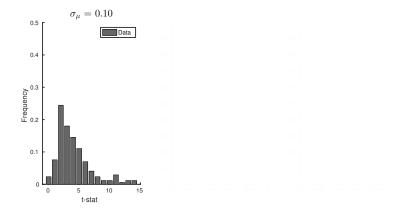
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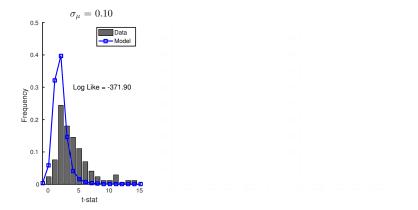
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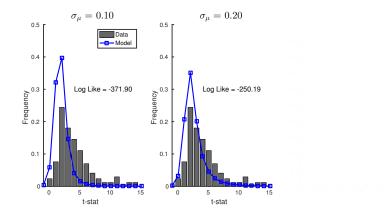
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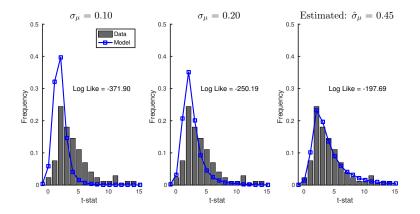
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### **Maximum Likelihood Estimation**

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# **Bias Adjustment and Shrinkage**

► We focus on Shrinkage defined by

- 100% Shrinkage  $\Rightarrow$  **p-hacking** dominates, bias-adjusted return = 0
- 0% Shrinkage  $\Rightarrow$  journal review works, bias-adjusted = in-sample

# **Bias Adjustment and Shrinkage**

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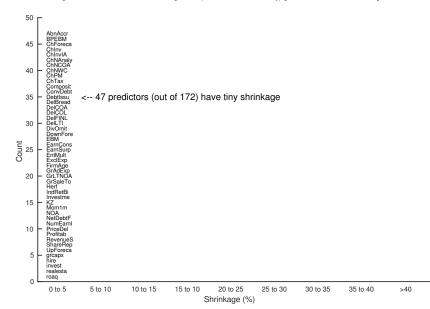
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- 100% Shrinkage  $\Rightarrow$  **p-hacking** dominates, bias-adjusted return = 0
- 0% Shrinkage  $\Rightarrow$  journal review works, bias-adjusted = in-sample
- Bayesian logic gives a shrinkage formula (Dawid 1994, Senn 2008, Efron 2011, 2012)

$$\begin{split} \mathsf{Shrinkage}_i &\approx \frac{[\mathsf{Standard Error}]_i^2}{\hat{\sigma}_{\mu}^2 + [\mathsf{Standard Error}]_i^2} \\ \hat{\sigma}_{\mu}^2 &= \mathsf{Estimated Dispersion of True Returns} \end{split}$$

# Results

[Bias-Adjusted Return]<sub>i</sub> =  $(1 - \text{Shrinkage}_i)[\text{In-Sample Return}]_i$ 



