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DISSECTING CHARACTERISTICS NONPARAMETRICALLY

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Preliminaries

- Nonparametric model:
- Models not have a parametric expression
 - e.g., k-nearest-neighbor
- **Models with a parametric expression, but the number of (effective) parameters are up to change**
 - e.g., lasso

Information v.s. incremental information

- “Informative”: the character is not independent with the return
 - Could be evaluated via port sort
- “incrementally informative”: the character offers a unique aspect of information for the return, which could not be replaced by other parameters.
 - Could be evaluated via additive models
 - We need incremental information from selected characters, since we include multiple characters into the prediction model

Expectation for the model

- Model the incremental information for each character

- Additive

$$\frac{\partial^2 m_t(c_1, \dots, c_S)}{\partial c_s \partial c_{s'}} = 0 \qquad m_t(c_1, \dots, c_S) = \sum_{s=1}^S m_{ts}(c_s),$$

- Interpretable: linear is not always the best choice.

- Perform well out-of-sample

- flexible

Both requirements point to nonlinearity

Group Lasso

$$\tilde{\beta}_t = \arg \min_{b_{sk}: s=1, \dots, S; k=1, \dots, L+2} \sum_{i=1}^N \left(R_{it} - \sum_{s=1}^S \sum_{k=1}^{L+2} b_{sk} p_k(\tilde{C}_{s,it-1}) \right)^2 + \lambda_1 \sum_{s=1}^S \left(\sum_{k=1}^{L+2} b_{sk}^2 \right)^{\frac{1}{2}}, \quad (5)$$

$p_k(\cdot)$: spline function series

$(\sum_{k=1}^{L+2} b_{sk}^2)^{1/2}$: group lasso as a result of nonlinearity

$\tilde{C}_{s,it-1}$: rank transformed character

Group lasso

- Two-step optimization

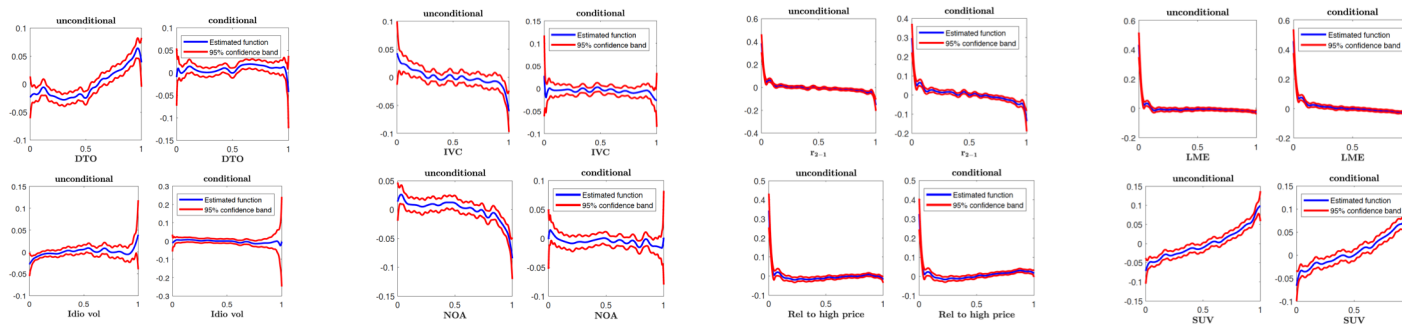
$$\check{\beta}_t = \arg \min_{b_{sk}: s=1, \dots, S; k=1, \dots, L+2} \sum_{i=1}^N \left(R_{it} - \sum_{s=1}^S \sum_{k=1}^{L+2} b_{sk} p_k(\tilde{C}_{s,it-1}) \right)^2 + \lambda_2 \sum_{s=1}^S \left(w_{ts} \sum_{k=1}^{L+2} b_{sk}^2 \right)^{\frac{1}{2}}. \quad (\text{A.7})$$

$$w_{ts} = \begin{cases} \left(\sum_{k=1}^{L+2} \tilde{\beta}_{sk}^2 \right)^{-\frac{1}{2}} & \text{if } \sum_{k=1}^{L+2} \tilde{\beta}_{sk}^2 \neq 0 \\ \infty & \text{if } \sum_{k=1}^{L+2} \tilde{\beta}_{sk}^2 = 0. \end{cases}$$

- Further panelizes unchosen characters (once out, never in)

