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ABSTRACT

The answer, of course, is that it can't. Hou, Xue, and Zhang's (2014) empirical model does price portfolios sorted on prior year's performance, but for reasons outside of q-theory---it does so by including a fundamental momentum factor, i.e., a factor based on momentum in firm fundamentals. The ROE factor, which does all the work pricing momentum, is constructed by sorting stocks on the most recently announced quarterly earnings, which tend to be high after positive earnings surprises. A post earnings announcement drift factor prices the model's ROE factor, and subsumes the role the ROE factor plays pricing momentum portfolios when both are included as explanatory variables. The HXZ model also only prices portfolios sorted on gross profitability by conflating earnings profitability, which drives the ROE factor's covariance with gross profitability, with post earnings announcement drift, which drives the ROE factor's high average returns. Controlling for fundamental momentum, the HXZ model also loses its power to explain the performance of gross profitability. These facts are inconsistent with a neoclassical interpretation of the empirical model.

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1. Introduction

Hou, Xue, and Zhang (2014, hereafter HXZ) introduce a multi-factor asset pricing model "inspired by investment-based asset pricing, which is in turn built on the neoclassical q-theory of investment" (p. 2). Hou, Xue, and Zhang (2014b) claim, in their abstract, that their model, which they dub the empirical q-factor model, "outperforms the [Fama and French, 2014] five-factor model, especially in capturing price and earnings momentum."

The q-factor model's superior performance pricing momentum strategies is unsurprising, given the construction of the HXZ profitability factor. This ROE factor is formed on the basis of the most recently announced quarterly earnings using monthly rebalancing, "because the most recent ROE contains the most up-to-date information about future ROE." This construction conflates basic economic profitability, which is highly persistent and what the q-theory model is ostensibly about, with earnings surprises and the associated post earnings announcement drift, which is highly transitory and outside the scope of the motivating theory.[1]

All of the empirical model's success pricing momentum strategies comes from earnings surprises and post earnings announcement drift. Disentangled factors, which separate the effects of lagged earnings and recent changes in earnings, price the ROE factor, and cannot be priced by the HXZ model. These factors basically proxy for a low frequency earnings profitability factor and a post earnings announcement drift factor, respectively. A model that includes a factor based on annual earnings profitability and a factor based on standardized unexpected earnings (SUE) also price the ROE factor, and completely subsume the ROE factor when used to price momentum. In regressions of momentum

[1] This construction also introduces a look-ahead bias into the factor, because quarterly earnings in Compustat include revisions, and thus not necessarily the earnings that were actually announced. This bias will tend to inflate the returns to the ROE factor, as stocks bought on the basis of future positive revisions will tend to perform strongly on the revision date. Quantifying the magnitude of this bias is beyond the scope of this paper, but could be addressed simply by lagging quarterly earnings sufficiently from the recorded earnings announcement dates.

onto the HXZ factors and a SUE factor, all of the pricing is done by SUE. The fact that a SUE factor prices momentum strategies is itself somewhat surprising, in light of Chan, Jegadeesh, and Lakonishok's (1996) well known conclusion that "past return and past earnings surprise each predict large drifts in future returns after controlling for the other" (p. 1681). The results are consistent, however, with Novy-Marx (2014), which shows that fundamental momentum, i.e., momentum in firm fundamentals, especially earnings, completely explains the performance of strategies based on price momentum.

The basic HXZ model also only succeeds in pricing portfolios sorted on gross profitability because it conflates earnings profitability with post earnings announcement drift. The disentangled factors, which price the ROE factor, cannot price gross profitability. Gross profitability loads heavily on the low frequency, low premia, earnings profitability factor, but is orthogonal to the high frequency, high premia, earnings innovation factor. The ROE factor essentially prices gross profitability by mistakenly attributing gross profitability's performance to post earnings announcement drift. All of gross profitability's loading on ROE comes through its correlation with the low frequency earnings profitability, while all of the ROE spread is driven by high frequency revisions to earnings.

There is also more generally a significant selection bias with regards to the choice of the test assets used to compare the performance of the HXZ model to the Fama and French model. The test assets used to compare the two models are chosen from the set of known anomalies, which are defined by their significant alphas relative to the Fama and French model. That is, the HXZ model does as well as the Fama and French model pricing strategies selected because of the difficulties they pose to the Fama and French model.

Ultimately the HXZ model succeeds in pricing momentum portfolios because it includes a momentum factor. Because its major success is essentially outside the motivating neo-classical theory, it is inappropriate to refer to it as a q-theory model, or to even call its ROE factor a profitability factor. These facts call into question the interpretation of the model as grounded by, and providing supporting evidence for, investment-based asset pricing.

The remainder of the paper proceeds as follows. Section 2 replicates the headline HXZ results, showing that a high frequency earnings-to-book factor generates remarkable performance and prices momentum. Section 3 decomposes earnings-to-book into lagged earnings-to-book and earnings innovations-to-book, and shows that the performance of the ROE factor, as well as the ROE factor's power pricing momentum, is driven by the latter. It also shows that a factor based on earnings innovations-to-book is essentially a fundamental momentum factor, driven by post earnings announcement drift (PEAD) and almost indistinguishable from a factor based on standardized unexpected earnings. Section 4 shows that the HXZ model's power pricing strategies based on gross profitability comes from conflating earnings profitability and PEAD, with all the covariance between gross profitability strategies and the ROE factor driven by the low frequency, unpriced, part of ROE, while the ROE's high average return is driven by the transient, high frequency component that is orthogonal to gross profitability. Section 5 concludes.

