Measuring the Effects of Firm Uncertainty on Economic Activity: New Evidence from One Million Documents

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Challenging to Measure of Firm Level Uncertainty

- (Ideal) firm-level measure would
  - summarize idiosyncratic implications of all risk factors to firm's outlook on future
  - disentangle expectations from uncertainty (subjective or not), e.g. forecast + forecast error
  - provide identifiable variation across firms and time

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- We employ the words firm use in SEC filings to measure "uncertainty"-related words in business context

- Compute new contextual measure of uncertainty based on the words in SEC annual and quarterly filings

  Company **R**eported **U**ncertainty Inde**X**, or **CRUX**

- Key value added — Provides firm-level, time-varying measure of uncertainty.

Our Approach & Results

- Advantages
  - Standardized and consistent panel data on filings
  - Capture uncertainty unmeasured by observable volatility

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  - Standardized and consistent panel data on filings
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- Results
  - Quantify first order delay and second order caution effects on investment and employment
  - Robust to large set of other first moment shock controls

- Broader Implications
  - Importance of idiosyncratic vs aggregate uncertainty in macro and firm-level investment/employment dynamics
  - Frequent filing of 10-K, 10-Q or amended reports could provide an contemporaneous index of reported uncertainty.

Contribution to Literature

- Testable predictions of real options models with irreversible costs [Bernanke (1983), Pindyck (1991) and Dixit & Pindyck (1994)...]
    1. **DELAY**: high uncertainty can reduce investment/hiring
    2. **CAUTION**: increased uncertainty attenuates response to demand shocks

- Limited work combining firm-level outcomes and firm-specific uncertainty measures
    - Stock price vol. and investment response (Leahy and Whited, 1996) and evidence of delay/caution effects (Bloom, Bond & Van Reenen, 2007; Bloom, 2009)
    - Implied volatility in equity options (Stein & Stone, 2013)–measurable only on traded options
    - **Survey Data:** Guiso and Parigi (1999), Bachmann et al. (2013, 2018) and Bloom et al. (2017)

- **<u>Text-based indices</u>** of aggreg policy uncertainty (Baker, Bloom, and Davis 2017), monetary policy uncertainty (Husted, Rogers and Sun 2017) and firm conf call discussion of political risk (Hassan et al., 2017).

Measuring Uncertainty in Context

- Publicly traded firms have **mandatory** filing requirement with SEC on regular schedule

- We parse text of all 10-K, 10-Q and their amendments each year.

- Constructing the measure:

$$\text{CRUX}_{it} = \frac{\text{Total uncertain words}_{it}}{\text{Total number of meaningful words}_{it}} \times 100.$$

  - Numerator: sum of words $\in \{uncertain, uncertainty, uncertainties, uncertainly\}$
  - Denominator: meaningful words omits 'the', 'a', etc.

What do firms report in filings: examples

- MACRO SHOCKS: "***Uncertainty*** about global and regional economic conditions" – Apple, 2013, 10-K, Risk Factors

- LITIGATION UNCERTAINTY: "***uncertainty*** of the outcome of the appeal from the District Courts certification decision" – Walmart 2006, first 10-Q, Financial Information

- POLICY UNCERTAINTY: "... ***uncertain*** timing associated with shifting production ...; and (v) ***uncertainties*** regarding the size and duration of EU tariffs." (Harley-Davidson, June 2018, 8-K, Regulation FD Disclosure)

What does CRUX actually measure?

- Let $\text{CRUX}_{it} = f(\mu_{it}, \sigma_{it}) + \varepsilon_{it}$, take first-order approx. around firm-level mean deviations in $\bar{\mu}_i$ and $\bar{\sigma}_i$

$$\text{CRUX}_{it} = f(\bar{\mu}_i, \bar{\sigma}_i) + f_\mu(\bar{\mu}_i, \bar{\sigma}_i)(\mu_{it} - \bar{\mu}_i) + f_\sigma(\bar{\mu}_i, \bar{\sigma}_i)(\sigma_{it} - \bar{\sigma}_i) + e_{it} \quad (1)$$

- Assumption: $f_\sigma(\cdot) > 0$ so that CRUX_{it} captures a relative ranking uncertainty within firm.

- Empirical ID reqs. within firm, time variation in uncertainty, i.e. $\text{Var}(\sigma_{it} - \bar{\sigma}_i) > 0$ so diffs across firms not just time-invariant uncertainty (and first moment) in business environment.

Breaking down sources of variation: CRUX regressed on progressive set of fixed effects

	Compustat Corporate Investment Sample	
	(1)	(2)
	R-squared	Incremental R-squared
Time FE	21.26%	21.26%
Industry FE (3-digit NAICS)	4.83%	4.41%
Industry (3-digit NAICS) × Time FE	27.65%	1.98%
Firm FE	46.41%	34.07%
Unexplained Residual	-	38.28%
Number of Industries	99	99
Number of Firms	8,514	8,514
Number of Observations	84,523	84,523

- Around 40% of variation comes from firm idiosyncratic shocks after controlling for firm FE and industry-year FE.

Firm-level Regression Specification

$$\Delta y_{it} = \lambda \text{CRUX}_{it} + \eta \text{CRUX}_{it} \cdot \Delta \log(sales)_{it-1} + \beta \cdot \boldsymbol{X_{it-1}} + \alpha_i + \alpha_t + \epsilon_{it},$$

- Dep. Vars: $\Delta y_{it} =$
  - investment rate $= \log(K_{it}/K_{it-1})$
  - DHS employment growth $= \frac{(\text{emp}_{it} - \text{emp}_{it-1})}{0.5(\text{emp}_{it} + \text{emp}_{it-1})} \in [-2, 2]$.
- Delay Effects: uncertainty+non-convex costs $\Rightarrow$ ↘ invest & emp growth $\Rightarrow \lambda < 0$
- Caution effects: sales shocks $\Delta \log(sales)_{it-1} > 0$ attenuated by high uncertainty $\Rightarrow \eta < 0$
- $\boldsymbol{X}_i$ includes Tobin's Q, lagged sales growth and its square
- firm fixed effects α_i absorb firm specific growth trends
- year α_t and NAICS 3 industry×year fixed effects $\alpha_{I,t}$ absorb industry supply/demand shocks

Caution Effects and Evidence for Uncertainty

$$\Delta y_{it} = \lambda \text{CRUX}_{it} + \eta \text{CRUX}_{it} \cdot \Delta \log(\text{sales})_{it-1} + \boldsymbol{\beta} \cdot \boldsymbol{X_{it-1}} + \alpha_i + \alpha_t + \epsilon_{it},$$

- Threat to identification: firms use "uncertainty" as a catch all term to describe bad shocks $\Rightarrow$ bias toward $\lambda < 0$

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- **BUT...** the same would not hold for the cautionary effect.

