Internet Appendix for

Innovation under Ambiguity and Risk

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A. Estimating Ambiguity

Our empirical measure of ambiguity is extracted from a firm's equity. Intuitively, ambiguity represents the uncertainty in future outcome *probabilities*, as opposed to risk, which measures the uncertainty in future *outcomes*. Utilizing the EUUP framework, the degree of ambiguity can be measured by the volatility of uncertain *probabilities*, just as the degree of risk can be measured by the volatility of uncertain *outcomes*. In particular, the degree of ambiguity can be measured by the expected probability-weighted average variance of probabilities (across the relevant events). Formally, the measure of ambiguity is given by (Izhakian, 2020)

$$\mho^2 [X] \; = \; \int \mathrm{E} [\varphi (x)] \, \mathrm{Var} [\varphi (x)] \, dx. \tag{1}$$

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This statistic can be estimated using trading data. The measure of ambiguity in Equation (1) is distinct from aversion to ambiguity. The former is a matter of beliefs (or information) and estimated from data, while the latter is a matter of subjective attitudes and endogenously determined by empirical estimations. Risk independence represents another major advantage of $\mho^2$; in contrast to risk measures, $\mho^2$ does not depend upon the magnitudes of the outcomes associated with the events, only upon the partition they induce over the state space.

We proceed with the empirical implementation under the following assumptions. As investors share the same information set, all have an identical set of priors over the intraday return distribution. Each prior in the set is represented by the observed daily intraday returns, and the number of priors in the set depends on the number of trading days in the month. The set of priors thus consists of 18–22 realized distributions over a month. For practical implementations, we discretize return distributions into n bins $B_j = (r_{j-1}, r_j]$ of equal size, such that each distribution is represented as a histogram. The height of the bar of a particular bin is computed as the frequency of daily intraday returns observed in that bin, and thus represents the probability of the returns in that bin. Equipped with these 18–22 daily return histograms, we compute the expected probability of being in a particular bin across the daily return distributions, $\mathrm{E}\left[\mathrm{P}\left(B_j\right)\right]$, as well as the variance of these probabilities, $\mathrm{Var}\left[\mathrm{P}\left(B_j\right)\right]$. We assign an equal likelihood to each histogram.[1] Using these values,

[1]Equal weighting is consistent with the *principle of insufficient reason*, which states that given n possibilities that are indistinguishable except for their names, each possibility should be assigned a probability equal to $\frac{1}{n}$ (Bernoulli, 1713; Laplace, 1814); with the idea of the simplest non-informative prior in Bayesian probability (Bayes et al., 1763), which assigns equal probabilities to all possibilities; and with the principle of maximum entropy (Jaynes, 1957), which states that the probability distribution which best describes the current state of knowledge is the one with the largest entropy.

the monthly degree of ambiguity of firm i is then computed as follows:

$$\mho^2 [r_i] \equiv \frac{1}{\sqrt{w(1-w)}} \sum_{j=1}^{n} \mathrm{E}[\mathrm{P}_i(B_j)] \,\mathrm{Var}[\mathrm{P}_i(B_j)]. \tag{2}$$

To minimize the impact of bin size on the scale of ambiguity, we apply a variation of Sheppard's correction and scale the probability weighted-average variance of probabilities to the size of the bins by $\frac{1}{\sqrt{w(1-w)}}$, where $w = r_j - r_{j-1}$.

We follow recent studies and estimate the empirical degree of firm-level ambiguity using intraday stock data from the *TAQ* database (e.g., Izhakian and Yermack, 2017; Augustin and Izhakian, 2020; Izhakian et al., 2022b). We compute the degree of ambiguity for each stock each month. In our implementation, we sample five-minute stock returns from 9:30 to 16:00 to mitigate microstructure effects (Andersen et al., 2001; Bandi and Russell, 2006; Liu et al., 2015). Thus, we obtain daily histograms of up to 78 intraday returns. If we observe no trade in a specific time point for a given stock, we compute returns based on the volume-weighted average of the nearest trading prices within 150 seconds distance from that time point. If there is no price change within this distance, we drop this five-minute observation of the given stock. We ignore returns between closing and next-day opening prices to eliminate the impact of overnight price changes and dividend distributions. We drop all days with fewer than 10 different five-minute returns; then we drop months with fewer than 10 intraday return distributions. We also drop extreme returns ($\pm 5\%$ log returns over five minutes), as many such returns are due to improper orders that are often later canceled by the stock exchange. In addition, we use the book value of total debt and the market value of equity estimated at every five-minute interval to unlever the intraday returns.[2] Finally, we normalize the intraday five-minute rates of return to daily returns.

For the bin formation, we divide the range of daily returns into 162 intervals. We form a grid of 160 bins, from -40% to $+40\%$, each of width 0.5%, in addition to the left and right tails, defined as $(-\infty, -40\%]$ and $(+40\%, +\infty)$, respectively. We compute the mean and the variance of probabilities for each interval, assigning equal likelihood to each distribution (i.e., all histograms are equally likely).[3] Some bins may not be populated with return realizations. Therefore, we assume a normal return distribution and use its moments to extrapolate return probabilities. That is, $\mathrm{P}_i(B_j) = \Phi(r_j; \mu_i, \sigma_i) - \Phi(r_{j-1}; \mu_i, \sigma_i)$, where $\Phi(\cdot)$ denotes the cumulative normal probability distribution, characterized by its mean μ_i and the variance σ_i^2 of the returns. As in French et al. (1987), we apply the Scholes and Williams (1977) adjustment for nonsynchronous trading to estimate the variance of returns.[4] This adjustment further eliminates any microstructure effects caused by bid-ask bounce, although our use of five-minute returns minimizes microstructure effects. Finally, $AMBIGUITY_{i,t}$, our measure of ambiguity of firm i in quarter t, is the average of the monthly ambiguity $\mho^2[r_i]$ over all months during quarter t.

An important characteristic of our measure of ambiguity is that it is outcome independent up to a state-space partition, which allows for a risk-independent examination of the impact of ambiguity on financial decisions. Specifically, the measure of ambiguity $\mho^2$ captures the variation

[2]The correlation between the ambiguity measure computed using unlevered returns and the one computed using (levered) stock returns is very high, so unlevering the returns does not alter our findings.

[3]The assignment of equal likelihoods is equivalent to assuming that the daily ratios $\frac{\mu}{\sigma}$ are Student's-t distributed. When $\frac{\mu}{\sigma}$ is Student's t-distributed, cumulative probabilities are uniformly distributed (e.g., Kendall and Stuart, 2010, Proposition 1.27, page 21).

[4]Scholes and Williams (1977) suggest adjusting the volatility of returns for nonsynchronous trading as $\sigma_t^2 = \frac{1}{N_t}\sum_{\ell=1}^{N_t}(r_{t,\ell} - \mathrm{E}[r_{t,\ell}])^2 + 2\frac{1}{N_t - 1}\sum_{\ell=2}^{N_t}(r_{t,\ell} - \mathrm{E}[r_{t,\ell}])(r_{t,\ell-1} - \mathrm{E}[r_{t,\ell-1}])$.

in the frequencies (probabilities) of outcomes but ignores the magnitudes of outcomes (returns). In contrast, the measure of risk captures the variation in the magnitudes of outcomes but ignores the variation in the frequencies with which outcomes are observed. Thus, the measure of ambiguity is risk independent, just as standard measures of risk are ambiguity independent, implying that these two measures capture distinct and different aspects of uncertainty.[5]

B. Variable Definitions

This section provides detailed definitions of all variables.

[Table IA.I]

C. Additional Analyses

This section provides additional robustness tests and analyses. In particular, Figure IA.1 plots the same histograms as in Figure 1, excluding penny stocks (stocks with price less than $5), very small firms (firms with a market capitalization less than $10 million) and very young firms (firms with less than 5 years in Compustat). Figure IA.2 plots the same histograms as in Figure 1 after excluding penny stocks, very small firms, and very young firms.

Table IA.III presents within-firm correlations for key variables for the *R&D Sample* (Panel A) and the *Patent Sample* (Panel B). Table IA.IV reports the autocorrelations of R&D, patents and citations. Table IA.V mimics Table II for splits of the high-tech firms into terciles based on firm

[5]Brenner and Izhakian (2018) and Augustin and Izhakian (2020) conduct extensive tests to validate the ambiguity measure we utilize and to address concerns that it may capture other well-known dimensions of uncertainty and (variation of) distributional moments. Thereby, these tests also address the concern that our measure of ambiguity captures time-varying distributional moments.

characteristics—age, leverage, size, and knowledge capital—measured at the end of the previous quarter, instead of average firm characteristics over the sample period. Tables IA.VI and IA.VII report additional robustness tests for the R&D results presented in Table I. Table IA.VI shows that the OLS results presented in Table I are robust to controlling for institutional ownership, illiquidity, and dividends, and also to using a broader measure of innovation investments (R&D plus CAPEX, scaled by assets at the beginning of the quarter), as well as to scaling R&D investments by the *adjusted* assets at the beginning of the quarter (where *adjusted* assets include the total assets from the balance sheet and the capitalized value of past R&D expenditures). Table IA.VII shows that the R&D results obtain if we control for dynamic endogeneity, unobservable heterogeneity, and simultaneity using the dynamic panel system GMM estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998). Table IA.VIII mimics Table III using ordered logit analysis of R&D increases, instead of multinomial logit regressions. Table IA.IX explores the determinants of patenting activity in high-tech firms. Table IA.X explores the determinants of patenting activity in non-high-tech firms. Table IA.XI explores the determinants of patenting activity in patent-intensive firms. Table IA.XII explores the determinants of patenting activity in large high-tech firms.

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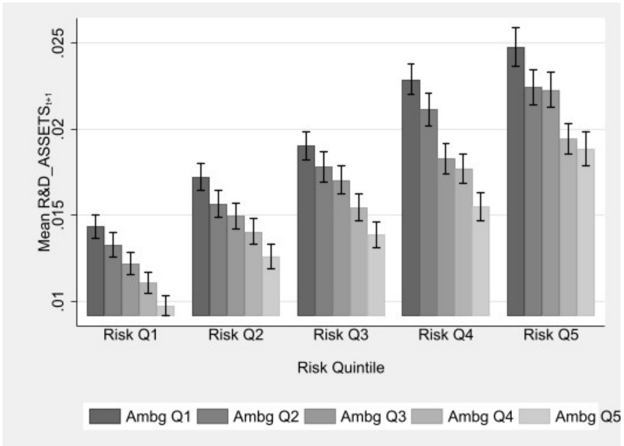
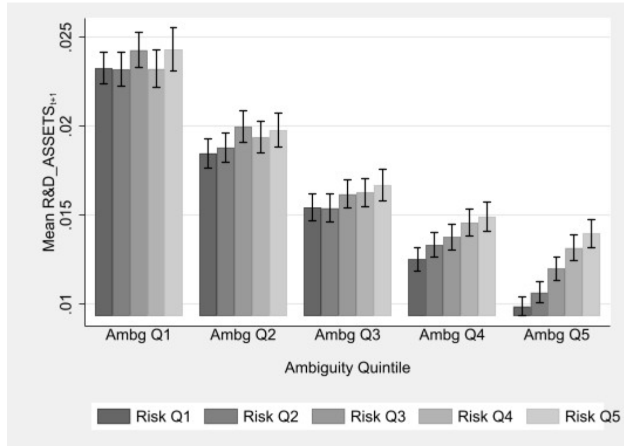
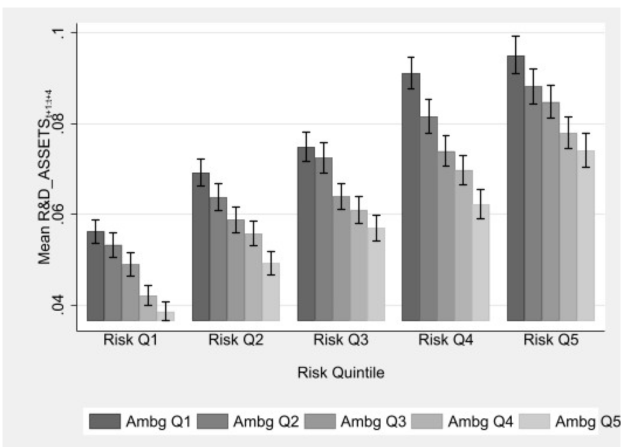


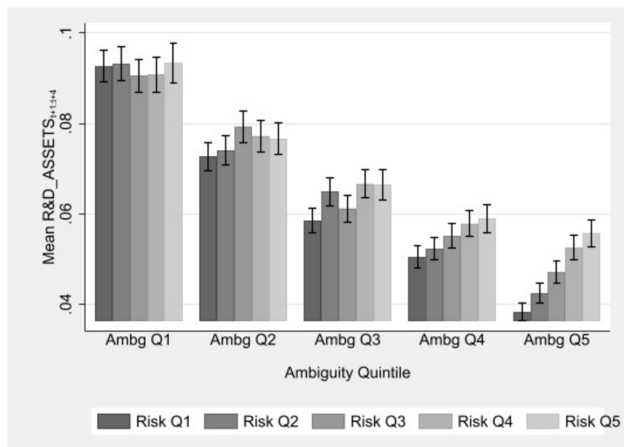
Panel A: Mean RD_ASSETS_{t+1} by Quintiles of Risk and Ambiguity



