The effects of uncertainty on firms' investment and hiring decisions – the role of an uncertainty measure

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The standard disclaimer applies

Agenda

1. Motivation
2. Data
3. Method
4. Results
5. Conclusions

1. Motivation

Motivation

- The *true* (deep) uncertainty is immeasurable (Knight, 1921), but there is a long tradition of investigating the impact of uncertainty on economic decisions

- Renewal of interest triggered first by the Global Financial Crisis, the Great Recession, and the influential paper by Bloom (2009):

  „(…) a macro uncertainty shock (…) produces a rapid drop and rebound in aggregate output and employment (…) because higher uncertainty causes firms to temporarily pause their investment and hiring. Productivity growth also falls (…). In the medium term the increased volatility from the shock induces an overshoot in output, employment, and productivity. Thus, uncertainty shocks generate short sharp recessions and recoveries."

- The pandemic and the Russo-Ukrainian War – even more interest in the subject

- There are some controversies in the literature:
  - uncertainty measurement
  - duration of the effects of uncertainty shocks
  - existence of the rebound / overshooting effect
  - sensitivity to country-specific factors
  - endogeneity of uncertainty

Motivation

- The literature (both theoretical and empirical) is rich in studies on the effects of uncertainty on firms' decisions.

- The adopted measure of uncertainty is often the most problematic part of empirical research. Since uncertainty is directly unobservable (or even immeasurable), there are many ideas as to how to approximate it, e.g.:
    - ex-ante dispersion of forecasts/expectations (e.g., Bachmann et al., 2013)
    - ex-post forecast/expectation error (e.g., Bachmann et al., 2013)
    - density forecasts (e.g., Rich and Tracy, 2010)
    - market volatility (e.g., Bloom, 2009)
    - text mining (e.g., Baker, Bloom and Davis, 2015)

- In our business survey, we ask an explicit question about the subjective qualitative assessment of the level of (individual) uncertainty:
    - this measure has its limitations as well, but it makes the research quite unique
    - it allows us to compare several measures of uncertainty

2. Data

Data

- Data come from a quarterly business survey called *NBP Quick Monitoring:*
  - 53 quarters from 2011Q3 to 2024Q3
  - $N_t \in [720; 1534]$, $\overline{N_t} = 1160$, $\sum N_t = 61482$
  - non-financial enterprises only, some branches omitted (mainly agriculture, forestry and fishing)
  - frankly speaking – non-random and non-representative sample (overrepresentation of large enterprises and enterprises in a good economic shape)

- Dependent variables (y) (three separate batteries of models):
  - plans regarding launching significant investments during the next quarter (binary variable)
  - planned change (YoY terms) in the scale of the investment during the next quarter (ordinal variable)
  - planned change (QoQ terms) in the scale of employment during the next quarter (ordinal variable)

- Explanatory variables (x):
  - uncertainty measures
  - control variables regarding both assessments of the current state and forecasts/plans/expectations
  - no structural variables since they are almost perfectly time-invariant, while we want to use fixed effects estimators

Dependent variables

Plans regarding launching significant investments over the next quarter	
Yes	1
No	0

Planned change (YoY terms) in the scale of the investment over the next quarter	full sample	investors
Significant increase	2	2
Insignificant increase	1	1
No change	0	0
Insignificant decrease	-1	-1
Significant decrease	-2	-2
Not applicable / No investment in both periods	0	.

Planned change (QoQ terms) in the scale of employment over the next quarter	
Increase	1
No change	0
Decrease	-1

Explanatory variables – uncertainty measures

Assessment of the level of uncertainty regarding the future economic situation of the enterprise – an individual measure	**5 levels: very high, high, medium, low, very low**
Share of enterprises reporting high uncertainty regarding the future economic situation of the enterprise – an aggregate measure	converted into standard score
Share of enterprises claiming in an open question that high uncertainty is an important problem – an aggregate measure	converted into standard score
Dispersion of forecasts of changes in the individual economic situation over the next quarter – an aggregate measure	converted into standard score
Share of enterprises that forecasted incorrectly the direction of change in the economic situation over the next quarter (ex-post assessment) – an aggregate measure	converted into standard score