- Suppose negative sales shock, $\Delta \log(\textit{sales})_{it-1} < 0$, and blamed on uncertainty

- Good sales shocks attributed to foresight ("we knew it all along")

  - If CRUX is purely a first moment shock then it's an inverse proxy for sales. $\Rightarrow \lambda < 0$
  - If investment reduced when CRUX high then the interaction coefficient on CRUX$\times \Delta \log(\textit{sales})_{it-1}$ is positive $\eta > 0$, i.e. employment or investment decline more when sales shocks are large.

- We reject $\hat{\eta} > 0$ across all specifications

Empirical Outline – Micro Outcomes and Data Sources

- COMPUSTAT firm level investment

- *Establishment* level investment – Manufacturing (CM/ASM)
  - SEC-EDGAR and CM/ASM matched sample
    - Summary statistics
  - Effect of Industry level CRUX on all CM/ASM multi-units firms
    - Summary statistics

- Firm-level employment growth and decompositions across establishment – Longitudinal Business Database
  - Summary Statistics

Binscatter: Investment negatively related to uncertainty
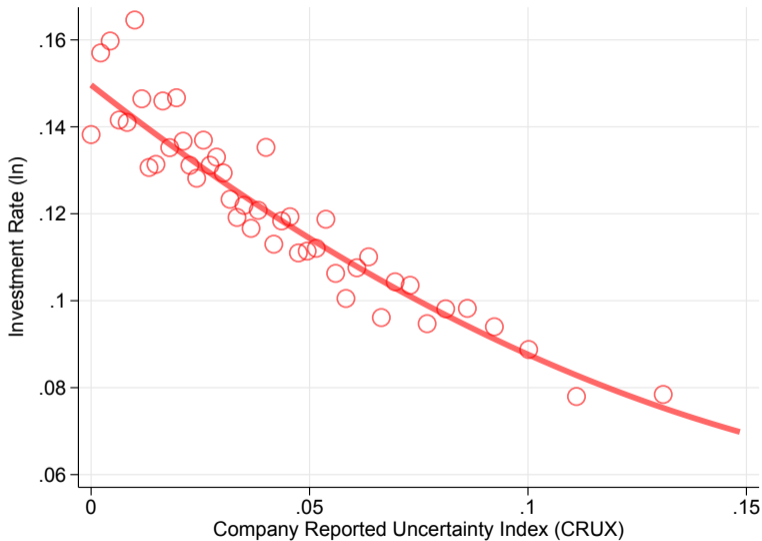
Investment Response to Sales Growth Attenuated for High Uncertainty
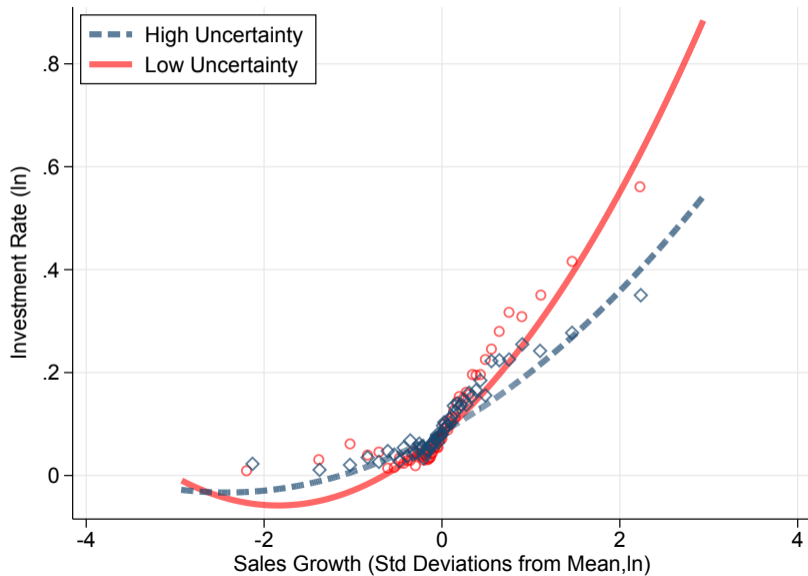
Compustat: Uncertainty and Firm Investment Rate

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent Variable: Log Change in Capital Stock K (Δln, t)			
CRUX (t)	-0.196***	-0.174***	-0.153***	-0.155***	-0.151***	-0.153***
	[0.0477]	[0.0472]	[0.0457]	[0.0453]	[0.0455]	[0.0452]
Sales Growth (Δln t-1)			0.127***	0.121***	0.125***	0.119***
			[0.00828]	[0.00749]	[0.00829]	[0.00749]
CRUX (t) × Sales Growth (Δln t-1)			-0.740***	-0.676***	-0.726***	-0.665***
			[0.108]	[0.105]	[0.108]	[0.105]
Sales Growth (Δln t-1) sqaured				0.0103***		0.0101***
				[0.00153]		[0.00153]
Log Tobin's Q (t-1)					0.0313***	0.0299***
					[0.00339]	[0.00334]
Constant	0.180***					
	[0.00363]					
Firm Fixed Effects	√	√	√	√	√	√
Year Fixed Effects	√					
Industry × Year Fixed Effects		√	√	√	√	√

- Delay: 1 SD increase in CRUX $\Rightarrow$ -1.2 log pts on investment ($= -0.153 \times 0.076 \times 100$)
- Caution: 1 SD sales shock is 7.3 lpts, at mean+1SD for CRUX, attenuated by 3.2 lp ($= -0.740 \times 0.076 \times 0.577 \times 100$), or 44%

