What Drives Anomaly Returns?

Lars A. Lochstoer and Paul C. Tetlock

UCLA and Columbia

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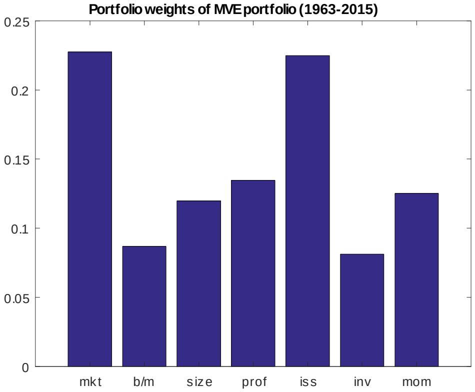
New factors contradict classic asset pricing theories

E.g.: value, size, profitability, issuance, investment, momentum

- Long-short portfolios: nearly market neutral, yet volatile ($> 10\%$ p.a.)
- In-sample Mean-Variance Efficient (MVE) portfolio:



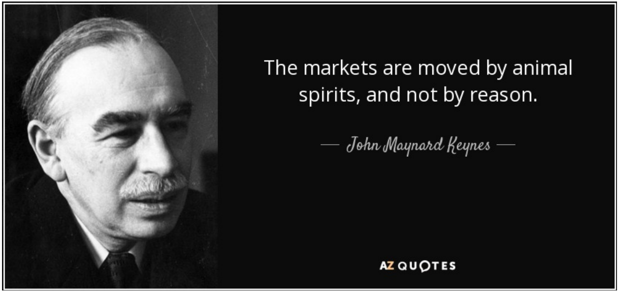
MVE Sharpe ratio: 1.25; Market beta of MVE portfolio: 0.3; R^2 of MVE on Mkt is 9%

What Drives Portfolio Returns?

Empirical fact: Returns driven mainly by price changes (i.e., P_{t+1}/P_t):

$$R_{t+1} = \frac{D_{t+1}}{P_t} + \frac{P_{t+1}}{P_t}$$

- Price depends on expected **cash flows** and **discount rates**
  - Recall the present value formula



Previous Research

Market-level returns: mostly discount rates

- Animal spirits or time-varying risk tolerance
  - Cochrane (1994): All variation in market P/D ratio due to time-varying discount rates

Stock-level returns: mostly cash flows

- Most variation in M/B ratios can be traced to fundamental cash flows (ROE)
  - Vuolteenaho (2002), Cohen, Polk, and Vuolteenaho (2003)

Our Paper

1. **Variation in returns to MVE and anomaly portfolios driven mainly by expected cash flows (i.e., fundamentals)**
    - Inconsistent with pure noise trader, sentiment, or preference shock story

2. **CF and DR news strongly negatively correlated**
    - Consistent with theories emphasizing errors in beliefs or changes in risk that are driven by firm-level cash flow shocks

3. **Anomaly CF and DR only weakly correlated with market CF and DR. Overall, little commonality in CF or DR news across different anomalies**
    - Inconsistent with 'cash flow beta' story (ICAPM)
    - Inconsistent with time-varying aggregate arbitrage capital story
    - Evidence points to anomaly-specific CF and DR news

Approach

Estimate *firm-level* panel Vector Autoregression

- Impose firm-level present value relation
- Focus on discount rate (DR) and cash flow (CF) shocks and return variance decompositions
- Aggregate firms' shocks to portfolio shocks using accurate approximation

Data

Annual data from 1962 through 2015

- Sources: Compustat, CRSP, and Davis, Fama, and French

Log real stock returns, B/M ratios, and clean-surplus ROE

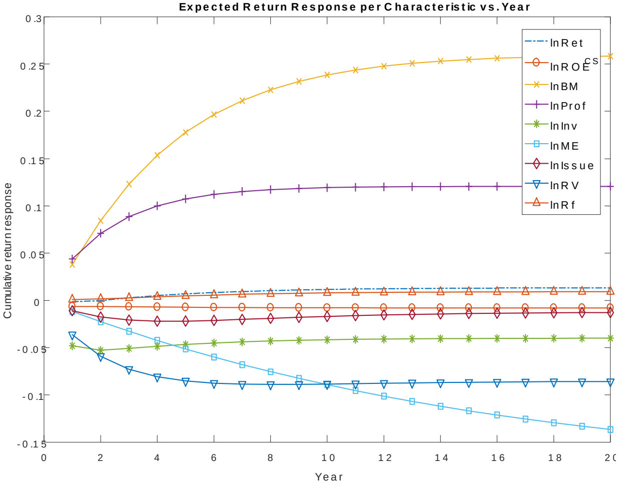
- Drop bottom NYSE size quintile ($\sim$2% of total mkt cap in 2010)

