

# **Internet Appendix to**

## **Machine Learning versus Economic Restrictions:**

### **Evidence from Stock Return Predictability**

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This Internet Appendix presents additional empirical results. Most of the results presented here are discussed in the paper.

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## Internet Appendix A: Variable Definitions

Variables	Definitions
<b>A. Stock Characteristics</b>	
Log(Price)	The logarithm of stock price as reported in CRSP.
Log(Size)	The logarithm of stock market capitalization, computed as the number of common shares outstanding times share price as reported in CRSP.
Book-to-Market	Book value of equity divided by the market capitalization at fiscal year-end, following Fama and French (2015).
Log(Illiquidity)	The logarithm of the stock illiquidity, computed in a given month $t$ as follows: $ILLIQ_{i,t} = (\sum_{d \in t}  R_{i,d,t}  / VOLD_{i,d,t}) / D_{i,t} \times 10^6$ , where $R_{i,d,t}$ refers to the percentage return of stock $i$ in day $d$ of month $t$ , $VOLD_{i,d,t}$ refers to the dollar trading volume at the same time, and $D_{i,t}$ is the number of trading days for stock $i$ in month $t$ , following Amihud (2002).
Beta	The beta in a given month $t$ is computed as follows: $R_{i,w,t} = \alpha_{i,t} + \beta_{i,t}MKT_{w,t} + e_{i,w,t}$ , where $R_{i,w,t}$ refers to the accumulated return of stock $i$ in week $w$ of month $t$ , and $MKT_{w,t}$ refers to the contemporaneous equal-weighted market returns. The $\beta_{i,t}$ is estimated in a three-year rolling window with at least 52 weeks of returns prior to the formation period, following Fama and MacBeth (1973).
1M Return	The monthly stock return as reported in CRSP.
12M Momentum	Formation period return in a given month $t$ , computed as the cumulative 11-month return from month $t - 11$ to month $t - 1$ , following Jegadeesh (1990).
IdioVol	The idiosyncratic volatility for stock $i$ in month $t$ , computed as the standard deviation of the residual $e_{i,w,t}$ , where $e_{i,w,t}$ is defined as in <i>Beta</i> , following Ali, Hwang, and Trombley (2003).
Absolute Accruals	The absolute value of accruals, computed in a given year $t$ as follows: $Accruals_{i,t} = (IB_{i,t} - OANCF_{i,t}) / ASSET_{i,t}$ , where $IB_{i,t}$ refers to the income before extraordinary items (COMPUSTAT annual item IB) of stock $i$ in year $t$ , $OANCF_{i,t}$ refers to the operating cash flows (item OANCF), and $ASSET_{i,t}$ refers to the average total assets (item AT) of the beginning and end of year $t$ . If $OANCF_{i,t}$ is missing, then set to $(\Delta CA_{i,t} - \Delta Cash_{i,t}) - (\Delta CL_{i,t} - \Delta STD_{i,t} - \Delta TP_{i,t}) - Dep_{i,t}$ , where $\Delta CA_{i,t}$ refers to the change in current assets (COMPUSTAT annual item ACT) of stock $i$ in year $t$ , $\Delta Cash_{i,t}$ refers to the change in cash and short-term investments (item CHE), $\Delta CL_{i,t}$ refers to the change in current liabilities (item LCT), $\Delta STD_{i,t}$ refers to the change in debt included in current liabilities (item DLC), $\Delta TP_{i,t}$ refers to the change in income taxes payable (item TXP), and $Dep_{i,t}$ refers to the depreciation and amortization expense (item DP), following Sloan (1996) and Bandyopadhyay, Huang, and Wirjanto (2010).
Log(Age)	The logarithm of the number of years since the first COMPUSTAT coverage, following Jiang, Lee, and Zhang (2005).
Asset Growth	Asset growth in a given year $t$ , computed as follows: $ASSETG_{i,t} = (ASSET_{i,t} - ASSET_{i,t-1}) / ASSET_{i,t-1}$ , where $ASSET_{i,t}$ refers to the total assets (COMPUSTAT annual item AT) of stock $i$ in year $t$ , following Cooper, Gulen, and Schill (2008).
$\Delta$ Shares Outstanding	The annual percent change in shares outstanding, following Pontiff and Woodgate (2008).
Corporate Investment	Corporate investment in a given quarter $t$ is computed as follows: $CI_{i,t} = PPE_{i,t} - (PPE_{i,t-1} + PPE_{i,t-2} + PPE_{i,t-3}) / 3$ , where $PPE_{i,t}$ refers to the ratio of change in net property, plant, and equipment (COMPUSTAT quarterly item PPENTQ) divided by sales (item SALEQ) of stock $i$ in quarter $t$ . If SALEQ is 0 or negative, then replace SALEQ with 0.01, following Titman, Wei, and Xie (2004).
Dividend-to-Price	Total dividends (COMPUSTAT annual item DVT) divided by market capitalization at fiscal year-end, following Litzenger and Ramaswamy (1982).
Gross Profitability	Gross profitability in a given year $t$ is computed as follows: $GP_{i,t} = (REVT_{i,t} - COGS_{i,t}) / ASSET_{i,t}$ , where $REVT_{i,t}$ refers to the total revenue (COMPUSTAT annual item REVT) of stock $i$ in year $t$ , $COGS_{i,t}$ refers to the cost of goods sold (item COGS), and $ASSET_{i,t}$ is the total assets (item AT), following Novy-Marx (2013).
Leverage	Total liabilities (COMPUSTAT annual item LT) divided by market capitalization at fiscal year-end, following Bhandari (1988).
ROA	Return on assets in a given quarter $t$ , computed as follows: $ROA_{i,t} = INCOME_{i,t} / ASSET_{i,t-1}$ , where $INCOME_{i,t}$ refers to the income before extraordinary items (COMPUSTAT quarterly item IBQ) of stock $i$ in quarter $t$ , and $ASSET_{i,t-1}$ refers to the total assets (item ATQ), following Balakrishnan, Bartov, and Faurel (2010).
ROE	Return on equity in a given quarter $t$ is computed as follows: $ROE_{i,t} = INCOME_{i,t} / EQUITY_{i,t-1}$ , where $INCOME_{i,t}$ refers to the income before extraordinary items (COMPUSTAT quarterly item

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	IBQ) of stock $i$ in quarter $t$ , and $EQUITY_{i,t-1}$ refers to the shareholders' equity. Depending on availability, we use stockholders' equity (item SEQQ), or common equity (item CEQQ) plus redemption value (item PSTKRQ), or common equity (item CEQQ) plus the carrying value of preferred stock (item PSTKQ), or total assets (item ATQ) minus total liabilities (item LTQ), in that order, as shareholders' equity, following Hou, Xue, and Zhang (2015).
%Rated	The number of firms with S&P long-term issuer credit rating divided by the total number of firms.
Credit Rating	The monthly S&P long-term issuer credit rating is as reported in COMPUSTAT. We transform the S&P ratings into ascending numerical scores, where AAA = 1, AA+ = 2, AA = 3, AA- = 4, A+ = 5, A = 6, A- = 7, BBB+ = 8, BBB = 9, BBB- = 10, BB+ = 11, BB = 12, BB- = 13, B+ = 14, B = 15, B- = 16, CCC+ = 17, CCC = 18, CCC- = 19, CC = 20, C = 21, and D = 22, following Avramov, Chordia, Jostova, and Philipov (2009).
Analyst Coverage	The number of analysts following the firm as reported in I/B/E/S in each quarter.
Analyst Dispersion	The standard deviation of analysts' earnings (earnings per share, EPS) forecasts divided by the absolute value of the median earnings forecast as reported in I/B/E/S in each quarter.
SUE	The standardized unexpected earnings (SUE) in a given quarter $t$ is computed as follows: $SUE_{i,t} = (EPS_{i,t} - F_{i,t})/P_{i,t}$ , where $EPS_{i,t}$ refers to the actual earnings per share for stock $i$ in quarter $t$ , $F_{i,t}$ refers to the median earnings forecast for the current fiscal quarter, and $P_{i,t}$ refers to the stock price. If $EPS_{i,t}$ or $F_{i,t}$ is missing then $SUE_{i,t} = \frac{INCOME_{i,t} - INCOME_{i,t-4}}{MV_{i,t}}$ , where $INCOME_{i,t}$ refers to the income before extraordinary items (COMPUSTAT quarterly item IBQ) of stock $i$ in quarter $t$ , and $MV_{i,t}$ refers to the stock market capitalization.
<b>B. Market State Measures</b>	
SENT	The monthly Baker and Wurgler (2007) investor sentiment. We use the raw version of the Baker-Wurgler sentiment index that excludes the NYSE turnover variable.
MKTVOL	The standard deviation of daily CRSP value-weighted index returns in a month.
VIX	The average daily VIX index of implied volatilities of S&P 500 index options in a month.
MKTILLIQ	The value-weighted average of stock-level Amihud (2002) illiquidity for all NYSE/AMEX stocks in a month, following Avramov, Cheng, and Hameed (2016). The stock-level Amihud illiquidity is defined as in <i>Log(Illiquidity)</i> .
DOWN	A dummy variable that takes a value of 1 if CRSP value-weighted index return is negative in a month and 0 otherwise.
TERM	The difference between the average yield of 10-year Treasury bonds and three-month T-bills, following Welch and Goyal (2008).
DEF	The difference between the average yield of bonds rated BAA and AAA by Moody's, following Welch and Goyal (2008).

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**Table IA1: Number of Stocks Over Time**

This table reports the average number of stocks per month on a year-by-year basis for the full sample as well as for subsamples for which we exclude the microcaps, require firms to have an S&P long-term issuer credit rating, and exclude observations from 12 months before to 12 months after an issuer credit rating downgrade.