Results: Uncertainty & Manuf. Investment Rate

| | Dependent Variable: Log Total Investment Rate (Δln, t) | | | | |
VARIABLES	(1)	(2)	(3)	(4)	(5)
CRUX (t)	-0.0690*	-0.0676*	-0.0681*	-0.0667*	
	[0.0353]	[0.0354]	[0.0354]	[0.0354]	
TVS Growth (Δln t-1)	0.0460***	0.0458***	0.0437***	0.0435***	0.0470***
	[0.00694]	[0.00697]	[0.00647]	[0.00650]	[0.00690]
CRUX (t) × TVS Growth (Δln t-1)	-0.335***	-0.337***	-0.314***	-0.316***	-0.373***
	[0.114]	[0.114]	[0.110]	[0.110]	[0.121]
TVS Growth (Δln t-1) squared			0.00540***	0.00541***	
			[0.00186]	[0.00186]	
Log Tobin's Q (t-1)		0.0153***		0.0154***	
		[0.00322]		[0.00320]	
Firm Fixed Effects	√	√	√	√	
Firm × Year Fixed Effects					√
Year Fixed Effects					
Industry × Year Fixed Effects	√	√	√	√	√

▶ Delay Effects: CRUX 1 SD above mean (0.07) reduces invest rate by 0.5 log points
  ($= -0.0690 \times 0.07 \times 100$), or more than half the average rate in sample (0.818)

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		[0.00322]		[0.00320]	
Firm Fixed Effects	√	√	√	√	
Firm × Year Fixed Effects					√
Year Fixed Effects					
Industry × Year Fixed Effects	√	√	√	√	√

▶ 1 SD sales shock & No Unc. ⇒ investment rate increases by 1.84 log points ($= 0.0460 \times 40.1$)

▶ High Uncertainty ⇒ attenuated by 0.94 log point ($= -0.335 \times 0.07 \times 40.1$), slightly above 50%

▶ Take column (3) and visualize - next slide.

Rising Uncertainty Attenuates Inv. Response to Sales Growth
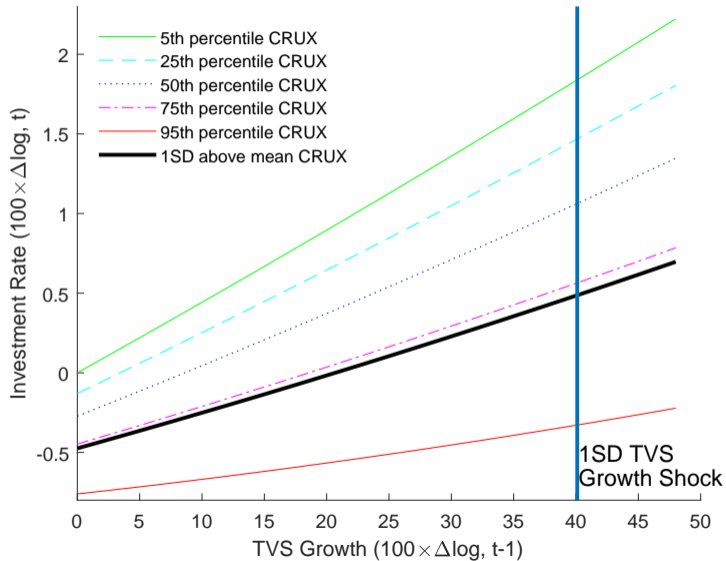
Delay vs Caution Effect on Manuf. Investment Rate
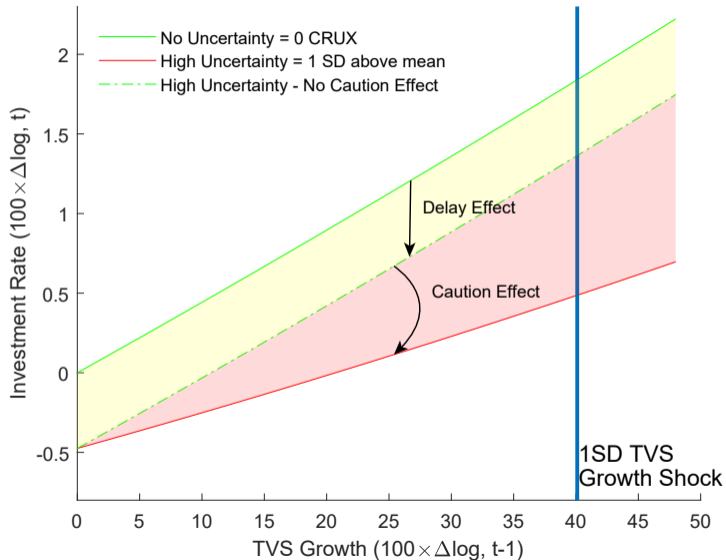
Robustness Checks

- COMPUSTAT
  - Compustat corporate investment results: `Compustat Investment Rate`
  - Compustat employment results: `Compustat Emp`
  - Other "uncertain" related words, such as risk: `Risk`
  - High uncertainty vs low uncertainty (one way of dealing with measurement error): `High vs Low Uncertainty`
  - Other measures of uncertainty
    - Realized volatility: `Realized Volatility + CRUX`
    - Implied volatility: `Implied Volatility + CRUX`
  - Introduction of "Item 1A Risk Factors": `Inv. + Post 2006 Indicator` `Emp. + Post 2006 Indicator` `Inv. + Risk Factor` `Emp. + Risk Factor`

Robustness Checks cont'd

- CM/ASM
  - Manuf. investment spike: Investment Spike
  - Manuf. investment rate (IPS-weighted): IPS-weighted Investment Rate
  - Equipment vs structure investment rate (IPS-weighted): IPS-weighted Investment Rate

- LBD
  - Uncertainty & Establishment growth results: Establishment Growth
  - Uncertainty & Establishment growth decomposition results: Establishment Growth Decomposition
  - LBD employment growth (IPS-weighted): IPS-weighted Employment Growth
  - LBD common vs idiosyncratic CRUX: Common vs Idiosyncratic CRUX

Summary

- When publicly trade companies say they are uncertain, they mean it – CRUX index is meaningful gauge at firm and aggregate level
  - Investment reduced by about 0.5% in Manuf. establishment level and Employment Growth reduces by 1.4% in response to high uncertainty shocks
  - A large portion job creation reduction comes from extensive margin (birth)
  - Firms also less responsive to positive sales shocks.
- Micro to macro aggregate effects
  - Effect of firm idiosyncratic uncertainty is salient when common industry uncertainty is controlled
  - Constructed industry level CRUX matters for entire CM/ASM matched sample

Manufacturing Data (CM/ASM) Summary Statistics

VARIABLES	Mean	Std Dev
CRUX	0.0409	[0.0288]
Peer CRUX	0.0804	[1.25]
Log Total Investment Rate	0.818	[14.7]
Investment Spike	4.7	[21.2]
Log Structure Investment Rate	0.178	[11.7]
Log Equipment Investment Rate	1.13	[17.5]
Lag TVS growth (log)	0.94	[40.1]
Lag TVS Growth (log) squared	0.161	[1.011]
Lag Tobin's Q (log)	0.437	[0.378]
N	133000	

Note: All variables except for lag Tobin's Q, and lag TVS growth sqaured, are in percentage points (value form sample × 100). This is establishment level data.

