Internet Appendix: Exporting Uncertainty: The Impact of Brexit on Corporate America

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Appendix A Model Analysis and Results

A.1 Disinvestment Decisions

In solving a firm's disinvestment problem, we first consider its decision at $t = 1$. If the firm had disinvested any of its endowed projects at $t = 0$, then it earns 0 for those projects. Among projects that were not disinvested at $t = 0$ (i.e., remain alive a $t = 1$), the firm can choose to sell any of them at $t = 1$ and receive cash flows of $s_{i2} + x_{i2} - \delta w$ per project. Else, it can choose not to sell and receive x_{i2} per project. As in the case of the investment decision, the firm's disinvestment policy is guided by the cash flows at $t = 2$ generated by project $\tilde{w}$. These cash flows can be characterized as:

$$\pi_{i2}(\tilde{w}) = \begin{cases} 0 & & \text{(Early Disinvestment)}, \\ s_{i2} + x_{i2} - \delta\tilde{w} & \text{if } s_{i2} > \delta\tilde{w} & \text{(Delayed Disinvestment)}, \\ x_{i2} & \text{if } s_{i2} \le \delta\tilde{w} & \text{(No Disinvestment)}. \end{cases} \tag{A.1}$$

Next, we consider the firm's disinvestment decision at $t = 0$. The optimal level of disinvestment at $t = 0$ can be expressed in terms of w^*, the breakeven project. The firm will optimally disinvest (sell) all projects in the range $[0, w^*)$, and not disinvest (choose to retain) any projects in the range $[w^*, W]$, instead of waiting until $t = 1$ to decide whether or not to disinvest. The firm's cash flows from disinvesting project $\tilde{w}$ at $t = 0$ is $s_{i1} + x_{i1} - \delta\tilde{w}$. Its expected cash flows from not disinvesting project $\tilde{w}$ at $t = 0$, and choosing instead to wait till $t = 1$ to decide, is $x_{i1} + \mathbb{E}[\max(s_{i2} + x_{i2} - \delta\tilde{w}, x_{i2})]$. Simplifying these two expressions, the firm disinvests project $\tilde{w}$ at $t = 0$ if:

$$s_{i1} - \delta\tilde{w} \ge x_{i2} + \mathbb{E}[\max(s_{i2} - \delta\tilde{w}, 0)]. \tag{A.2}$$

The breakeven condition for determining the optimal disinvestment level w^* at $t = 0$ is:

$$s_{i1} - \delta w^* = x_{i2} + \mathbb{E}[\max(s_{i2} - \delta w^*, 0)]. \tag{A.3}$$

In Lemma 3, we prove the existence of the optimal $t = 0$ investment level, w^*.

Lemma 3. *The optimal disinvestment level w^* at $t = 0$ is given by equation (A.3) for sufficiently large W.*

The breakeven condition in equation (A.3) implies that at $t = 0$ the firm sells all projects up to project w^*, as the benefits of doing so, s_{i1}, are expected to exceed the costs. Costs are made of two components: (1) the cost of selling the project, δw, and (2) the option value of waiting to choose whether to disinvest. The embedded optionality in the firm's disinvestment decision is key in generating a negative relation between uncertainty and disinvestment, as is the case with investment. As before, while the addition of a zero-mean spread does not change the left-hand side of equation (A.2), it increases the right-hand side of that inequality given the firm's option to forgo disinvestment in high income states. An increase in uncertainty in the distribution of s_{it} reduces the breakeven project level w^*, and correspondingly shrinks the set of projects the firm disinvests at $t = 0$, namely the interval $[0, w^*)$. We establish this result in Proposition 3.

Proposition 3. *Increased uncertainty leads to less disinvestment at $t = 0$. For $r' > r$, namely when $G(\cdot, r')$ is obtained by a mean-preserving spread of $G(\cdot, r)$, $w^*(r') < w^*(r)$. That is, $\frac{dw^*}{dr} < 0$.*

Taken together, the results of Proposition 1 and 3 imply that by increasing the value of the option to wait, greater uncertainty leads to decreases in *both* investment and disinvestment.

A.2 The Effect of Input Irreversibility

We now address the role played by the degree of irreversibility of capital and labor, as captured by their associated fixed costs. We do so by way of two propositions.

Proposition 4. *An increase in the degree of irreversibility of capital leads to less investment for higher levels of uncertainty in the first period; i.e.,* $\frac{dn^*}{d\kappa} < 0$.

Proposition 5. *An increase in the degree of irreversibility of labor leads to less investment for higher levels of uncertainty in the first period; i.e.,* $\frac{dn^*}{d\lambda} < 0$.

Combining the last two propositions with Proposition 1, we have that for an increase in uncertainty in the MPS sense (i.e., $r' > r$) and for greater degree of input irreversibility ($\kappa' > \kappa$ and $\lambda' > \lambda$), the following conditions hold with respect to investment:

$$n^*(r,\kappa,\lambda) > n^*(r',\kappa,\lambda) > n^*(r',\kappa',\lambda), \tag{A.4}$$

$$n^*(r,\kappa,\lambda) > n^*(r',\kappa,\lambda) > n^*(r',\kappa,\lambda').$$

The above conditions state that an increase in uncertainty reduces the set of projects the firm is willing to invest in at $t = 0$, electing to wait until uncertainty is partially resolved at $t = 1$ before deciding whether to invest. Notably, when the firm faces higher irreversible costs, it invests even less at $t = 0$. Differently put, an increase in uncertainty reduces investment in the first period, and the effect is modulated by the degree of irreversibility of capital or labor.