Panel B: Mean RD_ASSETS_{t+1} by Quintiles of Ambiguity and Risk



Panel C: Mean $RD\_ASSETS_{t+1:t+4}$ by Quintiles of Risk and Ambiguity

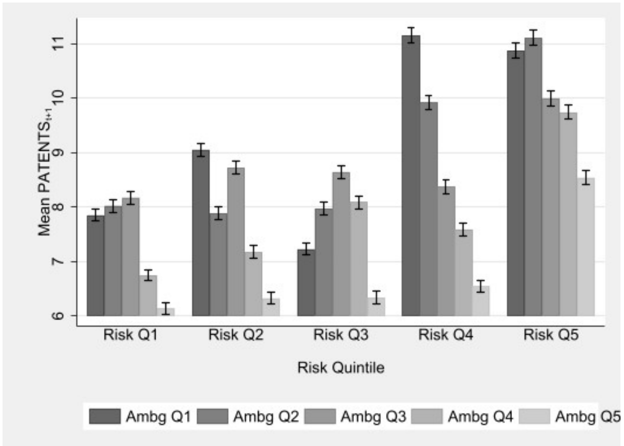


Panel D: Mean $RD\_ASSETS_{t+1:t+4}$ by Quintiles of Ambiguity and Risk

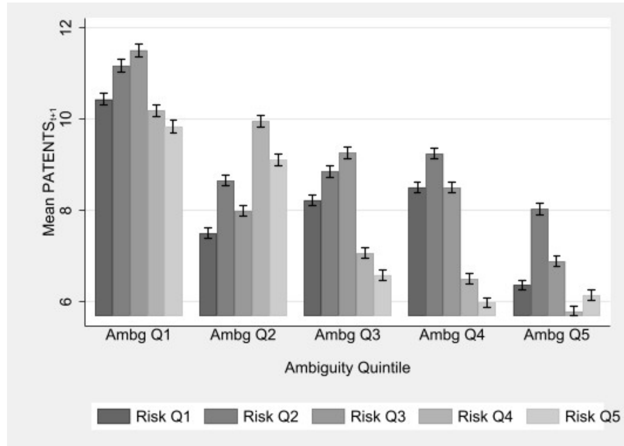
FIGURE IA.1

Mean R&D Investment for Dependent Sorts on Risk and Ambiguity: Robustness

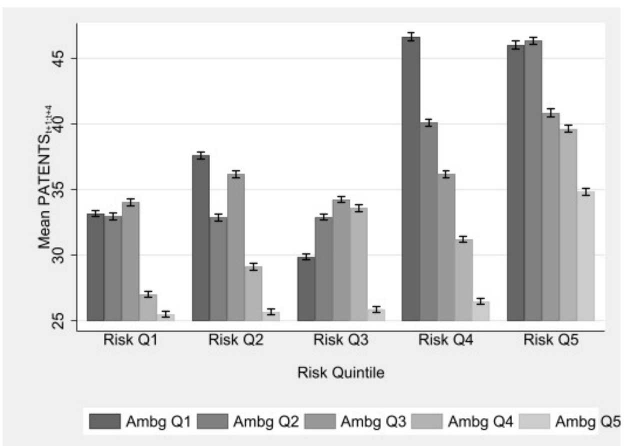
This figure plots mean R&D investments by portfolios formed each quarter within dependent sorts of risk then ambiguity. The sample period is 1993-2016. The sample consists of all firms with at least four quarters of data for all variables of interest and at least one quarter of positive R&D expenditures in Compustat during the sample period (*R&D Sample*), excluding penny stocks, very small firms, and very young firms. In Panels A and C, risk quintiles are formed each quarter within market capitalization quintiles to generate size-balanced portfolios; ambiguity quintiles are then formed within each of these market capitalization - risk portfolios. In Panels B and D, ambiguity quintiles are formed each quarter within market capitalization quintiles; risk quintiles are then formed within each of these market capitalization - ambiguity portfolios. Panels A and B plot the mean RD_ASSETS one quarter ahead (RD_ASSETS_{t+1}) and Panels C and D plot the mean RD_ASSETS one year ahead ($RD\_ASSETS_{t+1:t+4}$). Vertical bars indicate 95% confidence intervals.



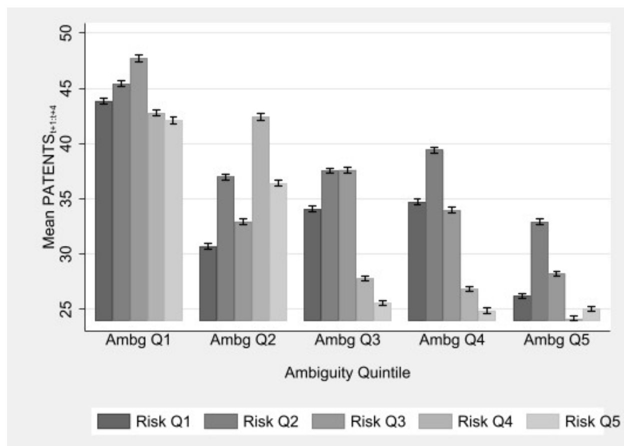
Panel A: Mean $PATENTS_{t+1}$ by Quintiles of Risk and Ambiguity



Panel B: Mean $PATENTS_{t+1}$ by Quintiles of Ambiguity and Risk



Panel C: Mean $PATENTS_{t+1:t+4}$ by Quintiles of Risk and Ambiguity



Panel D: Mean $PATENTS_{t+1:t+4}$ by Quintiles of Ambiguity and Risk

FIGURE IA.2

Mean Patent Counts for Dependent Sorts on Risk and Ambiguity

This figure plots mean patent counts by portfolios formed each quarter within dependent sorts of risk then ambiguity. The sample period is 1993-2016. The sample consists of all firms with at least four quarters of data for all variables of interest, four years in the pre-sample period, and at least one patent application filed during the sample period (*Patent Sample*), excluding penny stocks, very small firms, and very young firms. In Panels A and C, risk quintiles are formed each quarter within market capitalization quintiles to generate size-balanced portfolios; ambiguity quintiles are then formed within each of these market capitalization - risk portfolios. In Panels B and D, ambiguity quintiles are formed each quarter within market capitalization quintiles; risk quintiles are then formed within each of these market capitalization - ambiguity portfolios. Panels A and B plot the mean number of patents one quarter ahead ($PATENTS_{t+1}$), and Panels C and D plot the mean number of patents one year ahead ($PATENTS_{t+1:t+4}$). Vertical bars indicate 95% confidence intervals, where the confidence intervals are calculated assuming the Poisson distribution.

TABLE IA.I

Variable Definitions

Variable	Definitions
AGE	Number of quarters in Compustat.
$AMBIGUITY$	The ambiguity measure is detailed in Section III.D and Internet Appendix IA.A.
$ANALYST\_DISPERSION$	The standard deviation of analysts' earnings forecasts (from IBES), scaled by the average monthly price.
$ASSETS$	Compustat item *atq*.
ADJ_ASSETS	Assets adjusted for capitalized R&D. Compustat item *atq* + $RD\_CAPITAL$
$CAPEX$	Compustat item *capexy*, adjusted for fiscal year accumulation.
$CAPEX\_ASSETS$	The ratio of CAPEX to assets at the beginning of the quarter (Compustat item *atq*).
$CASH\_FLOW$	The ratio of cash-flow, calculated as (Income Before Extraordinary Items + Depreciation and Amortization) to assets at the beginning of the quarter, (*ibq* + *dpq*) / lagged *atq*.
$CITATIONS$	The number of citations received by all patents applied for in a given quarter, excluding self-cites. The number of citations for each patent is scaled by the average number of citations received by all patents in the same three-digit USPTO technology class filed in the same year (Hall et al., 2001).
$DIVIDENDS$	The ratio of dividends (Compustat item *dvy*, adjusted for fiscal year accumulation) to assets at the beginning of the quarter.
$HIGH\_KNOWLEDGE$	An indicator variable equal to 1 if the firm's $KNOWLEDGE\_CAPITAL$ in the top tercile across all firm-quarters in the sample.
K_L	The ratio of physical capital per employee. Compustat item *ppentq* divided by the number of empoyees. We estimate the number of employees at the end of each quarter by linear interpolation using the values at the beginning and at the end of the fiscal year from the Compustat Fundamentals Annual file (Compustat item *emp*). When the number of employees (*emp*) is missing either at the beginning or at the end of the fiscal year, we assign the value from the other year end point, if available, to all quarters during the year.
$KNOWLEDGE\_CAPITAL$	The capitalized number of citations received by the patents filed by the company (*gvkey*), excluding self-cites. The number of citations for each patent is scaled by the average number of citations received by all patents in the same three-digit USPTO technology class filed in the same year (Hall et al., 2001) (see $CITATIONS$). $KNOWLEDGE\_CAPITAL$ at the end of quarter t includes both citations already received by the firm's patents before the end of quarter t (*past citations*), as well as citations received after quarter t, and before the end of the sample period (*future citations*), provided that the patents were filed before the end of quarter t (the total citation stock in Hall et al. (2005)). Following Hall et al. (2005) we calculate $KNOWLEDGE\_CAPITAL$ using a depreciation rate of 15% (3.75% per quarter).

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TABLE IA.I: **Variable Definitions (Continued from Previous Page)**

Variable	Definition
$ILLIQUIDITY$	Following Amihud (2002), illiquidity is calculated as the average ratio of the daily absolute return to the (dollar) trading volume on that day. The average is taken over the trading days in the quarter, requiring at least 50 days with nonmissing data. Following Gao and Ritter (2010) we adjust the trading volume for Nasdaq firms as follows: we divide it by 2 prior to February 1, 2001, by 1.8 for February 1, 2001 to December 31, 2001, and by 1.6 for 2002 and 2003.
$INSTOWN$	Insitutional ownership, from the Thompson Reuters 13F database. Following Ben-David et al. (2021), after June 2013, we calculate institutional ownership using the 13F data parsed directly from the SEC EDGAR filings system, and available on WRDS.
$INSTOWN\_DED$	Dedicated institutional ownership; i.e., ownership by institutions with concentrated portfolio holdings and low turnover, according to the Bushee (1998) classification.
$INSTOWN\_QIX$	Quasi-indexer institutional ownership; i.e., ownership by institutions with diversified portfolios and low turnover, according to the Bushee (1998) classification.
$INSTOWN\_TRA$	Transient institutional ownership; i.e., ownership by institutions with diversified portfolios and high turnover, according to the Bushee (1998) classification.
$LARGE\_SIZE$	An indicator variable equal to 1 if the firm's quarterly sales are in the top tercile across all firm-quarters in the sample.
$LEVERAGE$	$(dlttq + dlcq)/atq$
LN_AGE	$\ln(1 + AGE)$
LN_ASSETS	$\ln(ASSETS)$
LN_K_L	$\ln(1 + K\_L)$
LN_MCAP	$\ln(MCAP)$
$LN\_PRECITATIONS$	$\ln(1 + PRECITATIONS)$
$LN\_PREPATENTS$	$\ln(1 + PREPATENTS)$
$LN\_RD\_CAPITAL$	$\ln(1 + RD\_CAPITAL)$
LN_SALES	$\ln(SALES)$
$LOW\&MED\_KNOWLEDGE$	An indicator variable equal to 1 if the firm's $KNOWLEDGE\_CAPITAL$ in the bottom or middle tercile across all firm-quarters in the sample.
$MCAP$	Market capitalization. Compustat item $prccq \times cshoq$.
$NASDAQ$	Indicator variable equal to 1 if the stock is traded on Nasdaq at the end of the quarter, and 0 otherwise.
$PATENTS$	The number of patents applied for during the quarter.
$PRECITATIONS$	The quarterly average of the number of citations received for patents applied for during the pre-sample period. See the definition of $PREPATENTS$.
$PRECITATIONS > 0$	An indicator variable equal to 1 if $PRECITATIONS > 0$, and 0 otherwise.