- Establishment level data

Manufacturing Data (CM/ASM) Summary Statistics

VARIABLES	Mean	Std Dev
Industry CRUX (Equally-Weighted)	0.219	[1.26]
Industry CRUX (IPS-Weighted)	0.219	[1.26]
Log Total Investment Rate	0.654	[15.2]
Investment Spike	4.75	[21.3]
Log Structure Investment Rate	-0.073	[11.1]
Log Equipment Investment Rate	0.98	[18.4]
Lag TVS growth (log)	0.697	[41.7]
Lag TVS Growth (log) squared	0.174	[1.037]
N	472000	

Note: All variables except for lag TVS growth sqaured, are in percentage points (value form sample × 100). This is establishment level data.

- Establishment level data
- Industry CRUX is calculated by taking equally or inverse propensity score (IPS) weighted average

Aggregate Effects on All Multi-unit Manuf. Establishments

	Dependent Variable: Log Total Investment Rate (Δln, t)					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Equally-Weighted Industry CRUX			IPS-Weighted Industry CRUX		
Industry CRUX (t)	-0.184***	-0.186***		-0.182***	-0.184***	
	[0.0565]	[0.0564]		[0.0565]	[0.0565]	
TVS Growth (Δln t-1)	0.0230***	0.0223***	0.0245***	0.0230***	0.0223***	0.0245***
	[0.00172]	[0.00168]	[0.00239]	[0.00172]	[0.00168]	[0.00239]
Industry CRUX (t) × TVS Growth (Δln t-1)	-0.370***	-0.324***	-0.389***	-0.369***	-0.323***	-0.388***
	[0.102]	[0.0994]	[0.150]	[0.102]	[0.0994]	[0.150]
TVS Growth (Δln t-1) squared		0.00392***	0.00432***		0.00392***	0.00432***
		[0.000875]	[0.00116]		[0.000875]	[0.00116]
Firm Fixed Effects	√	√		√	√	
Firm × Year Fixed Effects			√			√
Industry × Year Fixed Effects	√	√	√	√	√	√
R-squared	0.124	0.125	0.423	0.124	0.125	0.423

- Expands sample size to entire CM/ASM establishments of multi-unit firms
- To deal with selection issues, we weight CRUX measure by inverse propensity score constructed by fitting logit specifications - $\log \frac{p(X_{it})}{1-p(X_{it})} = X_{it}\theta_t$ - where establishment size, industry, age, payroll, survival indicator etc. are controlled

Effects of Uncertainty on Firm Investment Rate

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Log Change in Capital Stock K (Δln, t)					
CRUX (t)	-0.196***	-0.174***	-0.153***	-0.155***	-0.151***	-0.153***
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Sales Growth (Δln t-1)			0.127***	0.121***	0.125***	0.119***
			[0.00828]	[0.00749]	[0.00829]	[0.00749]
CRUX (t) × Sales Growth (Δln t-1)			-0.740***	-0.676***	-0.726***	-0.665***
			[0.108]	[0.105]	[0.108]	[0.105]
Sales Growth (Δln t-1) sqaured				0.0103***		0.0101***
				[0.00153]		[0.00153]
Log Tobin's Q (t-1)					0.0313***	0.0299***
					[0.00339]	[0.00334]
Constant	0.180***					
	[0.00363]					
Firm Fixed Effects	√	√	√	√	√	√
Year Fixed Effects	√					
Industry × Year Fixed Effects		√	√	√	√	√
Observations	84,523	83,806	83,806	83,806	83,806	83,806
R-squared	0.090	0.377	0.412	0.417	0.414	0.419
Number of Firms	8,514	7,882	7,882	7,882	7,882	7,882

Effects of Uncertainty on Firm Employment Growth

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent Variable: DHS Change in Employment (Δdhs, t)			
CRUX (t)	-0.236***	-0.230***	-0.232***	-0.234***	-0.225***	-0.227***
	[0.0556]	[0.0561]	[0.0562]	[0.0562]	[0.0546]	[0.0546]
Sales Growth (Δln t-1)			0.0281***	0.0265***	0.0190***	0.0179***
			[0.00654]	[0.00659]	[0.00637]	[0.00647]
CRUX (t) × Sales Growth (Δln t-1)			-0.258**	-0.248**	-0.217**	-0.210**
			[0.106]	[0.106]	[0.105]	[0.106]
Sales Growth (Δln t-1) sqaured				0.00302**		0.00215
				[0.00150]		[0.00140]
Log Tobin's Q (t-1)					0.122***	0.122***
					[0.00436]	[0.00438]
Constant	0.102***					
	[0.00661]					
Firm Fixed Effects	√	√	√	√	√	√
Year Fixed Effects	√					
Industry × Year Fixed Effects		√	√	√	√	√
Observations	107,918	106,250	106,250	106,250	106,250	106,250
R-squared	0.027	0.227	0.228	0.228	0.249	0.250
Number of Firms	13,236	11,651	11,651	11,651	11,651	11,651