Other characteristics forecasting returns and earnings

- *Firm-specific*: returns, earnings, B/M, ME/GDP, profitability, investment, issuance, realized variance
- *Aggregate*: real risk-free rate
  - Aggregate B/M, profitability + industry variables only in robustness checks

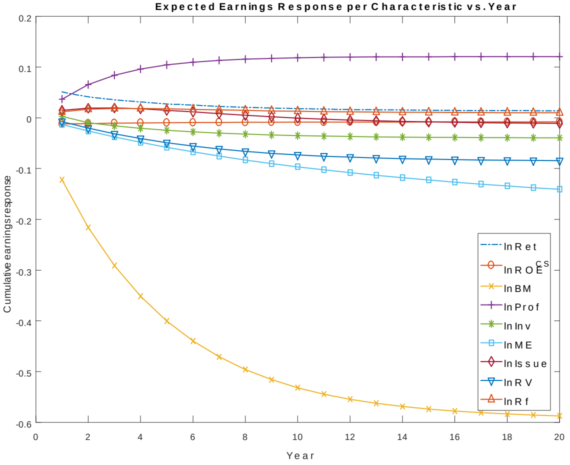
Expected Return at Different Horizons

- Firm-level effect of one standard deviation increase in characteristic
  - $\sum_{j=1}^{\tau} \kappa^{j-1} E_t \left[\tilde{r}_{t+j} \middle| char_{k,t} = +1 \text{ st.dev.}\right]$



Expected Earnings at Different Horizons

- Firm-level effect of one standard deviation increase in characteristic
  - $\sum_{j=1}^{\tau} \kappa^{j-1} E_t \left[\widetilde{roe}_{t+j} | char_{k,t} = +1 \text{ st.dev.} \right]$



Hypotheses about Anomaly Return Variance

Prediction from theories of pure sentiment shocks (e.g., DSSW 1990):

1. DR variation is a key component in return variance

Prediction from theories of pure cash flow shocks (e.g., simple CAPM):

2. CF variation is a key component in return variance

Predictions from countercyclical risk aversion, countercyclical firm risk, or overreaction to CF:

3. CF has a negative impact on DR, amplifying return variance

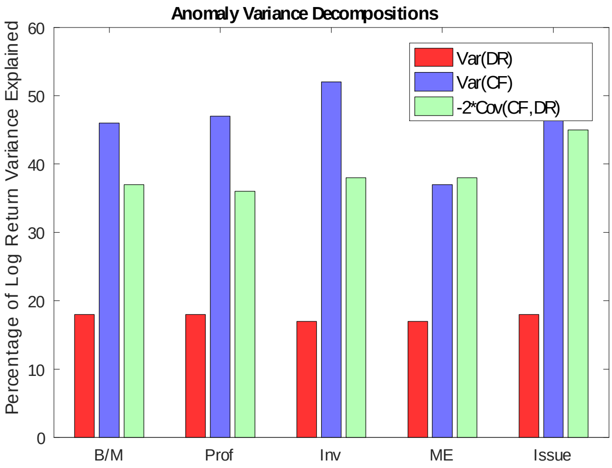
Prediction from underreaction to CF:

4. CF has a positive impact on DR, reducing return variance

Prediction from time-varying aggregate arbitrage capital:

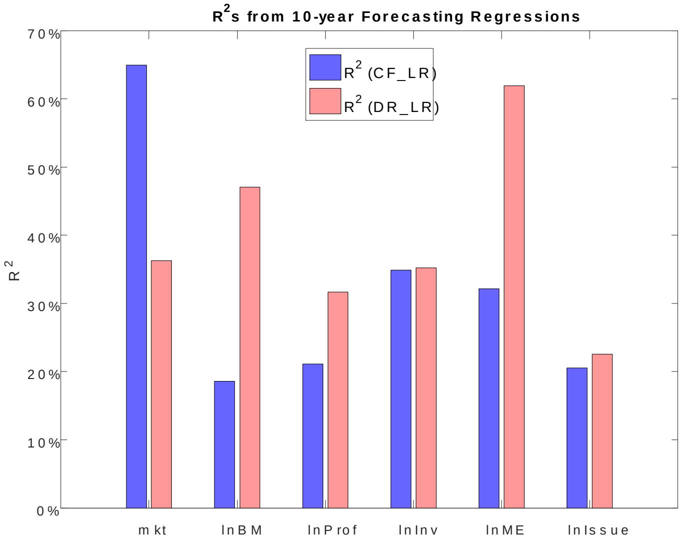
5. DR shocks correlated across anomaly returns

Anomaly Variance Decompositions



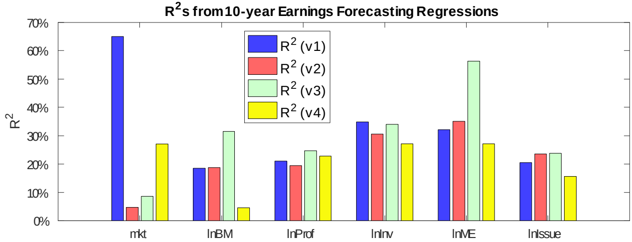
	B/M	Prof	Inv	ME	Issue
$Corr\,(DR, CF)$	-0.66^{**}	-0.62^{**}	-0.64^{**}	-0.78^{**}	-0.77^{**}
$Corr\,(Pred, Act)$	0.97^{**}	0.88^{**}	0.96^{**}	0.94^{**}	0.96^{**}

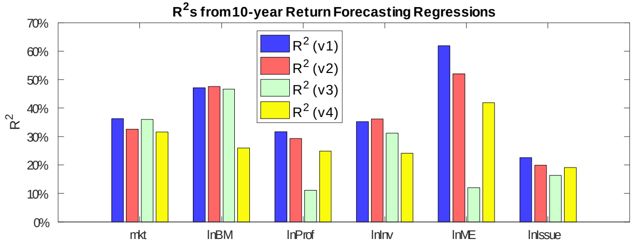
Predictive Power of CF and DR Components



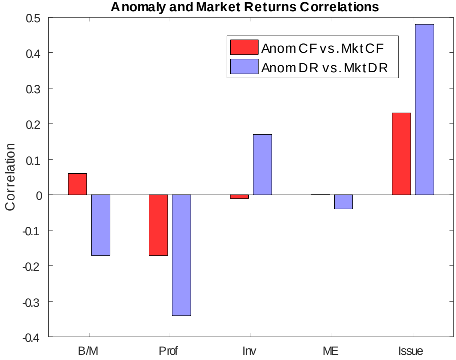
Predictive Power: Robustness

- (v1): panel VAR; (v2): add market b/m to v1; (v3): add interactions to v2; (v4): add industry b/m and prof to v1





Anomaly vs. Market CF and DR Correlations



- Low correlation between anomaly CF shocks and market CF shocks
  - I.e. little support for duration and bad-beta theories ($R^2_{adj} = -1.2\%$)
- Low correlation between anomaly DR shocks and market DR shocks
  - I.e. little support for common risk aversion, discount rate shocks ($R^2_{adj} = 19\%$)

Correlations Among Anomalies

Key findings

- Anomaly CF correlations are similar to anomaly DR correlations
- Most significant correlations are due to firm overlap (e.g., value vs. investment)
  - Most other correlations are economically small
- Low DR commonality broadly inconsistent with shocks to arb capital
  - Caveat: Excluding profitability DR would help this theory

Implications for Asset Allocation

Anomaly returns are to a large extent driven by future cash flows: fundamentals

- Indicates systematic differences in cash flow exposures of, say, high and low profitability firms
- Suggests analysis of such cash flow exposures/dynamics a fruitful way to form expectations of anomaly returns

Hard to time anomaly returns; easier to time *long-run* market returns

- Implies time-varying exposure to market risk in MVE portfolio
  - E.g., low market weight when market valuations are high
- Rebalance anomaly weights in MVE to maintain constant exposure (Merton, 1969)

Conclusion

We provide novel evidence on anomalies

- CF variation is the primary driver of anomaly returns
- DR amplifies CF variation
- Low commonality in anomaly and market return components