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| 50      | Г  |  |          |                |                          |          |
|---------|--|--|----------|----------------|--------------------------|----------|
| 45      | AbnAccr<br>BPEBM<br>ChForeca<br>ChInv<br>ChInvIA                               | AOP<br>Accruals<br>AdExp<br>AnalystV<br>AssetGro           |          |                |                          |          |
| 40      | ChNAnaly<br>ChNCOA<br>- ChNWC<br>ChPM<br>ChTax                                 | BetaTail<br>ChAssetT<br>ChEQ<br>ChangeIn<br>CompEqul       |          |                |                          |          |
| 35      | Composit<br>ConvDebt<br>DebtIssu<br>DelBread<br>DeICOA<br>DeICOL               | Coskewne<br>DelEqu<br>DivInd<br>EarnIncr<br>EarnSupB<br>FR |          |                |                          |          |
| 30      | <ul> <li>DelFINL</li> <li>DelLTI</li> <li>DivOmit</li> <li>DownFore</li> </ul> | FailureP<br>GP<br>GrGMToGr<br>GrSaleTo                     |          |                |                          |          |
| 25<br>O | EBM<br>EarnCons<br>EarnSurp<br>EntMult<br>ExclExp<br>FirmAge                   | IndMom<br>Intrinsi<br>LTLevera<br>MS<br>MeanRank<br>MomBey |          |                |                          |          |
| 20      | GrAdExp<br>– GrLTNOA<br>GrSaleTo<br>Herf                                       | MomSeas<br>OPLevera<br>OperProf<br>OrderBac                |          |                |                          |          |
| 15      | IndRetBi<br>Investme<br>KZ<br>Mom1m<br>NOA                                     | PctAcc<br>PctTotAc<br>RD<br>REV6<br>RIO_Idio               |          |                |                          |          |
| 10      | NetDebtF<br>NumEarnl<br>PriceDel<br>Profitab<br>RevenueS<br>ShareRep           | RoE<br>Sharels1<br>Sharels5<br>ShortInt<br>Skew1<br>VoISD  |          |                |                          |          |
| 5       | <ul> <li>UpForeca<br/>grcapx<br/>hire<br/>invest<br/>realesta</li> </ul>       | XFIN<br>pchdepr<br>pchgm_pc<br>retCongl<br>sar             |          |                |                          |          |
| 0       | roaq   | sinAlgo  |          |                |                          |          |
|         | 0 to 5   | 5 to 10  | 10 to 15 | 15 to 10<br>Si | 20 to 25<br>hrinkage (%) | 25 to 30 |

10/14

>40

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| 25<br>Count | EarnCons<br>EarnSurp<br>EntMult<br>ExclExp  | Intrinsi<br>LTLevera<br>MS<br>MeanBank                               |          |             |                           |           |           |          |     |
| 20          | FirmAge<br>GrAdExp<br>GrAdExp<br>GrLTNOA<br>GrSaleTo<br>Herf                                    | MomRev<br>MomSeas<br>OPLevera<br>OperProf<br>OrderBac                |          |             |                           |           |           |          |     |
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| 0           | roaq  |  |          |             |                           |           |           |          |     |
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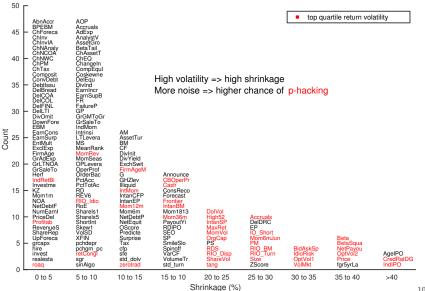
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|-------------|--|--|---|--|---|--|---|--|-------------------------------|----|
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| 30          | DelFINL<br>DelLTI<br>DivOmit<br>DownFore<br>EBM                                  | FailureP<br>GP<br>GrGMToGr<br>GrSaleTo<br>IndMom                   |   |  |   |  |   |  |                               |    |
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| 15          | KZ<br>Mom1m<br>NOA   | PctAcc<br>PctTotAc<br>RD<br>REV6<br>RIO_Idio<br>RoE                | Illiquid<br>IntMom<br>IntanCFP<br>IntanEP                         | CBOperPr<br>Cash<br>ConsReco<br>Forecast<br>Frontier<br>IntanBM                        |   |  |   |  |                               |    |
| 10          | NetDebtF<br>NumEarnI<br>PriceDel<br>Profitab<br>RevenueS                         | HoE<br>Sharels1<br>Sharels5<br>ShortInt<br>Skew1<br>VoISD          | Mom12m<br>Mom6m<br>NetDebtP<br>NetEquit<br>OScore                 | Mom1813<br>Mom36m  | DolVol<br>High52<br>IntanSP<br>MaxRet<br>MomVol               | Accruals<br>DelDRC<br>EP   |   |  |                               |    |
| 5           | ShareRep<br>UpForeca<br>grcapx<br>hire<br>invest<br>realesta<br>roag             | VolSD<br>XFIN<br>pchdepr<br>pchgm_pc<br>retCongl<br>sgr<br>sinAlgo | Predicte<br>Surprise<br>Tax<br>cfp<br>sfe<br>std_dolv<br>zerotrad | PayoutYi<br>RDIPO<br>SEO<br>SP<br>SmileSlo<br>Spinoff<br>VarCF<br>VolumeTr<br>std turn | MomVol<br>OrgCap<br>PS<br>RDS<br>RIO_Disp<br>ShareVol<br>tang | IO_Short<br>Mom6mJun<br>PM<br>RIO_BM<br>RIO_Turn<br>Size<br>ZScore | BidAskSp<br>IdioRisk<br>OptVol1<br>VolMkt | Beta<br>BetaSqua<br>NetPayou<br>OptVol2<br>Price<br>fgr5yrLa | AgelPO<br>CredRatDG<br>IndIPO |    |
| 0           | 0 to 5   | 5 to 10  | 10 to 15  | 15 to 10   | 20 to 25  | 25 to 30   | 30 to 35                                  | 35 to 40   | >40                           |    |
|             |  |  |   | S  | hrinkage (%)  |  |   |  |                               | 10 |