Uncertainty measures
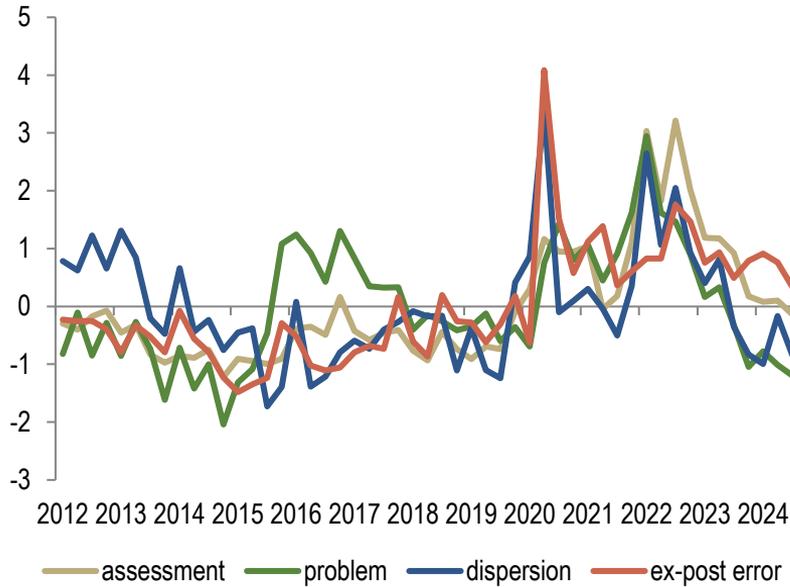
Correlation matrix

	assessment	problem	dispersion	ex-post error
assessment	1.00			
problem	0.67	1.00		
dispersion	0.65	0.32	1.00	
ex-post error	0.72	0.42	0.59	1.00

Explanatory variables – control variables

Assessment of the current economic situation of the enterprise	5 levels: very good, good, medium, poor, very poor
Capacity utilization	continuous variable
Demand forecasts over the next quarter (QoQ basis)	5 levels: durable increase, temporary or seasonal increase, no change, temporary or seasonal increase, durable decrease
Assessment of the current liquidity situation of the enterprise	3 levels: no problems, occasional problems, frequent problems
Bank debt repayment	3 levels: no problems, some problems, not applicable
Non-bank debt repayment	3 levels: no problems, occasional problems, frequent problems
Applying for a bank loan	5 levels: refusal due to lack of creditworthiness, refusal due to lack of collateral, refusal due to other reasons, application accepted, did not apply

3. Method

Method

- We deal with panel data for binary or ordinal variables
    - it is sensible to allow for fixed effects
    - the logit form is much more convenient than the probit form due to technical issues

- Binary dependent variable → Chamberlain (1980) conditional logit estimator
    - Conditional Maximum Likelihood approach
    - tackles the incidental parameters problem
    - consistent estimation of the parameters of interest (but no estimates of the fixed effects)

- Ordinal dependent variable → Blow-up and cluster (BUC) estimator by Baetschmann *et al.* (2015):
    - Pseudo/Quasi Maximum Likelihood approach
    - tackles both the incidental parameters problem and the identification problem
    - consistent estimation of the parameters of interest (but no estimates of the fixed effects)
    - a brilliant econometric idea behind the scenes ☺