Average Number of Stocks Over Time								
Year	GKX Sample				CPZ Sample			
	Full Sample	Nonmicrocaps	Credit Rating Sample	Nondowngrades	Full Sample	Nonmicrocaps	Credit Rating Sample	Nondowngrades
1987	5,320	1,928	1,042	764	2,080	939	554	406
1988	5,711	2,055	1,030	787	2,113	977	534	420
1989	5,799	2,110	985	731	2,191	994	509	400
1990	5,783	2,174	926	638	2,164	974	461	349
1991	5,827	2,337	901	633	2,266	1,056	450	337
1992	5,869	2,469	930	722	2,433	1,135	478	378
1993	6,209	2,696	1,005	809	2,504	1,171	501	405
1994	6,784	2,955	1,095	895	2,541	1,202	521	425
1995	7,270	3,327	1,165	955	2,551	1,295	542	439
1996	7,519	3,555	1,282	1,072	2,553	1,326	578	478
1997	7,830	3,667	1,405	1,150	2,635	1,372	640	512
1998	7,877	3,709	1,541	1,190	2,667	1,401	701	533
1999	7,523	3,733	1,638	1,188	2,689	1,449	735	519
2000	7,308	3,881	1,623	1,133	2,602	1,476	739	504
2001	7,068	3,576	1,601	1,048	2,563	1,430	739	491
2002	6,761	3,424	1,578	1,029	2,620	1,472	768	519
2003	6,402	3,387	1,550	1,108	2,649	1,541	795	567
2004	6,208	3,465	1,575	1,243	2,675	1,653	841	647
2005	6,154	3,447	1,559	1,238	2,755	1,679	850	648
2006	6,160	3,470	1,535	1,189	2,706	1,669	847	631
2007	6,148	3,424	1,483	1,109	2,533	1,607	822	612
2008	6,228	3,371	1,415	914	2,368	1,519	779	514
2009	5,910	3,272	1,360	904	2,296	1,497	753	512
2010	5,404	3,059	1,351	1,090	2,263	1,494	757	619
2011	5,279	3,036	1,354	1,129	2,234	1,508	773	657
2012	5,227	3,057	1,362	1,128	2,212	1,505	781	651
2013	5,117	3,054	1,376	1,176	2,169	1,490	788	666
2014	5,143	3,146	1,414	1,182	2,081	1,460	786	642
2015	5,270	3,270	1,464	1,109	2,024	1,413	788	564
2016	5,292	3,236	1,427	1,109	1,933	1,344	763	563
2017	5,255	3,213	1,385	1,274				
Total	21,882	13,119	4,715	4,499	7,904	5,083	2,436	2,294

**Table IA2: Performance of Portfolios Sorted by Neural Network Predicted Returns: Equal-Weighted Returns**

At the end of each month  $t$ , stocks are sorted into deciles according to their one-month-ahead out-of-sample predicted returns ( $\hat{R}$ ) using a neural network with three hidden layers (NN3) (Gu, Kelly, and Xiu 2020). This table reports the equal-weighted returns for month  $t + 1$  for each decile portfolio as well as the strategy of going long (short) on the highest (lowest) expected return stocks (“HML”) over the entire sample period from 1987 to 2017. Portfolio returns are further adjusted by the CAPM, Fama-French-Carhart 4-factor and Pástor-Stambaugh liquidity factor model (FFC+PS), Fama-French 5-factor model (FF5), Fama-French 6-factor model (FF6), and Stambaugh-Yuan 4-factor model (SY). Panel A reports the results for the full sample as well as the subsample that excludes microcaps. Panel B reports similar statistics for the subsamples that exclude nonrated firms and credit rating downgrades. Newey-West adjusted t-statistics are shown in parentheses. Numbers with “\*”, “\*\*”, and “\*\*\*” are significant at the 10%, 5%, and 1% levels, respectively.

Panel A: Equal-Weighted Returns to Investment Strategies Sorted by NN3-Predicted Returns (Full Sample and Microcaps Excluded)												
Rank of $\hat{R}$	Full Sample						Nonmicrocaps					
	Return	CAPM	FFC+PS	FF5	FF6	SY	Return	CAPM	FFC+PS	FF5	FF6	SY
Low	-0.121 (-0.26)	-1.383*** (-5.55)	-0.879*** (-5.23)	-0.763*** (-3.61)	-0.466*** (-3.09)	-0.381* (-1.73)	0.274 (0.60)	-1.067*** (-4.38)	-0.545*** (-3.32)	-0.391** (-2.05)	-0.112 (-0.90)	-0.024 (-0.12)
2	0.569 (1.59)	-0.498*** (-2.98)	-0.189* (-1.70)	-0.203 (-1.35)	0.011 (0.11)	0.135 (0.88)	0.666** (1.98)	-0.447*** (-3.31)	-0.182** (-2.06)	-0.172 (-1.32)	0.002 (0.03)	0.088 (0.72)
3	0.713** (2.32)	-0.235 (-1.62)	-0.086 (-0.88)	-0.146 (-1.21)	-0.005 (-0.05)	0.098 (0.80)	0.791*** (2.72)	-0.201* (-1.73)	-0.094 (-1.21)	-0.149 (-1.59)	-0.042 (-0.55)	0.074 (0.79)
4	0.931*** (3.29)	0.042 (0.30)	0.103 (1.09)	-0.009 (-0.08)	0.088 (0.90)	0.195 (1.63)	0.862*** (3.38)	-0.069 (-0.66)	-0.053 (-0.87)	-0.140* (-1.88)	-0.083 (-1.31)	0.010 (0.12)
5	0.962*** (3.61)	0.113 (0.77)	0.106 (1.04)	0.012 (0.11)	0.063 (0.59)	0.144 (1.15)	1.005*** (4.03)	0.106 (0.92)	0.058 (0.74)	-0.077 (-1.03)	-0.049 (-0.70)	0.042 (0.50)
6	1.115*** (4.23)	0.260* (1.73)	0.228** (2.15)	0.121 (1.13)	0.155 (1.41)	0.238* (1.88)	1.073*** (4.43)	0.186 (1.46)	0.105 (1.19)	-0.002 (-0.03)	0.004 (0.04)	0.082 (0.82)
7	1.205*** (4.36)	0.338** (2.04)	0.280** (2.37)	0.184 (1.56)	0.203* (1.69)	0.290** (2.14)	1.163*** (4.60)	0.256* (1.96)	0.140* (1.67)	0.041 (0.60)	0.026 (0.36)	0.075 (0.88)
8	1.344*** (4.49)	0.460** (2.47)	0.403*** (3.27)	0.302*** (2.63)	0.324*** (2.69)	0.427*** (3.03)	1.201*** (4.73)	0.289** (2.15)	0.161** (2.00)	0.036 (0.53)	0.016 (0.23)	0.111 (1.25)
9	1.563*** (4.95)	0.664*** (3.15)	0.614*** (4.68)	0.547*** (4.14)	0.570*** (4.12)	0.685*** (4.53)	1.333*** (5.09)	0.419*** (2.86)	0.272*** (3.31)	0.170** (2.41)	0.133* (1.89)	0.225** (2.36)
High	2.349*** (5.35)	1.360*** (4.17)	1.618*** (5.52)	1.586*** (4.96)	1.770*** (5.22)	1.931*** (5.12)	1.517*** (5.21)	0.559*** (3.13)	0.396*** (3.95)	0.290*** (3.02)	0.241** (2.50)	0.333*** (2.87)
HML	2.470*** (9.03)	2.742*** (9.78)	2.497*** (9.27)	2.349*** (9.35)	2.236*** (8.06)	2.312*** (7.91)	1.243*** (3.75)	1.625*** (5.04)	0.940*** (4.19)	0.680*** (2.89)	0.353** (2.02)	0.357 (1.37)

Table IA2—Continued

Panel B: Equal-Weighted Returns to Investment Strategies Sorted by NN3-Predicted Returns (Credit Rating Sample and Downgrades Excluded)												
Rank of $\hat{R}$	Credit Rating Sample						Nondowngrades					
	Return	CAPM	FFC+PS	FF5	FF6	SY	Return	CAPM	FFC+PS	FF5	FF6	SY
Low	0.056 (0.12)	-1.289*** (-4.94)	-0.741*** (-4.47)	-0.904*** (-3.02)	-0.488*** (-2.99)	-0.213 (-0.84)	1.103*** (2.63)	-0.147 (-0.65)	0.297* (1.85)	0.148 (0.64)	0.468*** (2.87)	0.762*** (3.13)
2	0.785** (2.12)	-0.329* (-1.84)	-0.140 (-1.23)	-0.358** (-2.11)	-0.118 (-1.03)	0.111 (0.55)	1.290*** (4.01)	0.225 (1.43)	0.388*** (3.24)	0.165 (1.07)	0.357*** (3.15)	0.617*** (3.26)
3	0.863** (2.51)	-0.158 (-0.85)	-0.108 (-0.84)	-0.357** (-2.50)	-0.195 (-1.56)	-0.006 (-0.03)	1.216*** (4.16)	0.251 (1.54)	0.282** (2.40)	0.049 (0.40)	0.175 (1.53)	0.365** (2.21)
4	0.972*** (3.11)	-0.035 (-0.21)	-0.021 (-0.20)	-0.251** (-2.38)	-0.128 (-1.43)	0.063 (0.41)	1.229*** (4.51)	0.271* (1.86)	0.248** (2.31)	0.066 (0.67)	0.148 (1.50)	0.324** (2.24)
5	1.188*** (4.30)	0.256* (1.69)	0.192** (2.07)	-0.023 (-0.24)	0.058 (0.68)	0.210 (1.52)	1.415*** (5.65)	0.517*** (3.73)	0.434*** (4.14)	0.230** (2.45)	0.283*** (3.06)	0.433*** (3.22)
6	0.986*** (3.61)	0.065 (0.43)	-0.045 (-0.46)	-0.192* (-1.88)	-0.155 (-1.55)	-0.049 (-0.39)	1.302*** (5.29)	0.413*** (2.92)	0.282*** (2.74)	0.121 (1.35)	0.135 (1.44)	0.245** (2.06)
7	1.124*** (4.16)	0.211 (1.36)	0.083 (0.78)	-0.115 (-1.21)	-0.090 (-0.93)	0.034 (0.27)	1.377*** (5.53)	0.493*** (3.24)	0.357*** (3.07)	0.161* (1.68)	0.169* (1.68)	0.301** (2.34)
8	1.186*** (4.42)	0.273* (1.78)	0.151 (1.37)	-0.074 (-0.73)	-0.044 (-0.45)	0.130 (0.93)	1.452*** (5.93)	0.568*** (3.92)	0.421*** (3.93)	0.216** (2.42)	0.215** (2.33)	0.367*** (2.86)
9	1.275*** (4.77)	0.361** (2.33)	0.210** (2.32)	0.030 (0.34)	0.030 (0.35)	0.206* (1.78)	1.512*** (6.08)	0.626*** (4.15)	0.454*** (5.06)	0.296*** (3.46)	0.277*** (3.31)	0.439*** (3.83)
High	1.431*** (4.42)	0.470** (2.31)	0.342** (2.53)	0.143 (1.08)	0.163 (1.27)	0.334** (2.26)	1.770*** (6.18)	0.850*** (4.52)	0.659*** (5.49)	0.471*** (4.70)	0.442*** (4.21)	0.558*** (4.16)
HML	1.374*** (4.08)	1.759*** (5.75)	1.083*** (4.59)	1.048*** (3.63)	0.652*** (3.16)	0.548* (1.93)	0.667** (2.11)	0.997*** (3.40)	0.362* (1.70)	0.323 (1.32)	-0.026 (-0.13)	-0.205 (-0.73)

**Table IA3: Performance of Portfolios Sorted by OLS Predicted Returns and Individual Anomalies**

At the end of each month  $t$ , stocks are sorted into deciles according to their one-month-ahead out-of-sample predicted returns using ordinary least squares (OLS). Panel A reports the equal- and value-weighted return for month  $t + 1$  for the strategy of going long (short) on the highest (lowest) expected return stocks (“HML”) over the entire sample period from 1987 to 2017. Portfolio returns are further adjusted by the CAPM, Fama-French-Carhart 4-factor and Pástor-Stambaugh liquidity factor model (FFC+PS), Fama-French 5-factor model (FF5), Fama-French 6-factor model (FF6), and Stambaugh-Yuan 4-factor model (SY). We report results for the full sample as well as subsamples that exclude microcaps, nonrated firms, and credit rating downgrades. Panel B reports similar statistics, while at the end of each month  $t$ , stocks are sorted into deciles according to each of the 94 firm characteristics. We adjust the sign of those characteristics so that a higher value predicts higher future performance according to the original studies. For each characteristic, we compute the equal- and value-weighted return for month  $t + 1$  for the strategy of going long (short) on the highest (lowest) expected return stocks (“HML”). Then, we compute an equal-weighted average of portfolio returns across 94 characteristics. Newey-West adjusted t-statistics are shown in parentheses. Numbers with “\*”, “\*\*”, and “\*\*\*” are significant at the 10%, 5%, and 1% levels, respectively.