2. Replication of headline results

Table 1 shows the performance of an ROE factor, constructed using the same methodology employed by Fama and French to construct the momentum factor, UMD. I employ the standard double sorting methodology of Fama and French (1993), instead of the triple sorting methodology preferred by HXZ, for simplicity and to ease comparison across models. Results are not sensitive to the details of factor construction, and if they were would raise additional concerns regarding the proposed factors. Specifically, ROE is an equal-weighted average of value-weighted large and small cap return-on-equity strategies, where large and small cap are defined as above and below NYSE median market capitalization, respectively, and the return-on-equity strategies buy and sell stocks ranked in the top and bottom 30% of return-on-equity, using NYSE breaks. Following HXZ, return-on-equity is measured using the most recently announced quarterly earnings before extraordinary items (Compustat item IBQ), scaled by quarterly book equity lagged one quarter. Earnings are assumed to be available at the end of the month during which they are announced (Compustat item RDQ). The factor is rebalanced monthly.[2] The sample begins in the middle of 1973, when reliable quarterly accounting data becomes available for a broad cross section of firms.

Table 1 shows results consistent with HXZ. Specification one shows that the ROE factor generates large, highly significant average excess returns of 65 bps/month over the 40 year sample. Specifications two shows an even more significant abnormal returns relative to the Fama and French (1993) 3-factor model, while specification three shows that the that the 4-factor model that additionally accounts for momentum explains almost none of the ROE factor's average returns.

The last four specifications of the table show the performance of UMD relative to the HXZ model. Specification four shows the momentum factor earned excess returns of 66 bps/month over the sample. Specification five shows that UMD loads significantly on the ROE factor, and that covariance with the ROE factor alone explains almost 60% of the UMD factor's abnormal returns. Specifications six and seven show that HXZ's four-factor model, which additionally includes Fama and French's market and size factors (MKT and SMB), and an investment factor (AG), constructed like HML using asset growth instead of book-to-market, explains 90% of the performance on UMD.[3] These specifications also

[2] The ROE factor holds positions for an average of roughly six months, yielding estimated transaction cost of 30 bps/month using the methodology of Novy-Marx and Velikov (2014). This is more similar to UMD (four month average holding times and estimated transaction costs of 50 bps/month) than it is to HML (three-year average holding times and estimated transaction costs of 6 bps/month). I ignore transaction costs for the rest of this paper for comparability to HXZ, but doing so obviously significantly overstates the factor's performance.

[3] Specifically, the AG factor is constructed using the same 2 x 3 methodology used for ROE, but the portfolios are only rebalanced annually, at the end of June, using accounting data from the fiscal year ending in the previous calendar year. This standard, conservative lag assumption of Fama and French (1993) basically ensures that accounting data used in the strategies is public at the time of portfolio formation.

Table 1
Basic facts

This table presents results of time-series regressions of the form:

$$y_t = \alpha + \boldsymbol{\beta}'\mathbf{X}_t + \varepsilon_t$$

where the y_t are the monthly excess returns to either the return-on-equity factor ROE (specifications one to three) or the Fama and French momentum factor UMD (specifications four to seven), and the explanatory factors are the returns to various combinations of the four Fama and French factors (MKT, SMB, HML, and UMD), an asset growth factor (AG), and the ROE factor. The sample covers July 1973 through December 2013, with the start date determined by the availability of quarterly Compustat data.

	y = ROE			y = UMD			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
α	0.65	0.85	0.63	0.66	0.27	0.24	0.07
	[4.81]	[6.84]	[5.43]	[3.24]	[1.38]	[1.16]	[0.33]
β_{MKT}		-0.09	-0.04			-0.03	-0.06
		[-3.20]	[-1.56]			[-0.57]	[-1.39]
β_{SMB}		-0.39	-0.39				0.33
		[-9.50]	[-10.5]				[4.95]
β_{HML}		-0.11	-0.03				
		[-2.53]	[-0.69]				
β_{UMD}			0.25				
			[9.98]				
β_{AG}						0.12	0.15
						[1.14]	[1.44]
β_{ROE}					0.59	0.59	0.73
					[9.43]	[8.99]	[10.4]
adj.-R^2 (%)		19.4	33.1		15.3	15.4	19.4

show that the marginal power the three additional factors add comes primarily through the inclusion of the size factor, not the investment factor.

3. ROE decomposition and relation to PEAD

The impressive observed performance of the high frequency ROE factor, and the factor's striking success pricing momentum, are quite surprising, at least in light of Fama and French's (2008) conclusion that the empirical evidence does "not provide much basis for the conclusion that, with controls for market cap and B/M, there is a positive relation between average returns and profitability" measured by return-on-equity (p. 1663). The seeming contradiction is completely resolved, however, by recognizing that the high frequency ROE factor's high average returns, as well as its power pricing momentum, are both driven by recent innovations to earnings, not from the level of earnings.

This can be seen simply by double sorting stocks into portfolios on the basis of lagged earnings-to-book equity and earnings innovations-to-book equity, where these come from decomposing return-on-equity:

$$ROE \equiv \frac{IBQ}{BEQ_{-1}} = \frac{IBQ_{-4}}{BEQ_{-1}} + \frac{IBQ - IBQ_{-4}}{BEQ_{-1}} \equiv \text{lagged-}E/B + \Delta E/B,$$

where IBQ and BEQ are quarterly income before extraordinary items and quarterly book equity, respectively, and subscripts denote quarterly lags.