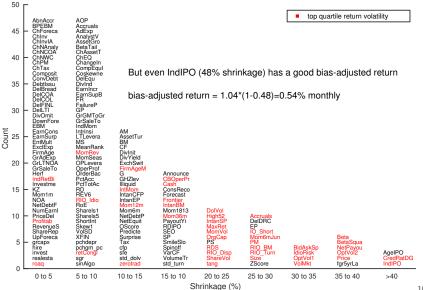
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| 30          | DelFINL<br>DelLTI<br>DivOmit<br>DownFore<br>FBM                  | FailureP<br>GP<br>GrGMToGr<br>GrSaleTo<br>IndMom             |  |   |   |  |   |  |                     |    |
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|             | 0.00   | 0.010  | 101010   |   | hrinkage (%)                                    | 2010 00                                      | 001000                                    | 00 10 40   |                     | 1( |

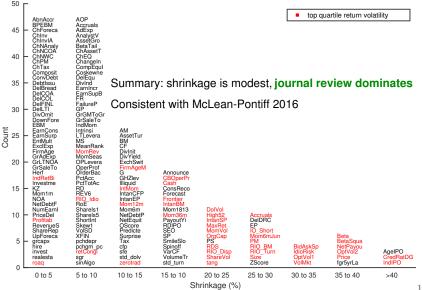
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| 25<br>Count | EamCons<br>EamSurp<br>EntMult<br>ExclExp<br>FirmAge<br>GrAdExp                     | Intrinsi<br>LTLevera<br>MS<br>MeanRank<br>MomRev<br>MomSeas            | AM<br>AssetTur<br>BM<br>CF<br>DivInit                 |   |  |  |   |  |                               |
| 20          | GrAdExp<br>GrLTNOA<br>GrSaleTo<br>Herf<br>IndRetBi                                 | MomSeas<br>OPLevera<br>OperProf<br>OrderBac<br>PctAcc<br>PctTotAc      | DivYield<br>ExchSwit<br>FirmAgeM<br>G<br>GHZley       | Announce<br>CBOperPr  |  |  |   |  |                               |
| 15          | KZ<br>Mom1m<br>NOA<br>NetDebtF   | PctTotAc<br>RD<br>REV6<br>RIO_Idio<br>RoE                              | Illiquid<br>IntMom<br>IntanCFP<br>IntanEP<br>Mom12m   | Cash<br>ConsReco<br>Forecast<br>Frontier<br>IntanBM               |  |  |   |  |                               |
| 10          | <ul> <li>NumEarnl</li> <li>PriceDel</li> <li>Profitab</li> <li>RevenueS</li> </ul> | Sharels1<br>Sharels5<br>ShortInt<br>Skew1<br>VoISD                     | Mom6m<br>NetDebtP<br>NetEquit<br>OScore<br>Predicte   | Mom1813<br>Mom36m<br>PayoutYi<br>RDIPO<br>SEO<br>SP               | DolVol<br>High52<br>IntanSP<br>MaxRet<br>MomVol                | Accruals<br>DelDRC<br>EP<br>IO_Short                               |   |  |                               |
| 5           | ShareRep<br>UpForeca<br>grcapx<br>hire<br>invest<br>realesta<br>roag               | VoiSD<br>XFIN<br>pchdepr<br>pchgm_pc<br>retCongl<br>sgr<br>sinAlgo     | Surprise<br>Tax<br>cfp<br>sfe<br>std_dolv<br>zerotrad | SEO<br>SP<br>SmileSlo<br>Spinoff<br>VarCF<br>VolumeTr<br>std turn | Mom voi<br>OrgCap<br>PS<br>RDS<br>RIO_Disp<br>ShareVol<br>tang | IO_Snort<br>Mom6mJun<br>PM<br>RIO_BM<br>RIO_Turn<br>Size<br>ZScore | BidAskSp<br>IdioRisk<br>OptVol1<br>VolMkt | Beta<br>BetaSqua<br>NetPayou<br>OptVol2<br>Price<br>fgr5yrLa | AgelPO<br>CredRatDG<br>IndIPO |
| 0           | 0 to 5   | 5 to 10  | 10 to 15  | 15 to 10  | 20 to 25   | 25 to 30   | 30 to 35                                  | 35 to 40   | >40                           |
|             |  |  |   | S   | hrinkage (%)   |  |   |  | :                             |