Panel A: Returns to Investment Strategies Sorted by OLS-Predicted Returns												
	Equal-Weighted						Value-Weighted					
	Return	CAPM	FFC+PS	FF5	FF6	SY	Return	CAPM	FFC+PS	FF5	FF6	SY
Full Sample	1.215*** (5.25)	1.162*** (4.78)	1.272*** (5.28)	1.521*** (5.95)	1.545*** (5.85)	1.475*** (4.69)	0.084 (0.39)	0.118 (0.50)	0.164 (0.64)	0.308 (1.09)	0.268 (0.92)	0.127 (0.37)
Nonmicrocaps	0.472** (2.37)	0.410* (1.84)	0.367* (1.66)	0.565** (2.42)	0.514** (2.19)	0.409 (1.47)	0.013 (0.07)	0.060 (0.30)	0.128 (0.61)	0.237 (1.04)	0.223 (0.95)	0.074 (0.25)
Credit Rating Sample	0.437* (1.78)	0.361 (1.50)	0.488** (2.02)	0.458** (2.00)	0.563** (2.33)	0.632** (2.02)	0.024 (0.12)	0.061 (0.27)	0.135 (0.61)	0.103 (0.46)	0.115 (0.49)	0.133 (0.51)
Nondowngrades	0.506** (2.39)	0.480** (2.13)	0.506** (2.29)	0.412* (1.96)	0.470** (2.08)	0.550** (1.97)	-0.008 (-0.04)	0.035 (0.15)	0.078 (0.34)	0.082 (0.34)	0.065 (0.26)	0.032 (0.12)
Panel B: Returns to Investment Strategies Sorted by Individual Anomalies												
	Equal-Weighted						Value-Weighted					
	Return	CAPM	FFC+PS	FF5	FF6	SY	Return	CAPM	FFC+PS	FF5	FF6	SY
Full Sample	0.366*** (5.92)	0.472*** (8.18)	0.346*** (7.91)	0.308*** (6.03)	0.250*** (6.07)	0.221*** (3.95)	0.192*** (2.91)	0.306*** (5.41)	0.189*** (4.88)	0.139*** (3.27)	0.092*** (2.89)	0.043 (1.19)
Nonmicrocaps	0.233*** (3.71)	0.344*** (6.11)	0.218*** (6.21)	0.167*** (4.40)	0.115*** (4.60)	0.079** (2.16)	0.170*** (2.74)	0.272*** (4.87)	0.151*** (4.02)	0.095** (2.57)	0.049* (1.87)	-0.003 (-0.09)
Credit Rating Sample	0.302*** (5.11)	0.387*** (6.78)	0.263*** (6.24)	0.244*** (4.59)	0.182*** (4.56)	0.121** (2.55)	0.131** (2.47)	0.215*** (4.75)	0.111*** (3.11)	0.092** (2.20)	0.045 (1.42)	-0.017 (-0.52)
Nondowngrades	0.124*** (2.60)	0.197*** (4.45)	0.103*** (3.31)	0.083** (2.11)	0.039 (1.22)	-0.017 (-0.44)	0.071 (1.48)	0.142*** (3.28)	0.046 (1.44)	0.038 (0.93)	-0.004 (-0.13)	-0.071* (-1.93)

**Table IA4: Neural Network Estimation Based on Subsamples: Equal-Weighted Returns**

At the end of each month  $t$ , stocks are sorted into deciles according to their NN3-predicted returns ( $\hat{R}$ ) (Gu, Kelly, and Xiu 2020). This table reports the equal-weighted return for month  $t + 1$  for the strategy of going long (short) on the highest (lowest) expected return stocks. Portfolio returns are further adjusted by the CAPM, Fama-French-Carhart 4-factor and Pástor-Stambaugh liquidity factor model (FFC+PS), Fama-French 5-factor model (FF5), Fama-French 6-factor model (FF6), and Stambaugh-Yuan 4-factor model (SY). We employ the full sample as well as subsamples that exclude microcaps, nonrated firms, and credit rating downgrades for the NN3 estimations (in the “Training” column) and the portfolio sorts (in the “Testing” column). Newey-West adjusted t-statistics are shown in parentheses. Numbers with “\*”, “\*\*”, and “\*\*\*” are significant at the 10%, 5%, and 1% levels, respectively.

Equal-Weighted Returns to Investment Strategies Sorted by NN3-Predicted Returns								
Training	Testing	Sample Period	Return	CAPM	FFC+PS	FF5	FF6	SY
Nonmicrocaps	Nonmicrocaps	1987–2017	1.505*** (4.79)	1.891*** (6.31)	1.147*** (5.89)	1.015*** (4.23)	0.655*** (4.25)	0.571** (2.49)
Credit Rating Sample	Credit Rating Sample	1999–2017	1.552** (2.48)	2.024*** (4.01)	1.482*** (4.40)	1.087** (2.32)	0.834*** (2.96)	0.442 (1.05)
Nondowngrades	Nondowngrades	1999–2017	0.935*** (2.81)	0.904** (2.44)	0.460 (1.59)	0.203 (0.69)	0.113 (0.42)	0.079 (0.23)
Full Sample	Full Sample	1987–2017	2.470*** (9.03)	2.742*** (9.78)	2.497*** (9.27)	2.349*** (9.35)	2.236*** (8.06)	2.312*** (7.91)
Full Sample	Nonmicrocaps	1987–2017	1.243*** (3.75)	1.625*** (5.04)	0.940*** (4.19)	0.680*** (2.89)	0.353** (2.02)	0.357 (1.37)
Full Sample	Full Sample	1999–2017	2.417*** (6.05)	2.692*** (7.03)	2.483*** (7.32)	2.297*** (6.64)	2.249*** (6.15)	2.300*** (5.67)
Full Sample	Nonmicrocaps	1999–2017	1.174** (2.28)	1.618*** (3.64)	1.111*** (4.30)	0.638** (2.18)	0.465** (2.30)	0.379 (1.14)
Full Sample	Credit Rating Sample	1999–2017	1.258** (2.49)	1.689*** (3.99)	1.136*** (4.08)	0.878** (2.29)	0.663*** (2.66)	0.376 (1.01)
Full Sample	Nondowngrades	1999–2017	0.354 (0.73)	0.733* (1.73)	0.194 (0.74)	-0.027 (-0.08)	-0.215 (-0.86)	-0.579 (-1.50)

**Table IA5: NN3-Predicted Alpha and Value-Weighted Loss Function**

At the end of each month  $t$ , stocks are sorted into deciles according to their NN3-predicted alphas ( $\hat{\alpha}$ ). We employ NN3 to predict FF6-adjusted returns ( $\hat{\alpha}$ ) and adopt a value-weighted loss function in the NN3 estimation. Panel A reports the month  $t + 1$  value-weighted return for each decile portfolio as well as the strategy of going long (short) on the highest (lowest) expected alpha stocks (“HML”) over the entire sample period from 1987 to 2017. Portfolio returns are further adjusted by the Fama-French 6-factor model (FF6). We report the results for the full sample as well as the subsamples that exclude microcaps, nonrated firms, and credit rating downgrades. Panel B reports similar statistics when decile portfolios are sorted by the NN3-predicted returns ( $\hat{R}$ ) (Gu, Kelly, and Xiu 2020) using the same universe of stocks. Newey-West adjusted t-statistics are shown in parentheses. Numbers with “\*”, “\*\*”, and “\*\*\*” are significant at the 10%, 5%, and 1% levels, respectively.

Panel A: Value-Weighted Returns to Investment Strategies Sorted by NN3-Predicted Alphas								
Rank of $\hat{\alpha}$	Full Sample		Nonmicrocaps		Credit Rating Sample		Nondowngrades	
	Return	FF6	Return	FF6	Return	FF6	Return	FF6
Low	0.168 (0.36)	-0.403** (-2.05)	0.538 (1.43)	-0.192 (-1.30)	0.515 (1.28)	-0.216 (-1.10)	1.012*** (2.83)	0.152 (0.77)
2	0.648* (1.90)	-0.155 (-1.11)	0.692** (2.21)	-0.170* (-1.81)	0.736** (2.20)	-0.147 (-1.14)	1.099*** (3.66)	0.240 (1.54)
3	0.781*** (2.63)	-0.113 (-0.98)	0.941*** (3.72)	0.021 (0.25)	0.941*** (3.25)	-0.028 (-0.25)	1.197*** (4.60)	0.261** (2.04)
4	0.943*** (3.84)	-0.059 (-0.80)	0.950*** (4.15)	-0.038 (-0.46)	0.895*** (3.51)	-0.023 (-0.23)	1.047*** (4.51)	0.162 (1.49)
5	0.854*** (3.73)	-0.121 (-1.57)	0.909*** (3.80)	-0.084 (-1.10)	1.008*** (4.35)	-0.064 (-0.71)	1.149*** (5.09)	0.082 (0.82)
6	1.079*** (4.75)	0.053 (0.64)	1.083*** (5.14)	0.072 (0.99)	1.042*** (4.58)	0.009 (0.11)	1.158*** (5.21)	0.112 (1.24)
7	0.979*** (4.08)	-0.053 (-0.69)	0.888*** (3.74)	-0.126 (-1.46)	1.002*** (4.47)	-0.092 (-1.13)	1.080*** (4.77)	-0.006 (-0.06)
8	0.994*** (4.64)	-0.062 (-0.77)	1.023*** (4.59)	-0.093 (-1.20)	0.909*** (3.76)	-0.163* (-1.78)	1.035*** (4.52)	-0.016 (-0.17)
9	1.076*** (4.32)	0.104 (1.16)	1.148*** (4.83)	0.161* (1.96)	1.079*** (4.92)	-0.048 (-0.57)	1.163*** (5.34)	0.047 (0.55)
High	1.224*** (4.18)	0.203 (1.40)	1.238*** (4.73)	0.184 (1.64)	1.215*** (4.74)	0.124 (1.06)	1.366*** (5.29)	0.282** (2.42)
HML	1.056*** (2.83)	0.606** (2.20)	0.700*** (2.61)	0.376* (1.86)	0.701** (2.20)	0.340 (1.37)	0.354 (1.22)	0.130 (0.53)