Appendix B Proofs

B.1 Proof of Lemma 1

Proof. Let us define

$$H(n^*) = v_{i1} + \mathbb{E}[v_{i2}] - (\kappa+\lambda)n^* - \mathbb{E}[\max(v_{i2} - (\kappa+\lambda)n^*, 0)].$$

To guarantee the existence of n^* as characterized by equation (6), it suffices to show that $H(n^*) = 0$ for some $n^* \in [0, N]$. Since $H(\cdot)$ is a sum of continuous functions, it is itself continuous. Since $v_{i1} > 0$ and $v_{i2} > 0$, it follows that:

$$H(0) = v_{i1} + \mathbb{E}[v_{i2}] - \mathbb{E}[\max(v_{i2}, 0)] = v_{i1} > 0.$$

Finally, for $N \to \infty$, we have that:

$$\begin{aligned}\lim_{N\to\infty} H(N) &= \lim_{N\to\infty} (v_{i1} + \mathbb{E}[v_{i2}] - (\kappa+\lambda)N) + \lim_{N\to\infty} (\mathbb{E}[\max(v_{i2} - (\kappa+\lambda)N, 0)]) \\ &= -\infty + 0 = -\infty.\end{aligned}$$

Thus, there must exist an $\bar{N} \in \mathbb{R}$ such that, for $N > \bar{N}$, $H(\bar{N}) < 0$. Putting these conditions together with the continuity of $H(\cdot)$ over $[0, N]$, the Intermediate Value Theorem guarantees that there exists an $n^* \in [0, N]$ such that $H(n^*) = 0$. □

B.2 Proof of Proposition 1

Proof. Let us define

$$H(n^*; r) = v_{i1} + \mathbb{E}[v_{i2}] - (\kappa+\lambda)n^* - \mathbb{E}[\max(v_{i2} - (\kappa+\lambda)n^*, 0); r] = 0$$

By the Implicit Function Theorem,

$$\frac{dn^*}{dr} = -\frac{\partial H/\partial n^*}{\partial H/\partial r}.$$

Considering first the derivative of H with respect to n^*, we have:

$$\begin{aligned}\frac{\partial H(n^*; r)}{\partial n^*} &= -(\kappa+\lambda) - \frac{\partial}{\partial n^*}\mathbb{E}[\max(v_{i2} - (\kappa+\lambda)n^*, 0); r] \\ &= -(\kappa+\lambda) - \mathbb{E}\left[\frac{\partial}{\partial n^*}\max(v_{i2} - (\kappa+\lambda)n^*, 0); r\right] \\ &= -(\kappa+\lambda) - \mathbb{E}[\max(v_{i2} - (\kappa+\lambda), 0); r] \\ &< 0.\end{aligned}$$

Next, considering the derivative of H with respect to r, we have:

$$\frac{\partial H(n^*; r)}{\partial r} = -\frac{\partial}{\partial r}\mathbb{E}[\max(v_{i2} - (\kappa+\lambda)n^*, 0); r].$$

Because $G(\cdot, r')$ is a MPS of $G(\cdot, r)$, for any convex function $J(\cdot)$,

$$\begin{aligned}\mathbb{E}\left[J(v_{i2}); r'\right] &= \int J(v_{i2})dG(v_{i2}, r') \\ &\geq \int J(v_{i2})dG(v_{i2}, r) \\ &= \mathbb{E}[J(v_{i2}); r].\end{aligned}$$

Since $\max(v_{i2} - (\kappa+\lambda)n^*, 0)$ is convex in v_{i2}, it follows that:

$$\mathbb{E}\left[\max(v_{i2} - (\kappa+\lambda)n^*, 0); r'\right] \geq \mathbb{E}[\max(v_{i2} - (\kappa+\lambda)n^*, 0); r] \,\forall r' > r.$$

This implies

$$\frac{\partial}{\partial r}\mathbb{E}[\max(v_{i2} - (\kappa+\lambda)n^*, 0); r] \geq 0.$$

Thus,

$$\begin{aligned}\frac{\partial H(n^*; r)}{\partial r} &= -\frac{\partial}{\partial r}\mathbb{E}[\max(v_{i2} - (\kappa+\lambda)n^*, 0); r] \\ &\leq 0.\end{aligned}$$

Putting these conditions together, we have:

$$\frac{dn^*}{dr} = -\frac{\partial H/\partial n^*}{\partial H/\partial r} < 0.$$