Table 2 shows results for value-weighted portfolios formed monthly using independent sorts on lagged-B/E and $\Delta B/E$. Panel A shows the performance of the high-minus-low lagged-B/E strategies constructed within $\Delta B/E$ quintiles, while panel B shows the performance of the high-minus-low $\Delta B/E$ strategies constructed within lagged-B/E quintiles (properties of all 25 of the double sorted portfolios are provided in Appendix Table A1). Panel A shows that the sort on lagged earnings-to-book generates large spreads in current return-on-equity (an average high-minus-low spread in portfolio IBQ/BEQ_{-1} of 8.3%), but fails to generate any spread in average returns. Gibbons, Ross, and Shanken (GRS) tests also fail to reject the hypotheses that either the three- or four-factor abnormal returns of the five high-minus-low lagged earnings-to-book strategies constructed within earnings innovation-to-book quintiles are jointly zero at the 5% level.

Panel B shows that the earnings innovations-to-book equity sort, despite generating slightly less spread in current return-on-equity (average high-minus-low spread in portfolio IBQ/BEQ_{-1} of 7.4%), generates large return spreads across lagged earnings-to-book quintiles (average of 64 bps/month), and large, highly significant three- and four-factor alphas.

Table 2

Strategies formed from double sorts on lagged earnings-to-book and earnings innovations-to-book

Most recent quarterly return-on-equity can be decomposed into changes to income-to-book equity and lagged income-to-book equity:

$$ROE \equiv \frac{IBQ}{BEQ_{-1}} = \frac{IBQ_{-4}}{BEQ_{-1}} + \frac{IBQ - IBQ_{-4}}{BEQ_{-1}} \equiv \text{lagged-}E/B + \Delta E/B,$$

where IBQ and BEQ are quarterly income before extraordinary items and quarterly book equity, respectively, and subscripts denote quarterly lags. The table shows the performance of the spread portfolios (high-minus-low quintiles) from independent double quintile sorts on the basis of lagged-E/B and $\Delta E/B$, using NYSE breaks (properties of all 25 individual portfolios provided in Table A1, in the appendix). Portfolios are rebalanced monthly, and returns are value-weighted. Panel A shows the strategies formed by buying (selling) high (low) lagged-E/B portfolios within $\Delta E/B$ quintiles. Panel B shows the strategies formed by buying (selling) high (low) $\Delta E/B$ portfolios within lagged-E/B quintiles. The table also provides spreads between the time-series averages of the portfolios quarterly earnings-to-book (IBQ/ATQ$_{-1}$). The sample covers July 1973 through December 2013, with the start date determined by the availability of quarterly Compustat data.

	Conditioning variable quintile						GRS
	(1)	(2)	(3)	(4)	(5)	Ave.	p-val.
Panel A: high-minus-low lagged-E/B strategies constructed within $\Delta E/B$ quintiles							
$E[r^e]$	0.13	0.23	-0.33	-0.06	-0.07	-0.02	36.6
	[0.52]	[1.08]	[-1.50]	[-0.29]	[-0.39]	[-0.12]	
α_{FF3}	0.43	0.48	-0.02	0.27	0.26	0.29	9.74
	[2.05]	[2.40]	[-0.08]	[1.47]	[1.58]	[2.22]	
α_{FF4}	0.37	0.38	-0.11	0.25	0.17	0.21	20.7
	[1.70]	[1.87]	[-0.53]	[1.32]	[1.03]	[1.62]	
ROE spread	12.3%	7.1%	6.5%	6.7%	8.8%	8.3%	
Panel B: high-minus-low $\Delta E/B$ strategies constructed within lagged-E/B quintiles							
$E[r^e]$	0.70	0.82	0.38	0.83	0.50	0.64	0.01
	[3.23]	[3.60]	[1.56]	[3.95]	[2.77]	[4.27]	
α_{FF3}	0.93	1.15	0.68	1.15	0.75	0.93	0.00
	[4.79]	[5.24]	[2.82]	[5.84]	[4.30]	[6.58]	
α_{FF4}	0.63	0.76	0.13	0.80	0.44	0.55	0.00
	[3.42]	[3.74]	[0.62]	[4.38]	[2.68]	[4.87]	
ROE spread	11.3%	6.2%	5.5%	6.0%	7.8%	7.4%	

3.1. ROE factor decomposition

The results of the preceding table suggest that the high average returns to the ROE factor are driven by recent innovations to earnings, not by the level of earnings. This section explores this further, by comparing the ROE factor to two new factors, constructed on the basis of lagged earnings-to-book (the lag-ROE factor) and earnings innovations-to-book (the ΔROE factor), using the same basic methodology used to construct the ROE factor.

The first two specifications of Table 3 show that individually the lag-ROE factor explains more of the variation in the ROE factor's returns than does the ΔROE factor (51.9% vs. 41.7%), but that the former does little to explain the ROE factor's monthly average excess return of 0.65%, while the latter does a remarkable job pricing ROE all by itself. The next three specifications show that the ΔROE factor also prices ROE with lag-ROE, alone or in conjunction with the Fama and French or the other HXZ factors.

While the ROE factor is in the span of the lag-ROE and ΔROE factors, the ROE cannot price either lag-ROE and ΔROE. Specifications six through nine of Table 3 show that the lag-ROE factor does not earn significant returns, or generate a significant Fama and French thee-factor alpha, but is significantly mispriced by ROE, either alone or in conjunction with the other factors employed by HXZ. This mispricing occurs because the HXZ model conflates the low frequency, low premia, persistent component of earnings profitability with the high frequency, high premia, transitory component. Lag-ROE only covaries with ROE through the first channel, but the HXZ model, unable to distinguish between the two channels, mistakenly attributes part of the average returns earned by the lag-ROE to the second. The model thus sees the negligible returns actually earned by the lag-ROE factor as significantly too low.

Specifications 10-12 show that the ΔROE factor earned large, highly significant average returns, and that these returns cannot be explained by the ROE factor, either alone or in conjunction with the other factors employed by HXZ.

