Uncertainty is More Than Risk - Survey Evidence on Knightian and Bayesian Firms

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Motivation

- Rapidly growing literature on measuring subjective beliefs
  - traditional approach: qualitative answers or forecasts
  - more recently: surveys elicit probabilities
  - uncertainty = risk (Bayesian uncertainty)

- This paper: do firm decision-makers think in probabilities?
  - new module in established German business survey
  - option to express beliefs by a probability interval
  - uncertainty can be Bayesian or Knightian
Survey question: how likely is positive sales growth?

Knightian responses pervasive among managers
  ▶ in any given quarter, 20-30% choose a probability interval
  ▶ 76% choose a probability interval at least once in four years
  → frequent switching between Bayesian & Knightian responses

Knightian responses reflect lack of clarity, not lack of sophistication
  ▶ evidence on planning process, (mis)calibration of probability forecasts

More Knightian responses when aggregate uncertainty high
  ▶ comovement of response switches & credit spreads
Literature

- Quantitative survey measures of uncertainty
  - household uncertainty about purchasing decisions Juster 66
  - many household surveys now contain uncertainty questions HRS, Bank of Italy SHIW, SEE, Michigan, NY Fed SCE
  - executive uncertainty about stock returns BenDavid-Graham-Harvey 13
  - firm uncertainty about sales: Guiso-Parigi 96 99, Bontempi-Golinelli-Parigi 10, Altig-Barrero-Bloom-Davis-Meyer-Parker 19, BCLS 19

- Knightian uncertainty
  - decision theory Ellsberg 61, Gilboa-Schmeidler 89,...
  - measurement in lab or household surveys by revealed preference Bossaerts et al. 16, Dimmock et al. 16,...
  - eliciting probability ranges in household surveys Manski-Molinari 10, Giustinelli-Pavoni 17, Delavande-Ganguli-Mengel 19, Giustinelli-Manski-Molinari 19
  - applications in macro & finance asset pricing (Epstein-Wang 94,...), bank runs (Caballero-Simsek 08,...), business cycles (Ilut-Schneider 14,...)
Outline

1. Data
2. Who is Knightian?
3. Are Knightians sophisticated?
4. Knightian responses and macro events
Data

ifo Business Tendency Survey
- long-running survey of German businesses
- used to produce leading indicators of German business cycle
- part of the EU-harmonized business sentiment survey
- asks firms to leave out seasonal effects

What is a firm?
- mostly stand-alone firm, sometimes divisions of conglomerates
- median # employees = 100; P90 = 570

New questions on Knightian uncertainty
- added to online questionnaire for manufacturing sector
- here use 19 waves 2013:Q2 - 2017:Q4
Quality of responses

- How many firms participate?
  - stable: 400-500 firms per wave
  - focus on firms with at least 5 observations: > 4000 firm-wave obs
  - participants similar to overall ifo survey
  - one time meta-survey in fall 2018: 500 participants

- Who in the firm responds? Results from meta-survey:
  1. someone in a leading position
     - 73% top management of firm, e.g. CEO, CFO, COO
     - 13% department heads
     - even if # employees > 500: 2/3 of responses from top management
  2. typically the same person
     - 83% of firms say ”always same person”; 15% ”mostly the same person”
     - less than 2% say ”2-3 people” or ”changes frequently”

- How do firms respond?
  - 80% of respondents use existing results from quantitative sales planning
Our question

- Survey administered in first two weeks of every quarter

- From questionnaire for July 2020:

  You can either answer with a probability or a probability interval.

  How do you assess the probability (in percentage terms) that your sales will increase in the third quarter of 2020

  - probability is ... percent
  - probability lies between ... and ... percent
  - don’t know

- Also questions about “sales staying the same” and “sales decreasing”
  - here use the “sales increase”-question only
Summary statistics: how likely is positive sales growth?