□

B.3 Proof of Proposition 2

Proof. Rearranging equation (10), we get:

$$m^* = \frac{1}{\alpha}\left(\overline{u_{i1}} - d_1 - d_2 + u_{i1} + \frac{\sqrt{\omega_i^2(r)+\sigma_x^2}}{1-\Phi\left(\frac{d_2-\overline{u_{i1}}}{\sqrt{\omega_i^2(r)+\sigma_x^2}}\right)}\left[\phi\left(\frac{d_2-\overline{u_{i1}}}{\sqrt{\omega_i^2(r)+\sigma_x^2}}\right)\right]\right)^{\frac{1}{\alpha-1}}.$$

It can be shown that $\frac{dm^*}{dr} > 0$ as:

$$\phi\left(\frac{d_2-\overline{u_{i1}}}{\sqrt{\omega_i^2(r)+\sigma_x^2}}\right)\left[1-\frac{\left(\frac{d_2-\overline{u_{i1}}}{\sqrt{\omega_i^2(r)+\sigma_x^2}}\right)\phi\left(\frac{d_2-\overline{u_{i1}}}{\sqrt{\omega_i^2(r)+\sigma_x^2}}\right)}{1-\Phi\left(\frac{d_2-\overline{u_{i1}}}{\sqrt{\omega_i^2(r)+\sigma_x^2}}\right)}\right]-\phi'\left(\frac{d_2-\overline{u_{i1}}}{\sqrt{\omega_i^2(r)+\sigma_x^2}}\right)\left(\frac{d_2-\overline{u_{i1}}}{\sqrt{\omega_i^2(r)+\sigma_x^2}}\right) > 0.$$

□

B.4 Proof of Proposition 4

Proof. Let us define

$$H(n^*;\kappa) = v_{i1} + \mathbb{E}[v_{i2}] - (\kappa+\lambda)n^* - \mathbb{E}[\max(v_{i2}-(\kappa+\lambda)n^*, 0)] = 0.$$

By the Implicit Function Theorem,

$$\frac{dn^*}{d\kappa} = -\frac{\partial H/\partial n^*}{\partial H/\partial \kappa}.$$

Considering first the numerator, we know from Proposition 1 that:

$$\frac{\partial H}{\partial n^*} < 0.$$

Next, considering the denominator,

$$\begin{aligned}\frac{\partial H}{\partial \kappa} &= -n^* - \frac{\partial}{\partial \kappa}\mathbb{E}[\max(v_{i2}-(\kappa+\lambda)n^*, 0)]\\ &= -n^* - \mathbb{E}\left[\frac{\partial}{\partial \kappa}\max(v_{i2}-(\kappa+\lambda)n^*, 0)\right]\\ &= -n^* - \mathbb{E}[\max(v_{i2}-n^*, 0)]\\ &< 0.\end{aligned}$$

Putting these together, we have:

$$\frac{dn^*}{d\kappa} = -\frac{\partial H/\partial n^*}{\partial H/\partial \kappa} < 0.$$

□

B.5 Proof of Proposition 5

Proof. Symmetric to the case of capital. □

Appendix C   Additional Results and Robustness Tests

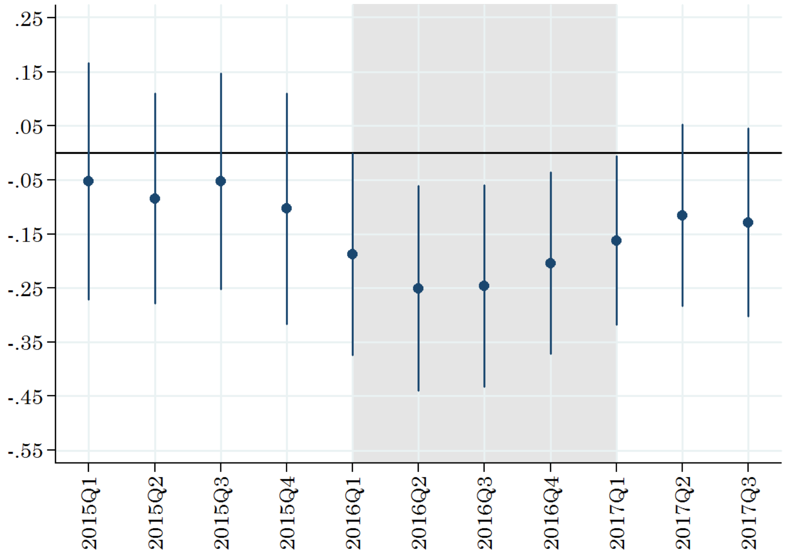

Figure C.1. Corporate Investment Trends around Brexit-related Events. This figure displays coefficients of investment regressions for the timeline of the main events related to Brexit. The shaded area marks the beginning of Brexit-related events, with the announcement of the date of the UK–EU referendum (2016:Q1).

Table C.2. Summary Statistics: Matched Sample

This table reports mean values for the main variables used in our empirical analyses in the matched sample. Each treated firm is matched to 3 control firms (with replacement) which are its nearest neighbors in terms of treatment propensity. The propensity score is a function of lagged STOCK_RETURNS, 1-quarter-ahead CONSENSUS_EARNINGS_FORECAST, TOBIN_Q, CASH_FLOW, SALES_GROWTH, and SIZE. Panel A shows summary statistics for the sample of treated and matched control firms as defined by β_i^{UK} (top tercile of β_i^{UK}). Panel B shows summary statistics for the sample of treated and matched control firms as defined by mentions of Brexit-related words in their 2015 10-K filings. The table also reports the differences in means and the p-value associated with a test statistic for the differences.