  

Panel B: Value-Weighted Returns to Investment Strategies Sorted by NN3-Predicted Returns								
Rank of $\hat{R}$	Full Sample		Nonmicrocaps		Credit Rating Sample		Nondowngrades	
	Return	FF6	Return	FF6	Return	FF6	Return	FF6
Low	0.398 (1.01)	-0.148 (-1.10)	0.418 (1.03)	-0.100 (-0.71)	0.446 (1.08)	-0.173 (-1.05)	0.797** (2.12)	0.099 (0.49)
2	0.695** (2.48)	-0.095 (-1.12)	0.701** (2.45)	-0.038 (-0.41)	0.774*** (2.66)	-0.085 (-0.82)	0.970*** (3.67)	0.113 (1.06)
3	0.923*** (3.58)	-0.026 (-0.31)	0.866*** (3.34)	-0.057 (-0.69)	0.867*** (3.17)	-0.030 (-0.27)	1.101*** (4.31)	0.228* (1.67)
4	0.965*** (4.27)	-0.036 (-0.59)	0.959*** (4.12)	-0.031 (-0.37)	0.897*** (3.57)	-0.147 (-1.56)	0.998*** (4.27)	-0.006 (-0.07)
5	0.945*** (4.22)	-0.086 (-1.21)	0.931*** (4.00)	-0.095 (-1.24)	1.072*** (4.77)	-0.022 (-0.30)	1.165*** (5.31)	0.075 (0.82)
6	1.006*** (4.65)	-0.085 (-0.94)	0.952*** (4.47)	-0.095 (-1.43)	0.935*** (4.24)	-0.128* (-1.67)	1.055*** (4.97)	-0.014 (-0.17)
7	1.112*** (4.72)	0.009 (0.11)	1.063*** (4.80)	-0.019 (-0.23)	0.989*** (4.58)	-0.119 (-1.44)	1.122*** (5.43)	0.042 (0.46)
8	1.181*** (5.02)	0.023 (0.25)	1.180*** (5.12)	0.040 (0.55)	1.247*** (5.48)	0.087 (1.21)	1.349*** (6.17)	0.205*** (2.77)
9	1.320*** (4.91)	0.148 (1.21)	1.122*** (4.83)	0.027 (0.33)	1.029*** (4.44)	-0.095 (-1.03)	1.097*** (4.85)	-0.038 (-0.40)
High	1.973*** (6.62)	0.846*** (5.46)	1.454*** (5.54)	0.248** (2.04)	1.502*** (5.91)	0.333*** (2.79)	1.584*** (6.31)	0.403*** (3.20)
HML	1.575*** (4.82)	0.994*** (4.70)	1.036*** (3.31)	0.349* (1.71)	1.056*** (3.29)	0.507** (2.30)	0.787*** (2.63)	0.303 (1.26)

**Table IA6: Performance of Portfolios Sorted by Risk Loadings on the Stochastic Discount Factor: Equal-Weighted Returns**

At the end of each month  $t$ , stocks are sorted into deciles according to their risk loadings ( $\beta$ ) on the stochastic discount factor estimated from a combination of deep neural networks (Chen, Pelger, and Zhu 2020). This table reports the equal-weighted returns for month  $t + 1$  for each decile portfolio as well as the strategy of going long (short) on the highest (lowest) risk loading stocks (“HML”) over the entire sample period from 1987 to 2016. Portfolio returns are further adjusted by the CAPM, Fama-French-Carhart 4-factor and Pástor-Stambaugh liquidity factor model (FFC+PS), Fama-French 5-factor model (FF5), Fama-French 6-factor model (FF6), and Stambaugh-Yuan 4-factor model (SY). Panel A reports the results for the full sample as well as the subsample that excludes microcaps. Panel B reports similar statistics for the subsamples that exclude nonrated firms and credit rating downgrades. Newey-West adjusted t-statistics are shown in parentheses. Numbers with “\*”, “\*\*”, and “\*\*\*” are significant at the 10%, 5%, and 1% levels, respectively.

Panel A: Equal-Weighted Returns to Investment Strategies Sorted by Risk Loadings (Full Sample and Microcaps Excluded)												
Rank of $\beta$	Full Sample						Nonmicrocaps					
	Return	CAPM	FFC+PS	FF5	FF6	SY	Return	CAPM	FFC+PS	FF5	FF6	SY
Low	-0.110 (-0.24)	-1.141*** (-4.10)	-0.889*** (-4.18)	-1.087*** (-4.93)	-0.826*** (-4.10)	-0.644** (-2.31)	0.315 (0.78)	-0.808*** (-3.96)	-0.512*** (-3.47)	-0.769*** (-4.12)	-0.505*** (-3.50)	-0.370* (-1.70)
2	0.607 (1.62)	-0.390** (-2.09)	-0.267** (-2.02)	-0.412*** (-3.01)	-0.263** (-1.98)	-0.175 (-1.01)	0.634** (1.98)	-0.387*** (-2.72)	-0.255*** (-2.62)	-0.403*** (-3.36)	-0.265** (-2.52)	-0.162 (-1.19)
3	0.876** (2.56)	-0.092 (-0.58)	-0.032 (-0.29)	-0.133 (-1.24)	-0.035 (-0.32)	0.050 (0.37)	1.018*** (3.26)	0.009 (0.07)	0.066 (0.72)	-0.057 (-0.60)	0.031 (0.34)	0.103 (0.98)
4	1.007*** (3.13)	0.053 (0.35)	0.071 (0.71)	-0.056 (-0.56)	0.015 (0.15)	0.120 (0.94)	0.945*** (3.22)	-0.021 (-0.17)	-0.012 (-0.13)	-0.157* (-1.71)	-0.098 (-1.13)	0.006 (0.06)
5	1.219*** (4.05)	0.281* (1.86)	0.263*** (3.06)	0.167* (1.70)	0.220** (2.30)	0.308*** (2.79)	1.094*** (3.86)	0.131 (1.02)	0.074 (0.98)	-0.017 (-0.22)	0.001 (0.01)	0.055 (0.64)
6	1.249*** (4.15)	0.310** (2.04)	0.242*** (2.82)	0.157* (1.68)	0.186** (2.05)	0.287*** (2.80)	1.279*** (4.46)	0.318** (2.39)	0.246*** (2.96)	0.140* (1.77)	0.156** (2.04)	0.237*** (2.78)
7	1.436*** (4.71)	0.492*** (3.00)	0.415*** (4.47)	0.292*** (3.00)	0.322*** (3.45)	0.446*** (3.97)	1.220*** (4.35)	0.256* (1.73)	0.183* (1.96)	0.039 (0.36)	0.065 (0.62)	0.172 (1.56)
8	1.687*** (5.61)	0.745*** (4.22)	0.706*** (6.31)	0.528*** (4.49)	0.581*** (5.03)	0.716*** (5.83)	1.412*** (4.81)	0.444*** (2.96)	0.346*** (3.83)	0.184** (2.11)	0.192** (2.31)	0.329*** (3.49)
9	1.998*** (5.93)	1.056*** (4.70)	1.073*** (6.26)	0.907*** (4.54)	1.017*** (5.05)	1.170*** (5.44)	1.567*** (5.49)	0.600*** (3.65)	0.494*** (4.87)	0.268*** (2.75)	0.294*** (3.28)	0.429*** (4.05)
High	3.336*** (7.01)	2.274*** (6.42)	2.583*** (7.99)	2.379*** (5.95)	2.667*** (6.83)	2.923*** (6.86)	1.901*** (5.53)	0.837*** (3.85)	0.820*** (5.84)	0.537*** (3.21)	0.656*** (4.76)	0.848*** (5.23)
HML	3.446*** (11.25)	3.415*** (11.17)	3.473*** (9.28)	3.465*** (8.94)	3.492*** (8.04)	3.566*** (8.01)	1.586*** (6.80)	1.645*** (6.98)	1.332*** (6.09)	1.306*** (6.42)	1.161*** (5.13)	1.218*** (5.06)

Table IA6—Continued

Panel B: Equal-Weighted Returns to Investment Strategies Sorted by Risk Loadings (Credit Rating Sample and Downgrades Excluded)												
Rank of $\beta$	Credit Rating Sample						Nondowngrades					
	Return	CAPM	FFC+PS	FF5	FF6	SY	Return	CAPM	FFC+PS	FF5	FF6	SY
Low	0.489 (1.02)	-0.640** (-2.24)	-0.372* (-1.68)	-0.762*** (-2.73)	-0.430* (-1.87)	-0.137 (-0.41)	1.013** (2.48)	-0.033 (-0.13)	0.228 (0.98)	-0.127 (-0.52)	0.147 (0.64)	0.401 (1.23)
2	0.720** (2.00)	-0.315* (-1.73)	-0.220 (-1.56)	-0.514*** (-3.07)	-0.329** (-2.31)	-0.094 (-0.45)	1.001*** (3.11)	0.027 (0.16)	0.090 (0.65)	-0.146 (-1.00)	-0.017 (-0.12)	0.178 (0.98)
3	1.015*** (3.20)	0.038 (0.23)	0.087 (0.73)	-0.151 (-1.05)	-0.010 (-0.08)	0.175 (1.04)	1.280*** (4.47)	0.339** (2.28)	0.378*** (2.80)	0.176 (1.29)	0.281** (2.17)	0.475*** (2.89)
4	0.947*** (3.16)	-0.022 (-0.14)	-0.042 (-0.39)	-0.267** (-2.08)	-0.183 (-1.57)	-0.051 (-0.37)	1.205*** (4.48)	0.278* (1.83)	0.254** (2.08)	0.025 (0.19)	0.084 (0.69)	0.222 (1.57)
5	1.057*** (3.74)	0.116 (0.85)	0.041 (0.42)	-0.129 (-1.24)	-0.072 (-0.73)	0.057 (0.46)	1.280*** (4.83)	0.367*** (2.82)	0.266** (2.36)	0.150 (1.41)	0.170 (1.54)	0.267** (2.08)
6	1.207*** (4.21)	0.262* (1.89)	0.165 (1.45)	0.001 (0.01)	0.033 (0.32)	0.175 (1.34)	1.385*** (5.20)	0.465*** (3.31)	0.348*** (2.75)	0.189* (1.74)	0.194* (1.74)	0.315** (2.35)
7	1.203*** (4.03)	0.250 (1.54)	0.125 (1.11)	-0.025 (-0.21)	0.003 (0.02)	0.150 (1.11)	1.435*** (5.17)	0.505*** (3.12)	0.355*** (3.14)	0.217* (1.84)	0.216* (1.86)	0.361*** (2.83)
8	1.238*** (4.22)	0.296* (1.70)	0.173 (1.49)	-0.021 (-0.18)	0.006 (0.05)	0.178 (1.44)	1.459*** (5.32)	0.542*** (3.11)	0.395*** (3.13)	0.192 (1.54)	0.191 (1.60)	0.355*** (2.61)
9	1.415*** (4.59)	0.441** (2.23)	0.331*** (2.67)	0.075 (0.59)	0.133 (1.15)	0.278** (2.11)	1.635*** (5.56)	0.684*** (3.45)	0.553*** (4.43)	0.288** (2.33)	0.331*** (2.84)	0.468*** (3.55)
High	2.007*** (4.69)	0.881*** (2.93)	0.968*** (4.17)	0.613** (2.15)	0.840*** (3.53)	1.120*** (4.17)	2.426*** (7.04)	1.412*** (5.59)	1.369*** (6.91)	1.087*** (5.44)	1.189*** (6.21)	1.395*** (7.01)
HML	1.519*** (5.74)	1.522*** (5.83)	1.340*** (4.44)	1.376*** (4.89)	1.270*** (3.93)	1.257*** (3.77)	1.413*** (4.85)	1.444*** (5.15)	1.141*** (3.88)	1.214*** (4.53)	1.041*** (3.50)	0.994*** (2.88)