Arbitrageurs exploiting anomalies are exposed to distinct fundamental risks arising from firms' cash flows

Most consistent with theories in which firm-level CFs drive investor overreaction or changes in risk

- Future research: use data on expectations and betas to disentangle these theories

Appendix

Details for Slide 2 (MVE portfolio)

Long-short anomaly portfolios are long decile 10 and short decile 1, or short decile 10 and long decile 1

- Which direction is chosen based on the direction of the anomaly
  - For instance, for b/m sorts we go long decile 10 and short decile 1 since average returns increasing in b/m
  - For issuance, we go long decile 1 and short decile 10 since average returns decreasing in issuance

The portfolio weights of the MVE portfolio add up to one in the bar plot simply as it yields familiar portfolio weight numbers

- The underlying portfolios are all zero-investment portfolios, so portfolio weights can sum to anything depending on amount of leverage chosen

For the market beta of the MVE portfolio, we chose leverage so as to match the volatility of MVE returns to be the same as the volatility of the market returns (15.4% p.a.).

The sample is July 1963 through December 2015, monthly data

The Firm-Level Model

Ohlson (1995) and Vuolteenaho (2002) log-linear approximation of present value equation:

$$\begin{aligned} bm_{i,t} &= E_t \sum_{j=1}^{\infty} \kappa^{j-1} r_{i,t+j} - E_t \sum_{j=1}^{\infty} \kappa^{j-1} e_{i,t+j} \\ &= DR_{i,t}^{bm} - CF_{i,t}^{bm}, \end{aligned}$$

- The log book-to-market ratio has a discount rate and cash flow component
- Comes from

$$r_{i,t+1} \approx e_{i,t+1} - \kappa bm_{i,t+1} + bm_{i,t}$$

where $e_{i,t} \equiv \ln\left(1 + ROE_{i.t}\right)$

$ROE_{i,t} = E_{i,t} / BE_{i,t-1}$ (earnings over lagged book equity)

Assumes clean-surplus accounting:

$$D_{i,t} = E_{i,t} - \Delta BE_{i,t}$$

Present-Value Relation

Solving for book-to-market:

$$\begin{aligned} bm_{i,t} &= E_t \sum_{j=1}^{\infty} \kappa^{j-1} r_{i,t+j} - E_t \sum_{j=1}^{\infty} \kappa^{j-1} e_{i,t+j} \\ &= DR_{i,t}^{bm} - CF_{i,t}^{bm}, \end{aligned}$$

where $DR_{i,t}^{bm}$ and $CF_{i,t}^{bm}$ are the components of firm valuation

Components of unexpected returns:

$$\begin{aligned} r_{i,t+1} - E_t\left[r_{i,t+1}\right] &= \left(E_{t+1} - E_t\right) \sum_{j=1}^{\infty} \kappa^{j-1} e_{i,t+j} - \left(E_{t+1} - E_t\right) \sum_{j=2}^{\infty} \kappa^{j-1} r_{i,t+j} \\ &= CF_{i,t+1} - DR_{i,t+1} \end{aligned}$$

- Same return decomposition as in Campbell (1991)

Implementation

Panel VAR as in Vuolteenaho (2002)

- Add predictors of anomaly expected returns and cash flows

Use clean-surplus (CS) earnings from the present-value restriction ($\kappa = 0.96$):

$$e^{CS}_{i,t+1} \equiv r_{i,t+1} + \kappa bm_{i,t+1} - bm_{i,t}$$

Characteristics in the VAR should predict

- For returns: $\beta'_{it}\lambda_t$, $E^{subj}_t[e_{i,t+1}] - E^{obj}_t[e_{i,t+1}]$, σ^2_{it}, r_{ft}
- For earnings: short-run and long-run components of expected ROE

VAR Specification

The dynamics of demeaned firm and aggregate characteristics, z_{it}, satisfy:

$$z_{i,t} = Az_{i,t-1} + \Sigma\varepsilon_{i,t}$$

Elements of $z_{i,t}$

- Firm-specific: returns, earnings, B/M, ME/GDP, profitability, investment, issuance, realized variance
- Aggregate: real risk-free rate
- Present-value relation imposed via CS earnings
  - Stochastic singularity arises: one row of A is implied by the others