Firm-Level Variables	Treated	Control	Difference	p-value
	Panel A: Market-Based Approach			
INVESTMENT	0.020	0.012	0.008	0.251
EMPLOYMENT_GROWTH (Annual)	0.083	0.061	0.022	0.424
R&D	0.030	0.016	0.014	0.385
DIVESTITURES (×100)	0.129	0.088	0.041	0.404
CASH	0.175	0.164	0.011	0.410
NON_CASH_WORKING_CAPITAL	0.058	0.086	–0.028	0.272
TOBIN_Q	1.948	1.928	0.020	0.383
CASH_FLOW	0.016	0.032	–0.016	0.610
SIZE (Log Assets)	6.677	7.205	–0.528	0.528
SALES_GROWTH	0.195	0.105	0.090	0.203
CONSENSUS_EARNINGS_FORECAST	0.023	0.025	–0.002	0.594
STOCK_RETURNS	0.021	0.038	–0.017	0.618
	Panel B: Textual-Search-Based Approach			
INVESTMENT	0.013	0.014	0.000	0.269
EMPLOYMENT_GROWTH (Annual)	0.084	0.078	0.006	0.429
R&D	0.030	0.022	0.008	0.749
DIVESTITURES (×100)	0.062	0.056	0.006	0.210
CASH	0.232	0.194	0.038	0.339
NON_CASH_WORKING_CAPITAL	0.041	0.057	–0.016	0.522
TOBIN_Q	2.199	2.037	0.162	0.166
CASH_FLOW	0.018	0.021	–0.003	0.836
SIZE (Log Assets)	7.059	6.581	0.478	0.293
SALES_GROWTH	0.162	0.167	–0.005	0.605
CONSENSUS_EARNINGS_FORECAST	0.055	0.023	0.032	0.137
STOCK_RETURNS	0.028	0.030	–0.002	0.758

Table C.1. Sample Selection

This table reports the filters applied to the original dataset obtained from COMPUSTAT, and the number of observations obtained at each step in order to generate the baseline sample described in Section IV.B.

Filter	Firm–Quarters
Raw COMPUSTAT between 2010:Q1 and 2016:Q4	262,412
Drop non-US firm–quarters (retain data reported in USD, with US headquarters, duplicates excluded)	160,254
Drop firm–quarters with negative fundamentals (ASSETS and SALES)	158,312
Drop financials and utilities	112,939
Drop if ASSETS or MARKET_CAPITALIZATION less than $10 million	93,011
Drop if missing key variables (INVESTMENT, ASSETS, CASH_FLOW, TOBIN_Q, SALES_GROWTH)	75,013
Drop if non-consecutive quarters, or less than 12 quarters of non-missing data	56,081
Drop if missing Hoberg and Phillips (2016) industry classification	49,107
Drop if missing β_i^{UK}	43,025
Drop if missing CRSP and I/B/E/S controls	41,630

Table C.3. The Impact of the Brexit Vote on Investment, Employment, R&D Expenditures and Divestitures: Propensity-Score Matching

This table reports output from equation (14) in a matched sample. The dependent variables are INVESTMENT, EMPLOYMENT_GROWTH, R&D and DIVESTITURES. Each treated firm is matched to 3 control firms (with replacement) which are its nearest neighbors in terms of treatment propensity. The propensity score is a function of lagged STOCK_RETURNS, 1-quarter-ahead CONSENSUS_EARNINGS_FORECASTS, TOBIN_Q, CASH_FLOW, SALES_GROWTH, SIZE. In the first specification, the treatment group is composed by the top tercile of β_i^{UK}, while the control group is composed by matched firms in the bottom tercile of β_i^{UK}. The second specification is a textual-search-based measure of UK-exposure that sums up the number of Brexit-related words in firms' 2015 10-K forms. The treatment group is made of firms with more than five entries, whereas the control group are matched firms with zero entries. The time dimension of the DID estimator is set so as to compare the two quarters following the announcement of the Brexit referendum victory (2016:Q3–Q4) *versus* the two quarters preceding the announcement of the referendum vote date (2015:Q3–Q4). T-statistics are computed using robust standard-errors (in parentheses) double-clustered at the firm and calendar quarter levels.

	INVESTMENT		EMPLOYMENT_GROWTH		R&D		DIVESTITURES	
	Treatment is Top Tercile of β_i^{UK}	Treatment is > 5 Brexit Entries in 10-Ks	Treatment is Top Tercile of β_i^{UK}	Treatment is > 5 Brexit Entries in 10-Ks	Treatment is Top Tercile of β_i^{UK}	Treatment is > 5 Brexit Entries in 10-Ks	Treatment is Top Tercile of β_i^{UK}	Treatment is > 5 Brexit Entries in 10-Ks
	1	2	3	4	5	6	7	8
POST × HIGH_β_i^{UK}	–0.151***		–3.156***		0.401***		–0.040***	
	(0.025)		(1.129)		(0.065)		(0.012)	
POST × HIGH_10-K_ENTRIES		–0.097***		–3.379**		0.183***		–0.022***
		(0.012)		(1.283)		(0.066)		(0.008)
Controls								
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects								
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,715	20,919	2,469	2,480	3,842	8,895	12,053	19,500
R-squared	0.75	0.73	0.49	0.45	0.88	0.87	0.34	0.29

Statistical significance levels: *** p-value<0.01, ** p-value<0.05, * p-value<0.10.