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TABLE IA.I: **Variable Definitions (Continued from Previous Page)**

Variable	Definition
$PREPATENTS$	The quarterly average of the number of patents applied for during the pre-sample period (Blundell et al., 1999). We use the history of patent data for each firm (*permco*) in the Kogan et al. (2017) dataset to calculate $PREPATENTS$. For firms that enter Compustat after 1993 (the first year in our sample), we use the first four years of data as the pre-sample period, and we start the sample with the fifth year in Compustat.
$PREPATENTS > 0$	An indicator variable equal to 1 if $PREPATENTS > 0$, and 0 otherwise.
Q	Tobin's Q. Calculated as (Market value of equity - Book value of equity - Deferred taxes + Assets) / Assets. $(cshoq \times prccq - ceqq - txdbq$ (replaced with zero when missing) $+ atq)/atq$. In Panel E of Table IA.VI and in Columns (7)-(9) of Table IA.VII, the denominator is $atq{+}RD\_CAPITAL$.
RD	R&D expenditures (Compustat item *xrdq*, replaced with 0 when missing).
RD_ADJ_ASSETS	The ratio of RD to adjusted assets at the beginning of the quarter (ADJ_ASSETS).
RD_ASSETS	The ratio of RD to assets at the beginning of the quarter (Compustat item *atq*).
RD_CAPEX_ASSETS	The ratio of total investment ($RD + CAPEX$) to assets at the beginning of the quarter (Compustat item *atq*).
$RD\_CAPITAL$	Capitalized R&D expenditures. Following Lev et al. (2005), Chan et al. (2001) and Chambers et al. (2002), we capitalize the R&D expenditure in the last five years, using a depreciation rate of 20% per year, or 5% per quarter: $RD\_CAPITAL_t = \sum_{k=0}^{15} RD_{t-k} \times (1 - k \times 0.05)$
$RD\_INCREASE$	An indicator variable equal to one if the firm experiences a significant increase in RD_ASSETS in the current quarter, i.e., if RD_ASSETS increases by more than 1% relative to the same quarter of the previous year, and zero otherwise.
$RD\_INCREASE\_CATEGORY$	A categorical variable that takes one of three possible values (in quarter $t + 1$): 0 (*No Increase*) if the firm does not experience a significant R&D increase in quarter $t+1$, nor in quarter $t+2$; 1 (*Delayed Increase*) if the firm experiences a significant R&D increase in quarter $t+2$, but not in quarter $t+1$; and 2 (*Immediate Increase*) if the firm experiences a significant R&D increase in quarter $t+1$. A significant R&D increase is defined as an increase of more than 1% in RD_ASSETS, relative to the same quarter of the previous year. (See also the definition of $RD\_INCREASE$.)
$MISSING\_RD$	An indicator variable equal to 1 if *xrdq* is missing in Compustat, and 0 otherwise.
RD_RATIO	$RD/(RD + CAPEX)$
$RISK$	The risk measure is defined in detail in Section III.D.
$SALES$	Compustat item *saleq*.
$SM\&MED\_SIZE$	An indicator variable equal to 1 if the firm's quarterly sales are in the bottom or middle tercile across all firm-quarters in the sample.

TABLE IA.II

Descriptive Statistics

This table presents descriptive statistics for the variables used in the analysis. The sample period is 1993-2016. In Panels A and B, the sample consists of all firms with at least four quarters of data for all variables of interest and at least one quarter of positive R&D expenditures in Compustat during the sample period (*R&D Sample*). In Panel B, the *R&D Sample* is split in two subsamples: *high-tech firms* (firms with three-digit SIC codes 283, 357, 366, 367, 382, 384, or 737) and *non-high-tech firms* (all other firms in the *R&D Sample*). The last two columns in Panel B report p-values for t tests of differences in means with unequal variances and Wilcoxon rank-sum tests for differences in medians, respectively. In Panel C, the sample consists of firms with at least four quarters of data for all variables of interest, four years in the pre-sample period, and at least one patent application filed during the sample period (*Patent Sample*). Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B.

Panel A: R&D Sample

	All Firms					
	N	**Mean**	**St. Dev.**	**p25**	**p50**	**p75**
RD_ASSETS_{t+1}	66,733	0.020	0.022	0.001	0.014	0.030
$CAPEX\_ASSETS_{t+1}$	66,293	0.012	0.013	0.004	0.008	0.015
RD_RATIO_{t+1}	66,256	0.499	0.356	0.066	0.585	0.824
$RD\_ASSETS_{t+1-t+4}$	61,289	0.078	0.082	0.015	0.051	0.117
$CAPEX\_ASSETS_{t+1-t+4}$	61,414	0.048	0.046	0.019	0.035	0.062
$RD\_RATIO_{t+1-t+4}$	60,554	0.526	0.304	0.267	0.565	0.803
$PATENTS_{t+1}$	66,668	7.492	28.689	0.000	1.000	4.000
$PATENTS_{t+1-t+4}$	62,088	31.368	115.132	0.000	3.000	17.000
$CITATIONS_{t+1}$	66,668	7.478	29.708	0.000	0.000	3.806
$CITATIONS_{t+1-t+4}$	62,088	31.007	107.527	0.000	2.381	18.259
$AMBIGUITY_t$	66,733	0.0207	0.0197	0.0070	0.0143	0.0273
$RISK_t$	66,733	0.0029	0.0055	0.0004	0.0009	0.0025
$ANALYST\_DISPERSION_t$	66,733	0.0054	0.0116	0.0008	0.0019	0.0051
$SALES_t$	66,733	780.946	2,465.043	46.774	166.312	584.087
$ASSETS_t$	66,733	3,378.341	12,016.890	242.256	771.675	2,607.760
$MCAP_t$	66,733	4,102.411	10,849.330	386.472	1,072.341	3,163.418
$RD\_CAPITAL_t$	66,733	297.144	1,016.721	22.269	68.531	193.628
$KNOWLEDGE\_CAPITAL_t$	66,726	159.343	495.070	2.476	21.278	100.708
Q_t	66,733	2.379	1.761	1.362	1.839	2.741
K_L_t	66,733	82.954	153.291	25.665	44.488	84.704
$CASH\_FLOW_t$	66,733	0.015	0.041	0.009	0.023	0.035
$LEVERAGE_t$	66,733	0.178	0.186	0.003	0.140	0.288
AGE_{t+1}	66,733	63.037	38.437	30.000	59.000	89.000
$INSTOWN\_DED_t$	66,733	0.063	0.087	0.000	0.027	0.096
$INSTOWN\_TRA_t$	66,733	0.158	0.118	0.072	0.139	0.223
$INSTOWN\_QIX_t$	66,733	0.359	0.217	0.190	0.353	0.530
$INSTOWN_t$	66,733	0.613	0.281	0.447	0.681	0.838
$NASDAQ_t$	66,733	0.559	0.497	0.000	1.000	1.000
$MISSING\_RD_{t+1}$	66,733	0.233	0.423	0.000	0.000	0.000

Panel B: R&D Sample - High-Tech vs Non High-Tech Firms

	High-Tech Firms						Non High-Tech Firms						P-Value for Diff. in	
	N	**Mean**	**St. Dev.**	**p25**	**p50**	**p75**	**N**	**Mean**	**St. Dev.**	**p25**	**p50**	**p75**	**Means**	**Medians**
RD_ASSETS_{t+1}	34,122	0.029	0.023	0.013	0.025	0.040	32,273	0.010	0.017	0.000	0.003	0.014	0.000	0.000
$CAPEX\_ASSETS_{t+1}$	33,878	0.011	0.013	0.003	0.007	0.013	32,080	0.013	0.012	0.005	0.009	0.016	0.000	0.000
RD_RATIO_{t+1}	33,870	0.684	0.271	0.563	0.768	0.888	32,052	0.305	0.331	0.000	0.187	0.594	0.000	0.000
$RD\_ASSETS_{t+1-t+4}$	30,701	0.116	0.083	0.054	0.100	0.160	29,963	0.039	0.058	0.006	0.018	0.044	0.000	0.000
$CAPEX\_ASSETS_{t+1-t+4}$	30,954	0.045	0.048	0.016	0.030	0.056	29,831	0.052	0.044	0.023	0.039	0.066	0.000	0.000
$RD\_RATIO_{t+1-t+4}$	30,281	0.693	0.233	0.571	0.757	0.872	29,655	0.357	0.273	0.120	0.320	0.555	0.000	0.000
$PATENTS_{t+1}$	34,076	8.200	33.034	0.000	1.000	4.000	32,255	6.774	23.283	0.000	0.000	4.000	0.000	0.000
$PATENTS_{t+1-t+4}$	31,348	34.655	133.483	0.000	4.000	19.000	30,105	27.829	91.256	0.000	3.000	16.000	0.000	0.000
$CITATIONS_{t+1}$	34,076	8.113	31.495	0.000	0.000	4.320	32,255	6.835	27.741	0.000	0.000	3.327	0.000	0.000
$CITATIONS_{t+1-t+4}$	31,348	34.060	120.231	0.000	2.930	20.584	30,105	27.715	91.369	0.000	1.890	16.072	0.000	0.000
$AMBIGUITY_t$	34,122	0.0176	0.0176	0.0058	0.0118	0.0227	32,273.0000	0.0240	0.0212	0.0088	0.0173	0.0323	0.000	0.000
$RISK_t$	34,122	0.0035	0.0062	0.0005	0.0011	0.0032	32,273.0000	0.0023	0.0047	0.0003	0.0007	0.0018	0.000	0.000
$ANALYST\_DISPERSION_t$	34,122	0.0058	0.0125	0.0008	0.0019	0.0053	32,273.0000	0.0051	0.0107	0.0009	0.0020	0.0049	0.000	0.005
$SALES_t$	34,122	357.450	1,128.131	29.310	82.934	272.896	32,273	1,232.846	3,288.914	107.854	345.634	1,047.236	0.000	0.000
$ASSETS_t$	34,122	1,832.867	5,345.912	165.456	448.985	1,427.051	32,273	5,027.441	16,214.800	432.883	1,354.867	4,090.291	0.000	0.000
$MCAP_t$	34,122	3,503.267	10,586.760	302.381	828.585	2,397.568	32,273	4,744.895	11,121.370	535.420	1,392.859	3,911.568	0.000	0.000
$RD\_CAPITAL_t$	34,122	336.685	969.915	33.737	84.684	242.273	32,273	256.480	1,065.464	13.123	52.806	154.807	0.000	0.000
$KNOWLEDGE\_CAPITAL_t$	34,119	162.608	523.366	3.684	23.450	104.461	32,269	156.460	463.725	1.461	19.041	98.086	0.109	0.000
Q_t	34,122	2.733	2.054	1.482	2.132	3.264	32,273	2.000	1.267	1.286	1.637	2.251	0.000	0.000
K_L_t	34,122	59.172	75.498	21.145	37.391	68.713	32,273	108.399	203.201	32.096	53.068	106.286	0.000	0.000
$CASH\_FLOW_t$	34,122	0.011	0.047	0.000	0.021	0.036	32,273	0.020	0.033	0.013	0.024	0.035	0.000	0.000
$LEVERAGE_t$	34,122	0.126	0.173	0.000	0.043	0.208	32,273	0.232	0.183	0.083	0.221	0.337	0.000	0.000
AGE_{t+1}	34,122	54.801	35.297	26.000	48.000	77.000	32,273	71.847	39.693	38.000	71.000	101.000	0.000	0.000
$INSTOWN\_DED_t$	34,122	0.059	0.084	0.000	0.020	0.088	32,273	0.068	0.091	0.000	0.035	0.103	0.000	0.000
$INSTOWN\_TRA_t$	34,122	0.168	0.124	0.077	0.149	0.238	32,273	0.148	0.109	0.068	0.130	0.207	0.000	0.000
$INSTOWN\_QIX_t$	34,122	0.337	0.219	0.160	0.317	0.513	32,273	0.382	0.212	0.232	0.386	0.547	0.000	0.000
$INSTOWN_t$	34,122	0.596	0.286	0.407	0.657	0.832	32,273	0.633	0.275	0.495	0.702	0.844	0.000	0.000
$NASDAQ_t$	34,122	0.768	0.422	1.000	1.000	1.000	32,273	0.339	0.474	0.000	0.000	1.000	0.000	0.000
$MISSING\_RD_{t+1}$	34,122	0.060	0.237	0.000	0.000	0.000	32,273	0.415	0.493	0.000	0.000	1.000	0.000	0.000