Alternative Modeling Strategy

Following Campbell (1991), extract CF shock as the residual from the VAR

- Let

$$z_{i,t+1} = \begin{bmatrix} r_{i,t+1} \\ x_{i,t+1} \end{bmatrix}$$

  follow panel VAR(1), where $x_{i,t+1}$ consists of predictors of returns

- Compute the DR component in the usual way, but let CF be

$$CF_{it+1} = r_{i,t+1} - E_t r_{i,t+1} + DR_{i,t+1}$$

- Thus, we do not need cash flows (e.g., roe or divs) in the VAR
  - We find very similar results

Bankruptcy

Log-linear model requires positive valuation multiples

- Bankruptcy results in a zero book value
- We create pseudo-firms to solve this issue
  - Portfolio with 1% invested in risk-free asset, 99% in firm
  - Total position value (stock + risk-free) is always greater than zero
  - Strategy return is -99% if firm return is -100%

VAR: Return and Earnings Forecasting Coefficients

	lnRet	lnROE^{CS}	lnBM
Lag lnRet	-0.003	0.118^{**}	0.126^{*}
	(0.056)	(0.014)	(0.055)
Lag lnROE^{CS}	-0.021	-0.039^{*}	-0.019
	(0.029)	(0.016)	(0.024)
Lag lnBM	0.045^{**}	-0.143^{**}	0.846^{**}
	(0.015)	(0.010)	(0.019)
Lag lnProf	0.043^{**}	0.037^{**}	-0.007
	(0.014)	(0.009)	(0.020)
Lag lnInv	-0.048^{**}	0.003	0.053^{**}
	(0.012)	(0.005)	(0.010)
Lag lnME	-0.012	-0.013^{**}	-0.001
	(0.012)	(0.004)	(0.011)
Lag lnIssue	-0.011^{+}	0.014^{**}	0.027^{**}
	(0.007)	(0.003)	(0.006)
Lag lnRV	-0.036	-0.007	0.030
	(0.025)	(0.007)	(0.021)
Lag lnRf	0.000	0.012	0.011
	(0.029)	(0.009)	(0.024)
R^2	0.046	0.243	0.675
N	53,737	53,737	53,737

Firm-Level Variance Decomposition

	$var(DR)$	$var(CF)$	$-2cov(DR, CF)$	$Corr(DR, CF)$
Panel A:				
Fraction of $var(\ln BM)$	0.190^{+}	0.473^{**}	0.338^{**}	-0.564^{+}
	(0.110)	(0.068)	(0.094)	(0.295)
Panel B:				
Fraction of $var(r)$	0.209^{+}	0.522^{**}	0.270^{**}	-0.409^{*}
	(0.117)	(0.111)	(0.064)	(0.160)

Aggregating Firm-Level to Portfolio-Level

Firm-level return decomposition is for log returns

- Portfolio log returns don't equal value-weighted firm log returns

Approximate firms' gross returns using a second-order expansion

- Very accurate in practice

$$
\begin{aligned}
R_{i,t+1} &= \exp\left(E_t r_{i,t+1}\right)\exp\left(CF_{i,t+1} - DR_{i,t+1}\right) \\
&\approx \exp\left(E_t r_{i,t+1}\right)\left\{ \begin{array}{c} 1 + CF_{i,t+1} + \frac{1}{2}CF_{i,t+1}^2 \\ -DR_{i,t+1} + \frac{1}{2}DR_{i,t+1}^2 + CF_{i,t+1}DR_{i,t+1} \end{array} \right\}
\end{aligned}
$$

Aggregating Firm-Level to Portfolio-Level

Apply portfolio weights, $\omega_{i,t}^{P}$, to firms' approximate gross (level) returns:

$$
\begin{aligned}
CF_{p,t+1}^{level} &= \sum_{i=1}^{n} \omega_{i,t}^{p} \exp\left(E_t r_{i,t+1}\right) \left\{ CF_{i,t+1} + \frac{1}{2} CF_{i,t+1}^{2} \right\}, \\
DR_{p,t+1}^{level} &= \sum_{i=1}^{n} \omega_{i,t}^{p} \exp\left(E_t r_{i,t+1}\right) \left\{ DR_{i,t+1} - \frac{1}{2} DR_{i,t+1}^{2} \right\}, \\
CFDR_{p,t+1}^{cross} &= \sum_{i=1}^{n} \omega_{i,t}^{p} \exp\left(E_t r_{i,t+1}\right) CF_{i,t+1} DR_{i,t+1}.
\end{aligned}
$$