- Extensive margin: three types of responses
  - 18% Certain: 13% probability zero, 5% probability one
  - 58% Bayesian: single probability $\in (0, 1)$
  - 22% Knightian: nondegenerate probability interval
  \[ \text{Knightian share} := \frac{\text{Knightian}}{\text{Uncertain}} = 28\% \]

- Define types of firms by share of Knightian responses in sample
  - 24% always-Bayesian, 76% ever-Knightian
    \[ \rightarrow \text{neglecting time series underestimates role of Knightian option} \]
  - among ever-Knightians:
    - median share of Knightian responses $= .3$
    - often (sometimes) Knightians have share up to (higher than) median
Time variation in responses

- Three states: Bayesian, Knightian, Certain
  - Certain vs Uncertain ≈ independent of Bayesian vs Knightian

- Transition matrix for uncertain responses:

<table>
<thead>
<tr>
<th></th>
<th>Bayesian in t+1</th>
<th>Knightian in t+1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayesian in t</td>
<td>.81</td>
<td>.19</td>
</tr>
<tr>
<td>Knightian in t</td>
<td>.45</td>
<td>.55</td>
</tr>
</tbody>
</table>

⇒ “Churn” large relative to fluctuations in Knightian share
⇒ Firms occasionally enter persistent Knightian spells
Summary statistics: how likely is positive sales growth?

- Intensive margin: probabilities & probability intervals

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>P10</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>P90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayesian</td>
<td>50</td>
<td>10</td>
<td>25</td>
<td>50</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>Knightian midpt</td>
<td>39</td>
<td>5</td>
<td>13</td>
<td>35</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>Knightian min</td>
<td>30</td>
<td>0</td>
<td>5</td>
<td>25</td>
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<td>70</td>
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<tr>
<td>Knightian max</td>
<td>47</td>
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<td>20</td>
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- Mean width of probability interval 17pp

⇒ Wide range of views!

⇒ Knightians *unconditionally* more pessimistic...

⇒ ...but many Knightian responses also in good times
Outline

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2. Who is Knightian?

3. Are Knightians sophisticated?

4. Knightian responses and macro events
Who is Knightian?

1. Self-assessed motivation for Knightian responses
   - results from meta-survey in fall 2018

2. Relationship to firms’ forecasts
   - separate survey module on one quarter ahead predictions (BCLS 2019)
   - elicits forecast, best + worst case scenarios
   → more Knightian responses if forecast ≈ 0, 0 ∈ [best, worst]
   → more Knightian responses / uncertain responses if forecast low

3. Predicting Knightian responses & firm types with firm characteristics
   - size, foreign sales share, average growth, vol of growth, sector
Motivation for Knightian Responses

Question from metasurvey: “We choose a probability interval when...

A  ...we expect an unusual sales development in the current quarter.”
B  ...our business environment has changed a lot in recent years.”
C  ...we are particularly cautious for the current quarter.”
D  ...we are missing an important piece of information.”

Respondents asked to rate relevance of each option on four point scale.

⇒ Fraction of firms that consider option ”applies” or ”applies somewhat”
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Knightian responses & firm characteristics

- Predicting response type & firm type

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<th>ever-Knightian firms</th>
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<tr>
<td>average</td>
<td>.28 (.02)</td>
<td>.76 (.02)</td>
</tr>
<tr>
<td>small</td>
<td>.32 (.02)</td>
<td>.85 (.03)</td>
</tr>
<tr>
<td>large</td>
<td>.26 (.02)</td>
<td>.74 (.04)</td>
</tr>
<tr>
<td>non-exporter</td>
<td>.35 (.03)</td>
<td>.87 (.04)</td>
</tr>
<tr>
<td>exporter</td>
<td>.26 (.01)</td>
<td>.73 (.02)</td>
</tr>
<tr>
<td>low growth</td>
<td>.31 (.02)</td>
<td>.79 (.04)</td>
</tr>
<tr>
<td>high growth</td>
<td>.25 (.02)</td>
<td>.70 (.05)</td>
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⇒ More Knightian: small, non-exporters, low growth firms
  - effects orthogonal, borderline significant
  - not much else explained by volatility, sector fixed effects
Transition between Bayesian & Knightian states

- Predicting Knightian responses with characteristics + current state
  - regressions on characteristics interacted with current state
  - characteristics matter only when interacted with Knightian state
  - explanatory power comes from predicting persistence of Knightian state, not switches from Bayesian to Knightian

- Example: small & large firms

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⇒ Firms differ in length of Knightian spells, not frequency
  - small, non-exporting firms have longer spells
  - large, exporting firms have shorter spells
Outline