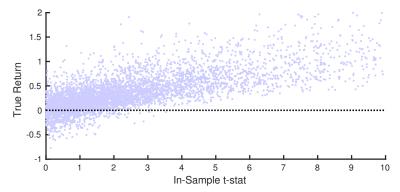
10/14



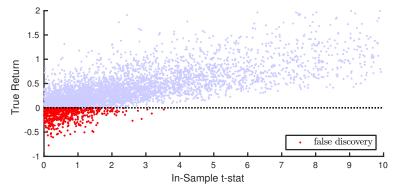




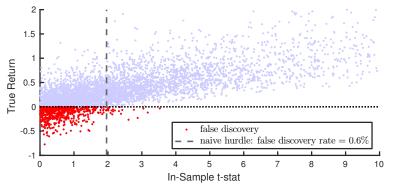
We can estimate the false discovery rate (FDR) (à la HLZ 2016)



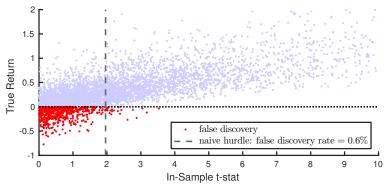
Simulate true returns and t-stats using estimated parameters



• Define false discoveries: true returns  $\leq 0$  (equivalent to HLZ)

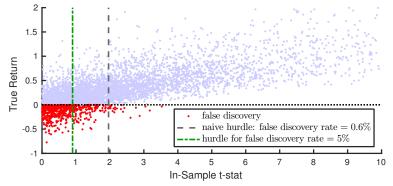


- Calculate false discovery rate (FDR) for a given t-stat hurdle
- ▶ Naive hurdle (1.96) implies a tiny FDR of 0.6%

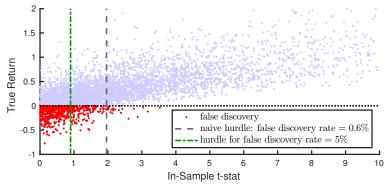


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|                            |                    | Variable Counts           |              |
|----------------------------|--------------------|---------------------------|--------------|
|                            | Harvey-<br>Liu-Zhu | Chordia-Goyal-<br>Saretto | Our<br>Paper |
| Aggregate Risk Factor      | 113                | 0                         | 0            |
| X-Sectional Predictor      | 202                | 2,100,000                 | 172          |
| X-Sectional & Top Tier Pub | 146                | <500                      | 151          |
| Total                      | 315                | 2,100,000                 | 172          |

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 Suggests p-hacking much worse among aggregate risk factors and outside top journals

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\*in top-tier pubs predicting cross-sectional stock returns, **for now** Consistent w/ McLean-Pontiff 2016, Jacobs-Müller 2016, Yan-Zheng 2017

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► Suggests a complete accounting for the typical anomaly return

- 13% publication bias (this paper)
- 35% mispricing that can be traded away (McLean and Pontiff 2016)
- 52% trading costs (Chen and Velikov 2017)