Table 3
ROE factor spanning tests

This table presents results of time-series regressions of the form:

$$y_t \quad = \quad \alpha + \boldsymbol{\beta}' \mathbf{X}_t + \varepsilon_t$$

where the y_t are the monthly excess returns to the return-on-equity factor ROE (specifications one to four), or similarly constructed factors based on the decomposition of return-on-equity into lagged earnings-to-book equity (lag-ROE, specifications five and six) and changes in earnings-to-book equity (ΔROE, specifications seven and eight). The explanatory factors are the returns to various combinations of the Fama and French factors (MKT, SMB, and HML), an asset growth factor (AG), and the ROE, lag-ROE, ΔROE factors. The sample covers July 1973 through December 2013, with the start date determined by the availability of quarterly Compustat data.

	$y = ROE$					$y =$ lag-ROE				$y = \Delta ROE$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
α	0.60	0.03	0.00	0.02	0.03	0.05	0.14	-0.32	-0.18	0.76	0.42	0.27
	[6.42]	[0.28]	[0.07]	[0.44]	[0.77]	[0.49]	[1.40]	[-4.19]	[-2.23]	[7.11]	[5.11]	[3.19]
β_{MKT}				-0.04	-0.04		-0.06		-0.05			0.09
				[-4.49]	[-4.40]		[-2.63]		[-2.93]			[4.81]
β_{SMB}				-0.05	-0.06		-0.29		-0.12			0.15
				[-3.82]	[-4.09]		[-9.14]		[-4.51]			[5.33]
β_{HML}				0.04			0.08					
				[2.55]			[2.47]					
β_{AG}					0.03				-0.09			0.01
					[1.17]				[-2.08]			[0.27]
β_{ROE}								0.57	0.50		0.51	0.60
								[22.9]	[17.9]		[18.6]	[20.7]
$\beta_{\text{lag-ROE}}$	0.91		0.89	0.82	0.83							
	[22.9]		[51.5]	[44.7]	[44.2]							
$\beta_{\Delta\text{ROE}}$		0.82	0.80	0.81	0.80							
		[18.6]	[45.9]	[46.6]	[47.7]							
adj.-R^2 (%)	51.9	41.7	91.0	92.0	91.9		21.8	51.9	54.8		41.7	48.6

3.2. The earnings innovation factor is a PEAD factor

The results presented so far are inconsistent with HXZ's conclusion that return-on-equity is the profitability measure most relevant for predicting cross sectional variation in expected returns, and that they use the most recently announced quarterly earnings simply "because the most recent ROE contains the most up-to-date information about future ROE" (HXZ, p. 14). Lagged earnings-to-price explains more of the variation in recent ROE than earnings innovations do, but HXZ's empirical results are driven almost entirely by the latter. These earnings innovations have power predicting returns because they are closely related to earnings surprises. Fundamental momentum, and the associated post earnings announcement drift, are completely outside of the scope of the q-theoretic story told in HXZ.

Figure 1 shows the close connection between earnings innovations and post earnings announcement drift. The figure gives the growth of a dollar, net of financing costs, invested in five different strategies in the middle of 1973. The five strategies include the ROE, lag-ROE, and ΔROE factors, a similarly constructed post earnings announcement drift factor, PEAD, based on standardized unexpected earnings (SUE), and a lower frequency earnings-to-book factor, E/B, based on annual return-on-equity that is only rebalanced once a year, at the end of June.[4]

The figure shows that the performance of the ΔROE and PEAD factors are quite similar. The returns to the two factors are 80.9% correlated at a monthly frequency, and generate similar excess returns over the sample, with the Sharpe ratio on PEAD slightly exceeding that on ΔROE (1.20 versus 1.11). The PEAD factor, like the earnings innovation factor, also generates significant abnormal returns relative to the HXZ four-factor model,

[4]standardized unexpected earnings (SUE) is calculated as the most recent year-over-year change in earnings per share, scaled by the standard deviation of the these earnings innovations over the last eight announcements, subject to a requirement of at least six observed announcements over the two year window. For earnings per share I use Compustat quarterly data item EPSPXQ (Earnings Per Share (Basic) / Excluding Extraordinary Items). Earnings announcement dates are Compustat quarterly data item RDQ.