Panel C: Patent Sample

	All Firms					
	N	**Mean**	**St. Dev.**	**p25**	**p50**	**p75**
RD_ASSETS_{t+1}	63,949	0.015	0.021	0.000	0.007	0.024
$CAPEX\_ASSETS_{t+1}$	63,588	0.013	0.013	0.005	0.009	0.017
RD_RATIO_{t+1}	63,530	0.386	0.371	0.000	0.366	0.757
$RD\_ASSETS_{t+1-t+4}$	59,835	0.059	0.076	0.000	0.027	0.094
$CAPEX\_ASSETS_{t+1-t+4}$	59,765	0.053	0.049	0.021	0.038	0.068
$RD\_RATIO_{t+1-t+4}$	59,213	0.408	0.339	0.000	0.403	0.730
$PATENTS_{t+1}$	63,949	7.805	29.388	0.000	1.000	4.000
$PATENTS_{t+1-t+4}$	60,315	32.233	117.068	0.000	3.000	18.000
$CITATIONS_{t+1}$	63,949	7.749	30.458	0.000	0.000	3.915
$CITATIONS_{t+1-t+4}$	60,315	31.750	109.648	0.000	2.388	18.357
$AMBIGUITY_t$	63,949	0.023	0.020	0.008	0.017	0.030
$RISK_t$	63,949	0.002	0.004	0.000	0.001	0.002
$ANALYST\_DISPERSION_t$	63,949	0.005	0.011	0.001	0.002	0.005
$SALES_t$	63,949	1,124.571	2,935.755	88.470	302.620	940.768
$ASSETS_t$	63,949	4,699.243	13,534.060	399.117	1,247.484	3,806.023
$MCAP_t$	63,949	5,330.998	13,293.740	539.776	1,487.733	4,468.540
$RD\_CAPITAL_t$	63,949	290.304	1,035.564	0.701	55.349	183.452
$KNOWLEDGE\_CAPITAL_t$	63,949	168.075	513.937	3.412	22.643	105.029
Q_t	63,949	2.179	1.493	1.306	1.723	2.503
K_L_t	63,949	102.427	202.667	27.506	47.785	96.029
$CASH\_FLOW_t$	63,949	0.020	0.035	0.013	0.024	0.036
$LEVERAGE_t$	63,949	0.199	0.182	0.023	0.180	0.308
AGE_{t+1}	63,949	72.713	36.958	42.000	70.000	99.000
$INSTOWN\_DED_t$	63,949	0.067	0.090	0.000	0.032	0.102
$INSTOWN\_TRA_t$	63,949	0.157	0.114	0.074	0.139	0.219
$INSTOWN\_QIX_t$	63,949	0.388	0.213	0.237	0.388	0.555
$INSTOWN_t$	63,949	0.645	0.271	0.516	0.713	0.851
$NASDAQ_t$	63,949	0.455	0.498	0.000	0.000	1.000

TABLE IA.III

Within-Firm Correlations

This table presents within-firm Pearson correlation coefficients for the variables used in the analysis. The sample period is 1993-2016. In Panel A, the sample consists of all firms with at least four quarters of data for all variables of interest and at least one-quarter of positive R&D expenditures in Compustat during the sample period (*R&D Sample*). In Panel B, the sample consists of all firms with at least four quarters of data for all variables of interest, four years in the pre-sample period, and at least one patent application filed during the sample period (*Patent Sample*). Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B.

Panel A: R&D Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) $AMBIGUITY_t$	1.000																
(2) $RISK_t$	0.001	1.000															
(3) $ANALYST\_DISPERSION_t$	-0.059	0.152	1.000														
(4) LN_SALES_t	0.222	-0.350	-0.073	1.000													
(5) Q_t	-0.035	-0.056	-0.159	-0.058	1.000												
(6) $LN\_K\_L_t$	-0.034	0.007	0.045	0.088	-0.093	1.000											
(7) $CASH\_FLOW_t$	0.024	-0.082	-0.190	0.191	0.198	-0.067	1.000										
(8) $LEVERAGE_t$	-0.013	0.021	0.107	0.064	-0.101	0.062	-0.135	1.000									
(9) LN_AGE_t	0.290	-0.408	0.032	0.504	-0.204	-0.034	-0.046	0.082	1.000								
(10) $LN\_RD\_CAPITAL_t$	0.168	-0.213	0.037	0.464	-0.163	0.105	-0.088	0.063	0.458	1.000							
(11) $LN\_KNOWLEDGE\_CAPITAL_t$	0.121	-0.193	0.015	0.345	-0.153	0.074	-0.065	0.034	0.411	0.380	1.000						
(12) $INSTOWN\_DED_t$	-0.079	0.131	-0.032	-0.165	0.053	0.040	0.032	-0.008	-0.272	-0.115	-0.170	1.000					
(13) $INSTOWN\_TRA_t$	-0.173	-0.072	-0.058	-0.045	0.127	0.009	0.055	-0.030	-0.067	-0.037	-0.036	0.076	1.000				
(14) $INSTOWN\_QIX_t$	0.165	-0.231	-0.022	0.207	-0.076	-0.026	-0.003	-0.066	0.305	0.159	0.173	-0.237	0.094	1.000			
(15) $INSTOWN_t$	0.073	-0.196	-0.057	0.128	0.010	-0.010	0.028	-0.061	0.194	0.110	0.087	0.157	0.552	0.801	1.000		
(16) $NASDAQ_t$	-0.050	0.097	-0.005	-0.104	0.017	-0.014	0.023	-0.014	-0.083	-0.063	-0.049	0.022	-0.011	-0.039	-0.036	1.000	
(17) $MISSING\_RD_{t+1}$	-0.023	0.025	0.009	-0.039	0.009	0.014	-0.004	0.007	-0.055	-0.117	-0.038	0.012	0.000	-0.020	-0.018	-0.011	1.000

Panel B: Patent Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) $AMBIGUITY_t$	1.000															
(2) $RISK_t$	-0.087	1.000														
(3) $ANALYST\_DISPERSION_t$	-0.081	0.147	1.000													
(4) LN_SALES_t	0.231	-0.315	-0.073	1.000												
(5) Q_t	-0.015	-0.050	-0.152	-0.046	1.000											
(6) $LN\_K\_L_t$	-0.019	-0.007	0.035	0.121	-0.087	1.000										
(7) $CASH\_FLOW_t$	0.030	-0.066	-0.198	0.165	0.241	-0.051	1.000									
(8) $LEVERAGE_t$	-0.021	0.053	0.117	0.047	-0.124	0.059	-0.152	1.000								
(9) LN_AGE_t	0.317	-0.376	0.038	0.504	-0.178	-0.010	-0.072	0.077	1.000							
(10) $LN\_RD\_CAPITAL_t$	0.147	-0.171	0.025	0.408	-0.131	0.094	-0.082	0.065	0.364	1.000						
(11) $LN\_KNOWLEDGE\_CAPITAL_t$	0.122	-0.152	0.021	0.341	-0.119	0.072	-0.072	0.022	0.363	0.331	1.000					
(12) $INSTOWN\_DED_t$	-0.086	0.144	-0.041	-0.195	0.054	0.019	0.037	-0.010	-0.312	-0.102	-0.153	1.000				
(13) $INSTOWN\_TRA_t$	-0.182	-0.051	-0.053	-0.056	0.117	0.001	0.050	-0.024	-0.073	-0.029	-0.042	0.068	1.000			
(14) $INSTOWN\_QIX_t$	0.175	-0.218	-0.020	0.204	-0.070	-0.002	-0.014	-0.068	0.292	0.117	0.146	-0.254	0.076	1.000		
(15) $INSTOWN_t$	0.080	-0.175	-0.056	0.115	0.011	0.003	0.018	-0.058	0.179	0.080	0.069	0.149	0.530	0.799	1.000	
(16) $NASDAQ_t$	-0.049	0.126	0.005	-0.100	0.010	-0.034	0.017	-0.008	-0.073	-0.037	-0.030	0.017	-0.013	-0.033	-0.032	1.000

TABLE IA.IV

Autocorrelations of R&D, Patents and Citations

This table presents autocorrelations of quarterly R&D investments (Panel A), and patent and citation counts (Panel B). The sample period is 1993-2016. *All Firms* refers to: all firms in the *R&D Sample* in Panel A; all firms in the *Patent Sample* in Panel B Columns (1)-(5); and all firms in the *Citation Sample* in Panel B Columns (6)-(10). High-tech firms are firms with three-digit SIC codes 283, 357, 366, 367, 382, 384, or 737. Patent-intensive firms are firms in the top tercile according to the average number of patents (Panel B Columns (1)-(5)) or citations (Panel B Columns (6)-(10)) per quarter during the sample period. In each panel, Columns (1) and (6) present autocorrelations calculated for all firm-quarters (*pooled*). The other columns report statistics for within-firm correlations. *Within-firm* autocorrelations are autocorrelations calculated separately for each firm in the sample. Columns (2) and (7) report the percentage of within-firm autocorrelations that are negative and significant at the 10% level or higher; Columns (3) and (8) report the percentage of within-firm autocorrelations that are positive and significant at the 10% level or higher; Columns (4) and (9), ((5) and (10)) report the mean (median) of within-firm autocorrelations in each sample. The Cumby-Huizinga test for autocorrelation, corresponding to the pooled autocorrelations in Columns (1) and (6), rejects the null hypothesis of no autocorrelation for all lags shown in the table (untabulated results available upon request). For each sample, the p-value for the Woolridge test of serial correlation for panel data is reported in the table. The autocorrelations of RD_ADJ_ASSETS are similar to those of RD_ASSETS and are not reported for brevity. Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B. Statistical significance at the 10%, 5%, and 1% level is indicated with *, **, and ***, respectively.

Panel A: Autocorrelations of Quarterly R&D Investment

		RD_ASSETS					RD_CAPEX_ASSETS				
			Within-Firm					Within-Firm			
	Lag	Pooled (1)	% Sig Negative (2)	% Sig Positive (3)	Mean (4)	Median (5)	Pooled (6)	% Sig Negative (7)	% Sig Positive (8)	Mean (9)	Median (10)
All Firms	1	0.854	7.5%	44.2%	0.311	0.439	0.800	3.2%	41.9%	0.299	0.383
	2	0.838	8.1%	37.5%	0.223	0.263	0.772	2.9%	35.6%	0.218	0.260
	3	0.826	8.8%	32.8%	0.160	0.151	0.743	4.9%	30.7%	0.149	0.170
	4	0.905	2.2%	53.4%	0.437	0.532	0.812	2.0%	44.7%	0.326	0.390
	5	0.804	9.9%	26.6%	0.095	0.054	0.702	7.1%	22.9%	0.062	0.046
	6	0.794	11.5%	25.1%	0.069	0.018	0.687	6.4%	22.0%	0.056	0.043
	7	0.784	12.1%	23.8%	0.058	-0.011	0.666	9.3%	19.6%	0.021	-0.007
	8	0.866	4.7%	46.5%	0.328	0.394	0.747	3.8%	36.4%	0.232	0.250
	Woolridge test (p-value) : 0.002						Woolridge test (p-value) : 0.000				
High-Tech	1	0.867	1.6%	52.7%	0.441	0.595	0.823	1.4%	46.0%	0.366	0.480
	2	0.840	2.9%	43.7%	0.324	0.439	0.785	1.9%	38.5%	0.262	0.328
	3	0.827	3.3%	38.7%	0.251	0.324	0.754	3.1%	33.1%	0.192	0.249
	4	0.853	2.9%	40.4%	0.308	0.374	0.765	2.6%	35.4%	0.235	0.274
	5	0.794	4.5%	30.0%	0.162	0.195	0.706	4.9%	25.2%	0.105	0.120
	6	0.776	6.4%	29.2%	0.143	0.175	0.683	4.6%	24.1%	0.099	0.127
	7	0.766	7.5%	27.9%	0.124	0.140	0.666	6.6%	22.6%	0.068	0.062
	8	0.794	6.6%	31.2%	0.167	0.187	0.689	4.8%	25.7%	0.133	0.144
	Woolridge test (p-value) : 0.000						Woolridge test (p-value) : 0.000				
Non High-Tech	1	0.731	15.0%	31.2%	0.123	-0.091	0.689	5.3%	33.7%	0.187	0.195
	2	0.723	15.1%	27.8%	0.077	-0.124	0.670	4.1%	28.9%	0.134	0.141
	3	0.708	15.7%	23.2%	0.036	-0.146	0.633	7.3%	24.8%	0.070	0.038
	4	0.934	1.3%	68.3%	0.600	0.794	0.820	1.3%	54.6%	0.431	0.525
	5	0.685	16.3%	20.6%	-0.004	-0.164	0.586	10.1%	17.8%	-0.012	-0.069
	6	0.680	17.3%	18.8%	-0.025	-0.180	0.580	8.8%	17.2%	-0.006	-0.042
	7	0.664	17.9%	17.4%	-0.022	-0.175	0.544	12.9%	14.1%	-0.056	-0.125
	8	0.901	2.3%	64.0%	0.529	0.725	0.749	3.1%	48.2%	0.347	0.416
	Woolridge test (p-value) : 0.011						Woolridge test (p-value) : 0.265				