**Table IA7: IPCA Estimation Based on Subsamples and the Unrestricted IPCA Model**

At the end of each month  $t$ , stocks are sorted into deciles according to their one-month-ahead out-of-sample predicted returns ( $\hat{R}$ ) using instrumented principal component analysis (IPCA) (Kelly, Pruitt, and Su 2019). Panel A reports the month  $t + 1$  value-weighted returns for the strategy of going long (short) on the highest (lowest) expected return stocks. Portfolio returns are further adjusted by the Fama-French 6-factor model (FF6). We employ the full sample as well as subsamples that exclude microcaps, nonrated firms, and credit rating downgrades for the IPCA estimations (in the “Estimation” column) and the portfolio sorts (in the “Testing” column). Panel B employs the unrestricted IPCA model (without zero-alpha restriction) and reports the month  $t + 1$  value-weighted returns and FF6-adjusted returns for each decile portfolio as well as the strategy of going long (short) on the highest (lowest) expected return stocks (“HML”). We report the results for the full sample as well as subsamples that exclude microcaps, nonrated firms, and credit rating downgrades over the entire sample period from 1987 to 2017. Panel C reports similar statistics for the post-2001 period. Newey-West adjusted  $t$ -statistics are shown in parentheses. Numbers with “\*”, “\*\*”, and “\*\*\*” are significant at the 10%, 5%, and 1% levels, respectively.

Panel A: Value-Weighted Returns to Investment Strategies Sorted by IPCA-Predicted Returns				
Estimation	Testing	Sample Period	Return	FF6
Nonmicrocaps	Nonmicrocaps	1987–2017	1.059*** (5.87)	0.757*** (5.30)
Credit Rating Sample	Credit Rating Sample	1996–2017	0.722* (1.87)	0.434* (1.79)
Nondowngrades	Nondowngrades	1996–2017	0.586 (1.63)	0.118 (0.44)
Full Sample	Full Sample	1987–2017	0.945*** (5.62)	0.624*** (3.31)
Full Sample	Nonmicrocaps	1987–2017	0.901*** (5.57)	0.613*** (3.71)
Full Sample	Full Sample	1996–2017	1.000*** (4.61)	0.684*** (3.02)
Full Sample	Nonmicrocaps	1996–2017	0.918*** (4.52)	0.637*** (3.32)
Full Sample	Credit Rating Sample	1996–2017	1.012*** (4.70)	0.708*** (3.33)
Full Sample	Nondowngrades	1996–2017	0.797*** (3.54)	0.506** (2.21)

Table IA7—Continued

Panel B: Value-Weighted Returns to Investment Strategies Sorted by IPCA-Predicted Returns (1987–2017)								
Rank of $\hat{R}$	Full Sample		Nonmicrocaps		Credit Rating Sample		Nondowngrades	
	Return	FF6	Return	FF6	Return	FF6	Return	FF6
Low	0.374	-0.241***	0.320	-0.267***	0.359	-0.318***	0.672**	-0.039
	(1.22)	(-2.97)	(1.01)	(-3.06)	(1.12)	(-2.91)	(2.42)	(-0.30)
2	0.821***	-0.018	0.732***	-0.080	0.747***	-0.124	0.916***	0.043
	(3.14)	(-0.28)	(2.72)	(-1.04)	(2.65)	(-1.65)	(3.51)	(0.50)
3	0.906***	0.025	0.882***	0.045	0.929***	0.093	1.066***	0.267***
	(3.64)	(0.36)	(3.60)	(0.76)	(3.57)	(1.12)	(4.52)	(2.66)
4	0.907***	-0.057	0.941***	0.004	0.980***	-0.006	1.121***	0.162*
	(4.04)	(-1.06)	(3.88)	(0.06)	(4.07)	(-0.08)	(4.90)	(1.93)
5	0.995***	-0.048	0.947***	-0.051	0.972***	-0.100	1.113***	0.030
	(4.29)	(-0.64)	(4.16)	(-0.89)	(4.22)	(-1.34)	(5.21)	(0.38)
6	1.129***	0.008	0.995***	-0.041	0.958***	-0.123	1.045***	-0.036
	(4.82)	(0.12)	(4.36)	(-0.55)	(4.13)	(-1.65)	(4.77)	(-0.38)
7	1.092***	0.054	1.130***	0.015	1.044***	-0.026	1.095***	0.047
	(4.56)	(0.67)	(4.95)	(0.25)	(4.63)	(-0.34)	(4.91)	(0.58)
8	1.202***	0.124	1.082***	0.052	1.098***	0.007	1.256***	0.166*
	(4.93)	(1.26)	(4.53)	(0.64)	(4.73)	(0.08)	(5.46)	(1.73)
9	1.453***	0.279***	1.240***	0.110	1.206***	0.055	1.284***	0.140
	(5.40)	(2.73)	(5.18)	(1.17)	(5.07)	(0.52)	(5.38)	(1.25)
High	1.480***	0.244*	1.409***	0.219**	1.263***	0.063	1.380***	0.157
	(4.88)	(1.71)	(5.01)	(1.97)	(4.74)	(0.53)	(5.05)	(1.26)
HML	1.106***	0.485***	1.089***	0.486***	0.904***	0.381**	0.708***	0.196
	(4.61)	(2.88)	(4.85)	(3.58)	(3.89)	(2.42)	(3.18)	(1.19)

  

Panel C: Value-Weighted Returns to Investment Strategies Sorted by IPCA-Predicted Returns (2001–2017)								
Rank of $\hat{R}$	Full Sample		Nonmicrocaps		Credit Rating Sample		Nondowngrades	
	Return	FF6	Return	FF6	Return	FF6	Return	FF6
Low	0.103	-0.421***	0.070	-0.434***	0.050	-0.528***	0.356	-0.271*
	(0.22)	(-3.78)	(0.15)	(-3.48)	(0.10)	(-3.37)	(0.91)	(-1.67)
2	0.532	-0.155*	0.433	-0.251***	0.429	-0.305***	0.587	-0.126
	(1.35)	(-1.88)	(1.06)	(-2.63)	(1.01)	(-3.15)	(1.53)	(-1.12)
3	0.658*	0.009	0.613*	0.017	0.534	-0.063	0.706**	0.151
	(1.77)	(0.08)	(1.69)	(0.21)	(1.35)	(-0.54)	(2.01)	(1.08)
4	0.678**	-0.043	0.659*	-0.061	0.748**	0.023	0.867***	0.183
	(2.12)	(-0.67)	(1.84)	(-0.57)	(2.21)	(0.20)	(2.83)	(1.63)
5	0.716**	0.008	0.764**	0.028	0.619*	-0.140	0.769**	-0.009
	(2.21)	(0.09)	(2.35)	(0.40)	(1.80)	(-1.44)	(2.50)	(-0.10)
6	0.848***	0.073	0.712**	-0.017	0.721**	0.002	0.817***	0.118
	(2.73)	(0.89)	(2.26)	(-0.18)	(2.25)	(0.02)	(2.76)	(0.90)
7	0.779**	0.067	0.813***	0.033	0.814***	0.069	0.842***	0.090
	(2.48)	(0.66)	(2.61)	(0.42)	(2.65)	(0.71)	(2.86)	(0.89)
8	0.825***	0.096	0.772**	0.097	0.759**	0.072	0.910***	0.227**
	(2.69)	(0.96)	(2.52)	(1.04)	(2.52)	(0.74)	(3.16)	(2.39)
9	1.164***	0.364***	0.942***	0.222**	0.906***	0.193*	0.957***	0.240**
	(3.37)	(3.00)	(3.15)	(2.44)	(3.00)	(1.68)	(3.25)	(2.05)
High	1.168***	0.278	1.070***	0.182	1.047***	0.168	1.146***	0.238
	(3.18)	(1.64)	(2.97)	(1.43)	(3.01)	(1.17)	(3.17)	(1.50)
HML	1.065***	0.699***	1.000***	0.616***	0.997***	0.696***	0.790***	0.509**
	(3.26)	(3.34)	(3.08)	(3.68)	(3.03)	(3.63)	(2.67)	(2.52)

## Table IA8: Performance of Machine Learning Portfolios in Predictive Regressions

Panel A presents the results of the following monthly time series regressions, as well as their corresponding Newey-West adjusted t-statistics:

$$HML_t = \alpha_0 + \beta_1 High\ SENT_{t-1} + \beta_2 High\ MKTVOL_{t-1} + \beta_3 High\ MKTILLIQ_{t-1} + \beta_4 M_{t-1} + c'_1 F_t + c'_2 F_t \times High\ SENT_{t-1} + c'_3 F_t \times High\ MKTVOL_{t-1} + c'_4 F_t \times High\ MKTILLIQ_{t-1} + e_t,$$

where  $HML_t$  refers to the value-weighted returns on the high minus low decile portfolios sorted by the NN3-predicted returns (Gu, Kelly, and Xiu 2020) across all stocks in month  $t$ ;  $High\ SENT_{t-1}$  refers to a dummy variable that takes a value of 1 if the Baker and Wurgler (2007) investor sentiment is above the median over the entire sample period and 0 otherwise;  $High\ MKTVOL_{t-1}$  refers to a dummy variable that takes a value of 1 if the market volatility is above the median over the entire sample period and 0 otherwise, and  $High\ MKTILLIQ_{t-1}$  refers to a dummy variable that takes a value of 1 if market illiquidity is above the median and 0 otherwise. We obtain the median breakpoint for market illiquidity in the pre- and post-2001 periods separately.  $High\ SENT_{t-1}$  can be replaced with  $High\ PLS\ SENT_{t-1}$ , defined as a dummy variable that takes a value of 1 if the aligned investor sentiment from Huang, Jiang, Tu, and Zhou (2015) is above the median over the entire sample period and 0 otherwise.  $High\ MKTVOL_{t-1}$  can also be replaced with  $High\ VIX_{t-1}$ , defined as a dummy variable that takes a value of 1 if the implied market volatility is above the median over the entire sample period and 0 otherwise.  $M_{t-1}$  refers to a set of other proxies for market conditions, including down market state (DOWN), defined as a dummy variable that takes a value of 1 if the CRSP value-weighted index return is negative and 0 otherwise; term spread (TERM), defined as the difference between the average yield of 10-year Treasury bonds and three-month T-bills, and default spread (DEF), defined as the difference between the average yield of bonds rated BAA and AAA by Moody's. The vector  $F$  stacks the Fama-French six factors, including the market factor (MKT), the size factor (SMB), the book-to-market factor (HML), the profitability factor (RMW), the investment factor (CMA), and the momentum factor (MOM). Panels B to D report similar statistics when decile portfolios are sorted by the risk loadings on the stochastic discount factor (Chen, Pelger, and Zhu 2020), IPCA-predicted returns (Kelly, Pruitt, and Su 2019), and CA2-predicted returns (Gu, Kelly, and Xiu 2021). Internet Appendix A provides detailed definitions for each variable. Numbers with "\*", "\*\*", and "\*\*\*" are significant at the 10%, 5%, and 1% levels, respectively.