4. Results

Results – launching significant investments

Odds ratios and p-values

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
individual	very low	1.18 (0.006)	1.16 (0.018)	1.18 (0.007)	1.16 (0.014)	1.17 (0.000)	1.15 (0.020)			1.15 (0.019)			
	low	1.07 (0.065)	1.05 (0.193)	1.06 (0.077)	1.05 (0.133)	1.06 (0.112)	1.05 (0.195)			1.05 (0.190)			
	medium	-	-	-	-	-	-			-			
	high	0.85 (0.000)	0.88 (0.004)	0.86 (0.001)	0.87 (0.001)	0.86 (0.001)	0.87 (0.003)			0.87 (0.003)			
	very high	0.83 (0.046)	0.88 (0.168)	0.84 (0.060)	0.85 (0.101)	0.84 (0.070)	0.87 (0.135)			0.87 (0.146)			
	no answer	1.11 (0.399)	1.09 (0.508)	1.11 (0.412)	1.09 (0.504)	1.08 (0.534)	1.08 (0.552)			1.12 (0.398)			
aggregate	assessment		0.91 (0.000)				0.92 (0.000)	0.62 (0.000)					0.83 (0.292)
	problem			0.98 (0.150)			1.05 (0.002)		1.64 (0.000)				1.04 (0.839)
	dispersion				0.92 (0.000)		0.96 (0.031)				0.39 (0.000)		0.61 (0.058)
	ex-post error					0.94 (0.000)	0.98 (0.330)					0.15 (0.000)	0.99 (0.958)
	time dummies	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓

Results – launching significant investments

Odds ratios and p-values

individual								
very low	1.18 0.006	1.16 0.018	1.18 0.007	1.16 0.014	1.17 0.000	1.15 0.020		1.15 0.019
low	1.07 0.065	1.05 0.193	1.06 0.077	1.05 0.133	1.06 0.112	1.05 0.195		1.05 0.190
medium	-	-	-	-	-	-		-
high	0.85 0.000	0.88 0.004	0.86 0.001	0.87 0.001	0.86 0.001	0.87 0.003		0.87 0.003
very high	0.83 0.046	0.88 0.168	0.84 0.060	0.85 0.101	0.84 0.070	0.87 0.135		0.87 0.146
no answer	1.11 0.399	1.09 0.508	1.11 0.412	1.09 0.504	1.08 0.534	1.08 0.552		1.12 0.398

- Negative correlation between individual uncertainty and investment plans

- No difference between the „effects" of high and very high uncertainty

- Very robust results with respect to including aggregate measures of uncertainty and time dummies

Results – launching significant investments

- Mostly negative correlation between aggregate uncertainty measures and investment plans, but the results lack robustness

- Be careful with uncertainty measures based on open questions – if uncertainty is reported more often, other factors that are of greater importance for investment decisions (e.g., demand, EU funds) may be reported less frequently, or sources of uncertainty may be named explicitly (e.g., pandemics, war, regulations)

- Do include time dummies (or macro control variables)

assessment		0.91 0.000				0.92 0.000		0.62 0.000				0.83 0.292
problem			0.98 0.150			1.05 0.002			1.64 0.000			1.04 0.839
dispersion				0.92 0.000		0.96 0.031				0.39 0.000		0.61 0.058
ex-post error					0.94 0.000	0.98 0.330					0.15 0.000	0.99 0.958
time dummies	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓

(row group label: aggregate)

Results – scale of the investment (investors only)

<div align="center">Odds ratios and p-values</div>

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
individual	very low	1.34 (0.000)	1.31 (0.000)	1.34 (0.000)	1.32 (0.000)	1.32 (0.000)	1.31 (0.000)	1.30 (0.000)					
	low	1.18 (0.000)	1.16 (0.000)	1.17 (0.000)	1.16 (0.000)	1.16 (0.000)	1.16 (0.000)	1.16 (0.000)					
	medium	-	-	-	-	-	-	-					
	high	0.84 (0.000)	0.86 (0.000)	0.85 (0.000)	0.85 (0.000)	0.85 (0.000)	0.86 (0.000)	0.85 (0.000)					
	very high	0.78 (0.005)	0.82 (0.032)	0.80 (0.012)	0.81 (0.018)	0.80 (0.013)	0.81 (0.023)	0.80 (0.012)					
	no answer	0.96 (0.726)	0.94 (0.568)	0.96 (0.685)	0.94 (0.544)	0.92 (0.448)	0.91 (0.405)	0.96 (0.744)					
aggregate	assessment		0.92 (0.000)				0.99 (0.840)		0.77 (0.002)				0.86 (0.213)
	problem			0.96 (0.006)			1.00 (0.832)			1.32 (0.002)			0.98 (0.888)
	dispersion				0.92 (0.000)		0.95 (0.002)				0.59 (0.002)		0.76 (0.183)
	ex-post error					0.90 (0.000)	0.92 (0.000)					0.35 (0.002)	1.03 (0.779)
	time dummies	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓

Results – scale of the investment (investors only)

Odds ratios and p-values

individual	very low	1.34 0.000	1.31 0.000	1.34 0.000	1.32 0.000	1.32 0.000	1.31 0.000	1.30 0.000
	low	1.18 0.000	1.16 0.000	1.17 0.000	1.16 0.000	1.16 0.000	1.16 0.000	1.16 0.000
	medium	-	-	-	-	-	-	-
	high	0.84 0.000	0.86 0.000	0.85 0.000	0.85 0.000	0.85 0.000	0.86 0.000	0.85 0.000
	very high	0.78 0.005	0.82 0.032	0.80 0.012	0.81 0.018	0.80 0.013	0.81 0.023	0.80 0.012
	no answer	0.96 0.726	0.94 0.568	0.96 0.685	0.94 0.544	0.92 0.448	0.91 0.405	0.96 0.744

- The „effects" of uncertainty on the scale of the investment are higher than on the probability of launching significant investments

- Again, the results are very robust with respect to including aggregate measures of uncertainty and time dummies

Results – scale of the investment (investors only)

- Results similar as in the case of modeling the probability of launching significant investments:
  - Mostly negative correlation, but the results lack robustness
  - Be careful with uncertainty measures based on open questions
  - Do include time dummies (or macro control variables)

aggregate	assessment	0.92 0.000				0.99 0.840		0.77 0.002				0.86 0.213
	problem		0.96 0.006			1.00 0.832			1.32 0.002			0.98 0.888
	dispersion		0.92 0.000			0.95 0.002				0.59 0.002		0.76 0.183
	ex-post error			0.90 0.000	0.92 0.000					0.35 0.002		1.03 0.779
	time dummies	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓

Results – scale of employment

Odds ratios and p-values

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
individual	very low	1.24 (0.004)	1.29 (0.001)	1.26 (0.002)	1.25 (0.003)	1.27 (0.001)	1.28 (0.001)	1.27 (0.001)					
	low	1.13 (0.001)	1.17 (0.000)	1.15 (0.000)	1.14 (0.001)	1.15 (0.000)	1.17 (0.000)	1.19 (0.000)					
	medium	-	-	-	-	-	-	-					
	high	0.86 (0.001)	0.82 (0.000)	0.83 (0.000)	0.85 (0.000)	0.85 (0.000)	0.81 (0.000)	0.79 (0.000)					
	very high	0.82 (0.034)	0.75 (0.002)	0.77 (0.004)	0.81 (0.023)	0.80 (0.014)	0.74 (0.001)	0.68 (0.000)					
	no answer	1.00 (0.993)	1.04 (0.760)	1.01 (0.906)	1.01 (0.929)	1.05 (0.647)	1.04 (0.728)	0.86 (0.225)					
aggregate	assessment		1.17 (0.000)				1.19 (0.000)		0.94 (0.511)				0.91 (0.528)
	problem			1.13 (0.000)			1.05 (0.005)			1.07 (0.511)			0.96 (0.790)
	dispersion				1.04 (0.011)		0.89 (0.000)				0.88 (0.511)		0.85 (0.502)
	ex-post error					1.12 (0.000)	1.06 (0.000)					0.77 (0.511)	1.33 (0.061)
	time dummies	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓

Results – scale of employment

Odds ratios and p-values

individual									
very low	1.24	1.29	1.26	1.25	1.27	1.28		1.27
	0.004	0.001	0.002	0.003	0.001	0.001		0.001
low	1.13	1.17	1.15	1.14	1.15	1.17		1.19
	0.001	0.000	0.000	0.001	0.000	0.000		0.000
medium	-	-	-	-	-	-		-
high	0.86	0.82	0.83	0.85	0.85	0.81		0.79
	0.001	0.000	0.000	0.000	0.000	0.000		0.000
very high	0.82	0.75	0.77	0.81	0.80	0.74		0.68
	0.034	0.002	0.004	0.023	0.014	0.001		0.000
no answer	1.00	1.04	1.01	1.01	1.05	1.04		0.86
	0.993	0.760	0.906	0.929	0.647	0.728		0.225

- The „effects" of high uncertainty are slightly lower, while the effects of low uncertainty are slightly higher than in the case of the scale of the investment. However, in general, the results are very similar.