Table C.4. Parallel Trends: Market-Based Approach

This table reports the average INVESTMENT (Panel A), EMPLOYMENT_GROWTH (Panel B), R&D (Panel C), and DIVESTITURES (Panel D) for firms in the treated and control groups going back different periods prior to Brexit. The treatment group is composed by the top tercile of β_i^{UK}, while the control group is composed by firms in the bottom tercile of β_i^{UK}. The table also reports the differences in means and the p-value associated with a test statistic for the differences.

Periods prior to Brexit	Treated	Control	Difference	p-value
	Panel A (Quarterly Frequency): INVESTMENT			
One	1.165	1.027	0.138	0.156
Two	1.184	0.942	0.242	0.153
Three	1.362	1.135	0.227	0.281
Four	1.100	1.381	–0.281	0.600
Five	1.433	1.115	0.318	0.369
Six	0.996	1.526	–0.530	0.380
	Panel B (Annual Frequency): EMPLOYMENT_GROWTH			
One	3.794	3.906	–0.112	0.951
Two	9.723	4.812	4.911	0.369
Three	6.434	5.033	1.401	0.374
Four	9.265	5.217	4.048	0.126
Five	10.178	8.083	2.095	0.223
Six	8.113	8.985	–0.872	0.670
	Panel C (Quarterly Frequency): R&D			
One	4.441	2.641	1.800	0.317
Two	2.568	4.369	–1.801	0.311
Three	2.275	3.760	–1.485	0.434
Four	4.150	2.376	1.774	0.197
Five	4.342	2.399	1.943	0.221
Six	4.287	2.465	1.822	0.229
	Panel D (Quarterly Frequency): DIVESTITURES			
One	0.076	0.057	0.019	0.234
Two	0.056	0.102	-0.046	0.748
Three	0.071	0.077	-0.006	0.710
Four	0.073	0.054	0.019	0.218
Five	0.071	0.054	0.017	0.289
Six	0.056	0.043	0.013	0.304

Table C.5. Parallel Trends: Textual-Search-Based Approach

This table reports the average INVESTMENT (Panel A), EMPLOYMENT_GROWTH (Panel B), R&D (Panel C), and DIVESTITURES (Panel D) for firms in the treated and control groups going back different periods prior to Brexit. The treatment indicator is a textual-search-based measure of UK-exposure that sums up the number of Brexit-related words in firms' 2015 10-K forms. The treatment group is made of firms with more than five entries, whereas the control group are firms with zero entries. The table also reports the differences in means and the p-value associated with a test statistic for the differences.

Periods prior to Brexit	Treated	Control	Difference	p-value
	Panel A (Quarterly Frequency): INVESTMENT			
One	0.958	1.064	–0.106	0.202
Two	0.930	1.047	–0.117	0.186
Three	1.124	1.203	–0.079	0.419
Four	1.174	1.090	0.084	0.348
Five	1.194	1.140	0.054	0.570
Six	1.110	1.122	–0.012	0.897
	Panel B (Annual Frequency): EMPLOYMENT_GROWTH			
One	9.711	8.881	0.830	0.678
Two	11.400	13.321	–1.921	0.343
Three	7.600	6.290	1.310	0.448
Four	8.972	6.828	2.144	0.258
Five	10.286	10.076	0.210	0.914
Six	9.928	8.619	1.309	0.498
	Panel C (Quarterly Frequency): R&D			
One	4.972	5.334	–0.362	0.488
Two	4.830	5.054	–0.224	0.653
Three	4.230	4.218	0.012	0.979
Four	4.246	4.423	–0.177	0.683
Five	4.733	4.258	0.475	0.279
Six	4.263	4.419	–0.156	0.729
	Panel D (Quarterly Frequency): DIVESTITURES			
One	0.051	0.059	-0.008	0.566
Two	0.062	0.058	0.004	0.783
Three	0.062	0.076	–0.014	0.297
Four	0.066	0.054	0.012	0.378
Five	0.055	0.038	0.017	0.165
Six	0.039	0.046	–0.007	0.578

Table C.6. The Impact of the Brexit Vote on Investment, Employment, R&D and Divestitures: Cash Flow News Decomposition

This table reports output from equation (14). The dependent variables are INVESTMENT, EMPLOYMENT_GROWTH, R&D and DIVESTITURES. The treatment group is composed by the top tercile of $\beta^{UK}_{i,CF}$, while the control group is composed by firms in the bottom tercile of $\beta^{UK}_{i,CF}$. A firm's $\beta^{UK}_{i,CF}$ is estimated as follows. First, we decompose volatility of monthly stock returns into cash flow and discount rate news components using the Campbell and Shiller (1988) approach as applied to individual stocks by Vuolteenaho (2002). Next, we estimate equation (13) with the cash flow component as the dependent variable, to obtain $\beta^{UK}_{i,CF}$ for each firm. The time dimension of the DID estimator is set so as to compare the two quarters following the announcement of the referendum and Brexit's victory (2016:Q3–Q4) *versus* the two quarters preceding the announcement (2015:Q3–Q4). T-statistics are computed using robust standard-errors (in parentheses) double-clustered at the firm and calendar quarter levels.

