6 Industrial technological innovations and stock returns

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As new technologies increase productivity and investment efficiency, industrial technological innovations may be able to explain the expected returns on industry portfolios. I consider the ten industry portfolios constructed by Kenneth French including nondurable goods, durable goods, manufacturing, energy, hi-tech, shops, health, utilities, and others based on four-digit Standard Industrial Classification (SIC) codes.[20] Meanwhile, industrial patent shocks and R&D shocks are constructed to measure industrial technological innovations.

To construct industrial patent shocks, I collect the company names from CRSP/Compustat dataset and then search these names in the USPTO dataset.[21] The matching process produces 4,988 firms with 608,004 successful patent applications in the period 1976Q1-2005Q4. Because the law of large number might not apply to firms and industries, the sample period ends in 2005Q4 to accommodate the two-year approval lag. I then break down all patent counts into ten industries based on assignee firms' SIC codes. The base of each industry's cumulative patents is estimated based on its percentage in all patents filed in 1976 and the total patent base used in Section 3.1. Lastly, I compute industrial patent shocks following the procedure of Section 3.2.

The construction of industrial R&D shocks is more straightforward. Quarterly industrial R&D flow is simply the sum of quarterly R&D expenses reported by all firms in each industry. The base of each industry's cumulative R&D expenses is determined by its R&D percentage in all industries reported in 1989 and the total R&D base used in Section 3.1. Finally, industrial R&D shocks are computed according to the procedure of Section 3.2.

Table **??** reports the summary statistics of portfolio returns, patent shocks, and R&D shocks of ten industries. Note that the R&D shocks of utilities industry are unavailable due to the lack of

[20] I thank Kenneth French for providing the data available at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french

[21] Instead of using the NBER patent dataset of Hall, Jaffe, and Trajtenberg (2001), I decide to manually collect my patent dataset in order to have updated patent data and quarterly application dates.

corresponding R&D data. I note that both patent shocks and R&D shocks in hi-tech and health industries are positive on average, which reflect the surge of these two industries in the past three decades. I also note that the nondurable goods industry provides the highest returns among all industries (4.2% with t-statistic 5.19) over the past three decades, while the telecom industry provides the lowest returns (3.1% with t-statistic 3.46).

I first investigate the predictive ability of industrial patent shocks and R&D shocks for the returns on individual industry portfolios. As reported in Panel A of Table **??**, I regress the real returns and excess returns of a specific industry portfolio on lagged technology shocks of that industry. Patent shocks are found to be positively correlated with one-quarter ahead portfolio returns in most industries. Eight and seven out of ten coefficients of patent shocks are positive in the regressions for real returns and excess returns, respectively. Similar results are found in R&D shocks-based regressions. I note that the coefficients of technology shocks in manufacturing, hi-tech, and health industries are all positive. This finding is intuitive as these industries are more technology-intensive than others. The prevailing insignificance of t-statistics in this table may be attributed to the idiosyncratic noises in industry portfolios or industry-specific business cycles.

To further test the effect of industrial technologies on stock returns, I implement pooled predictive regressions that may mitigate the influence of idiosyncratic noises in Panel B. I find that, controlling for common intercept or fixed effects, industrial patent shocks and R&D shocks have limited explanatory power for industry portfolio returns and premiums. The coefficients of these two shocks range from 0.3 to 0.4% with t-statistics between 1.10 and 1.48. Despite these insignificant coefficients, Table **??** hints at a lead-lag relation between industrial technological innovations and industry portfolio returns, which is consistent with the predictability hypothesis.

Table 12: Summary statistics for ten industry portfolios

This table reports the summary statistics of all variables used in the empirical analysis of ten industry portfolios. The t-statistics reported are the results of t-tests for mean zero. Sample period: 1977Q1–2005Q4 for patent shocks and portfolio returns, and 1991Q2–2006Q4 for R&D shocks.