Panel A: Value-Weighted Returns to Investment Strategies Sorted by NN3-Predicted Returns Regressed on Lagged Market States								
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	0.867 (1.14)	0.941 (1.39)	1.255 (1.43)	1.181 (1.64)	1.500** (2.02)	1.103 (1.59)	1.679* (1.94)	1.079 (1.44)
High SENT	0.227 (0.58)		-0.006 (-0.01)		-0.184 (-0.38)		-0.263 (-0.46)	
High PLS SENT		0.459 (0.95)		0.236 (0.48)		0.463 (0.88)		0.449 (0.80)
High MKTVOL	0.959* (1.93)	0.922* (1.89)			0.661 (1.23)	0.672 (1.21)		
High VIX			1.648*** (3.29)	1.599*** (3.28)			1.418** (2.56)	1.591*** (2.87)
High MKTILLIQ	0.591 (1.37)	0.693 (1.52)	0.694 (1.41)	0.727 (1.46)	0.669 (1.43)	0.839* (1.78)	0.391 (0.77)	0.442 (0.87)
DOWN	-0.691* (-1.71)	-0.712* (-1.70)	-0.803* (-1.74)	-0.827* (-1.76)	-0.310 (-0.76)	-0.422 (-1.05)	-0.295 (-0.64)	-0.437 (-0.97)
TERM	-0.145 (-0.80)	-0.221 (-1.06)	-0.193 (-0.95)	-0.226 (-1.02)	-0.161 (-0.97)	-0.260 (-1.29)	-0.154 (-0.80)	-0.214 (-1.00)
DEF	-0.248 (-0.33)	-0.282 (-0.39)	-0.735 (-0.94)	-0.687 (-0.93)	-0.804 (-1.28)	-0.475 (-0.71)	-1.232* (-1.80)	-0.851 (-1.20)
MKT	-0.196*** (-3.35)	-0.193*** (-3.31)	-0.218*** (-3.01)	-0.216*** (-2.99)	0.292** (2.27)	0.245** (2.01)	0.171 (1.50)	0.174 (1.30)
MKT × High SENT					-0.119 (-1.00)		-0.150 (-1.15)	
MKT × High PLS SENT						-0.110 (-0.87)		-0.186 (-1.26)
MKT × High MKTVOL					-0.364*** (-3.20)	-0.343*** (-2.85)		
MKT × High VIX							-0.260** (-1.99)	-0.268** (-2.07)
MKT × High MKTILLIQ					-0.241** (-2.34)	-0.220** (-2.23)	-0.230** (-1.99)	-0.185 (-1.50)
SMB	0.532*** (4.56)	0.528*** (4.57)	0.538*** (4.21)	0.534*** (4.20)	0.268 (1.57)	0.346** (1.97)	0.158 (0.81)	0.301 (1.57)
SMB × High SENT					0.291 (1.64)		0.316 (1.62)	
SMB × High PLS SENT						0.102 (0.52)		0.027 (0.13)
SMB × High MKTVOL					-0.091 (-0.54)	-0.130 (-0.81)		
SMB × High VIX							0.060 (0.34)	-0.005 (-0.03)
SMB × High MKTILLIQ					0.500** (2.48)	0.539*** (2.63)	0.543** (2.43)	0.597*** (2.60)
HML	0.125 (1.02)	0.125 (1.02)	0.139 (1.09)	0.135 (1.07)	-0.131 (-0.51)	0.113 (0.44)	-0.209 (-0.82)	0.087 (0.34)
HML × High SENT					0.640*** (3.21)		0.685*** (2.99)	
HML × High PLS SENT						0.220 (0.78)		0.193 (0.68)
HML × High MKTVOL					-0.227 (-0.88)	-0.248 (-0.93)		
HML × High VIX							-0.086 (-0.31)	-0.145 (-0.51)
HML × High MKTILLIQ					0.116 (0.53)	0.034 (0.15)	0.087 (0.34)	0.020 (0.07)
RMW	0.582*** (6.84)	0.581*** (6.82)	0.585*** (6.72)	0.584*** (6.70)	0.420** (2.25)	0.332* (1.73)	0.372** (2.10)	0.377** (2.11)
RMW × High SENT					0.016 (0.10)		0.091 (0.52)	
RMW × High PLS SENT						0.179 (1.13)		0.178 (1.06)
RMW × High MKTVOL					-0.018 (-0.10)	-0.031 (-0.17)		
RMW × High VIX							0.005 (0.03)	-0.079 (-0.41)
RMW × High MKTILLIQ					0.172 (1.17)	0.166 (1.10)	0.201 (1.24)	0.182 (1.15)
CMA	0.733*** (6.15)	0.731*** (6.28)	0.715*** (5.57)	0.712*** (5.65)	-0.307 (-1.15)	-0.002 (-0.01)	-0.050 (-0.20)	0.282 (0.96)
CMA × High SENT					0.182 (0.83)		0.186 (0.75)	
CMA × High PLS SENT						-0.237 (-0.85)		-0.336 (-1.09)
CMA × High MKTVOL					0.878*** (3.28)	0.930*** (3.83)		
CMA × High VIX							0.671** (2.00)	0.713** (2.52)
CMA × High MKTILLIQ					0.092 (0.32)	-0.026 (-0.10)	0.009 (0.03)	-0.038 (-0.13)
MOM	0.520*** (3.20)	0.517*** (3.16)	0.497*** (2.94)	0.498*** (2.94)	0.261 (0.80)	0.124 (0.36)	0.603** (2.05)	0.367 (1.28)
MOM × High SENT					-0.304 (-0.93)		-0.428 (-1.09)	
MOM × High PLS SENT						-0.161 (-0.47)		-0.195 (-0.50)
MOM × High MKTVOL					0.455 (1.26)	0.477 (1.29)		
MOM × High VIX							-0.191 (-0.56)	-0.050 (-0.14)
MOM × High MKTILLIQ					-0.144 (-0.51)	0.107 (0.37)	0.035 (0.11)	0.318 (1.01)
Obs	372	372	335	335	372	372	335	335
R-squared	0.522	0.523	0.543	0.544	0.614	0.603	0.612	0.602

Panel B: Value-Weighted Returns to Investment Strategies Sorted by Risk Loadings Regressed on Lagged Market States								
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	0.435 (0.32)	1.257 (1.03)	0.530 (0.36)	1.554 (1.20)	0.962 (0.80)	1.759 (1.54)	0.857 (0.64)	2.125* (1.73)
High SENT	1.160* (1.91)		1.124* (1.75)		0.865 (1.26)		1.010 (1.42)	
High PLS SENT		0.863 (1.25)		0.623 (0.89)		0.559 (0.87)		0.614 (0.94)
High MKTVOL	1.066 (1.56)	1.022 (1.50)			0.921 (1.38)	0.901 (1.28)		
High VIX			1.564** (2.28)	1.382** (2.06)			1.755*** (2.60)	1.326** (1.98)
High MKTILLIQ	1.608** (2.20)	1.830** (2.27)	1.849** (2.31)	2.145** (2.47)	1.203* (1.79)	1.370* (1.84)	1.160 (1.55)	1.379* (1.71)
DOWN	-0.874 (-1.28)	-0.844 (-1.22)	-1.152 (-1.60)	-1.092 (-1.50)	-0.602 (-0.92)	-0.595 (-0.90)	-0.977 (-1.39)	-0.801 (-1.14)
TERM	0.037 (0.13)	-0.137 (-0.41)	-0.001 (-0.00)	-0.207 (-0.59)	-0.021 (-0.08)	-0.097 (-0.36)	-0.103 (-0.36)	-0.227 (-0.76)
DEF	-0.291 (-0.30)	-0.664 (-0.70)	-0.568 (-0.55)	-0.943 (-0.98)	-0.552 (-0.55)	-1.243 (-1.07)	-0.709 (-0.68)	-1.619 (-1.37)
MKT	0.163 (1.51)	0.170 (1.59)	0.203 (1.59)	0.212* (1.68)	0.054 (0.31)	0.292 (1.58)	-0.057 (-0.36)	0.202 (1.16)
MKT × High SENT					0.106 (0.55)		0.129 (0.59)	
MKT × High PLS SENT						-0.185 (-0.99)		-0.267 (-1.36)
MKT × High MKTVOL					-0.026 (-0.16)	-0.093 (-0.54)		
MKT × High VIX							0.084 (0.47)	0.031 (0.18)
MKT × High MKTILLIQ					0.229 (1.35)	0.142 (0.75)	0.305 (1.51)	0.238 (1.15)
SMB	0.626*** (3.82)	0.632*** (3.91)	0.634*** (3.65)	0.642*** (3.73)	0.447* (1.82)	0.185 (0.74)	0.275 (1.00)	0.098 (0.39)
SMB × High SENT					-0.019 (-0.07)		0.101 (0.32)	
SMB × High PLS SENT						0.398 (1.62)		0.425 (1.47)
SMB × High MKTVOL					-0.463* (-1.86)	-0.550** (-2.30)		
SMB × High VIX							-0.217 (-0.75)	-0.337 (-1.16)
SMB × High MKTILLIQ					1.024*** (3.58)	1.149*** (3.89)	0.930*** (2.77)	1.072*** (3.22)
HML	0.479*** (2.92)	0.489*** (2.95)	0.462*** (2.79)	0.465*** (2.77)	0.252 (0.76)	0.054 (0.17)	0.742** (2.45)	0.279 (0.97)
HML × High SENT					-0.105 (-0.30)		-0.303 (-0.80)	
HML × High PLS SENT						0.347 (0.93)		0.623* (1.70)
HML × High MKTVOL					0.305 (0.78)	0.254 (0.65)		
HML × High VIX							-0.305 (-0.86)	-0.352 (-0.93)
HML × High MKTILLIQ					0.034 (0.09)	-0.045 (-0.12)	0.066 (0.18)	-0.076 (-0.21)
RMW	0.013 (0.09)	0.011 (0.08)	0.028 (0.19)	0.030 (0.20)	0.496 (1.65)	0.234 (0.95)	0.858*** (2.76)	0.488* (1.96)
RMW × High SENT					-0.380 (-1.42)		-0.509* (-1.84)	
RMW × High PLS SENT						-0.045 (-0.21)		-0.094 (-0.44)
RMW × High MKTVOL					-0.133 (-0.52)	-0.040 (-0.18)		
RMW × High VIX							-0.571** (-2.04)	-0.402* (-1.70)
RMW × High MKTILLIQ					-0.416 (-1.33)	-0.353 (-1.24)	-0.322 (-1.02)	-0.228 (-0.77)
CMA	0.134 (0.57)	0.149 (0.63)	0.179 (0.72)	0.199 (0.78)	-0.475 (-1.24)	-0.146 (-0.35)	-0.469 (-1.23)	-0.067 (-0.16)
CMA × High SENT					-0.218 (-0.63)		-0.054 (-0.14)	
CMA × High PLS SENT						-0.519 (-1.35)		-0.616 (-1.58)
CMA × High MKTVOL					0.168 (0.50)	0.232 (0.70)		
CMA × High VIX							0.153 (0.46)	0.254 (0.81)
CMA × High MKTILLIQ					1.379** (2.53)	1.157** (2.41)	1.499** (2.51)	1.332** (2.53)
MOM	-0.192 (-0.62)	-0.201 (-0.64)	-0.216 (-0.65)	-0.212 (-0.63)	0.212 (0.48)	0.626 (1.51)	0.071 (0.16)	0.523 (1.39)
MOM × High SENT					0.367 (0.59)		0.568 (0.86)	
MOM × High PLS SENT						-0.354 (-0.71)		-0.513 (-1.02)
MOM × High MKTVOL					-0.789* (-1.74)	-0.970** (-2.13)		
MOM × High VIX							-0.596 (-1.34)	-0.624 (-1.41)
MOM × High MKTILLIQ					0.520 (1.13)	0.558 (1.18)	0.544 (1.18)	0.556 (1.20)
Obs	360	360	323	323	360	360	323	323
R-squared	0.168	0.164	0.184	0.180	0.273	0.269	0.296	0.289