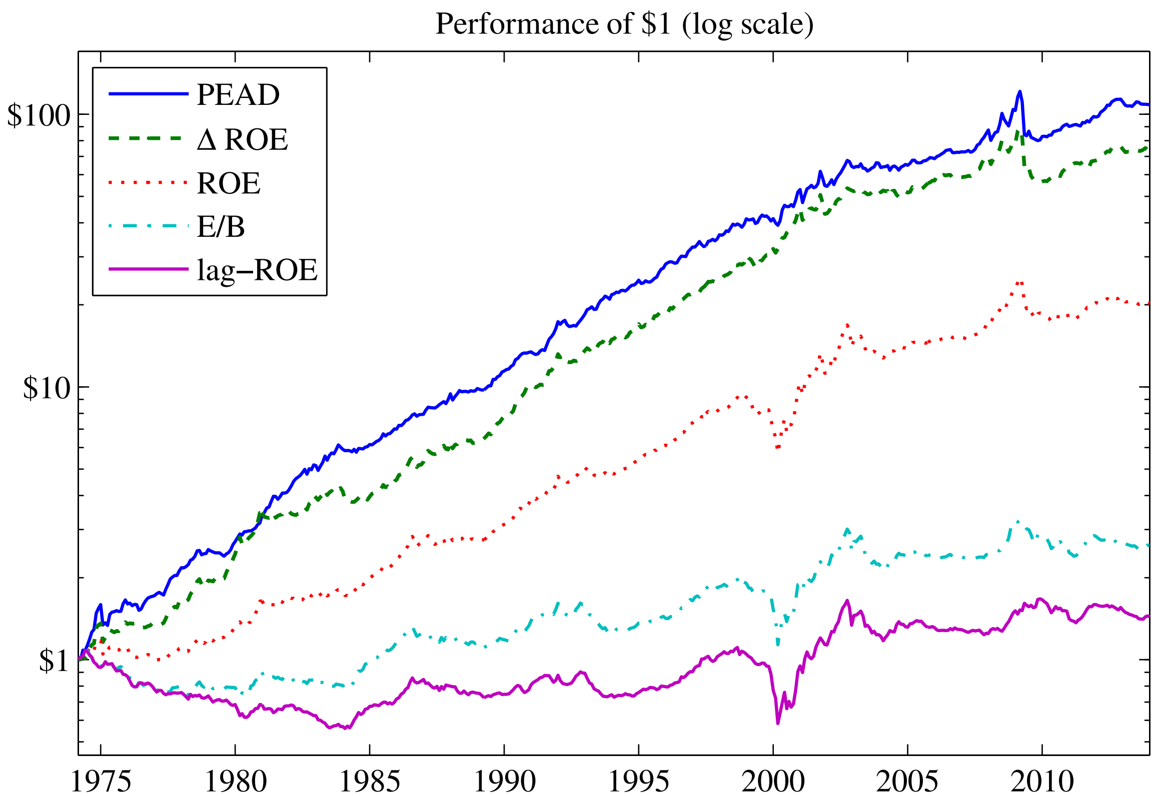

Fig. 1. Comparison of earnings innovation and PEAD factors. The figure shows the value of a dollar, net of financing costs, invested at the end of the first quarter of 1974 in the ROE factor, rebalanced monthly on the basis of the most recently announced quarterly earnings-to-book, and similarly constructed factors based on standardized unexpected earnings (PEAD), earnings innovations-to-book (ΔROE), lagged earnings-to-book (lag-ROE), and a lower frequency earnings-to-book strategy based on annual return-on-equity, which is only rebalanced once a year, at the end of June (E/B). To facilitate comparison factor are scaled to match the sample average volatility of the ROE factor, 10.4%. The start date is determined by the availability of the quarterly Compustat data, and the requirement of at least six observations of year-over-year changes to quarterly earnings for the scaling of the earnings surprise variable.

28 bps/month with a t-statistic of 4.16. This last fact seems to contradict the HXZ claim that their model, and in particular the ROE factor, prices portfolios sorted on standardized unexpected earnings, the variable used to construct the PEAD factor. The two facts are, however, easily reconciled. The ROE factor puts 50% of its weight on, and derives 75% of its average returns from, the stocks with below NYSE median market cap that make up only

9% of the market by capitalization. The ROE factor, which is sorted on a noisy measure of earnings surprises but overweights small cap stocks where post earnings announcement drift is strong, can price the value-weighted test assets in HXZ, which are sorted on a clean measure of earnings surprises but driven primarily by large cap stocks where PEAD is weak. ROE cannot price the PEAD factor, which is sorted on the clean measure of earnings surprises but overweights small cap stocks just as much as ROE.

The figure also shows that the factors based on lagged quarterly earnings-to-book and annual earnings-to-book are also closely related, with a monthly return correlation of 89.9%. The ROE factor, which conflates earnings surprises with low frequency earnings profitability performs, not surprisingly, somewhere in between.

3.3. PEAD drives ROE's performance, and its power pricing momentum

The close connection between PEAD and the earnings innovation factor ΔROE, and consequently between PEAD and ROE, can be made formal by repeating the spanning tests of Tables 1 and 3, but additionally including the PEAD factor as an explanatory strategy.

The first four specifications of Table 4 replicate specifications two through five of Table 3, replacing the lagged-earnings and earnings innovation factors with the PEAD factor and the low frequency earnings-to-book factor, E/B. Specification one shows that the PEAD factor, like the earnings innovation factor, prices the ROE factor all by itself, and explains roughly the same fraction of the ROE factor's return variation, 40.9% versus the 41.7% explained by ΔROE in specification two of Table 3. Specification two through four show that the PEAD factor also prices the ROE factor in conjunction with the low frequency earnings factor, the two together alone, or in conjunction with the Fama and French factors, or with the other factors employed by HXZ.

Specification five replicates the headline results of HXZ, also shown in specification seven of Table 1, that the HXZ four-factor model prices momentum. It does so primarily through a large, highly significant loading of 0.76 on the ROE factor.

Table 4
PEAD prices ROE, and subsumes ROE pricing UMD

This table presents results of time-series regressions of the form:

$$y_t = \alpha + \boldsymbol{\beta}' \mathbf{X}_t + \varepsilon_t$$

where the y_t are the monthly excess returns to the return-on-equity factor ROE (specifications one to four), or the Fama and French momentum factor UMD (specifications five and six). The explanatory factors are the returns to various combinations of the Fama and French factors (MKT, SMB, and HML), an asset growth factor (AG), the ROE, the PEAD factor, and the low frequency earnings-to-book factor (E/B). The sample covers April 1974 through December 2013, with the start date determined by the data requirements for the PEAD factor.