Effects "Risk" on Firm Investment and Hiring Decisions

VARIABLES	Log Change in Capital Stock K (Δln, t)				DHS Change in Employment (Δdhs, t)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RISK (t)	0.0709***	0.0599***	0.0639***	0.0637***	0.0259	0.0253	0.0259	0.0244
	[0.0187]	[0.0180]	[0.0180]	[0.0180]	[0.0170]	[0.0169]	[0.0169]	[0.0167]
Sales Growth (Δln t-1)		0.108***	0.106***	0.105***		0.00999	0.00950	0.00466
		[0.00863]	[0.00798]	[0.00796]		[0.00649]	[0.00652]	[0.00626]
RISK (t) × Sales Growth (Δln t-1)		-0.141***	-0.150***	-0.155***		0.0381	0.0335	0.0195
		[0.0510]	[0.0505]	[0.0503]		[0.0345]	[0.0352]	[0.0333]
Sales Growth (Δln t-1) sqaured			0.0109***	0.0106***			0.00305**	0.00218
			[0.00155]	[0.00155]			[0.00151]	[0.00141]
Log Tobin's Q (t-1)				0.0307***				0.122***
				[0.00334]				[0.00437]
Constant								
Firm Fixed Effects	√	√	√	√	√	√	√	√
Year Fixed Effects								
Industry × Year Fixed Effects	√	√	√	√	√	√	√	√
Observations	83,806	83,806	83,806	83,806	106,250	106,250	106,250	106,250
R-squared	0.377	0.412	0.417	0.419	0.227	0.228	0.228	0.250
Number of cusip8id	7,882	7,882	7,882	7,882	11,651	11,651	11,651	11,651

▶ Same way we create CRUX

▶ List of words on numerator: risk, risked, riskier, riskiest, riskily, riskiness, risking, risks, risky.

Effects of "High Uncertainty" on Firm Investment Rate

VARIABLES	Dependent Variable: Log Change in Capital Stock K (Δln, t)					
	(1)	(2)	(3)	(4)	(5)	(6)
High CRUX (t)	-0.00720***	-0.00601**	-0.00516**	-0.00558**	-0.00482*	-0.00525**
	[0.00272]	[0.00272]	[0.00259]	[0.00257]	[0.00259]	[0.00256]
Sales Growth (Δln t-1)			0.121***	0.117***	0.119***	0.115***
			[0.00825]	[0.00767]	[0.00823]	[0.00765]
High CRUX (t) × Sales Growth (Δln t-1)			-0.0517***	-0.0504***	-0.0508***	-0.0497***
			[0.00934]	[0.00908]	[0.00932]	[0.00905]
Sales Growth (Δln t-1) sqaured				0.0107***		0.0104***
				[0.00154]		[0.00155]
Log Tobin's Q (t-1)					0.0314***	0.0299***
					[0.00338]	[0.00332]
Constant	0.178***					
	[0.00361]					
Firm Fixed Effects	√	√	√	√	√	√
Year Fixed Effects	√					
Industry × Year Fixed Effects		√	√	√	√	√
Observations	84,523	83,806	83,806	83,806	83,806	83,806
R-squared	0.090	0.377	0.412	0.417	0.414	0.419
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Effects of Uncertainty on Firm Investment Rate

Adding Realized Volatility as Control

VARIABLES	Dependent Variable: Log Change in Capital Stock K (Δln, t)					
	(1)	(2)	(3)	(4)	(5)	(6)
CRUX (t)	-0.165***	-0.134***	-0.119**	-0.119**	-0.110**	-0.110**
	[0.0502]	[0.0496]	[0.0483]	[0.0480]	[0.0477]	[0.0474]
Sales Growth (Δln t-1)			0.127***	0.119***	0.120***	0.113***
			[0.0125]	[0.0112]	[0.0123]	[0.0110]
CRUX (t) × Sales Growth (Δln t-1)			-0.753***	-0.714***	-0.740***	-0.702***
			[0.135]	[0.129]	[0.133]	[0.126]
Real Vol (t-1)	-0.0143	-0.0467***	-0.0330**	-0.0350**	-0.0518***	-0.0536***
	[0.0142]	[0.0138]	[0.0147]	[0.0147]	[0.0144]	[0.0144]
Real Vol (t-1) × Sales Growth (Δln t-1)			0.0433	0.0585*	0.0442	0.0592*
			[0.0361]	[0.0345]	[0.0348]	[0.0333]
Sales Growth (Δln t-1) sqaured				0.00932***		0.00917***
				[0.00199]		[0.00194]
Log Tobin's Q (t-1)					0.0546***	0.0542***
					[0.00378]	[0.00377]
Constant	0.181***					
	[0.00410]					
Firm Fixed Effects	√	√	√	√	√	√
Year Fixed Effects	√					
Industry × Year Fixed Effects		√	√	√	√	√

Effects of Uncertainty on Firm Investment Rate

| VARIABLES | Dependent Variable: Log Change in Capital Stock K (Δln, t) | | | | | |
	(1)	(2)	(3)	(4)	(5)	(6)
CRUX (t)	-0.251***	-0.246***	-0.232***	-0.233***	-0.222***	-0.223***
	[0.0714]	[0.0708]	[0.0697]	[0.0697]	[0.0689]	[0.0690]
Sales Growth (Δln t-1)			0.150***	0.153***	0.144***	0.147***
			[0.0174]	[0.0154]	[0.0170]	[0.0151]
CRUX (t) × Sales Growth (Δln t-1)			-0.969***	-0.993***	-0.940***	-0.959***
			[0.192]	[0.182]	[0.187]	[0.179]
Impl Vol (t-1)	0.00681***	0.00486***	-0.00824	-0.00774	-0.00536	-0.00500
	[0.00121]	[0.000821]	[0.0122]	[0.0119]	[0.0121]	[0.0120]
Impl Vol (t-1) × Sales Growth (Δln t-1)			0.00772	0.00741	0.00597	0.00574
			[0.00817]	[0.00801]	[0.00813]	[0.00801]
Sales Growth (Δln t-1) sqaured				-0.00265		-0.00206
				[0.00369]		[0.00357]
Log Tobin's Q (t-1)					0.0374***	0.0372***
					[0.00555]	[0.00551]
Constant	0.274***					
	[0.00855]					
Firm Fixed Effects	√	√	√	√	√	√
Year Fixed Effects	√					