	Variable	Mean (%)	Median (%)	Max. (%)	Min. (%)	Std. (%)	t-stat. (zero)	1st auto. autocor.
Nondurables	Port. returns	4.208	4.603	22.377	-22.343	8.544	5.19	-0.102
	Patent shocks	0.001	0.004	0.093	-0.054	0.024	0.25	0.622
	R&D shocks	0.012	0.037	0.342	-0.310	0.138	0.70	0.059
Durables	Port. returns	3.139	3.572	29.989	-27.389	10.943	3.02	-0.034
	Patent shocks	0.001	0.003	0.022	-0.051	0.010	1.20	0.654
	R&D shocks	-0.009	0.007	0.440	-0.464	0.191	-0.37	0.411
Manufacturing	Port. returns	3.681	4.727	24.036	-23.619	8.581	4.52	-0.092
	Patent shocks	-0.001	0.000	0.020	-0.018	0.006	-1.11	0.668
	R&D shocks	0.014	0.029	0.222	-0.341	0.107	1.02	0.183
Energy	Port. returns	3.960	4.439	25.262	-22.949	8.429	4.95	-0.054
	Patent shocks	-0.001	-0.002	0.016	-0.019	0.006	-2.35	0.619
	R&D shocks	0.016	0.015	0.503	-0.587	0.179	0.72	0.220
Hi-tech	Port. returns	3.606	4.302	39.909	-34.643	13.469	2.82	0.033
	Patent shocks	0.005	0.005	0.100	-0.122	0.041	1.30	0.889
	R&D shocks	0.052	0.006	1.341	-0.505	0.292	1.42	0.670
Telecom	Port. returns	3.123	3.997	26.606	-22.759	9.508	3.46	0.080
	Patent shocks	0.002	-0.003	0.356	-0.342	0.105	0.25	0.640
	R&D shocks	-0.026	-0.035	0.858	-0.835	0.308	-0.66	0.495
Shops	Port. returns	4.010	4.171	32.549	-28.944	10.267	4.12	-0.043
	Patent shocks	0.000	-0.004	0.107	-0.132	0.050	-0.06	0.557
	R&D shocks	0.054	0.014	2.167	-0.856	0.516	0.83	0.398
Health	Port. returns	4.072	3.793	26.122	-24.016	9.395	4.57	0.016
	Patent shocks	0.000	0.002	0.101	-0.111	0.036	0.12	0.717
	R&D shocks	0.065	0.038	0.487	-0.369	0.164	3.17	0.476
Utilities	Port. returns	3.233	3.880	27.133	-19.329	7.316	4.66	0.048
	Patent shocks	-0.001	0.002	0.026	-0.029	0.010	-1.47	0.684
	R&D shocks	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Others	Port. returns	3.952	4.554	23.000	-23.954	9.429	4.42	-0.056
	Patent shocks	0.000	-0.001	0.105	-0.061	0.021	0.19	0.742
	R&D shocks	0.073	0.011	1.710	-0.916	0.478	1.31	0.335

Table 13: Patent shocks, R&D shocks, and the returns on ten industry portfolios

I regress the real returns or excess returns on ten industry portfolios on lagged industry-specific patent shocks or R&D shocks ($Tech$). All technology shocks considered in regressions have been standardized for interpretational purpose. The sample sizes involving patent shocks and R&D shocks are 1977Q1–2005Q4 and 1991Q2–2006Q4, respectively. Note that I can not find sufficient R&D data of utilities industry in the examined sample period. Numbers in parentheses are t-statistics based on the Newey-West (1987) standard errors.

Panel A: Industry-specific regressions

	Real returns						**Excess returns**					
	Patent shocks			R&D shocks			Patent shocks			R&D shocks		
Industry	$Tech$	$t(Tech)$	$adjR^2$	$Tech$	$t(Tech)$	$adjR^2$	$Tech$	$t(Tech)$	$adjR^2$	$Tech$	$t(Tech)$	$adjR^2$
Nondurables	0.000	0.01	-0.009	0.007	0.85	-0.006	-0.001	-0.11	-0.009	0.007	0.85	-0.007
Durables	0.019	2.15	0.014	-0.010	-0.70	-0.007	0.019	2.09	0.012	-0.010	-0.72	-0.007
Manufacturing	0.007	1.10	-0.003	0.003	0.30	-0.014	0.005	0.79	-0.006	0.003	0.28	-0.015
Energy	-0.007	-1.19	-0.002	0.001	0.21	-0.016	-0.008	-1.25	-0.000	0.001	0.18	-0.016
Hi-tech	0.011	0.76	-0.003	0.008	0.37	-0.013	0.008	0.54	-0.006	0.008	0.39	-0.013
Telecom	0.004	0.42	-0.008	-0.018	-2.09	0.014	0.003	0.36	-0.008	-0.017	-1.99	0.011
Shops	0.003	0.26	-0.009	0.014	1.36	0.012	0.002	0.21	-0.009	0.014	1.35	0.012
Health	0.011	1.62	0.005	0.016	2.23	0.019	0.010	1.35	0.001	0.016	2.19	0.019
Utilities	0.005	0.91	-0.004	N/A	N/A	N/A	0.005	0.87	-0.004	N/A	N/A	N/A
Others	-0.002	-0.35	-0.009	0.003	0.36	-0.014	-0.002	-0.55	-0.009	0.003	0.34	-0.015

Panel B: Pooled regressions

	Real returns						**Excess returns**					
	Patent shocks			R&D shocks			Patent shocks			R&D shocks		
Regression	$Tech$	$t(Tech)$	$adjR^2$	$Tech$	$t(Tech)$	$adjR^2$	$Tech$	$t(Tech)$	$adjR^2$	$Tech$	$t(Tech)$	$adjR^2$
Common intercept	0.004	1.47	0.003	0.004	1.19	0.004	0.003	1.10	0.001	0.004	1.19	0.003
Fixed effects	0.004	1.48	-0.004	0.004	1.19	-0.007	0.003	1.10	-0.005	0.004	1.19	-0.008