	INVESTMENT	EMPLOYMENT_GROWTH	R&D	DIVESTITURES
	Treatment is Top Tercile of $\beta^{UK}_{i,CF}$ 1	Treatment is Top Tercile of $\beta^{UK}_{i,CF}$ 2	Treatment is Top Tercile of $\beta^{UK}_{i,CF}$ 3	Treatment is Top Tercile of $\beta^{UK}_{i,CF}$ 4
POST × HIGH_$\beta^{UK}_{i,CF}$	–0.330***	–5.147**	0.348***	–0.034***
	(0.014)	(1.925)	(0.050)	(0.010)
Controls				
Firm	Yes	Yes	Yes	Yes
Fixed Effects				
Firm	Yes	Yes	Yes	Yes
Industry×Time	Yes	Yes	Yes	Yes
Observations	14,709	3,247	5,060	14,953
R-squared	0.75	0.45	0.88	0.33

Statistical significance levels: *** p-value<0.01, ** p-value<0.05, * p-value<0.10.

Table C.7. The Impact of the Brexit Vote on US Investment: First-Moment Controls

This table reports output from equation (14). The dependent variables are INVESTMENT and EMPLOYMENT_GROWTH. INVESTMENT is defined as capital expenditures divided by lagged total assets (quarterly). EMPLOYMENT_GROWTH is the percentage change in the number of employees (annual). In the first specification, the measure of UK-exposure (β_i^{UK}) enters the regression as a linear continuous variable. In the second specification, the treatment group is composed by the top tercile of β_i^{UK}, while the control group is composed by firms in the bottom tercile of β_i^{UK}. The third specification is a textual-search-based measure of UK-exposure that sums up the number of Brexit-related words in firms' 2015 10-K forms. The treatment group is made of firms with more than five entries, whereas the control group are firms with zero entries. The time dimension of the DID estimator is set so as to compare the two quarters following the announcement of the Brexit referendum victory (2016:Q3–Q4) *versus* the two quarters preceding the announcement of the vote date (2015:Q3–Q4). The specifications also include the first-moment instruments for the USD–GBP exchange rate, the price of oil, and the Treasury rate from Alfaro, Bloom, and Lin (2018). T-statistics are computed using robust standard-errors (in parentheses) double-clustered at the firm and calendar quarter levels.

	Panel A: INVESTMENT		
	Linear Model 1	Treatment is Top Tercile of β_i^{UK} 2	Treatment is >5 Brexit Entries in 10-Ks 3
POST	–0.042		
	(0.030)		
POST × β_i^{UK}	–0.127***		
	(0.016)		
POST × HIGH_β_i^{UK}		–0.182***	
		(0.018)	
POST × HIGH_10-K_ENTRIES			–0.063***
			(0.010)
SIZE	0.105**	0.088	0.186**
	(0.050)	(0.108)	(0.081)
TOBIN_Q	0.162***	0.108***	0.168***
	(0.018)	(0.038)	(0.021)
CASH_FLOW	1.486***	1.540*	0.270
	(0.475)	(0.760)	(0.542)
SALES_GROWTH	0.059**	0.056	0.032
	(0.028)	(0.046)	(0.025)
CONSENSUS_EARNINGS_FORECAST	0.051***	0.025	0.028**
	(0.012)	(0.014)	(0.012)
STOCK_RETURNS	–0.053	0.117	–0.062
	(0.044)	(0.083)	(0.048)
Controls			
Macroeconomic	Yes	No	No
First-Moment Instruments	Yes	Yes	Yes
Fixed Effects			
Firm	Yes	Yes	Yes
Industry×Time	No	Yes	Yes
Observations	41,630	17,199	21,253
R-squared	0.68	0.75	0.73

Statistical significance levels: *** p-value<0.01, ** p-value<0.05, * p-value<0.10.

	Panel B: EMPLOYMENT_GROWTH		
	Linear Model	Treatment is Top Tercile of β_i^{UK}	Treatment is > 5 Brexit Entries in 10-Ks
	1	2	3
POST	1.986		
	(2.787)		
POST × β_i^{UK}	–3.999*		
	(2.186)		
POST × HIGH_β_i^{UK}		–4.924***	
		(1.566)	
POST × HIGH_10-K_ENTRIES			–1.111**
			(0.545)
SIZE	16.997***	17.486***	16.156***
	(2.119)	(2.590)	(3.178)
TOBIN_Q	3.288***	2.112	3.616***
	(0.614)	(1.120)	(0.898)
CASH_FLOW	–4.682	–10.845	–3.512
	(5.017)	(6.515)	(7.697)
SALES_GROWTH	–1.738	–1.468	–0.734
	(1.058)	(1.381)	(1.620)
CONSENSUS_EARNINGS_FORECAST	0.288**	–0.056	0.420**
	(0.101)	(0.216)	(0.160)
STOCK_RETURNS	4.726***	5.563***	4.697**
	(0.969)	(1.093)	(1.432)
Controls			
Macroeconomic	Yes	No	No
First-Moment Instruments	Yes	Yes	Yes
Fixed Effects			
Firm	Yes	Yes	Yes
Industry×Time	No	Yes	Yes
Observations	9,143	3,540	4,173
R-squared	0.35	0.45	0.45

Statistical significance levels: *** p-value<0.01, ** p-value<0.05, * p-value<0.10.