Portfolio return decomposition

$$
R_{p,t+1} - \sum_{i=1}^{n} \omega_{i,t}^{p} \exp\left(E_t r_{i,t+1}\right) \approx CF_{p,t+1}^{level} - DR_{p,t+1}^{level} + CFDR_{p,t+1}^{cross}
$$

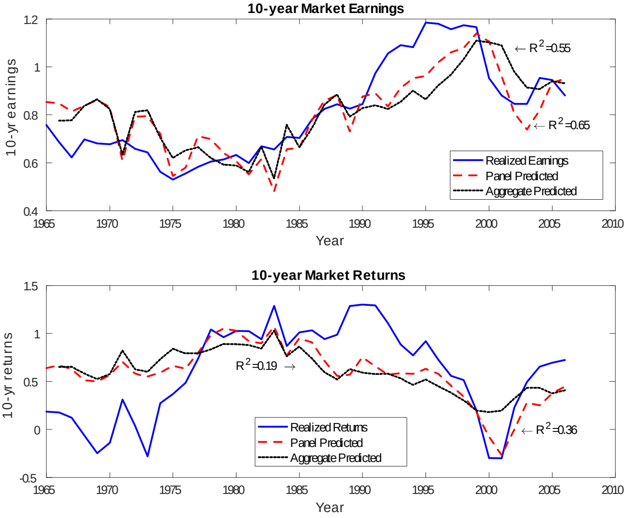
Market Variance Decompositions

	$var(DR)$	$var(CF)$	$var(Cross)$	-2$cov(DR, CF)$	$Corr(DR, CF)$	$Corr(Pred, Act)$
Panel A: Panel VAR						
Fraction of $var(R_m)$	0.183	0.632**	0.009*	0.219	−0.322	0.986**
	(0.128)	(0.176)	(0.004)	(0.237)	(0.466)	(0.001)
Panel B: Market VAR						
Fraction of $var(R_m)$	0.281	0.248		0.471**	−0.892**	
	(0.226)	(0.181)		(0.052)	(0.148)	

- Market VAR is a standard market-level VAR with market returns, earnings, and book-to-market ratio

Predicting Market Earnings and Returns

- Panel VAR outperforms Market VAR



Out-of-sample specification tests

Estimate VAR using data until 1990. Then roll forward, predict 1- and 10-year market returns and earnings

- (v1): panel VAR; (v2): add market b/m to v1; (v3): add interactions to v2; (v4): add industry b/m and prof to v1

	Mean Squared Prediction Error			
	1-year forecasts		10-year forecasts	
	Earnings	Returns	Earnings	Returns
Aggregate VAR	**0.0040**	0.037	1.541	1.209
Panel VAR v1	0.0046	**0.033**	**0.085**	**0.439**
Panel VAR v2	0.0052	0.043	1.639	2.152
Panel VAR v3	0.0059	0.036	684.069	813.918
Panel VAR v4	0.0045	0.037	1.268	2.350

Anomaly CF Shock Correlations

Panel A: Cash Flow Shocks	1	2	3	4
Book-to-market (1)	1.00			
Profitability (2)	-0.29^{**}	1.00		
	(0.03)			
- Investment (3)	0.66^{**}	-0.25^{**}	1.00	
	(0.03)	(0.03)		
- Size (4)	0.18^{+}	-0.25^{**}	0.25^{**}	1.00
	(0.11)	(0.05)	(0.06)	
- Issuance (5)	0.27^{**}	0.40^{**}	0.52^{**}	-0.14^{**}
	(0.03)	(0.03)	(0.03)	(0.03)

Anomaly DR Shock Correlations

Panel B: Discount Rate Shocks	1	2	3	4
Book-to-market (1)	1.00			
Profitability (2)	−0.30**	1.00		
	(0.06)			
- Investment (3)	0.62**	−0.20*	1.00	
	(0.04)	(0.08)		
- Size (4)	0.34**	−0.27**	0.07	1.00
	(0.02)	(0.04)	(0.10)	
- Issuance (5)	0.25**	0.50**	0.52**	−0.24**
	(0.06)	(0.04)	(0.04)	(0.06)