Panel B: Autocorrelations of Quarterly Patent and Citation Counts

		PATENTS					*CITATIONS*				
			Within-Firm					**Within-Firm**			
	Lag	**Pooled**	**% Sig Negative**	**% Sig Positive**	**Mean**	**Median**	**Pooled**	**% Sig Negative**	**% Sig Positive**	**Mean**	**Median**
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
All Firms	1	0.913	1.5%	27.9%	0.136	0.087	0.728	0.5%	19.0%	0.065	-0.010
	2	0.909	1.5%	27.2%	0.121	0.075	0.742	0.8%	18.5%	0.061	-0.004
	3	0.889	1.1%	25.9%	0.114	0.060	0.672	0.9%	17.0%	0.052	-0.023
	4	0.922	1.0%	27.7%	0.148	0.112	0.746	0.3%	19.2%	0.093	0.025
	5	0.873	1.5%	22.3%	0.106	0.048	0.682	1.0%	15.5%	0.058	-0.018
	6	0.875	1.5%	21.6%	0.097	0.061	0.698	0.7%	16.8%	0.065	-0.015
	7	0.858	1.6%	19.3%	0.078	0.023	0.721	1.3%	15.6%	0.058	-0.018
	8	0.881	1.8%	21.4%	0.099	0.061	0.733	0.7%	16.2%	0.063	-0.016
	Woolridge test (p-value) : 0.890						Woolridge test (p-value) : 0.055				
High-Tech	1	0.906	1.6%	28.3%	0.149	0.117	0.729	0.5%	19.1%	0.067	-0.011
	2	0.896	0.8%	28.2%	0.139	0.103	0.754	1.0%	17.9%	0.075	0.029
	3	0.876	0.9%	24.5%	0.125	0.079	0.718	0.8%	15.2%	0.060	-0.011
	4	0.915	0.6%	26.0%	0.161	0.134	0.779	0.2%	17.8%	0.108	0.051
	5	0.856	1.8%	22.0%	0.127	0.091	0.654	1.5%	16.4%	0.061	-0.012
	6	0.860	2.0%	21.1%	0.085	0.048	0.676	0.9%	14.6%	0.039	-0.020
	7	0.844	2.3%	17.7%	0.061	0.000	0.737	1.6%	14.3%	0.054	-0.029
	8	0.866	1.9%	20.3%	0.097	0.080	0.747	1.1%	14.9%	0.063	0.002
	Woolridge test (p-value) : 0.283						Woolridge test (p-value) : 0.076				
Non High-Tech	1	0.916	2.0%	26.2%	0.117	0.054	0.688	0.4%	17.8%	0.056	-0.018
	2	0.923	2.4%	25.5%	0.098	0.036	0.692	1.0%	16.9%	0.040	-0.021
	3	0.907	1.4%	23.8%	0.086	0.020	0.584	0.8%	15.9%	0.041	-0.025
	4	0.936	0.9%	29.0%	0.153	0.092	0.686	0.5%	19.7%	0.095	0.012
	5	0.898	1.3%	20.8%	0.092	0.021	0.684	1.1%	13.8%	0.044	-0.023
	6	0.891	1.1%	20.7%	0.098	0.049	0.688	0.9%	15.1%	0.066	-0.015
	7	0.871	1.0%	18.7%	0.073	0.018	0.660	1.7%	14.4%	0.055	-0.018
	8	0.894	1.4%	21.1%	0.096	0.044	0.677	0.3%	15.9%	0.064	-0.017
	Woolridge test (p-value) : 0.142						Woolridge test (p-value) : 0.088				
Patent-Intensive	1	0.904	1.2%	49.0%	0.301	0.319	0.701	0.9%	32.7%	0.174	0.160
	2	0.899	1.2%	46.0%	0.270	0.291	0.716	0.9%	30.4%	0.134	0.128
	3	0.878	1.2%	41.9%	0.222	0.232	0.639	1.0%	27.9%	0.120	0.100
	4	0.914	1.1%	45.9%	0.284	0.294	0.719	0.5%	30.9%	0.191	0.184
	5	0.860	1.6%	36.0%	0.206	0.219	0.649	1.3%	24.2%	0.121	0.106
	6	0.862	2.0%	34.4%	0.193	0.206	0.666	0.9%	23.8%	0.131	0.115
	7	0.844	1.8%	29.2%	0.142	0.138	0.688	2.3%	22.0%	0.095	0.083
	8	0.869	1.5%	32.6%	0.182	0.188	0.702	0.9%	24.6%	0.124	0.100
	Woolridge test (p-value) : 0.886						Woolridge test (p-value) : 0.056				

TABLE IA.V

Subsample Analysis of R&D Investment in High-Tech Firms

This table presents OLS regression coefficients for R&D investment. The dependent variable is RD_ASSETS_{t+1} in Panels A1 and B1, and $RD\_ASSETS_{t+1:t+4}$ in Panels A2 and B2. The sample period is 1993-2016. The sample is the same as in Table II (the *R&D Sample*, excluding penny stocks, very small firms, and very young firms, and further restricted to high-tech firms). In Panel A (B), the sample is split into age and leverage (sales and knowledge capital) terciles, with the split variable being measured at the end of quarter t. $HIGH$ is an indicator variable that takes the value 1 if the split variable is in the top tercile across all firm-quarters in the sample (i.e., for old firms, high-leverage firms, large firms, and high-knowledge-capital firms, respectively), and 0 otherwise. All regressions include the following control variables: LN_SALES_t, Q_t, $LN\_K\_L_t$, $CASH\_FLOW_t$, $LEVERAGE_t$, LN_AGE_{t+1}, $LN\_RD\_CAPITAL_t$, $NASDAQ_t$ and $MISSING\_RD_{t+1}$. In Panels A1 and B1, $MISSING\_RD_{t+1}$ is an indicator variable equal to 1 if the firm has missing R&D expenditures in Compustat in quarter $t+1$ and 0 otherwise. In Panels A2 and B2, $MISSING\_RD_{t+1}$ is the number of quarters with missing R&D in Compustat in the period $t+1:t+4$. All regressions include firm (*new gvkey*) fixed effects and quarter-year fixed effects. Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B. Standard errors are clustered by firm. Statistical significance at the 10%, 5%, and 1% level is indicated with *, **, and ***, respectively.

Panel A: **Subsamples by Age and Leverage in the Previous Quarter**

	AGE (Quarter t)					**LEVERAGE (Quarter t)**				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
	Young	**Middle**	**Old**	**All Firms**		**Low**	**Medium**	**High**	**All Firms**	
A1: RD_ASSETS one quarter ahead (quarter $t+1$)										
$AMBIGUITY_t$	-0.038**	-0.032**	-0.021*	-0.042***	-0.041***	-0.054**	-0.019	-0.037***	-0.051***	-0.050***
	(0.018)	(0.016)	(0.013)	(0.013)	(0.013)	(0.024)	(0.016)	(0.014)	(0.014)	(0.014)
$RISK_t$	0.451***	0.201*	0.261**	0.337***	0.349***	0.419***	0.176*	0.350***	0.335***	0.350***
	(0.089)	(0.110)	(0.104)	(0.075)	(0.079)	(0.145)	(0.090)	(0.122)	(0.075)	(0.081)
$AMBIGUITY_t \times HIGH_t$				0.009	0.006				0.029**	0.026*
				(0.015)	(0.015)				(0.014)	(0.014)
$RISK_t \times HIGH_t$					-0.123					-0.083
					(0.108)					(0.098)
$HIGH_t$				0.001	0.001				-0.003***	-0.003***
				(0.001)	(0.001)				(0.001)	(0.001)
$ANALYST\_DISPERSION_t$	0.052**	0.058**	0.046	0.066***	0.067***	0.069**	0.043	0.014	0.064***	0.065***
	(0.023)	(0.029)	(0.043)	(0.022)	(0.021)	(0.030)	(0.028)	(0.032)	(0.022)	(0.022)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	8,339	8,029	8,045	24,413	24,413	8,138	8,138	8,137	24,413	24,413
N firms	728	637	410	1,074	1,074	624	726	585	1,074	1,074
Adj R2	0.811	0.804	0.795	0.772	0.772	0.784	0.798	0.808	0.772	0.772
A2: RD_ASSETS four quarters ahead (quarters $t+1:t+4$)										
$AMBIGUITY_t$	-0.123**	-0.114**	-0.096**	-0.145***	-0.143***	-0.219**	-0.052	-0.169***	-0.188***	-0.183***
	(0.061)	(0.056)	(0.043)	(0.048)	(0.049)	(0.102)	(0.058)	(0.048)	(0.055)	(0.055)
$RISK_t$	1.853***	0.701*	1.112**	1.190***	1.223***	1.905***	0.740**	1.279***	1.185***	1.253***
	(0.383)	(0.409)	(0.454)	(0.311)	(0.330)	(0.654)	(0.342)	(0.443)	(0.312)	(0.345)
$AMBIGUITY_t \times HIGH_t$				0.007	0.000				0.097*	0.085
				(0.056)	(0.056)				(0.053)	(0.054)
$RISK_t \times HIGH_t$					-0.318					-0.343
					(0.458)					(0.402)
$HIGH_t$				0.002	0.003				-0.010***	-0.009***
				(0.003)	(0.003)				(0.003)	(0.003)
$ANALYST\_DISPERSION_t$	0.068	0.145	0.260**	0.192***	0.193***	0.135	0.125	0.013	0.187***	0.189***
	(0.089)	(0.107)	(0.122)	(0.068)	(0.068)	(0.115)	(0.125)	(0.082)	(0.069)	(0.069)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7,531	7,319	7,215	22,065	22,065	7,355	7,355	7,355	22,065	22,065
N firms	655	586	376	973	973	563	657	535	973	973
Adj R2	0.877	0.871	0.878	0.835	0.835	0.846	0.872	0.876	0.836	0.836

Panel B: **Subsamples by Size and Knowledge Capital in the Previous Quarter**

	SIZE (Quarter t)					**KNOWLEDGE_CAPITAL (Quarter t)**				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
	Small	**Medium**	**Large**	**All Firms**		**Low**	**Medium**	**High**	**All Firms**	
B1: RD_ASSETS one quarter ahead (quarter $t+1$)										
$AMBIGUITY_t$	-0.092***	-0.022	-0.010	-0.060***	-0.060***	-0.051***	-0.040**	-0.020	-0.060***	-0.065***
	(0.020)	(0.016)	(0.015)	(0.015)	(0.015)	(0.018)	(0.017)	(0.016)	(0.015)	(0.015)
$RISK_t$	0.483***	0.210	0.576	0.338***	0.338***	0.313***	0.392***	1.319***	0.344***	0.337***
	(0.078)	(0.129)	(0.370)	(0.074)	(0.074)	(0.091)	(0.110)	(0.404)	(0.074)	(0.074)
$AMBIGUITY_t \times HIGH_t$				0.033*	0.034**				0.044**	0.062***
				(0.017)	(0.017)				(0.019)	(0.019)
$RISK_t \times HIGH_t$					0.082					0.813**
					(0.353)					(0.321)
$HIGH_t$				-0.000	-0.001				-0.002*	-0.003***
				(0.001)	(0.001)				(0.001)	(0.001)
$ANALYST\_DISPERSION_t$	0.083***	0.031	0.035	0.065***	0.065***	0.063**	0.078*	0.035	0.065***	0.064***
	(0.025)	(0.026)	(0.030)	(0.022)	(0.022)	(0.026)	(0.042)	(0.024)	(0.022)	(0.022)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	8,138	8,138	8,137	24,413	24,413	8,137	8,137	8,136	24,410	24,410
N firms	691	505	323	1,074	1,074	560	520	306	1,074	1,074
Adj R2	0.805	0.768	0.760	0.772	0.772	0.749	0.815	0.799	0.772	0.772
B2: RD_ASSETS four quarters ahead (quarters $t+1:t+4$)										
$AMBIGUITY_t$	-0.330***	-0.116*	-0.039	-0.205***	-0.200***	-0.157**	-0.173***	-0.083	-0.204***	-0.216***
	(0.087)	(0.064)	(0.053)	(0.060)	(0.060)	(0.070)	(0.061)	(0.061)	(0.057)	(0.056)
$RISK_t$	1.893***	0.779	0.145	1.191***	1.189***	1.146***	1.568***	4.014***	1.222***	1.211***
	(0.336)	(0.579)	(1.048)	(0.309)	(0.309)	(0.363)	(0.480)	(1.077)	(0.308)	(0.308)
$AMBIGUITY_t \times HIGH_t$				0.092	0.075				0.122*	0.164**
				(0.067)	(0.066)				(0.073)	(0.070)
$RISK_t \times HIGH_t$					-0.890					1.876
					(1.167)					(1.212)
$HIGH_t$				-0.001	0.000				-0.007*	-0.010**
				(0.003)	(0.003)				(0.004)	(0.004)
$ANALYST\_DISPERSION_t$	0.189*	-0.004	0.241***	0.189***	0.193***	0.150	0.185	0.170	0.189***	0.184***
	(0.112)	(0.092)	(0.086)	(0.068)	(0.069)	(0.101)	(0.115)	(0.104)	(0.068)	(0.068)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7,355	7,355	7,355	22,065	22,065	7,355	7,355	7,355	22,065	22,065
N firms	613	466	302	973	973	505	471	288	973	973
Adj R2	0.848	0.853	0.864	0.835	0.835	0.848	0.877	0.837	0.836	0.836

TABLE IA.VI

Determinants of R&D Investment: Robustness Tests

This table presents OLS coefficient estimates for R&D investment. The dependent variable is RD_ASSETS_{t+1} in Panels A, B and C, $RD\_CAPEX\_ASSETS_{t+1}$ in Panel D, and $RD\_ADJ\_ASSETS_{t+1}$ in Panel E. The sample period is 1993-2016. The sample consists of all firms with at least four quarters of data for all variables of interest and at least one quarter of positive R&D expenditures in Compustat during the sample period (*R&D Sample*), excluding penny stocks, very small firms, and very young firms. All regressions include the following control variables: LN_SALES_t, Q_t, $LN\_K\_L_t$, $CASH\_FLOW_t$, $LEVERAGE_t$, LN_AGE_{t+1}, $LN\_RD\_CAPITAL_t$, $NASDAQ_t$ and $MISSING\_RD_{t+1}$. The denominator used to calculate Q_t is the book value of assets (Compustat item *atq* at the end of quarter t) in Panels A–D, and the book value of assets plus capitalized R&D (Compustat item *atq* at the end of quarter t plus $RD\_CAPITAL_t$) in Panel E. In Columns 1, 3 and 5, $MISSING\_RD_{t+1}$ is an indicator variable equal to 1 if the firm has missing R&D expenditures in Compustat in quarter $t+1$, and 0 otherwise. In Columns 2, 4 and 6, $MISSING\_RD_{t+1}$ is the number of quarters with missing R&D in Compustat in the period $t+1 : t+4$. All regressions include firm (*new gvkey*) fixed effects and quarter-year fixed effects. Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B. Standard errors are clustered by firm. Statistical significance at the 10%, 5%, and 1% level is indicated with *, **, and ***, respectively.