Appendix D Timeline of Brexit Key Events

Jun · 26 · 2012	David Cameron is elected with support of the UK Independent Party
Jan · 11 · 2013	PM David Cameron makes contingent promise: A referendum before 2017 if Conservatives win the 2015 general elections
May · 07 · 2015	General Elections: Cameron wins another term on tight margin of votes
Jun · 09 · 2015	House of Commons approves the European Union Referendum Act
Dec · 14 · 2015	House of Lords approves the Referendum
Dec · 17 · 2015	EU Referendum Act receives Royal Assent. A referendum is to be held on the question “Should the UK remain a member of the EU or leave?”
Feb · 20 · 2016	**Announcement:** Cameron announces that referendum will be held on June 23 2016
Apr · 15 · 2016	Start of the referendum campaign period
Jun · 23 · 2016	**Referendum** takes place, Brexit wins
Jun · 24 · 2016	Result of the referendum is announced (Brexit wins)
Jul · 13 · 2016	David Cameron resigns, Theresa May assumes as Prime Minister
Oct · 02 · 2016	PM May voices intention to trigger Article 50 (exit process) by March 2017
Jan · 24 · 2017	UK Supreme Court rules that the UK government must hold a vote in parliament before beginning the process of leaving EU, delaying Prime Minister May’s timetable
Feb · 08 · 2017	House of Commons approves Theresa May’s Article 50 bill without amendments to proceed with Brexit negotiation with the EU
Mar · 29 · 2017	UK–EU Brexit negotiations begin

Figure D.1. Timeline of the Brexit Referendum. This figure lists the key events preceding the referendum leading to Brexit. Events in **bold blue** represent two key dates used in our analysis; the *Announcement* of the date when the referendum would be held, and the *Referendum* vote itself.

Appendix E Measures of Exposure to Automation

E.1 Details on Automation Exposure Measures

For more details on the geographic measure of exposure to automation for all commuting zones in the continental US, we refer the reader to Acemoglu and Restrepo (2020) and Leigh and Kraft (2018). In this appendix, we describe in more detail the procedure to construct our text-based measure of automation exposure at the firm level. We draw inspiration from an extensive literature in corporate finance that uses textual analysis (e.g., Loughran and McDonald (2011)) and define a dictionary of keywords that capture automation at the firm level. We first gather the syllabuses of many courses on "*Industrial Automation and Integration*" taught at top Engineering schools in North America (MIT, CalTech, University of Toronto, among others). Reading each syllabus, we identify the most frequently adopted textbook. This analysis points to Benhabib's (2003) *"Manufacturing: Design, Production, Automation, and Integration"* as one of the most commonly required textbooks in these universities.

With the textbook in hand, we parse its full textual content and use a standard keyword ranking algorithm ("*TextRank*", see Mihalcea and Tarau (2004)) to order the most distinctive keywords reflecting automation. Following the usual procedures in textual analysis (e.g., exclusion of "stop words"), we select the top 100 keywords that are closely related to automation and use them as a dictionary for parsing firms' 10-Ks. The list of keywords is provided in Table E.1. Finally, we define AUTOMATION_i, which is a continuous variable (in logs) that measures how frequently the top 100 automation keywords appear in the firm's business description (Section 1 of the 10-K form) and management discussion (Section 7 of the 10-K form). To capture cases in which a firm discusses automation efforts in only one year, we average the word count across all years in our sample. $\text{AUTOMATION}_i = \log(1 + \text{AUTOMATION\_KEYWORDS}_i)$, where $\text{AUTOMATION\_KEYWORDS}_i$ is the number of mentions of the top 100 automation-related keywords in firm i's 10-K forms. Figure E.1 shows a histogram with the distribution of the AUTOMATION_i variable.