	$y = ROE$				$y = UMD$				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
α	0.01	0.04	-0.01	-0.01	0.03	-0.20	-0.29	-0.31	-0.29
	[0.09]	[0.60]	[-0.08]	[-0.12]	[0.17]	[-1.09]	[-1.57]	[-1.92]	[-1.78]
β_{MKT}			0.03	0.03	-0.06	-0.07	-0.05	-0.17	-0.18
			[2.09]	[2.23]	[-1.30]	[-1.80]	[-1.28]	[-4.76]	[-4.79]
β_{SMB}			-0.01	-0.02	0.42	0.28	0.36	0.21	0.19
			[-0.54]	[-0.74]	[6.42]	[4.82]	[5.85]	[4.30]	[3.45]
β_{HML}			0.05						
			[2.51]						
β_{AG}				0.08	0.11	-0.13	-0.03	0.13	0.12
				[2.32]	[1.09]	[-1.35]	[-0.36]	[1.55]	[1.40]
β_{ROE}					0.76		0.29		-0.06
					[11.2]		[3.55]		[-0.81]
$\beta_{\text{E/B}}$		0.84	0.84	0.86					
		[34.9]	[31.3]	[29.6]					
β_{PEAD}	1.07	0.76	0.78	0.76		1.41	1.14		
	[18.2]	[23.6]	[23.7]	[23.3]		[14.7]	[9.33]		
$\beta_{\Delta\text{ROE}}$								1.30	1.35
								[20.3]	[15.1]
adj.-R^2 (%)	40.9	83.4	83.7	83.6	22.2	32.5	34.2	47.4	47.4

Specifications six through nine shows that ROE's power pricing momentum comes from the fundamental momentum in ROE. Specifications six shows that the model that replaces the ROE factor with the PEAD factor also prices UMD, and explains one and a half times as much of UMD's return variation, 32.5% versus 22.2%. Specification seven shows that including the PEAD factor in addition to the ROE factor reduces the loading on ROE from 0.76 to 0.29, a 62% reduction. The addition of ROE to the model that already includes PEAD also does little to increase the UMD return variation explained by the model.

Specifications eight and nine show even stronger results using the alternative fundamental momentum factor, ΔROE. Specification eight shows that replacing the ROE factor in the HXZ model with the ΔROE factor more than doubles the UMD return variation explained by the model, 47.4% versus 22.2%. Specification nine shows that ΔROE completely subsumes the role played by ROE pricing the momentum strategy, reducing the loading on ROE from a highly significant 0.76 to an insignificant -0.06, while the addition of the ROE factor does nothing to improve the explanatory power of the model that already includes ΔROE.

4. What about profitability?

HXZ also claim that ROE subsumes Novy-Marx's (2013) gross profitability. It only does so, again, by conflating earnings profitability with fundamental momentum. Strategies based on gross profitability load on ROE because they are correlated with the low frequency, low premia part of the factor. The factor prices the strategies because it carries a large premia driven by the orthogonal, earnings innovations component. In effect the ROE factor prices gross profitability by adjusting the returns downward to account for gross profitability's supposedly large exposure to post earnings announcement drift, despite the fact that gross profitability has none. Table 5 shows that the disentangled factors, lag-ROE and ΔROE, which do not conflate the two distinct effects, cannot price gross profitability.

Table 5
Pricing gross profitability with the conflated factor
This table presents results of time-series regressions of the form:

$$\text{PMU}_t \quad = \quad \alpha + \boldsymbol{\beta}'\mathbf{X}_t + \varepsilon_t,$$

where PMU_t is the monthly excess returns to the profitable-minus-unprofitable factor, constructed using the same methodology used to form the Fama and French HML factor, but on the basis of gross profitability (revenues minus cost of goods sold, scaled by assets) instead of book-to-market. The explanatory factors are the returns to various combinations of the Fama and French factors (MKT, SMB, and HML), an asset growth factor (AG), and the ROE, lag-ROE, and ΔROE factors. PMU excludes financial firms (those with one digit SIC codes of 6; results including financials provided in the appendix). The sample covers July 1973 through December 2013, with the start date determined by the availability of quarterly Compustat data.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
α	0.28	0.40	0.10	0.17	0.12	0.22	0.30
	[2.62]	[3.84]	[0.99]	[1.60]	[1.21]	[2.19]	[3.24]
β_{MKT}		-0.02		-0.01	0.01	0.01	0.01
		[-1.02]		[-0.24]	[0.25]	[0.54]	[0.56]
β_{SMB}		-0.02		0.14	0.10	0.18	0.15
		[-0.72]		[3.96]	[2.99]	[5.59]	[4.99]
β_{HML}		-0.27			-0.23		-0.31
		[-7.40]			[-6.91]		[-9.83]
β_{AG}				-0.34		-0.30	
				[-6.15]		[-5.57]	
β_{ROE}			0.27	0.30	0.33		
			[8.11]	[8.38]	[9.32]		
$\beta_{\text{lag-ROE}}$						0.50	0.60
						[11.5]	[15.0]
$\beta_{\Delta\text{ROE}}$						0.11	0.02
						[2.76]	[0.51]
adj.-R^2		9.92	11.8	22.1	23.6	30.5	38.4

The first specification of the table shows the average monthly excess returns to a profitable-minus-unprofitable factor, PMU, constructed using the same methodology used to form the Fama and French HML factor, but on the basis of gross profitability (revenues minus cost of goods sold, scaled by assets) instead of book-to-market.[5] PMU generates

[5] Gross profits-to-assets tends to be low for financial firms (those with one-digit SIC codes of 6), because of their high levels of financial assets, so I exclude financials when constructing PMU, but results are even stronger retaining financials (Table A2, in the Appendix). The PMU factor holds positions for an average of almost five years, even longer than HML, and has estimated transaction costs of 4 bps/month, an order of magnitude lower than those estimated for ROE.

significant excess returns over the sample (28 bps/month with a test-statistic of 2.62). Specification two shows an even larger, more significant, three-factor alpha (40 bps/month with a test-statistic of 3.84). Specifications three through five show that the returns to PMU are not significant after controlling for the ROE factor, alone, or in conjunction with the Fama and French factors, or with the other factors employed by HXZ. Also, while the PMU factor's returns are insignificant relative to the HXZ model, the model only explains about a third of the PMU factor's average returns.