- Again, the results are very robust.

Results – scale of employment

- If we do not include time dummies, higher aggregate uncertainty seems to boost employment plans

- If we include time dummies, the aggregate uncertainty measures are not statistically significant

	assessment										
assessment	1.17 (0.000)					1.19 (0.000)	0.94 (0.511)				0.91 (0.528)
problem		1.13 (0.000)				1.05 (0.005)		1.07 (0.511)			0.96 (0.790)
dispersion			1.04 (0.011)			0.89 (0.000)			0.88 (0.511)		0.85 (0.502)
ex-post error				1.12 (0.000)		1.06 (0.000)				0.77 (0.511)	1.33 (0.061)
time dummies	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓ ✓

aggregate

Robustness checks and additional results

- Results are very similar if we apply two schemes of weighting observations to control for the fact that the sample is non-random and non-representative:
  - mimicking the structure of the population of enterprises in the financial statements database provided by Statistics Poland (the Central Statistical Office)
  - mimicking the share of enterprises increasing investment outlays in the abovementioned database

- Results are generally robust if we tackle the seasonality problem and model seasonal differences ($S_4 y_{it} = y_{it} - y_{it-4}$) instead of levels ($y_{it}$)

- Results are less clear-cut and statistically significant if we use the lagged instead of the current assessment of individual uncertainty (but they still hold water)

- Additional estimates reveal that uncertainty Granger causes all dependent variables while uncertainty is Granger caused by employment plans only

- To-do: impulse responses (via local projections)

5. Conclusions

Conclusions

- We confirm the negative correlation between individual uncertainty and both investment and employment plans, and the results are very robust

- Aggregate uncertainty seems to be much more important for investment than employment plans, but the results for aggregate uncertainty measures are not robust

- It seems that different measures of aggregate uncertainty proxy different types of uncertainty

- Two practical implications for modeling the effects of aggregate uncertainty:
  - Be careful with uncertainty measures based on open questions
  - Do include time dummies (or macro control variables)

Thank you for your attention!

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Supplementary slides

Uncertainty measures

- Assessment of the level of uncertainty regarding the future economic situation of the enterprise – an individual measure

  How does the enterprise assess the level of uncertainty regarding its future economic condition?:

  a. very high
  b. high
  c. medium
  d. low
  e. very low

- Share of enterprises reporting high uncertainty regarding the future economic situation of the enterprise – an aggregate measure

  $\%a + \%b$

Uncertainty measures

- Share of enterprises claiming in an open question that high uncertainty is an important problem – an aggregate measure

Please give a brief outline of problems (approx. 10 sentences) which are of particular importance for the economic condition of the enterprise in the nearest future (half a year). Please present those issues which impact the volume of output (the possibility of increasing the output or the reasons for reducing the scale of activity), liquidity of the enterprise, bank loan debt and export profitability. When the enterprise does not face any major difficulties and does not anticipate encountering them in the given period, please enter "no problems".

The answers are categorized into pre-defined categories (i.a. „uncertainty") by text mining procedures and then double-checked by humans. Since the process is subjective and the response rate is relatively low (selection problem), we use only the aggregate frequencies.

Uncertainty measures

- Dispersion of forecasts of changes in the individual economic situation over the next quarter – an aggregate measure

How does the enterprise assess its current economic condition, excluding seasonal fluctuations typical for this period?:

a. very good
b. rather good
c. neutral
d. bad
e. very bad

$$Dispersion = \sqrt{\%a + \%b + \%d + \%e - [\%a + \%b - \%d - \%e]^2}$$

Uncertainty measures

- Share of enterprises that forecasted incorrectly the direction of change in the economic situation over the next quarter (ex-post assessment) – an aggregate measure

Forecast	*Change in the economic condition*	*Ex post forecast error*
improvement	improvement or no change	0
	worsening	1
worsening	worsening or no change	0
	improvement	1
no change	no change	0
	worsening or improvement	1