Panel C: Value-Weighted Returns to Investment Strategies Sorted by IPCA-Predicted Returns Regressed on Lagged Market States								
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	0.176 (0.36)	0.274 (0.57)	0.084 (0.16)	0.302 (0.59)	0.394 (0.77)	0.239 (0.51)	0.233 (0.42)	0.312 (0.62)
High SENT	0.158 (0.49)		0.276 (0.82)		0.175 (0.41)		0.186 (0.43)	
High PLS SENT		0.152 (0.38)		0.226 (0.58)		0.453 (1.10)		0.501 (1.20)
High MKTVOL	0.142 (0.52)	0.134 (0.49)			-0.005 (-0.02)	-0.090 (-0.28)		
High VIX			0.302 (0.83)	0.248 (0.70)			0.312 (0.74)	0.191 (0.44)
High MKTILLIQ	0.130 (0.41)	0.168 (0.47)	0.258 (0.70)	0.345 (0.86)	0.118 (0.30)	0.123 (0.31)	0.203 (0.45)	0.289 (0.64)
DOWN	0.157 (0.44)	0.159 (0.45)	-0.055 (-0.15)	-0.044 (-0.12)	0.257 (0.67)	0.307 (0.83)	0.137 (0.33)	0.137 (0.34)
TERM	-0.006 (-0.05)	-0.035 (-0.23)	-0.037 (-0.25)	-0.097 (-0.56)	-0.018 (-0.14)	-0.064 (-0.42)	-0.047 (-0.30)	-0.156 (-0.90)
DEF	0.204 (0.47)	0.159 (0.36)	0.274 (0.62)	0.197 (0.43)	0.088 (0.19)	0.155 (0.30)	0.128 (0.30)	0.106 (0.19)
MKT	0.048 (0.98)	0.050 (1.01)	0.085 (1.57)	0.087 (1.64)	0.033 (0.37)	0.170* (1.78)	0.020 (0.22)	0.183* (1.83)
MKT × High SENT					-0.016 (-0.17)		0.080 (0.80)	
MKT × High PLS SENT						-0.261*** (-2.94)		-0.225** (-2.28)
MKT × High MKTVOL					0.071 (0.79)	0.122 (1.40)		
MKT × High VIX							0.086 (0.78)	0.103 (0.97)
MKT × High MKTILLIQ					-0.049 (-0.53)	-0.051 (-0.52)	-0.081 (-0.75)	-0.039 (-0.36)
SMB	0.164** (2.05)	0.164** (2.06)	0.173** (2.02)	0.174** (2.03)	0.166 (1.05)	0.074 (0.49)	0.084 (0.58)	0.027 (0.21)
SMB × High SENT					-0.146 (-0.87)		-0.092 (-0.53)	
SMB × High PLS SENT						-0.036 (-0.21)		-0.063 (-0.35)
SMB × High MKTVOL					0.013 (0.08)	0.016 (0.11)		
SMB × High VIX							0.105 (0.66)	0.123 (0.77)
SMB × High MKTILLIQ					0.152 (0.87)	0.182 (1.06)	0.179 (0.95)	0.211 (1.15)
HML	0.067 (0.74)	0.068 (0.76)	0.014 (0.16)	0.015 (0.17)	0.072 (0.35)	0.142 (0.78)	0.205 (1.19)	0.200 (1.23)
HML × High SENT					0.021 (0.12)		-0.138 (-0.77)	
HML × High PLS SENT						-0.085 (-0.45)		-0.026 (-0.12)
HML × High MKTVOL					0.034 (0.19)	0.087 (0.45)		
HML × High VIX							-0.056 (-0.28)	-0.031 (-0.15)
HML × High MKTILLIQ					-0.139 (-0.72)	-0.119 (-0.65)	-0.206 (-0.98)	-0.220 (-1.04)
RMW	0.368*** (5.53)	0.367*** (5.48)	0.374*** (5.31)	0.374*** (5.29)	0.311** (2.53)	0.360*** (3.44)	0.300** (2.35)	0.349*** (3.30)
RMW × High SENT					0.099 (0.89)		0.104 (0.82)	
RMW × High PLS SENT						0.072 (0.71)		0.078 (0.74)
RMW × High MKTVOL					-0.120 (-1.30)	-0.121 (-1.36)		
RMW × High VIX							-0.114 (-1.09)	-0.124 (-1.29)
RMW × High MKTILLIQ					0.160 (1.48)	0.090 (0.92)	0.174 (1.46)	0.110 (0.99)
CMA	0.004 (0.04)	0.005 (0.05)	0.030 (0.29)	0.033 (0.32)	-0.239 (-1.00)	-0.060 (-0.23)	-0.086 (-0.43)	0.102 (0.44)
CMA × High SENT					-0.248 (-1.15)		-0.111 (-0.51)	
CMA × High PLS SENT						-0.443* (-1.76)		-0.478* (-1.76)
CMA × High MKTVOL					0.251 (1.19)	0.313 (1.57)		
CMA × High VIX							0.085 (0.35)	0.203 (0.89)
CMA × High MKTILLIQ					0.079 (0.35)	0.068 (0.32)	0.003 (0.01)	0.101 (0.43)
MOM	0.262** (1.98)	0.260* (1.96)	0.305** (2.14)	0.306** (2.15)	-0.237 (-0.96)	-0.054 (-0.22)	-0.154 (-0.65)	0.087 (0.37)
MOM × High SENT					0.208 (0.77)		0.394 (1.29)	
MOM × High PLS SENT						-0.081 (-0.33)		-0.201 (-0.73)
MOM × High MKTVOL					0.499* (1.87)	0.453 (1.61)		
MOM × High VIX							0.245 (0.82)	0.282 (0.98)
MOM × High MKTILLIQ					0.034 (0.12)	0.107 (0.38)	0.150 (0.49)	0.258 (0.84)
Obs	372	372	335	335	372	372	335	335
R-squared	0.296	0.296	0.317	0.316	0.340	0.351	0.349	0.356