The last two specifications show that the models lose their power to price PMU when the ROE factor is decomposed into the factors based on lagged earnings-to-price and earnings innovations-to-price (lag-ROE and ΔROE). PMU loads heavily on the low return lag-ROE factor, but not on the high return ΔROE. As a result PMU has a significant abnormal return relative to models that employ the disentangled ROE factors, and consequently do not incorrectly attribute gross profitability's performance to post earnings announcement drift. The appendix shows similar results for models that employ the ROE factor in conjunction with either or both of the disentangled factors (Table A3).

5. Conclusion

Hou, Xue, and Zhang's (2014) alternative factor model prices momentum with fundamental momentum, not with profitability. Their ROE factor does covary with firms that have consistently high earnings profitability, but covaries almost as strongly with firms that have experienced recent positive earnings surprises. This large exposure to earnings surprises is crucial for all of the HXZ results. The ROE factor's high average returns are driven by post earnings announcement drift, and a PEAD factor both prices the ROE factor and subsumes all of its power pricing momentum.

The ROE factor also only explains gross profitability by conflating persistent, low frequency, economic profitability with the high frequency, transitory impact of earnings surprises. Strategies based on gross profitability load on the ROE factor because of the former, and these loadings only explain the strategies performance because of the ROE factor's high average returns, which are driven by the latter. The HXZ model thus essentially explains the high average returns to strategies based on gross profitability by counter-factually attributing the strategies' high returns to post earnings announcement drift. Controlling for PEAD, the ROE factor loses its power to price gross profitability. The ROE factor's conflation of earnings profitability and PEAD also leads it to significantly misprice strategies based on lagged- or low-frequency earnings profitability. These strategies do not generate high average returns, but covary strongly with the ROE factor, so have highly significant negative alphas relative to the HXZ model.

These facts are inconsistent with Hou, Xue, and Zhang's (2014) q-theoretic interpretation of their factors. Investment based asset pricing provides strong motivation for including profitability and investment factors into an empirical asset pricing model, but not for the HXZ model. The ROE factor is a fundamental momentum factor, not a profitability factor, and outside the scope of the motivating theory.

Appendix: Additional tables

Table A1
Double sorts on lagged earnings-to-book and earnings innovations-to-book, underlying portfolios

Most recent quarterly return-on-equity can be decomposed into changes to income-to-book equity and lagged income-to-book equity:

$$ROE \equiv \frac{IBQ}{BEQ_{-1}} = \frac{IBQ_{-4}}{BEQ_{-1}} + \frac{IBQ - IBQ_{-4}}{BEQ_{-1}} \equiv \text{lagged-}E/B + \Delta E/B,$$

where IBQ and BEQ are quarterly income before extraordinary items and quarterly book equity, respectively, and subscripts denote quarterly lags. The table shows the performance (average monthly excess returns, and alphas relative to the Fama and French three-factor model, and alphas relative to the four-factor model that includes UMD), of the 25 portfolios independently double quintile sorted on the basis of lagged-E/B and $\Delta E/B$, using NYSE breaks. Portfolios are rebalanced monthly, and returns are value-weighted. The table also provides the time-series average of the portfolio quarterly earnings-to-book (IBQ/ATQ$_{-1}$). The sample covers July 1973 through December 2013, with the start date determined by the availability of quarterly Compustat data.

ΔROE	Lagged-ROE quintile					Lagged-ROE quintile				
quintile	1	2	3	4	5	1	2	3	4	5
Panel A: Average excess returns (%/month)						Panel A2: Excess return t-stats				
1	0.19	0.11	0.31	0.32	0.33	0.51	0.37	1.07	1.15	1.31
2	0.27	0.40	0.39	0.58	0.50	0.95	1.72	1.76	2.57	2.22
3	0.79	0.58	0.65	0.56	0.46	2.88	2.72	3.22	2.50	2.14
4	0.71	0.71	0.60	0.64	0.65	2.58	3.03	2.66	2.78	2.92
5	0.89	0.93	0.69	1.14	0.82	3.26	3.40	2.47	4.16	3.34
Panel B: Three-factor alphas (%/month)						Panel B2: Three-factor alpha t-stats				
1	-0.78	-0.83	-0.54	-0.52	-0.35	-4.29	-4.83	-3.25	-3.77	-3.05
2	-0.51	-0.33	-0.34	-0.14	-0.03	-3.60	-2.98	-3.33	-1.38	-0.21
3	0.04	-0.03	0.08	0.01	0.02	0.23	-0.36	0.97	0.08	0.19
4	0.01	0.13	0.03	0.11	0.28	0.07	1.27	0.27	1.20	2.78
5	0.15	0.32	0.14	0.63	0.41	1.36	2.47	0.95	4.88	3.45
Panel C: Four-factor alphas (%/month)						Panel C2: Four-factor alpha t-stats				
1	-0.52	-0.59	-0.20	-0.24	-0.16	-2.98	-3.56	-1.33	-1.92	-1.46
2	-0.34	-0.15	-0.24	-0.07	0.04	-2.47	-1.41	-2.37	-0.67	0.30
3	0.16	-0.01	0.07	0.05	0.05	1.02	-0.06	0.83	0.61	0.48
4	-0.03	0.12	-0.03	0.04	0.22	-0.25	1.16	-0.36	0.42	2.11
5	0.11	0.18	-0.07	0.56	0.28	0.98	1.38	-0.48	4.32	2.40
Panel D: Portfolio ROE (IBQ/ATQ$_{-1}$, %)										
1	-9.89	-2.52	-0.89	-0.04	1.40					
2	-1.08	1.19	2.15	3.15	5.16					
3	0.23	1.92	2.87	3.93	5.76					
4	0.89	2.56	3.58	4.59	6.84					
5	2.38	4.57	5.56	6.68	10.2					