Effects of Uncertainty on Firm Investment Rate

Adding Post 2006 Indicator

VARIABLES	Dependent Variable: Log Change in Capital Stock K (Δln, t)					
	(1)	(2)	(3)	(4)	(5)	(6)
CRUX (t)	-0.111*	-0.152**	-0.0992	-0.112*	-0.0974	-0.110*
	[0.0652]	[0.0653]	[0.0622]	[0.0615]	[0.0620]	[0.0614]
CRUX (t) × Post 2006	-0.187**	-0.0485	-0.134*	-0.109	-0.132*	-0.109
	[0.0796]	[0.0799]	[0.0764]	[0.0756]	[0.0759]	[0.0751]
CRUX (t) × Sales Growth (Δln t-1)			-0.568***	-0.505***	-0.565***	-0.504***
			[0.133]	[0.134]	[0.133]	[0.134]
CRUX (t) × Sales Growth (Δln t-1) × Post 2006			-0.345***	-0.342***	-0.323***	-0.321***
			[0.117]	[0.119]	[0.117]	[0.119]
Sales Growth (Δln t-1)			0.126***	0.120***	0.124***	0.118***
			[0.00826]	[0.00751]	[0.00827]	[0.00751]
Sales Growth (Δln t-1) squared				0.0103***		0.0101***
				[0.00151]		[0.00152]
Log Tobin's Q (t-1)					0.0310***	0.0296***
					[0.00339]	[0.00333]
Constant	0.179***					
	[0.00368]					
Firm Fixed Effects	√	√	√	√	√	√

Effects of Uncertainty on Firm Employment Growth

Adding Post 2006 Indicator

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: DHS Change in Employment (Δdhs, t)					
CRUX (t)	-0.330***	-0.293***	-0.284***	-0.289***	-0.276***	-0.280***
	[0.0744]	[0.0758]	[0.0762]	[0.0762]	[0.0750]	[0.0750]
CRUX (t) × Post 2006	0.197**	0.136	0.118	0.123	0.120	0.124
	[0.0868]	[0.0902]	[0.0903]	[0.0903]	[0.0884]	[0.0885]
CRUX (t) × Sales Growth (Δln t-1)			-0.303**	-0.290**	-0.306**	-0.297**
			[0.133]	[0.135]	[0.133]	[0.134]
CRUX (t) × Sales Growth (Δln t-1) × Post 2006			0.0933	0.0880	0.175	0.171
			[0.126]	[0.126]	[0.126]	[0.126]
Sales Growth (Δln t-1)			0.0282***	0.0265***	0.0193***	0.0182***
			[0.00657]	[0.00663]	[0.00642]	[0.00651]
Sales Growth (Δln t-1) squared				0.00301**		0.00213
				[0.00150]		[0.00139]
Log Tobin's Q (t-1)					0.122***	0.122***
					[0.00436]	[0.00438]
Constant	0.103***					
	[0.00663]					
Firm Fixed Effects	√	√	√	√	√	√

Effects of Uncertainty on Firm Investment Rate

Adding "Risk Factors"

VARIABLES	Dependent Variable: Log Change in Capital Stock K (Δln, t)					
	(1)	(2)	(3)	(4)	(5)	(6)
CRUX (t)	-0.120*	-0.157**	-0.110*	-0.120**	-0.112*	-0.122**
	[0.0628]	[0.0631]	[0.0604]	[0.0599]	[0.0603]	[0.0597]
Risk Factors (t)	0.0162	0.00133	0.00720	0.00621	0.00969	0.00861
	[0.00995]	[0.0101]	[0.00967]	[0.00959]	[0.00972]	[0.00964]
CRUX (t) × Risk Factors (t)	-0.177**	-0.0381	-0.115	-0.0967	-0.106	-0.0880
	[0.0774]	[0.0781]	[0.0756]	[0.0751]	[0.0749]	[0.0743]
CRUX (t) × Sales Growth (Δln t-1)			-0.624***	-0.547***	-0.613***	-0.539***
			[0.123]	[0.123]	[0.124]	[0.123]
CRUX (t) × Sales Growth (Δln t-1) × Risk Factors (t)			-0.276**	-0.306***	-0.269**	-0.298**
			[0.114]	[0.117]	[0.114]	[0.117]
Sales Growth (Δln t-1)			0.126***	0.120***	0.124***	0.118***
			[0.00825]	[0.00748]	[0.00826]	[0.00748]
Sales Growth (Δln t-1) squared				0.0104***		0.0101***
				[0.00152]		[0.00153]
Log Tobin's Q (t-1)					0.0312***	0.0298***
					[0.00339]	[0.00334]
Constant	0.179***					
	[0.00367]					

Firm Fixed Effects

Effects of Uncertainty on Firm Employment Growth

Adding "Risk Factors"

VARIABLES	Dependent Variable: DHS Change in Employment (Δdhs, t)					
	(1)	(2)	(3)	(4)	(5)	(6)
CRUX (t)	-0.309***	-0.272***	-0.265***	-0.269***	-0.272***	-0.275***
	[0.0739]	[0.0751]	[0.0754]	[0.0754]	[0.0741]	[0.0741]
Risk Factors (t)	-0.0460***	-0.0436***	-0.0421***	-0.0424***	-0.0324***	-0.0326***
	[0.0121]	[0.0120]	[0.0119]	[0.0119]	[0.0119]	[0.0119]
CRUX (t) × Risk Factors (t)	0.167*	0.101	0.0850	0.0890	0.117	0.120
	[0.0851]	[0.0888]	[0.0892]	[0.0893]	[0.0876]	[0.0877]
CRUX (t) × Sales Growth (Δln t-1)			-0.278**	-0.263**	-0.256**	-0.246*
			[0.126]	[0.128]	[0.125]	[0.127]
CRUX (t) × Sales Growth (Δln t-1) × Risk Factors (t)			0.0539	0.0434	0.0959	0.0884
			[0.123]	[0.123]	[0.124]	[0.123]
Sales Growth (Δln t-1)			0.0279***	0.0263***	0.0189***	0.0178***
			[0.00655]	[0.00661]	[0.00639]	[0.00649]
Sales Growth (Δln t-1) squared				0.00301**		0.00213
				[0.00150]		[0.00140]
Log Tobin's Q (t-1)					0.122***	0.122***
					[0.00436]	[0.00438]
Constant	0.102***					
	[0.00664]					