Dissecting characteristics

- Finding 1: not all informative characteristics are incrementally informative



Info -> non-info

Non-Info -> info

Info -> info

Dissecting characteristics

- Finding 2: the significance of some characters (or interaction of characters) are susceptible to the variation of time / company size

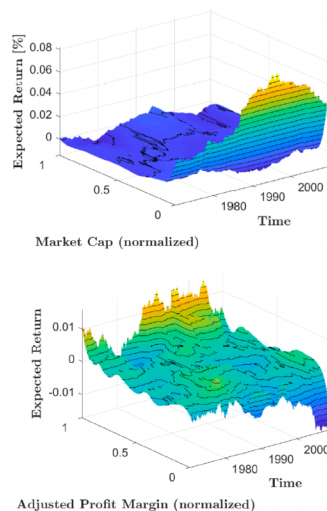
Firms	All	Size > q ₁₀	Size > q ₂₀	Size > q ₂₀
Sample	Full	Full	Full	Full
Knots	20	15	15	10
Sample Size	1,629,155	959,757	763,850	763,850
# Selected	25	15	9	13
Sharpe Ratio	3.33	3.13	2.48	2.72

Characteristics	# Selected	(1)	(2)	(3)	(4)
BEME	1	BEME			
ΔShrout	4	ΔShrout	ΔShrout	ΔShrout	ΔShrout
ΔSO	4	ΔSO	ΔSO	ΔSO	ΔSO
DTO	1	DTO			
Investment	1	Investment			
Lturnover	2	Lturnover	Lturnover		
NOA	1		NOA		
PM _{adj}	1	PM _{adj}			
r ₂₋₁	1	r ₂₋₁			
r ₆₋₂	2		r ₆₋₂		r ₆₋₂
r ₁₂₋₂	1		r ₁₂₋₂		
r ₁₂₋₇	4	r ₁₂₋₇	r ₁₂₋₇	r ₁₂₋₇	r ₁₂₋₇
r ₃₆₋₁₃	3	r ₃₆₋₁₃	r ₃₆₋₁₃		r ₃₆₋₁₃
Rel.to.high.price	2	Rel.to.high.price	Rel.to.high.price		Rel.to.high.price
S2P	3			S2P	S2P
SUV	4	SUV	SUV	SUV	SUV
Total vol	4	Total vol	Total vol	Total vol	Total vol

Characteristics × Size					
A2ME	1	A2ME			
BEME _{adj}	1	BEME _{adj}			
DTO	1	DTO			
EPS	1	EPS			
NOA	1	NOA			
r ₂₋₁	4	r ₂₋₁	r ₂₋₁	r ₂₋₁	r ₂₋₁
r ₆₋₂	4	r ₆₋₂	r ₆₋₂	r ₆₋₂	r ₆₋₂
r ₁₂₋₂	4	r ₁₂₋₂	r ₁₂₋₂	r ₁₂₋₂	r ₁₂₋₂
Rel.to.high.price	1	Rel.to.high.price			
Ret max	1	Ret max			
ROC	1				ROC
ROE	1	ROE			
SUV	1	SUV			

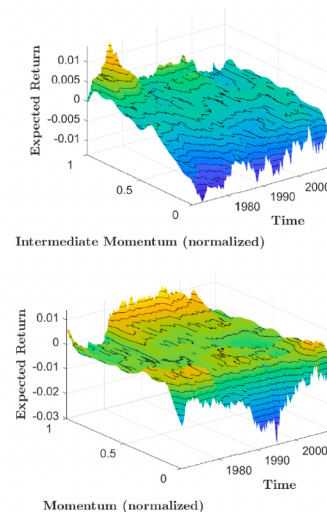
Dissecting characteristics

Figure 6: Time-varying Conditional Mean Function: Size (LME) and adjusted Profit Margin (PM_{adj})



Effect of normalized size (LME) and adjusted profit margin (PM_{adj}) on average returns over time (see equation (3)) conditional on all other selected characteristics. The sample period is January 1965 to June 2014. See Section A.1 in the online appendix for variable definitions.

Figure 7: Time-varying Conditional Mean Function: Intermediate Momentum (r_{12-7}) and Standard Momentum (r_{12-2})



Effect of normalized intermediate momentum (r_{12-7}) and standard momentum (r_{12-2}) on average returns over time (see equation (3)) conditional on all other selected characteristics. The sample period is January 1965 to June 2014. See Section A.1 in the online appendix for variable definitions.

Dissecting characteristics

- Finding 3: with correct model, the number of necessary parameters to maintain model prediction power is fewer than thought ...