Table A2
Pricing gross profitability with the conflated factor, financials included

This table presents results of time-series regressions of the form:

$$\mathrm{PMU}_t = \alpha + \boldsymbol{\beta}'\mathbf{X}_t + \varepsilon_t,$$

where PMU_t is the monthly excess returns to the profitable-minus-unprofitable factor, constructed using the same methodology used to form the Fama and French HML factor, but on the basis of firms ranking (percentile) on gross profitability (revenues minus cost of goods sold, scaled by assets) instead of book-to-market. Because financial firms (those with one digit SIC codes of 6) tend to have large asset bases the gross-profits-to-assets ratio tends to be low for financials, financials and non-financials are ranked on gross profitability separately. The explanatory factors are the returns to various combinations of the Fama and French factors (MKT, SMB, and HML), an asset growth factor (AG), and the ROE, lag-ROE, and ΔROE factors. The sample covers July 1973 through December 2013, with the start date determined by the availability of quarterly Compustat data.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
α	0.28	0.43	0.15	0.24	0.21	0.26	0.35
	[2.81]	[4.75]	[1.51]	[2.57]	[2.38]	[2.78]	[4.18]
β_{MKT}		-0.04		-0.03	-0.02	-0.02	-0.01
		[-2.07]		[-1.22]	[-1.00]	[-0.84]	[-0.84]
β_{SMB}		0.02		0.16	0.12	0.19	0.16
		[0.56]		[5.24]	[3.82]	[6.21]	[5.61]
β_{HML}		-0.35			-0.32		-0.38
		[-11.2]			[-10.9]		[-13.5]
β_{AG}				-0.42		-0.38	
				[-8.29]		[-7.76]	
β_{ROE}			0.20	0.23	0.25		
			[6.30]	[6.99]	[8.26]		
$\beta_{\text{lag-ROE}}$						0.34	0.47
						[8.37]	[13.0]
$\beta_{\Delta\text{ROE}}$						0.12	0.02
						[3.35]	[0.48]
adj.-R^2		21.3	7.38	24.5	30.9	28.6	41.6

Table A3

Pricing gross profitability with ROE and the decomposed ROE factors lag-ROE and ΔROE.

This table presents results of time-series regressions of the form:

$$\text{PMU}_t = \alpha + \boldsymbol{\beta}'\mathbf{X}_t + \varepsilon_t,$$

where PMU_t is the monthly excess returns to the profitable-minus-unprofitable factor, constructed using the same methodology used to form the Fama and French HML factor, but on the basis of gross profitability (revenues minus cost of goods sold, scaled by assets) instead of book-to-market. The explanatory factors are the returns to various combinations of the Fama and French factors (MKT, SMB, and HML), an asset growth factor (AG), and the ROE, lag-ROE, and ΔROE factors. PMU excludes financial firms (those with one digit SIC codes of 6; results including financials provided in the appendix). The sample covers July 1973 through December 2013, with the start date determined by the availability of quarterly Compustat data.

	(1)	(2)	(3)	(4)	(5)	(6)
α	0.24	0.31	0.24	0.30	0.22	0.30
	[2.44]	[3.32]	[2.32]	[3.11]	[2.22]	[3.24]
β_{MKT}	0.02	0.01	0.02	0.03	0.01	0.01
	[0.73]	[0.59]	[0.79]	[1.34]	[0.35]	[0.52]
β_{SMB}	0.19	0.16	0.18	0.15	0.18	0.15
	[5.60]	[4.95]	[5.08]	[4.62]	[5.32]	[4.88]
β_{HML}		-0.31		-0.32		-0.31
		[-10.1]		[-9.66]		[-9.74]
β_{AG}	-0.30		-0.34		-0.29	
	[-5.76]		[-6.23]		[-5.51]	
β_{ROE}	0.09	0.02	0.47	0.59	-0.10	-0.02
	[2.12]	[0.40]	[9.56]	[12.8]	[-0.92]	[-0.15]
$\beta_{\text{lag-ROE}}$	0.42	0.59			0.58	0.62
	[7.48]	[10.8]			[5.93]	[6.72]
$\beta_{\Delta\text{ROE}}$			-0.27	-0.45	0.19	0.03
			[-4.84]	[-8.12]	[1.98]	[0.36]
adj.-R^2	30.1	38.4	25.6	32.6	30.5	38.3

References

[1] Chan, Louis, Narasimhan Jegadeesh, and Josef Lakonishok. 1996. "Momentum Strategies." Journal of Finance 51, pp. 1681–1713.

[2] Fama, Eugene F., and Kenneth R. French. 1993. "Common risk factors in the returns of stocks and bonds." Journal of Finance, pp. 3–56.

[3] Fama, Eugene F., and Kenneth R. French. 2008. "Dissecting anomalies." Journal of Finance, pp. 1653–1678.

[4] Fama, Eugene F., and Kenneth R. French. 2014. "A five-factor asset pricing model." Working paper.

[5] Hou, Kewei, Chen Xue, and Lu Zhang. 2014. "Digesting anomalies: An investment approach." Review of Financial Studies, forthcoming.

[6] Hou, Kewei, Chen Xue, and Lu Zhang. 2014. "A comparison of new factor models." NBER Working Paper 20682.

[7] Novy-Marx, Robert. 2013. "The other side of value: The gross profitability premium." Journal of Financial Economics 108, pp. 1–28.

[8] Novy-Marx, Robert. 2014. "Fundamentally, momentum is fundamental momentum." Working paper.

[9] Novy-Marx, Robert, and Mihail Velikov. 2014. "A taxonomy of anomalies and their trading costs." NBER working paper 20721.