E.2 Additional Figures and Tables

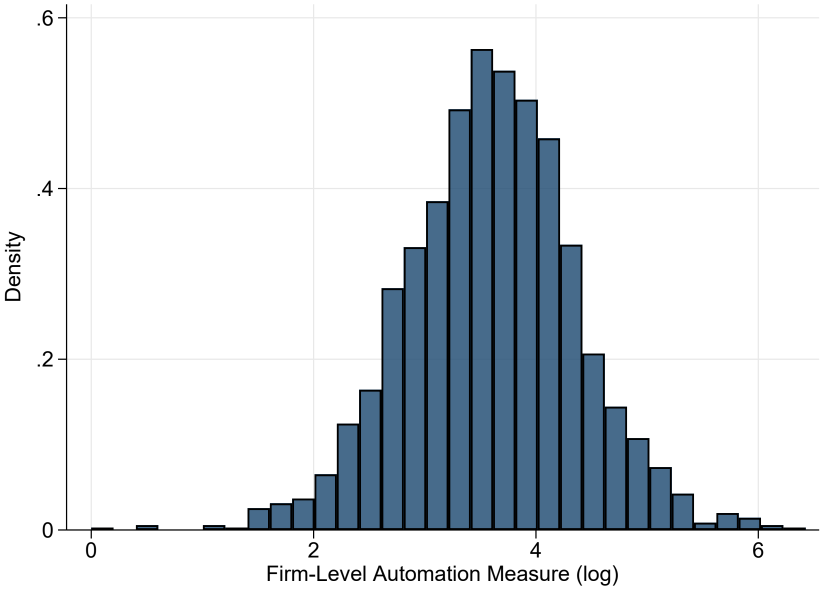

Figure E.1. Distribution of Firm-Level Measure of Automation Exposure. This figure shows the histogram of the text-based, firm-level measure of automation exposure. Specifically, the measure is constructed as $\text{AUTOMATION}_i = \log(1 + \text{AUTOMATION\_KEYWORDS}_i)$, where $\text{AUTOMATION\_KEYWORDS}_i$ is the number of mentions of the top 100 automation-related keywords in firm i's 10-K forms as described in Subsection E.1. The total number of firm i's keyword mentions per year are then averaged across the pre-Brexit sample period of our baseline analysis (2010–15).

Table E.1. List of Automation-Related Keywords

This table reports the list of top 100 automation-related keywords as identified by the procedure listed in Section E.1.

Automation-Related Keywords

- machine tool design
- design parts
- industrial design processes
- design processes
- automated production machines
- material removal machine tools
- manufacturing systems
- statistical process control tools
- composite part design
- process materials
- manufacturing process
- nc machine tool control
- modular product design
- product materials
- discrete parts manufacturing
- industrial machine tools
- product design methods
- aircraft parts manufacturing
- based processes
- metal parts
- metal fabrication processes
- large sheet metal parts
- metal processes
- mechanical part orienting systems
- machine tools
- manufacturing machines
- multidisciplinary product design teams
- manufactured parts
- automatic machine tools
- part models
- machine tool vibrations
- large parts
- automated machine tools
- robot chip formation
- material removal machine
- modern machine tools
- machine tool history
- based manufacturing
- ultrasonic machine tools
- statistical process control
- cnc machine tools
- based material removal
- engineering design models
- part geometries
- orientation systems
- mold design techniques
- other large manufacturing companies
- larger design
- experimental design procedures
- automatic device control
- metal cutting tools
- robot motion control
- metal forming processes
- industrial processes
- discrete parts manufacturing industries
- other engineering products
- based systems
- many parts
- small mechanical parts
- cutting tools
- other casting processes
- design parameter values
- robots
- robot part fabrication
- industrial robots
- product assembly
- complex geometry parts
- individual component designs
- lean manufacturing machines
- autonomous manufacturing systems
- machine vision systems
- process controllers
- automotive parts
- machining processes
- robot fabrication process
- material handling robots
- continuous path machining process
- layered parts
- cylindrical parts
- industrial manufacturing environments
- composite parts
- thermoplastic parts
- laminated parts
- industrial robot applications
- manufacturing system modeling
- deformation processes
- parametric design
- resistance welding processes
- integral designs
- robot motion controllers
- computer integrated manufacturing
- integrated sensors
- programmable manufacturing devices
- aided design aspects
- microdetailed aerospace parts
- automata tools
- robot programming techniques
- such playback-based robot motion techniques
- commercial industrial robots
- automated manufacturing

Table E.2. The Impact of the Brexit Vote on Automation Exposure

This table reports output from equation (14). The dependent variable is AUTOMATION$_{i,t}$, which is constructed from a dictionary of keywords that capture exposure to automation at the firm level, as described in Appendix E. This text-based continuous variable is the logarithm of the total number of automation-related keywords that appear in firm is business description (10-K Section 1) and management discussion (10-K Section 7), at the firm-year level. In the first specification, the treatment group is composed by the top tercile of β_i^{UK}, while control group is composed by firms in the bottom tercile of β_i^{UK}. The second specification is a textual-search-based measure of UK-exposure that sums up the number of Brexit-related words in firms' 2015 10-K forms. The treatment group is made of firms with more than five entries, whereas the control group are firms with zero entries. The testing specification and estimation procedure is as per the EMPLOYMENT_GROWTH tests in Table 2.

	AUTOMATION$_{i,t}$	
	Treatment is Top Tercile of β_i^{UK} 1	Treatment is >5 Brexit Entries in 10-Ks 2
POST × HIGH_β_i^{UK}	0.144*	
	(0.075)	
POST × HIGH_10-K_ENTRIES		0.096*
		(0.048)
Controls		
Firm	Yes	Yes
Fixed Effects		
Firm	Yes	Yes
Industry×Time	Yes	Yes
Observations	3,540	4,173
R-squared	0.20	0.28

Statistical significance levels: *** p-value<0.01, ** p-value<0.05, * p-value<0.10.