Firm Fixed Effects

Effects of Uncertainty on Manuf. Investment Spike

| VARIABLES | Dependent Variable: Indicator Arithmetic Investment Rate ≥ 20% (t) | | | | | |
	(1)	(2)	(3)	(4)	(5) IPS-Weighted	(6)
CRUX (t)	-0.116**	-0.114**		-0.0997*	-0.0972*	
	[0.0527]	[0.0526]		[0.0530]	[0.0528]	
TVS Growth (Δln t-1)	0.0405***	0.0373***	0.0371***	0.0400***	0.0370***	0.0369***
	[0.00489]	[0.00468]	[0.00462]	[0.00493]	[0.00474]	[0.00475]
CRUX (t) × TVS Growth (Δln t-1)	-0.298***	-0.273***	-0.290***	-0.274***	-0.251***	-0.272***
	[0.0875]	[0.0861]	[0.0882]	[0.0892]	[0.0876]	[0.0918]
TVS Growth (Δln t-1) squared		0.00691***	0.00609***		0.00702***	0.00619***
		[0.00145]	[0.00136]		[0.00143]	[0.00135]
Log Tobin's Q (t-1)		0.0157***			0.0164***	
		[0.00510]			[0.00509]	
Firm Fixed Effects	√	√		√	√	
Firm × Year Fixed Effects			√			√
Industry × Year Fixed Effects	√	√	√	√	√	√
R-squared	0.071	0.072	0.214	0.071	0.073	0.215

Effects of Uncertainty on Manuf. Investment Rate (IPS-weighted)

| VARIABLES | Dependent Variable: Log Total Investment Rate (Δln, t) | | | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
					IPS-Weighted	
CRUX (t)	-0.0690*	-0.0667*		-0.0630*	-0.0608*	
	[0.0353]	[0.0354]		[0.0345]	[0.0346]	
TVS Growth (Δln t-1)	0.0460***	0.0435***	0.0448***	0.0447***	0.0424***	0.0437***
	[0.00694]	[0.00650]	[0.00642]	[0.00665]	[0.00624]	[0.00615]
CRUX (t) × TVS Growth (Δln t-1)	-0.335***	-0.316***	-0.354***	-0.311***	-0.294***	-0.336***
	[0.114]	[0.110]	[0.118]	[0.107]	[0.104]	[0.111]
TVS Growth (Δln t-1) squared		0.00541***	0.00492***		0.00538***	0.00491***
		[0.00186]	[0.00190]		[0.00174]	[0.00176]
Log Tobin's Q (t-1)		0.0154***			0.0155***	
		[0.00320]			[0.00318]	
Firm Fixed Effects	√	√		√	√	
Firm × Year Fixed Effects			√			√
Industry × Year Fixed Effects	√	√	√	√	√	√
R-squared	0.071	0.072	0.214	0.071	0.073	0.215

Effects of Uncertainty on Manuf. Equipment and Structure Investment (IPS-weighted)

VARIABLES	Log Equipment Investment Rate (Δln, t)			Log Structure Investment Rate (Δln, t)		
	(1)	(2)	(3)	(4)	(5)	(6)
CRUX (t)	-0.0703	-0.0678		-0.0257	-0.0244	
	[0.0430]	[0.0432]		[0.0253]	[0.0251]	
TVS Growth (Δln t-1)	0.0539***	0.0514***	0.0534***	0.0249***	0.0237***	0.0241***
	[0.00781]	[0.00734]	[0.00716]	[0.00475]	[0.00447]	[0.00471]
CRUX (t) × TVS Growth (Δln t-1)	-0.348***	-0.330***	-0.387***	-0.201***	-0.193***	-0.194**
	[0.129]	[0.126]	[0.132]	[0.0762]	[0.0734]	[0.0835]
TVS Growth (Δln t-1) squared		0.00566***	0.00504***		0.00264*	0.00237
		[0.00192]	[0.00192]		[0.00143]	[0.00150]
Log Tobin's Q (t-1)		0.0198***			0.0114***	
		[0.00416]			[0.00218]	
Firm Fixed Effects	√	√		√	√	
Firm × Year Fixed Effects			√			√
Industry × Year Fixed Effects	√	√	√	√	√	√
R-squared	0.095	0.097	0.247	0.048	0.049	0.188

Effects of Uncertainty on Firm Establishment Growth

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Dependent Variable: DHS Change in Number of Establishments (Δdhs, t)				
CRUX (t)	-0.132	-0.145*	-0.12	-0.13	-0.129	-0.13	-0.129
	[0.0843]	[0.0874]	[0.0866]	[0.0864]	[0.0864]	[0.0863]	[0.0863]
Sales Growth (Δln t-1)			0.0663***	0.0884***	0.0854***	0.0884***	0.0853***
			[0.00867]	[0.0123]	[0.0123]	[0.0124]	[0.0124]
CRUX (t) × Sales Growth (Δln t-1)				-0.529***	-0.521***	-0.530***	-0.527***
				[0.199]	[0.198]	[0.199]	[0.198]
Sales Growth (Δln t-1) squared						-0.0000843	-0.000584
						[0.00291]	[0.00287]
Log Tobin's Q (t-1)					0.0334***		0.0335***
					[0.00709]		[0.00711]
Constant	0.0850***						
	[0.0114]						
Firm Fixed Effects	√	√	√	√	√	√	√
Year Fixed Effects	√						
Industry × Year Fixed Effects		√	√	√	√	√	√
R-squared	0.02	0.23	0.233	0.233	0.234	0.233	0.234

Effects of Uncertainty on Firm Establishment Growth Decomposition

VARIABLES	(1) Total	(2) Birth	(3) Death	(4) Acquisition	(5) Divestiture
			Dependent Variable: DHS Change in Establishment (Δdhs, t)		
CRUX (t)	-0.13	-0.144***	-0.00786	-0.0649**	0.0865*
	[0.0864]	[0.0410]	[0.0521]	[0.0297]	[0.0450]
Sales Growth (Δln t-1)	0.0884***	0.0260***	0.0375***	0.0209***	0.00393
	[0.0123]	[0.00405]	[0.00691]	[0.00323]	[0.00733]
CRUX (t) × Sales Growth (Δln t-1)	-0.529***	-0.193***	-0.169	-0.162***	-0.00597
	[0.199]	[0.0576]	[0.140]	[0.0461]	[0.119]
R-squared	0.233	0.231	0.251	0.217	0.244