	All Firms		High-Tech		Non High-Tech	
	(1)	(2)	(3)	(4)	(5)	(6)
	One Quarter	One Year	One Quarter	One Year	One Quarter	One Year
	$t+1$	$t+1:t+4$	$t+1$	$t+1:t+4$	$t+1$	$t+1:t+4$
Panel A: Controlling for Institutional Ownership						
$AMBIGUITY_t$	-0.012**	-0.072***	-0.038***	-0.140***	0.000	-0.045***
	(0.005)	(0.018)	(0.011)	(0.043)	(0.005)	(0.016)
$RISK_t$	0.172***	0.819***	0.334***	1.210***	0.023	0.307**
	(0.045)	(0.174)	(0.075)	(0.310)	(0.042)	(0.139)
$ANALYST\_DISPERSION_t$	0.050***	0.122***	0.065***	0.192***	0.025***	0.041*
	(0.010)	(0.033)	(0.022)	(0.068)	(0.009)	(0.024)
$INSTOWN\_DED_t$	-0.000	0.005	-0.003	-0.006	0.000	0.005
	(0.001)	(0.005)	(0.003)	(0.010)	(0.001)	(0.004)
$INSTOWN\_TRA_t$	-0.000	0.002	-0.000	0.006	0.000	-0.000
	(0.001)	(0.004)	(0.002)	(0.007)	(0.001)	(0.005)
$INSTOWN\_QIX_t$	0.000	-0.001	0.000	-0.003	0.000	0.001
	(0.000)	(0.002)	(0.001)	(0.003)	(0.001)	(0.002)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	51,218	47,159	24,413	22,065	26,604	24,652
N firms	1,917	1,769	1,074	973	911	848
Adj R2	0.816	0.885	0.772	0.835	0.785	0.889
Panel B: Controlling for Illiquidity						
$AMBIGUITY_t$	-0.012**	-0.072***	-0.038***	-0.143***	0.001	-0.044***
	(0.005)	(0.018)	(0.011)	(0.043)	(0.005)	(0.016)
$RISK_t$	0.173***	0.813***	0.322***	1.151***	0.021	0.306**
	(0.046)	(0.177)	(0.076)	(0.319)	(0.042)	(0.142)
$ANALYST\_DISPERSION_t$	0.050***	0.120***	0.066***	0.191***	0.025***	0.041
	(0.010)	(0.033)	(0.022)	(0.068)	(0.009)	(0.025)
$ILLIQUIDITY_t$	-0.000	-0.000	0.001	0.003	-0.000	-0.000*
	(0.000)	(0.000)	(0.001)	(0.003)	(0.000)	(0.000)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	51,218	47,159	24,413	22,065	26,604	24,652
N firms	1,917	1,769	1,074	973	911	848
Adj R2	0.816	0.885	0.772	0.835	0.785	0.889

	All Firms		High-Tech		Non High-Tech	
	(1)	(2)	(3)	(4)	(5)	(6)
	One Quarter	One Year	One Quarter	One Year	One Quarter	One Year
	$t+1$	$t+1:t+4$	$t+1$	$t+1:t+4$	$t+1$	$t+1:t+4$
Panel C: Controlling for Dividends						
$AMBIGUITY_t$	-0.013**	-0.075***	-0.040***	-0.149***	-0.000	-0.045***
	(0.005)	(0.019)	(0.011)	(0.043)	(0.005)	(0.016)
$RISK_t$	0.175***	0.813***	0.340***	1.204***	0.021	0.302**
	(0.045)	(0.175)	(0.075)	(0.310)	(0.042)	(0.141)
$ANALYST\_DISPERSION_t$	0.051***	0.121***	0.066***	0.192***	0.025***	0.041
	(0.010)	(0.033)	(0.022)	(0.068)	(0.009)	(0.025)
$DIVIDENDS_t$	0.070*	0.149	0.137*	0.482	0.058*	0.086
	(0.038)	(0.154)	(0.076)	(0.329)	(0.034)	(0.124)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	51,218	47,159	24,413	22,065	26,604	24,652
N firms	1,917	1,769	1,074	973	911	848
Adj R2	0.816	0.885	0.772	0.836	0.785	0.889
Panel D: Total Investment (R&D plus CAPEX, $RD\_CAPEX\_ASSETS_{t+1}$)						
$AMBIGUITY_t$	-0.011	-0.081***	-0.030**	-0.117**	-0.000	-0.063**
	(0.007)	(0.028)	(0.014)	(0.058)	(0.008)	(0.028)
$RISK_t$	0.167***	1.106***	0.262***	1.215***	0.023	0.742***
	(0.061)	(0.261)	(0.098)	(0.455)	(0.073)	(0.269)
$ANALYST\_DISPERSION_t$	0.019	-0.089*	0.040	-0.027	-0.003	-0.137***
	(0.014)	(0.047)	(0.026)	(0.094)	(0.016)	(0.044)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	50,918	46,705	24,263	21,827	26,458	24,438
N firms	1,909	1,757	1,069	967	908	841
Adj R2	0.714	0.792	0.686	0.763	0.677	0.777
Panel E: Adjusting Total Assets For Capitalized R&D ($RD\_ADJ\_ASSETS_{t+1}$)						
$AMBIGUITY_t$	-0.004	-0.038***	-0.015**	-0.061**	0.000	-0.030***
	(0.004)	(0.012)	(0.007)	(0.026)	(0.004)	(0.011)
$RISK_t$	0.077***	0.435***	0.151***	0.608***	0.020	0.199*
	(0.029)	(0.109)	(0.046)	(0.187)	(0.032)	(0.110)
$ANALYST\_DISPERSION_t$	0.024***	0.040**	0.029**	0.064	0.015**	0.005
	(0.006)	(0.020)	(0.012)	(0.040)	(0.006)	(0.016)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	51,052	46,832	24,283	21,836	26,569	24,559
N firms	1,909	1,764	1,066	969	911	848
Adj R2	0.819	0.897	0.780	0.841	0.764	0.900

TABLE IA.VII

Dynamic Panel GMM Analysis of R&D Investment

This table presents coefficient estimates from regressions of R&D investment using the dynamic panel system GMM estimator of Arellano and Bover (1995) and Blundell and Bond (1998). The dependent variable is RD_ASSETS_{t+1} in Columns 1-3, $RD\_CAPEX\_ASSETS_{t+1}$ in Columns 4-6, and $RD\_ADJ\_ASSETS_{t+1}$ in Columns 7-9. The model includes the first four lags of the dependent variable, denoted by RD_t, RD_{t-1}, RD_{t-2} and RD_{t-3}. The sample period is 1993-2016. For each dependent variable, Column A presents results for the *R&D Sample*, restricted to high-tech firms (three-digit SIC codes 283, 357, 366, 367, 382, 384, or 737). In Column B, the sample is as in Column A, excluding penny stocks and very small firms. In Column C, the sample is as in Column A, excluding penny stocks, very small firms, and very young firms. Each regression includes quarter-year fixed effects. All explanatory variables are assumed to be endogenous with the exception of LN_AGE_{t+1} and the quarter-year dummy variables. The lagged values of the dependent variable and of the endogenous variables, all measures two and three years before quarter t (quarters $t-4:t-11$) are used as instruments. AR(1) and AR(2) are tests for first-order and second-order serial correlation in the first-differenced residuals under the null of no serial correlation. The Hansen test of over-identification is under the null that all instruments are valid. The Diff-in-Hansen test of exogeneity is under the null that instruments used for the equations in levels are exogenous. Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B. Standard errors are clustered by firm and incorporate the Windmeijer (2005) finite sample correction. Statistical significance at the 10%, 5%, and 1% level is indicated with *, **, and ***, respectively.

	RD_ASSETS_{t+1}			$RD\_CAPEX\_ASSETS_{t+1}$			$RD\_ADJ\_ASSETS_{t+1}$		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
$AMBIGUITY_t$	-0.149**	-0.171***	-0.150***	-0.206**	-0.187**	-0.167**	-0.062*	-0.071**	-0.047
	(0.058)	(0.054)	(0.058)	(0.085)	(0.077)	(0.073)	(0.037)	(0.035)	(0.035)
$RISK_t$	0.702**	0.929	2.230***	0.902*	0.671	2.021	0.127	0.229	0.915*
	(0.353)	(0.609)	(0.748)	(0.476)	(0.883)	(1.432)	(0.220)	(0.425)	(0.489)
$ANALYST\_DISPERSION_t$	-0.007	-0.027	-0.022	-0.053	-0.092	-0.094	-0.009	-0.015	-0.028
	(0.047)	(0.045)	(0.041)	(0.069)	(0.098)	(0.090)	(0.025)	(0.025)	(0.024)
LN_SALES_t	0.004**	0.004**	0.005***	0.005**	0.004	0.003	0.002	0.001	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Q_t	-0.000	-0.000	0.000	0.002**	0.002**	0.002*	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
$LN\_K\_L_t$	0.000	0.004**	0.002	-0.003	0.002	0.002	-0.000	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
$CASH\_FLOW_t$	-0.009	-0.004	-0.026	0.004	0.068*	0.066	-0.013	-0.003	-0.007
	(0.022)	(0.025)	(0.025)	(0.032)	(0.040)	(0.044)	(0.012)	(0.013)	(0.014)
$LEVERAGE_t$	-0.002	-0.000	-0.000	-0.012	-0.007	-0.008	-0.002	-0.001	0.000
	(0.005)	(0.005)	(0.005)	(0.007)	(0.008)	(0.007)	(0.003)	(0.003)	(0.003)
LN_AGE_{t+1}	-0.004**	-0.005***	-0.005**	-0.003	-0.005**	-0.004	-0.002**	-0.002*	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
$NASDAQ_t$	0.005	0.002	0.003	0.008	0.004	0.000	0.005*	0.004	0.003
	(0.004)	(0.004)	(0.005)	(0.006)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)
$MISSING\_RD_{t+1}$	-0.018***	-0.018***	-0.016***	-0.021***	-0.021***	-0.020***	-0.013***	-0.013***	-0.014***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.002)
RD_t	0.128**	0.096*	0.053	0.069	0.074	0.072*	0.053	0.046	0.054
	(0.054)	(0.057)	(0.057)	(0.049)	(0.047)	(0.043)	(0.053)	(0.049)	(0.047)
RD_{t-1}	0.088*	0.094*	0.064	0.078	0.104**	0.096**	0.036	0.052	0.061
	(0.052)	(0.051)	(0.046)	(0.051)	(0.049)	(0.043)	(0.051)	(0.047)	(0.043)
RD_{t-2}	0.062	0.035	-0.008	0.022	-0.008	0.016	0.029	0.034	0.031
	(0.047)	(0.047)	(0.047)	(0.045)	(0.039)	(0.040)	(0.049)	(0.043)	(0.043)
RD_{t-3}	0.208***	0.214***	0.217***	0.160***	0.170***	0.189***	0.231***	0.239***	0.246***
	(0.051)	(0.047)	(0.052)	(0.037)	(0.032)	(0.035)	(0.051)	(0.047)	(0.047)
Constant	0.010	0.002	0.004	0.022*	0.010	0.013	0.014**	0.010**	0.007
	(0.008)	(0.007)	(0.009)	(0.012)	(0.010)	(0.011)	(0.006)	(0.005)	(0.006)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	18,241	15,635	13,661	18,061	15,482	13,544	17,977	15,396	13,491
N firms	1,168	1,016	829	1,161	1,010	827	1,160	1,006	824
AR(1) test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test (p-value)	0.924	0.247	0.224	0.140	0.028	0.050	0.702	0.767	0.954
Hansen test of over-identification (p-value)	0.202	0.251	0.324	0.038	0.027	0.056	0.141	0.187	0.279
Diff-in-Hansen tests of exogeneity (p-value)	0.085	0.400	0.177	0.544	0.669	0.618	0.720	0.777	0.352

TABLE IA.VIII

Ordered Logit Analysis of R&D Increases

This table presents the coefficient estimates of random-effects ordered logit regressions of significant R&D increases. A significant R&D increase is defined as an increase in RD_ASSETS greater than 1% relative to the same quarter of the previous year. The dependent variable in the ordered logit model, $RD\_INCREASE\_CATEGORY_{t+1}$ takes one of three possible values: 0 (*No Increase*) if the firm does not experience a significant R&D increase in quarter $t+1$, nor in quarter $t+2$; 1 (*Delayed Increase*) if the firm experiences a significant R&D increase in quarter $t+2$, but not in quarter $t+1$; 2 (*Immediate Increase*) if the firm experiences a significant R&D increase in quarter $t+1$ (whether or not it also experiences a significant R&D increase in quarter $t+2$). The sample period is 1993-2016. In Column 1, the sample consists of all firms with at least four quarters of data for all variables of interest and at least one quarter of positive R&D expenditures in Compustat during the sample period (*R&D Sample*). In Column 2, the *R&D Sample* is restricted to firms that experience at least one significant R&D increase. In Column 3, the sample is as in Column 2, excluding penny stocks and very small firms. In Columns 4-6, the sample is as in Columns (1)-(3), but restricted to firms with three-digit SIC codes 283, 357, 366, 367, 382, 384, or 737 (high-tech firms). All regressions include the following control variables: LN_SALES_t, Q_t, $LN\_K\_L_t$, $CASH\_FLOW_t$, $LEVERAGE_t$, LN_AGE_{t+1}, $LN\_RD\_CAPITAL_t$, $NASDAQ_t$ and $MISSING\_RD_{t+1}$, as well as quarter fixed effects and year fixed effects. *Cut1* and *Cut2* are the estimates for the cutpoints (threshold) parameters, i.e., the estimated values of the latent variable in the ordered logit model, used to differentiate the adjacent levels of the response variable ($RD\_INCREASE\_CATEGORY_{t+1}$). σ_u^2 is the variance of the (firm) random effect. Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B. Standard errors are clustered by firm. Statistical significance at the 10%, 5%, and 1% level is indicated with *, **, and ***, respectively.