Panel D: Value-Weighted Returns to Investment Strategies Sorted by CA2-Predicted Returns Regressed on Lagged Market States								
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	-0.827 (-0.81)	-0.511 (-0.58)	-0.745 (-0.67)	-0.276 (-0.30)	0.192 (0.21)	0.192 (0.24)	0.300 (0.29)	0.407 (0.47)
High SENT	0.463 (1.03)		0.488 (1.00)		-0.011 (-0.02)		0.010 (0.02)	
High PLS SENT		0.385 (0.72)		0.193 (0.35)		0.034 (0.06)		0.058 (0.10)
High MKTVOL	0.077 (0.13)	0.058 (0.10)			-0.265 (-0.49)	-0.238 (-0.42)		
High VIX			0.190 (0.34)	0.126 (0.23)			0.307 (0.55)	0.364 (0.61)
High MKTILLIQ	0.490 (0.79)	0.589 (0.90)	0.821 (1.24)	0.938 (1.34)	0.267 (0.51)	0.251 (0.47)	0.281 (0.49)	0.359 (0.64)
DOWN	-0.963* (-1.66)	-0.955 (-1.63)	-1.114* (-1.84)	-1.081* (-1.78)	-0.588 (-1.23)	-0.699 (-1.38)	-0.711 (-1.35)	-0.848 (-1.52)
TERM	0.262 (1.25)	0.187 (0.78)	0.208 (0.90)	0.129 (0.52)	0.124 (0.73)	0.084 (0.43)	0.030 (0.16)	-0.036 (-0.17)
DEF	0.777 (0.81)	0.632 (0.68)	0.784 (0.79)	0.607 (0.64)	0.152 (0.17)	0.266 (0.27)	0.075 (0.08)	0.082 (0.08)
MKT	0.022 (0.27)	0.025 (0.31)	0.049 (0.48)	0.052 (0.51)	-0.107 (-0.59)	-0.083 (-0.51)	-0.070 (-0.38)	-0.018 (-0.10)
MKT × High SENT					0.133 (0.91)		0.128 (0.74)	
MKT × High PLS SENT						0.057 (0.39)		-0.037 (-0.22)
MKT × High MKTVOL					0.052 (0.34)	0.033 (0.22)		
MKT × High VIX							-0.112 (-0.60)	-0.089 (-0.49)
MKT × High MKTILLIQ					0.001 (0.01)	0.027 (0.18)	0.142 (0.82)	0.145 (0.88)
SMB	0.346** (2.46)	0.348** (2.46)	0.325** (2.23)	0.329** (2.25)	0.089 (0.45)	-0.062 (-0.34)	0.078 (0.38)	0.001 (0.00)
SMB × High SENT					-0.233 (-1.15)		-0.169 (-0.77)	
SMB × High PLS SENT						-0.002 (-0.01)		-0.113 (-0.55)
SMB × High MKTVOL					0.099 (0.46)	0.095 (0.44)		
SMB × High VIX							0.066 (0.30)	0.106 (0.50)
SMB × High MKTILLIQ					0.821*** (2.94)	0.839*** (2.98)	0.805*** (2.85)	0.829*** (3.01)
HML	0.201 (1.42)	0.206 (1.45)	0.172 (1.18)	0.175 (1.19)	0.306 (1.17)	0.430* (1.68)	0.279 (1.02)	0.389 (1.57)
HML × High SENT					0.270 (1.00)		0.303 (1.02)	
HML × High PLS SENT						0.151 (0.59)		0.312 (1.13)
HML × High MKTVOL					-0.516* (-1.82)	-0.535* (-1.91)		
HML × High VIX							-0.362 (-1.24)	-0.442 (-1.54)
HML × High MKTILLIQ					0.151 (0.57)	0.129 (0.47)	0.023 (0.09)	-0.057 (-0.20)
RMW	0.333*** (4.04)	0.333*** (4.05)	0.344*** (3.99)	0.346*** (3.99)	0.610*** (3.16)	0.533*** (3.23)	0.815*** (3.54)	0.738*** (4.14)
RMW × High SENT					-0.053 (-0.32)		-0.101 (-0.57)	
RMW × High PLS SENT						0.144 (1.11)		0.143 (1.14)
RMW × High MKTVOL					-0.183 (-1.02)	-0.189 (-1.15)		
RMW × High VIX							-0.431** (-1.98)	-0.465*** (-2.69)
RMW × High MKTILLIQ					-0.287 (-1.64)	-0.290* (-1.86)	-0.244 (-1.44)	-0.246 (-1.61)
CMA	0.127 (0.60)	0.133 (0.62)	0.158 (0.70)	0.168 (0.75)	-0.458 (-1.55)	-0.423 (-1.29)	-0.175 (-0.57)	-0.019 (-0.05)
CMA × High SENT					0.064 (0.21)		0.089 (0.28)	
CMA × High PLS SENT						0.137 (0.41)		-0.131 (-0.40)
CMA × High MKTVOL					0.458 (1.46)	0.533* (1.71)		
CMA × High VIX							0.005 (0.01)	0.158 (0.46)
CMA × High MKTILLIQ					0.654 (1.50)	0.628 (1.60)	0.863** (1.98)	0.836** (2.21)
MOM	0.364 (1.38)	0.361 (1.35)	0.358 (1.26)	0.359 (1.27)	-0.012 (-0.03)	0.282 (0.73)	0.263 (0.55)	0.489 (1.20)
MOM × High SENT					-0.205 (-0.43)		-0.325 (-0.63)	
MOM × High PLS SENT						-0.753* (-1.75)		-1.102** (-2.49)
MOM × High MKTVOL					0.280 (0.62)	0.190 (0.45)		
MOM × High VIX							-0.263 (-0.58)	-0.086 (-0.21)
MOM × High MKTILLIQ					0.713* (1.67)	0.703* (1.68)	1.091** (2.53)	1.143*** (2.96)
Obs	360	360	324	324	360	360	324	324
R-squared	0.185	0.185	0.189	0.187	0.284	0.290	0.297	0.307

**Table IA9: Performance of Machine Learning Portfolios and their Attribution: IPCA and Conditional Autoencoder**

This table reports the monthly returns from the unconditional strategy (WML) and its decomposition into intra-industry ( $WML^{INTRA}$ ) and inter-industry ( $WML^{INTER}$ ) return components, as depicted in Equation (5). In Panel A1, we report the returns for WML, where the strategy takes long (short) positions in the winner (loser) stocks that are expected to outperform (underperform) the market according to the IPCA-predicted returns (Kelly, Pruitt, and Su 2019). In Panel A2, we report the returns for  $WML^{INTRA}$ , where the strategy takes long (short) positions in the stocks that are expected to outperform (underperform) the industry portfolio.  $H^{INTRA}$  and  $H$  are the scaling factors for the unconditional and intra-industry strategies. Panel A3 reports the return for  $WML^{INTER}$ , where the strategy takes long (short) positions in the industry portfolios that are expected to outperform (underperform) the market portfolio.  $H^{INTER}$  is the scaling factor for the inter-industry strategy. Portfolio returns are further adjusted by the Fama-French 6-factor model (FF6). We report the results for the full sample as well as subsamples that exclude microcaps, nonrated firms, and credit rating downgrades. Panel B reports similar statistics when portfolios are sorted according to the CA2-predicted returns (Gu, Kelly, and Xiu 2021). Both IPCA and CA2 impose a zero-alpha restriction. Newey-West adjusted t-statistics are shown in parentheses. Numbers with “\*”, “\*\*”, and “\*\*\*” are significant at the 10%, 5%, and 1% levels, respectively.

Panel A: Returns to Investment Strategies Sorted by IPCA-Predicted Returns								
Rank	Full Sample		Nonmicrocaps		Credit Rating Sample		Nondowngrades	
	Return	FF6	Return	FF6	Return	FF6	Return	FF6
<b>Panel A1: Unconditional Payoff</b>								
Loser	0.072 (0.21)	-0.642*** (-4.83)	0.383 (1.23)	-0.460*** (-5.37)	0.400 (1.19)	-0.510*** (-4.25)	1.011*** (3.56)	0.023 (0.21)
Winner	2.019*** (6.02)	1.216*** (8.56)	1.451*** (5.19)	0.365*** (6.40)	1.432*** (4.69)	0.216** (2.50)	1.716*** (6.47)	0.466*** (6.10)
WML	1.947*** (14.24)	1.858*** (15.11)	1.067*** (8.15)	0.825*** (8.02)	1.032*** (7.70)	0.726*** (5.84)	0.705*** (5.83)	0.443*** (4.39)
<b>Panel A2: Intra-Industry Payoff</b>								
Loser	0.160 (0.47)	-0.611*** (-5.04)	0.426 (1.38)	-0.489*** (-6.86)	0.524 (1.64)	-0.530*** (-5.04)	1.041*** (3.74)	-0.063 (-0.65)
Winner	1.951*** (5.93)	1.208*** (8.03)	1.408*** (5.11)	0.392*** (6.47)	1.363*** (4.25)	0.258*** (2.80)	1.721*** (6.37)	0.561*** (6.68)
$WML^{INTRA}$	1.791*** (15.91)	1.819*** (15.69)	0.982*** (10.09)	0.881*** (9.96)	0.839*** (9.46)	0.788*** (7.79)	0.681*** (8.56)	0.623*** (7.13)
$WML^{INTRA} \times H^{INTRA}/H$	1.609*** (15.90)	1.636*** (15.65)	0.846*** (10.11)	0.761*** (9.97)	0.691*** (9.45)	0.651*** (7.77)	0.554*** (8.59)	0.508*** (7.15)
<b>Panel A3: Inter-Industry Payoff</b>								
Loser	0.608* (1.77)	-0.033 (-0.20)	0.721** (2.36)	-0.108 (-0.95)	0.602* (1.72)	-0.233* (-1.80)	1.207*** (4.20)	0.263** (2.16)
Winner	1.400*** (4.02)	0.462*** (3.58)	1.190*** (4.06)	0.031 (0.47)	1.204*** (4.08)	-0.090 (-1.01)	1.463*** (5.55)	0.156** (2.02)
$WML^{INTER}$	0.791*** (4.38)	0.495*** (3.52)	0.469*** (2.76)	0.138 (1.06)	0.601*** (3.57)	0.143 (1.01)	0.257* (1.84)	-0.107 (-0.86)
$WML^{INTER} \times H^{INTER}/H$	0.338*** (4.34)	0.222*** (3.56)	0.221*** (2.66)	0.064 (0.98)	0.341*** (3.59)	0.075 (0.89)	0.151* (1.87)	-0.065 (-0.90)

Table IA9—Continued

Panel B: Returns to Investment Strategies Sorted by CA2-Predicted Returns								
Rank	Full Sample		Nonmicrocaps		Credit Rating Sample		Nondowngrades	
	Return	FF6	Return	FF6	Return	FF6	Return	FF6
<b>Panel B1: Unconditional Payoff</b>								
Loser	0.206 (0.48)	-0.322** (-2.18)	0.299 (0.74)	-0.297*** (-3.01)	0.086 (0.19)	-0.663*** (-4.25)	1.178*** (3.31)	0.299** (2.24)
Winner	1.863*** (4.22)	1.348*** (4.51)	1.243*** (4.32)	0.138** (2.01)	1.194*** (3.34)	0.040 (0.30)	1.616*** (5.48)	0.393*** (3.81)
WML	1.657*** (8.91)	1.670*** (6.96)	0.944*** (4.51)	0.436*** (3.47)	1.107*** (4.73)	0.703*** (3.88)	0.438** (2.40)	0.094 (0.68)
<b>Panel B2: Intra-Industry Payoff</b>								
Loser	0.266 (0.61)	-0.320** (-2.28)	0.348 (0.88)	-0.363*** (-4.73)	0.263 (0.59)	-0.603*** (-4.06)	1.217*** (3.49)	0.255* (1.89)
Winner	1.815*** (4.06)	1.363*** (4.51)	1.187*** (4.09)	0.172*** (2.77)	1.099*** (2.94)	0.046 (0.33)	1.588*** (5.34)	0.450*** (4.24)
WML <sup>INTRA</sup>	1.550*** (9.45)	1.684*** (7.41)	0.838*** (5.17)	0.535*** (5.75)	0.835*** (4.48)	0.649*** (4.04)	0.371** (2.57)	0.194 (1.47)
WML <sup>INTRA</sup> × H <sup>INTRA</sup> /H	1.467*** (9.52)	1.598*** (7.52)	0.739*** (5.25)	0.478*** (5.83)	0.724*** (4.61)	0.569*** (4.17)	0.327*** (2.76)	0.184* (1.68)
<b>Panel B3: Inter-Industry Payoff</b>								
Loser	0.655* (1.84)	0.128 (0.81)	0.638* (1.92)	0.006 (0.05)	0.399 (1.01)	-0.378** (-2.34)	1.193*** (3.80)	0.307** (2.46)
Winner	1.232*** (3.63)	0.372** (2.36)	1.054*** (3.79)	-0.054 (-0.70)	1.095*** (3.54)	-0.146 (-1.44)	1.392*** (5.09)	0.139 (1.47)
WML <sup>INTER</sup>	0.578*** (2.84)	0.244 (1.41)	0.416** (2.17)	-0.060 (-0.39)	0.697*** (3.19)	0.232 (1.25)	0.198 (1.22)	-0.168 (-1.26)
WML <sup>INTER</sup> × H <sup>INTER</sup> /H	0.190** (2.53)	0.072 (1.09)	0.205** (2.11)	-0.043 (-0.53)	0.383*** (3.17)	0.134 (1.30)	0.111 (1.23)	-0.090 (-1.28)