Effects of Uncertainty on Firm Employment Growth (IPS-weighted)

VARIABLES	(1) Total	(2) Birth	(3) Extensive Margin Death	(4) Acquisition	(5) Divestiture	(6) Net	(7) Continuer Creation	(8) Destruction	(9) Churning
			Dependent Variable: DHS Change in Employment (Δdhs, t)						
CRUX (t)	-0.225**	-0.113***	-0.0507	-0.0405	0.0882*	-0.108**	-0.0630**	-0.0451	-0.209**
	[0.0932]	[0.0337]	[0.0530]	[0.0303]	[0.0474]	[0.0517]	[0.0316]	[0.0378]	[0.0963]
Sales Growth (Δln t-1)	0.148***	0.0193***	0.0358***	0.0232***	0.00442	0.0652***	0.0350***	0.0301***	0.00721
	[0.0161]	[0.00363]	[0.00821]	[0.00368]	[0.00881]	[0.0107]	[0.00452]	[0.00819]	[0.0119]
CRUX (t) × Sales Growth (Δln t-1)	-0.543**	-0.156***	-0.152	-0.189***	0.0439	-0.0907	-0.152**	0.0614	-0.451*
	[0.245]	[0.0469]	[0.164]	[0.0469]	[0.138]	[0.170]	[0.0600]	[0.139]	[0.230]
R-squared	0.268	0.253	0.278	0.257	0.257	0.203	0.248	0.241	0.339

Effect of Common Industry Uncertainty and Firm-specific Uncertainty on Employment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					Dependent Variable: DHS Change in Employment (Δdhs, t)			
VARIABLES	Equally-Weighted Peer CRUX				IPS-Weighted Peer CRUX			
Peer CRUX (t)	-0.137	-0.0937	-0.121	-0.0771	-0.146	-0.103	-0.13	-0.0872
	[0.314]	[0.316]	[0.314]	[0.315]	[0.312]	[0.313]	[0.311]	[0.313]
Peer CRUX (t) × Sales Growth (Δln t-1)	-1.341*	-0.876	-1.370**	-0.886	-1.278*	-0.803	-1.314*	-0.822
	[0.703]	[0.727]	[0.684]	[0.718]	[0.704]	[0.728]	[0.687]	[0.719]
CRUX (t)		-0.202**		-0.201**		-0.201**		-0.201**
		[0.0852]		[0.0844]		[0.0852]		[0.0844]
CRUX (t) × Sales Growth (Δln t-1)		-0.463*		-0.485**		-0.471*		-0.492**
		[0.250]		[0.243]		[0.249]		[0.242]
Sales Growth (Δln t-1)	0.129***	0.149***	0.120***	0.141***	0.129***	0.149***	0.120***	0.141***
	[0.0112]	[0.0162]	[0.0118]	[0.0158]	[0.0112]	[0.0162]	[0.0118]	[0.0158]
Sales Growth (Δln t-1) squared			-0.00348	-0.00415			-0.00349	-0.00416
			[0.00375]	[0.00383]			[0.00375]	[0.00383]
Log Tobin's Q (t-1)			0.0815***	0.0814***			0.0816***	0.0814***
			[0.00780]	[0.00780]			[0.00780]	[0.00780]
R-squared	0.253	0.253	0.256	0.257	0.253	0.253	0.256	0.257

▶ Construct "peer CRUX" and inverse propensity score (IPS) weights same way as in CM/ASM

▶ Effect of firm-specific uncertainty knocks out the effect of uncertainty from their peers.

Aggregate Evidence: Investment and GDP

- ▶ Time series of Real Gross Private Domestic Investment, Real GDP and Investment/GDP ratio
- ▶ We take annual log changes in the quarterly outcomes: $\Delta \ln Z_t = \ln Z_t - \ln Z_{t-4}$.
- ▶ Set of controls:
  - (1) S&P 500 Index – first moment control for expectations
  - (2) VIX – alternative higher frequency second moment control for uncertainty
  - (3) Lags of dependent variable

$$\Delta \ln Z_t = \lambda^Z \mathrm{CRUX}_t + \beta_1^Z \Delta \ln Z_{t-1} + \beta_2^Z \Delta \ln \mathrm{SP500}_t$$
$$+ \beta_3^Z \mathrm{VIX}_t^{MA(4)} + \varepsilon_t.$$

Reduced Form Evidence: Gross Investment/GDP Ratio

	OLS			ML	
Panel A: Dependent Variable: Annual Change in Gross Investment to GDP Ratio (ln)					
	(1)	(2)	(3)	(4)	(5)
Controls:	Baseline	S&P 500 (Δln)	VIX	Lagged Dep. Var.	ALL
CRUX(t)	**-4.328***	**-2.815***	**-4.331****	**-4.267****	**-3.151****
	[2.429]	**[1.592]**	**[1.233]**	**[1.134]**	**[0.798]**
Change in S&P 500(ln)		0.283***			0.247***
		[0.0494]			[0.0465]
VIX (4 period MA)			-0.00650***		-0.00277**
			[0.00167]		[0.00136]
Lagged Gross Invest/GDP(Δln)				-0.239	-0.239
				[0.146]	[0.146]
R-Squared	0.114	0.488	0.399	-	-
Newey-West Bandwidth	14	19	19	-	-

▶ OLS with Newey-West Standard Errors for Baseline

▶ ML when include one period lagged dep. vars.

▶ Robust to OLS or IV with lagged dep. var

▶ Robust to different lags

BLS Agg Data Summary Statistics

	Employment	Establishment
CRUX	0.000851	0.000851
	[0.00610]	[0.00610]
Net	0.00203	0.00204
	[0.00622]	[0.0168]
Gross Gain	0.0683	0.272
	[0.00679]	[0.0164]
Gain (opening)	0.0137	0.0562
	[0.00224]	[0.00255]
Gain (expansion)	0.0546	0.216
	[0.00472]	[0.0151]
Gross Loss	0.0663	0.270
	[0.00730]	[0.0156]
Loss (closing)	0.0130	0.0538
	[0.00218]	[0.00346]
Loss (contraction)	0.0533	0.216
	[0.00535]	[0.0136]