	R&D Sample - All Firms			**R&D Sample - High-Tech Firms**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$AMBIGUITY_t$	-10.174***	-8.109***	-4.370	-12.935***	-10.880***	-6.320*
	(3.007)	(2.886)	(2.955)	(3.838)	(3.621)	(3.710)
$RISK_t$	13.049	16.433*	19.825	21.805*	28.255**	31.959**
	(9.884)	(9.480)	(12.825)	(11.548)	(11.330)	(15.796)
$ANALYST\_DISPERSION_t$	6.111***	6.457***	15.609***	5.118**	6.563**	14.440***
	(2.236)	(2.259)	(4.399)	(2.578)	(2.680)	(4.994)
Cut1	0.513	-1.032**	-1.293***	0.687	-0.724	-1.075*
	(0.477)	(0.436)	(0.487)	(0.555)	(0.502)	(0.570)
Cut2	1.143**	-0.400	-0.637	1.309**	-0.099	-0.426
	(0.478)	(0.435)	(0.487)	(0.555)	(0.501)	(0.569)
σ_u^2	1.979***	0.615***	0.704***	1.818***	0.626***	0.748***
	(0.164)	(0.065)	(0.084)	(0.179)	(0.078)	(0.103)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	38,107	16,426	13,491	18,828	11,376	9,129
N Firms	2,200	887	727	1,258	656	531
Log Likelihood	-9,078.54	-8,179.00	-6,270.17	-6,711.29	-6,169.65	-4,683.67

TABLE IA.IX

Determinants of Patenting Activity in High-Tech Firms

This table presents coefficient estimates of count models for patenting activity. The dependent variable is $PATENTS$ in Panel A, and $CITATIONS$ in Panel B. The sample period is 1993-2016. The sample is the same as in Table IV, restricted to firms with three-digit SIC codes 283, 357, 366, 367, 382, 384, or 737 (high-tech firms). Marginal effects are calculated as differences in predicted counts at high (the 90th percentile of the estimation sample) and low (the 10th percentile of the estimation sample) $AMBIGUITY_t$ and $RISK_t$, while keeping all other variables at their sample means. All regressions include the following control variables: $INSTOWN\_DED_t$, $INSTOWN\_TRA_t$, $INSTOWN\_QIX_t$, LN_SALES_t, Q_t, $LN\_K\_L_t$, $CASH\_FLOW_t$, $LEVERAGE_t$, LN_AGE_{t+1}, $LN\_RD\_CAPITAL_t$, $NASDAQ_t$, as well as three-digit SIC code fixed effects, Blundell et al. (1999) pre-sample firm fixed-effects and quarter-year fixed-effects. Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B. Standard errors are clustered by firm. Statistical significance at the 10%, 5%, and 1% level is indicated with *, **, and ***, respectively.

	Poisson				**Negative Binomial**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	One quarter	**Year 1**	**Year 2**	**Year 3**	**One quarter**	**Year 1**	**Year 2**	**Year 3**
	$t+1$	$t+1:t+4$	$t+5:t+8$	$t+9:t+12$	$t+1$	$t+1:t+4$	$t+5:t+8$	$t+9:t+12$
Panel A: Patents								
Coefficients								
$AMBIGUITY_t$	-2.529*	-2.796*	-3.761**	-3.941**	0.056	0.115	-1.782	-1.609
	(1.422)	(1.498)	(1.589)	(1.897)	(1.894)	(1.962)	(2.060)	(2.217)
$RISK_t$	-61.459***	-68.234***	-81.854***	-83.198***	-15.957*	-12.348	-22.646***	-27.511***
	(16.654)	(17.664)	(20.467)	(22.395)	(9.689)	(8.271)	(8.753)	(9.837)
$ANALYST\_DISPERSION_t$	9.372***	9.900***	9.211***	7.479**	4.055	3.025	1.026	2.378
	(3.171)	(2.985)	(3.034)	(3.323)	(3.457)	(3.544)	(3.650)	(3.751)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	20,059	18,684	16,559	14,636	20,059	18,684	16,559	14,636
N firms	799	799	761	709	799	799	761	709
Pseudo R-squared					0.160	0.131	0.126	0.121
Marginal Effects								
(1) Low Ambiguity	3.445	14.374	15.489	16.439	3.213	13.484	14.942	16.001
(2) High Ambiguity	3.095	12.799	13.328	14.100	3.221	13.548	13.915	15.029
Marginal Effect (2) – (1)	-0.350*	-1.574*	-2.162**	-2.339**	0.008	0.065	-1.027	-0.972
	(0.194)	(0.828)	(0.888)	(1.087)	(0.258)	(1.100)	(1.191)	(1.345)
(3) Low Risk	3.644	15.348	16.746	17.853	3.300	13.787	15.087	16.365
(4) High Risk	2.848	11.589	11.813	12.413	3.095	13.103	13.698	14.512
Marginal Effect (4) – (3)	-0.796***	-3.759***	-4.934***	-5.440***	-0.205*	-0.683	-1.389**	-1.853***
	(0.221)	(0.998)	(1.254)	(1.481)	(0.124)	(0.456)	(0.541)	(0.672)
Panel B: Citations								
Coefficients								
$AMBIGUITY_t$	-2.393*	-2.992**	-2.618	-3.694*	1.960	1.530	-0.254	0.111
	(1.435)	(1.523)	(1.759)	(1.959)	(2.213)	(2.183)	(2.215)	(2.496)
$RISK_t$	-69.013***	-76.136***	-85.859***	-88.719***	-8.026	-10.984	-20.354*	-24.868**
	(18.624)	(19.655)	(21.433)	(22.172)	(11.789)	(9.990)	(10.913)	(12.000)
$ANALYST\_DISPERSION_t$	7.934**	9.402**	9.138***	6.932*	6.480*	5.084	4.203	5.660
	(3.411)	(3.984)	(3.495)	(3.760)	(3.909)	(4.091)	(4.005)	(4.246)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	19,801	18,453	16,371	14,490	19,801	18,453	16,371	14,490
N firms	781	781	744	694	781	781	744	694
Pseudo R-squared					0.114	0.101	0.098	0.093
Marginal Effects								
(1) Low Ambiguity	4.241	17.730	18.583	19.975	3.490	14.576	15.807	16.747
(2) High Ambiguity	3.831	15.658	16.735	17.298	3.792	15.533	15.648	16.820
Marginal Effect (2) – (1)	-0.409*	-2.072**	-1.848	-2.677*	0.303	0.957	-0.160	0.073
	(0.246)	(1.055)	(1.240)	(1.410)	(0.344)	(1.369)	(1.393)	(1.632)
(3) Low Risk	4.548	19.105	20.592	21.972	3.655	15.226	16.293	17.512
(4) High Risk	3.458	13.997	14.325	14.966	3.540	14.558	14.950	15.725
Marginal Effect (4) – (3)	-1.090***	-5.108***	-6.267***	-7.005***	-0.115	-0.668	-1.343*	-1.787**
	(0.308)	(1.388)	(1.641)	(1.834)	(0.168)	(0.608)	(0.728)	(0.881)

TABLE IA.X

Determinants of Patenting Activity in Non-High-Tech Firms

This table presents the coefficient estimates of count models for patenting activity. The dependent variable is $PATENTS$ in Panel A, and $CITATIONS$ in Panel B. The sample period is 1993-2016. The sample is the same as in Table IV, excluding firms with three-digit SIC codes 283, 357, 366, 367, 382, 384, or 737 (non-high-tech firms). Marginal effects are calculated as differences in predicted counts at high (the 90th percentile of the estimation sample) and low (the 10th percentile of the estimation sample) $AMBIGUITY_t$ and $RISK_t$, while keeping all other variables at their sample means. All regressions include the following control variables: $INSTOWN\_DED_t$, $INSTOWN\_TRA_t$, $INSTOWN\_QIX_t$, LN_SALES_t, Q_t, $LN\_K\_L_t$, $CASH\_FLOW_t$, $LEVERAGE_t$, LN_AGE_{t+1}, $LN\_RD\_CAPITAL_t$, $NASDAQ_t$, as well as three-digit SIC code fixed-effects, Blundell et al. (1999) pre-sample firm fixed-effects and quarter-year fixed-effects. Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B. Standard errors are clustered by firm. Statistical significance at the 10%, 5%, and 1% level is indicated with *, **, and ***, respectively.

	Poisson				**Negative Binomial**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	One quarter	**Year 1**	**Year 2**	**Year 3**	**One quarter**	**Year 1**	**Year 2**	**Year 3**
	$t+1$	$t+1:t+4$	$t+5:t+8$	$t+9:t+12$	$t+1$	$t+1:t+4$	$t+5:t+8$	$t+9:t+12$
Panel A: Patents								
Coefficients								
$AMBIGUITY_t$	-1.716	-1.855	-2.003	-3.125*	-2.113	-0.984	-1.863	-2.716*
	(1.360)	(1.395)	(1.466)	(1.704)	(1.348)	(1.345)	(1.349)	(1.413)
$RISK_t$	-25.368	-27.035	-34.339*	-32.905*	-14.057	-6.928	-12.304	1.358
	(16.384)	(17.047)	(18.178)	(18.030)	(8.629)	(7.848)	(8.235)	(10.161)
$ANALYST\_DISPERSION_t$	-13.383***	-14.757***	-16.002***	-11.676*	-5.119*	-3.615	-5.432**	-7.835***
	(3.653)	(4.425)	(5.306)	(6.279)	(2.733)	(2.670)	(2.667)	(2.854)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	33,751	32,023	29,431	26,981	33,751	32,023	29,431	26,981
N firms	1,021	1,021	992	957	1,021	1,021	992	957
Pseudo R-squared					0.219	0.181	0.179	0.176
Marginal Effects								
(1) Low Ambiguity	0.912	3.846	3.980	3.898	0.834	3.470	3.628	3.441
(2) High Ambiguity	0.835	3.498	3.600	3.352	0.748	3.299	3.305	3.018
Marginal Effect (2)-(1)	-0.077	-0.348	-0.380	-0.546*	-0.086	-0.170	-0.323	-0.423*
	(0.061)	(0.260)	(0.277)	(0.297)	(0.054)	(0.231)	(0.232)	(0.217)
(3) Low Risk	0.911	3.842	4.011	3.844	0.814	3.433	3.556	3.258
(4) High Risk	0.842	3.527	3.586	3.441	0.779	3.359	3.417	3.273
Marginal Effect (4)-(3)	-0.069	-0.315	-0.424*	-0.403*	-0.035	-0.074	-0.140	0.015
	(0.045)	(0.198)	(0.223)	(0.220)	(0.021)	(0.084)	(0.093)	(0.112)
Panel B: Citations								
Coefficients								
$AMBIGUITY_t$	-1.367	-1.134	-1.328	-2.261	-1.748	-0.888	-0.763	-2.758*
	(1.485)	(1.371)	(1.344)	(1.440)	(1.569)	(1.500)	(1.608)	(1.579)
$RISK_t$	35.096	9.620	-48.141**	-50.622**	-2.222	0.036	-12.106	-1.566
	(38.475)	(34.325)	(20.511)	(21.154)	(10.600)	(9.365)	(9.623)	(10.343)
$ANALYST\_DISPERSION_t$	-13.282***	-14.732***	-18.622***	-14.122**	-6.365*	-5.026	-7.244**	-11.920***
	(5.114)	(4.650)	(5.635)	(6.572)	(3.528)	(3.105)	(3.073)	(3.327)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	32,928	31,268	28,776	26,417	32,928	31,268	28,776	26,417
N firms	985	985	958	927	985	985	958	927
Pseudo R-squared					0.166	0.147	0.147	0.145
Marginal Effects								
(1) Low Ambiguity	1.050	4.418	4.242	4.133	0.907	3.805	3.682	3.591
(2) High Ambiguity	0.978	4.168	3.968	3.703	0.829	3.635	3.543	3.140
Marginal Effect (2) – (1)	-0.071	-0.250	-0.274	-0.430	-0.078	-0.170	-0.139	-0.450*
	(0.077)	(0.300)	(0.277)	(0.274)	(0.069)	(0.285)	(0.291)	(0.254)
(3) Low Risk	0.974	4.260	4.415	4.248	0.877	3.736	3.687	3.411
(4) High Risk	1.086	4.392	3.776	3.586	0.871	3.737	3.545	3.393
Marginal Effect (4) – (3)	0.113	0.131	-0.639**	-0.662**	-0.006	0.000	-0.142	-0.018
	(0.125)	(0.472)	(0.272)	(0.276)	(0.029)	(0.111)	(0.113)	(0.118)