1. Data

2. Who is Knightian?
   - firms in dire straits & with uncertain outlook
   - small, non-exporting firms, who go through long Knightian spells

3. Are Knightians sophisticated?

4. Knightian responses and aggregate events
Are Knightians sophisticated?

- Self-assessment of the planning process
  - several meta-survey questions on how planning works
  - use of routine quantitative planning when answering survey?
  - follow up: use of statistical analysis or scenario analysis?
    → virtually no difference between always-Bayesian, ever-Knightian firms

- Actual forecasting performance
  - check calibration: compare survey probability to frequency
  - Bayesian case: nonparametric regression of event dummy on probability
  - for Knightians, use midpoint probability, also assess location of interval
Survey probability vs frequency of sales increase

⇒ Bayesians too pessimistic (optimistic) at low (high) probabilities
Knightian midpoint probability vs frequency

\[ \text{probability of sales increase} \]

\[ \Rightarrow \text{Knightian midpoint probability similarly miscalibrated} \]
Frequency & Knightian probability interval by midpoint

⇒ frequency not inside average probability interval for bad outlook
Outline

1. Data

2. Who is Knightian?
   - firms in with uncertain outlook or in tough times
   - especially small, non-exporting firms

3. Are Knightians sophisticated?
   - similar to Bayesians in planning process & performance

4. Knightian responses and aggregate events
Knightian responses & aggregate events

- Sample 2013 Q2 - 2017 Q3
  - recovery from 2011 crisis
  - multiple episodes of bond market turbulence
  - aggressive policy measures to lower borrowing costs
  - most prominent: Greek crisis 2014-5

- Knightian share moves with risk premia in asset markets

- Aggregate events shift individual transitions
European bond markets 2013-2017: junk bond yields

Below Inv. Grade EA Corp. Debt Yield

- Taper talk
- ECB QE announced
- Greece bailout
- ECB corp. bond program announced
- ECB QE extension announced

1/1/2013 1/1/2014 1/1/2015 1/1/2016 1/1/2017 1/1/2018

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10y Spread GRE-GER

1/1/2013 to 1/1/2018
Knightian share over time

- Taper talk
- ECB QE announced
- Greece bailout
- ECB corp. bond program announced
- ECB QE extension announced

Timeline:
- 1/1/2013
- 1/1/2014
- 1/1/2015
- 1/1/2016
- 1/1/2017
- 1/1/2018
Time varying transition probabilities

- ECB QE announced
- Greece bailout
- ECB corp. bond program announced
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Bayes to Knight
Knight to Bayes

Uncertainty is More Than Risk
Knightian share & Greek bond spread
Exporters: sharp spike as in Greek spreads
Small firms: delayed response as in junk bond yields

10y Spread GRE-GER
Knightsian Share

1/1/2013 1/1/2014 1/1/2015 1/1/2016 1/1/2017 1/1/2018

10y Spread GRE-GER
Knightsian Share
Small firms: delayed response as in junk bond yields
Knightian responses & aggregate events

- Knightian share moves with risk premia in asset markets
  - for large exporters, with Greek yields
  - for small non-exporters, with low grade yields
  \[\Rightarrow\] consistent with models of asset pricing under ambiguity
  \[\Rightarrow\] “source dependence”: Knightian events not the same for all firms

- Aggregate events shift individual transitions
  \[\Rightarrow\] bond market turbulence: more switches to Knightian
  \[\Rightarrow\] policy interventions: more switches to Bayesian
  \[\Rightarrow\] slow recovery from Greek crisis: longer Knightian spells
  \[\Rightarrow\] all three important for movement in Knightian share
Survey question: how likely is positive sales growth?

Knightian responses pervasive among managers
  ▶ in any given quarter, 20-30% choose a probability interval
  ▶ 76% choose a probability interval at least once in four years
    → firms enter persistent Knightian spells

Knightian responses reflect lack of clarity, not lack of sophistication
  ▶ self-assessed motivation & forecasting performance (calibration)
  ▶ more Knightian responses from small firms with bad outlook

More Knightian responses when aggregate uncertainty high
  ▶ spike during Greek crisis: more short spells by large, exporting firms
  ▶ persistence after Greek crisis: longer spells of small, non-exporting firms