TABLE IA.XI

Determinants of Patenting Activity in Patent-Intensive Firms

This table presents the coefficient estimates of count models for patenting activity. The dependent variable is $PATENTS$ in Panel A, and $CITATIONS$ in Panel B. The sample period is 1993-2016. The sample is the same as in Table IV, restricted to either firms in the top tercile according to the average number of patents per quarter filed during the sample period – patent-intensive firms (Panel A); or to firms in the top tercile according to the average number of citations-weighted patents filed during the sample period – citation-intensive firms (Panel B). Marginal effects are calculated as differences in predicted counts at high (the 90$^{\text{th}}$ percentile of the estimation sample) and low (the 10$^{\text{th}}$ percentile of the estimation sample) $AMBIGUITY_t$ and $RISK_t$, while keeping all other variables at their sample means. All regressions include the following control variables: $INSTOWN\_DED_t$, $INSTOWN\_TRA_t$, $INSTOWN\_QIX_t$, LN_SALES_t, Q_t, $LN\_K\_L_t$, $CASH\_FLOW_t$, $LEVERAGE_t$, LN_AGE_{t+1}, $LN\_RD\_CAPITAL_t$, $NASDAQ_t$, as well as three-digit SIC code fixed-effects, Blundell et al. (1999) pre-sample firm fixed-effects and quarter-year fixed-effects. Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B. Standard errors are clustered by firm. Statistical significance at the 10%, 5%, and 1% level is indicated with *, **, and ***, respectively.

	Poisson				**Negative Binomial**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	One quarter	**Year 1**	**Year 2**	**Year 3**	**One quarter**	**Year 1**	**Year 2**	**Year 3**
	$t+1$	$t+1:t+4$	$t+5:t+8$	$t+9:t+12$	$t+1$	$t+1:t+4$	$t+5:t+8$	$t+9:t+12$
Panel A: Patents								
Coefficients								
$AMBIGUITY_t$	-2.085*	-2.417**	-2.971**	-3.928***	-1.865*	-1.813*	-2.765***	-3.387***
	(1.129)	(1.175)	(1.268)	(1.414)	(1.085)	(1.037)	(1.032)	(1.098)
$RISK_t$	-7.136	-11.193	-16.022	-13.352	-22.074**	-24.300***	-25.701***	-19.253**
	(16.603)	(16.634)	(16.824)	(16.206)	(10.107)	(9.240)	(9.135)	(9.173)
$ANALYST\_DISPERSION_t$	4.136	4.136	4.931	2.602	4.288	4.099	2.908	0.462
	(4.088)	(4.152)	(4.073)	(3.737)	(3.278)	(3.282)	(3.591)	(3.674)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	22,004	20,899	19,266	17,742	22,004	20,899	19,266	17,742
N firms	598	598	580	557	598	598	580	557
Pseudo R-squared					0.124	0.107	0.105	0.103
Marginal Effects								
(1) Low Ambiguity	10.514	43.394	45.756	48.158	10.963	45.291	48.449	50.657
(2) High Ambiguity	9.401	38.159	39.221	39.523	9.919	41.127	41.976	42.721
Marginal Effect (2) – (1)	-1.113*	-5.235**	-6.536**	-8.636***	-1.044*	-4.164*	-6.473***	-7.936***
	(0.594)	(2.504)	(2.742)	(3.063)	(0.606)	(2.377)	(2.414)	(2.588)
(3) Low Risk	10.103	41.567	43.565	44.965	10.716	44.435	46.712	48.068
(4) High Risk	9.973	40.717	42.274	43.830	10.293	42.486	44.511	46.328
Marginal Effect (4) – (3)	-0.130	-0.850	-1.291	-1.135	-0.422**	-1.949***	-2.201***	-1.740**
	(0.305)	(1.270)	(1.366)	(1.388)	(0.195)	(0.748)	(0.794)	(0.839)
Panel B: Citations								
Coefficients								
$AMBIGUITY_t$	-1.902	-2.076*	-2.209*	-3.419**	-0.201	-0.494	-1.424	-2.397*
	(1.201)	(1.198)	(1.330)	(1.351)	(1.345)	(1.233)	(1.242)	(1.241)
$RISK_t$	37.377	12.952	-28.259*	-28.841**	-8.961	-17.543	-27.196***	-21.426**
	(39.291)	(30.046)	(15.008)	(14.709)	(13.317)	(10.817)	(9.637)	(9.669)
$ANALYST\_DISPERSION_t$	2.049	2.663	2.552	-0.059	5.832	6.243	4.427	1.150
	(3.431)	(3.636)	(3.555)	(3.650)	(3.958)	(3.941)	(3.765)	(3.756)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	20,876	19,831	18,272	16,813	20,876	19,831	18,272	16,813
N firms	581	581	561	534	581	581	561	534
Pseudo R-squared					0.076	0.076	0.075	0.073
Marginal Effects								
(1) Low Ambiguity	12.238	50.053	51.148	54.146	12.259	50.658	53.055	55.837
(2) High Ambiguity	11.070	44.906	45.696	45.707	12.130	49.366	49.337	49.583
Marginal Effect (2) – (1)	-1.168	-5.147*	-5.452*	-8.439**	-0.129	-1.293	-3.718	-6.255*
	(0.726)	(2.918)	(3.252)	(3.297)	(0.864)	(3.212)	(3.217)	(3.203)
(3) Low Risk	11.372	47.351	50.124	51.897	12.302	50.913	52.793	54.261
(4) High Risk	12.220	48.559	47.397	48.984	12.092	49.205	50.026	51.981
Marginal Effect (4) – (3)	0.849	1.208	-2.727*	-2.913*	-0.211	-1.707	-2.767***	-2.280**
	(0.897)	(2.805)	(1.472)	(1.505)	(0.314)	(1.063)	(1.003)	(1.046)

TABLE IA.XII

Determinants of Patenting Activity in Large High-Tech Firms

This table presents the coefficient estimates of count models for patenting activity. The dependent variable is $PATENTS$ in Panel A, and $CITATIONS$ in Panel B. The sample period is 1993-2016. The sample is the same as in Table IV, restricted to firms with three-digit SIC codes 283, 357, 366, 367, 382, 384, or 737 (high-tech firms), and further restricted to firms in the top tercile according to the average quarterly sales during the sample period. Marginal effects are calculated as differences in predicted counts at high (the 90$^{\text{th}}$ percentile of the estimation sample) and low (the 10$^{\text{th}}$ percentile of the estimation sample) $AMBIGUITY_t$ and $RISK_t$, while keeping all other variables at their sample means. All regressions include the following control variables: $INSTOWN\_DED_t$, $INSTOWN\_TRA_t$, $INSTOWN\_QIX_t$, LN_SALES_t, Q_t, $LN\_K\_L_t$, $CASH\_FLOW_t$, $LEVERAGE_t$, LN_AGE_{t+1}, $LN\_RD\_CAPITAL_t$, $NASDAQ_t$, as well as three-digit SIC code fixed effects, Blundell et al. (1999) pre-sample firm fixed-effects and quarter-year fixed-effects. Sample construction is detailed in Section III.A. Variable definitions are in Table IA.I of Internet Appendix IA.B. Standard errors are clustered by firm. Statistical significance at the 10%, 5%, and 1% level is indicated with *, **, and ***, respectively.

	Poisson				**Negative Binomial**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	One quarter	**Year 1**	**Year 2**	**Year 3**	**One quarter**	**Year 1**	**Year 2**	**Year 3**
	$t+1$	$t+1:t+4$	$t+5:t+8$	$t+9:t+12$	$t+1$	$t+1:t+4$	$t+5:t+8$	$t+9:t+12$
Panel A: Patents								
Coefficients								
$AMBIGUITY_t$	-2.523*	-2.664*	-3.295*	-3.276	-1.385	-0.922	-2.078	-2.289
	(1.519)	(1.619)	(1.731)	(2.004)	(2.085)	(2.214)	(2.297)	(2.498)
$RISK_t$	-63.272	-73.567*	-84.465*	-84.624*	-98.188***	-99.730***	-126.167***	-103.890***
	(43.495)	(43.665)	(46.599)	(47.861)	(32.442)	(29.058)	(32.967)	(32.862)
$ANALYST\_DISPERSION_t$	8.744***	9.210***	8.427***	6.370*	8.007*	8.610*	7.405	6.750
	(3.181)	(3.007)	(3.102)	(3.602)	(4.422)	(4.396)	(4.522)	(5.121)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	8,892	8,390	7,613	6,936	8,892	8,390	7,613	6,936
N firms	263	263	253	242	263	263	253	242
Pseudo R-squared					0.134	0.108	0.105	0.101
Marginal Effects								
(1) Low Ambiguity	8.815	36.574	39.228	41.024	8.412	34.640	38.016	40.595
(2) High Ambiguity	7.668	31.632	32.995	34.726	7.792	32.943	34.086	36.133
Marginal Effect (2) – (1)	-1.147*	-4.943*	-6.233*	-6.298*	-0.620	-1.697	-3.930	-4.462
	(0.687)	(2.974)	(3.204)	(3.733)	(0.935)	(4.080)	(4.357)	(4.878)
(3) Low Risk	8.719	36.419	39.038	41.087	8.754	36.544	40.077	42.122
(4) High Risk	7.795	31.905	33.335	34.863	7.357	30.543	31.656	34.430
Marginal Effect (4) – (3)	-0.924	-4.514*	-5.702*	-6.224*	-1.397***	-6.001***	-8.421***	-7.693***
	(0.642)	(2.719)	(3.186)	(3.558)	(0.478)	(1.829)	(2.296)	(2.486)
Panel B: Citations								
Coefficients								
$AMBIGUITY_t$	-2.124	-2.517	-1.852	-2.773	-0.053	1.055	-0.727	-0.664
	(1.686)	(1.855)	(1.985)	(2.105)	(2.209)	(2.274)	(2.285)	(2.477)
$RISK_t$	-72.341	-86.987*	-85.103*	-89.102*	-90.182***	-63.476**	-98.402***	-90.454***
	(49.403)	(47.848)	(46.872)	(47.176)	(32.009)	(30.805)	(31.515)	(31.697)
$ANALYST\_DISPERSION_t$	6.411*	8.076*	7.177*	4.531	12.302**	13.445**	10.416**	8.062
	(3.472)	(4.130)	(3.675)	(4.255)	(4.993)	(5.223)	(4.751)	(5.008)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	8,740	8,245	7,490	6,832	8,740	8,245	7,490	6,832
N firms	257	257	247	237	257	257	247	237
Pseudo R-squared					0.104	0.091	0.089	0.085
Marginal Effects								
(1) Low Ambiguity	9.366	38.935	40.600	43.226	8.253	33.425	36.758	38.965
(2) High Ambiguity	8.324	33.914	36.812	37.517	8.229	35.415	35.372	37.667
Marginal Effect (2)-(1)	-1.042	-5.021	-3.788	-5.708	-0.024	1.990	-1.387	-1.299
	(0.822)	(3.672)	(4.022)	(4.255)	(1.010)	(4.312)	(4.344)	(4.827)
(3) Low Risk	9.400	39.239	41.641	43.857	8.792	35.847	39.009	41.318
(4) High Risk	8.276	33.578	35.533	36.910	7.501	31.995	32.473	34.682
Marginal Effect (4)-(3)	-1.124	-5.660*	-6.107*	-6.947*	-1.290***	-3.852**	-6.536***	-6.635***
	(0.767)	(3.123)	(3.350)	(3.644)	(0.461)	(1.871)	(2.078)	(2.353)