Aggregate Risk or Aggregate Uncertainty? Evidence from UK Households

Claudio Michelacci EIEF

Luigi Paciello EIEF

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BdF-CEPR workshop "Heterogeneous Agents or Heterogeneous Information: Which Route for Monetary Policy?"

Introduction

- Knight(1921) distinguishes **risk** vs **uncertainty**

  Caballero-Krishnamurthy (2008), Ilut-Schneider (2014), Ilut (2012), Bianchi-Ilut-Shneider (2018), Michelacci-Paciello (2018)

- How **important** is **KU**? Does it **vary** over time?

- Under KU+ ambiguity, **preferences** negatively affect **beliefs**

Introduction

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- How **important** is **KU**? Does it **vary** over time?

- Under KU+ ambiguity, **preferences** negatively affect **beliefs**
- Assume Taylor rule $\ln R_t = \ln \bar{R} + \phi \ln \Pi_t - m_t$. Hence:

$$\ln \Pi_{t+1} = \frac{1}{\phi} \left(\ln R_{t+1} + m_{t+1} - \ln \bar{R} \right)$$

- Under KU, agents who like a **monetary loosening** ($m \uparrow$) and **high interest rate** have **lower expected inflation**, the more so the greater the amount of KU.

- Use data on preferences and expectations from BoE

The BoE Survey of Inflation Attitudes (BEIAS)

Representative of UK households 2003-2019

1. *"If a choice had to be made either to raise interest rates to try to keep inflation down, or keep interest rates down and allow prices in the shops to rise faster, which would you prefer—interest rates to rise or prices to rise faster?"*
   - $d_{im} = 1$ if i prefers prices to rise faster (preference for $m \uparrow$)

2. *"Which would be best for you personally, for interest rates to go up over the next few months, or to go down, or to stay where they are now, or would it make no difference either way?"*
   - $d_{ir} = 1$ if i prefers interest rates up

The roadmap

1. Theoretical background:
   - NK model with wealth heterogeneity & ambiguity aversion
   - Testable predictions: wealth $\Longrightarrow$ preferences $\Longrightarrow$ expectations
   - Mapping from observable statistics to uncertainty

2. Empirical analysis:
   - Effects of wealth on preferences
   - Effects of preferences on expected inflation
   - Measurement of uncertainty
   - Backup implications of uncertainty for output

NK closed economy with heterogeneous assets

- **Households**: $i \in [0,1]$, initial assets a_{it}, labor supply $\ell_i = 1$

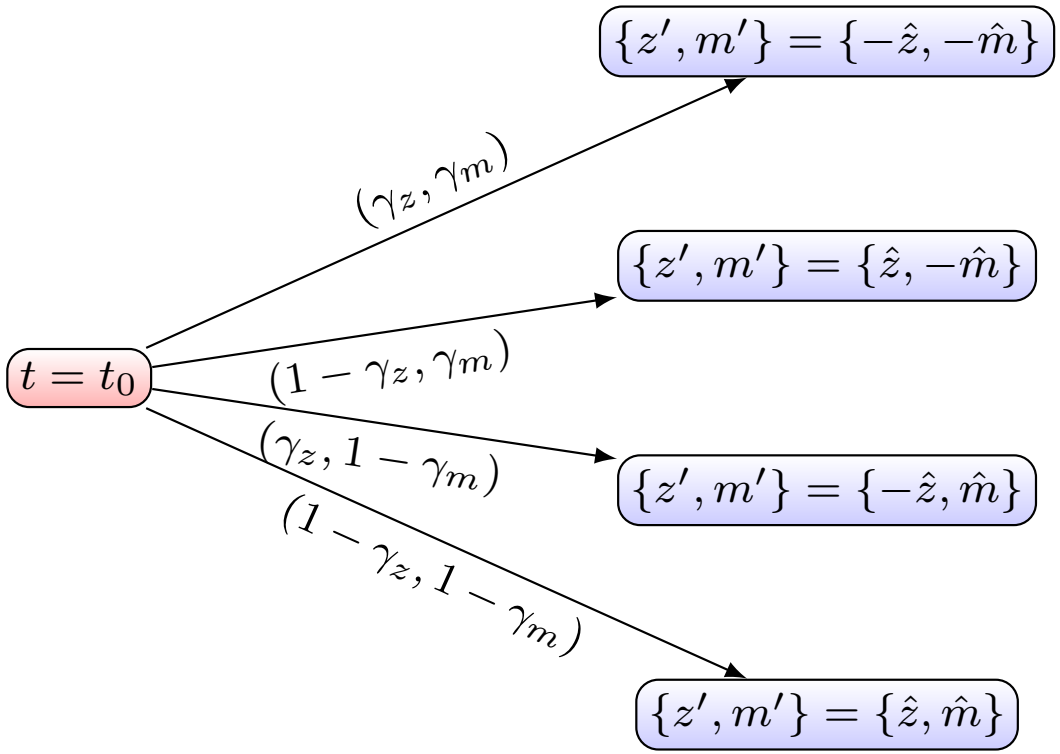
$$\text{Preferences:} \quad U(c_{it}) = \frac{c_{it}^{1-\sigma}}{1-\sigma} \quad \sigma \geq 1$$

$$\text{Bud. Const.:} \quad c_{it} + a_{it+1} \leq (1-\tau_w)\,\ell_i\,w_t + r_t\,a_{it} + \tau_{it},$$

- **Labor market**: Walrasian, take real wage w_t as given
- **Consumption**: CES aggregator of mass 1 varieties
- **Firms**: Rotemberg sticky prices; Output $y_{jt} = x_{jt}^{1-\alpha}(e^{z_t}\,\ell_{jt})^{\alpha}$
- **Monetary policy**: $\ln R_t/\bar{R} = \phi\,(\ln \Pi_t - m_t)$; $r_t = R_{t-1}/\Pi_t$
- **Fiscal policy**: Supply bonds B, G, τ_{it}. Tax labor & dividends
- **Mutual fund**: Own equity & govt. debt. Supply $A_t = \int a_{it} di$

MIT uncertainty shocks at $t = t_0$

- Real shock: $z_{t_0+1} \in \{-\hat{z}, \hat{z}\}$ & Monetary shock: $m_{t_0+1} \in \{-\hat{m}, \hat{m}\}$



- Probabilities γ_z and γ_m unknown (known under risk)
- No uncertainty at $t \geq t_0 + 1$: observe z_{t_0+1}, m_{t_0+1}, then

$$z_t = \varrho_z z_{t-1}$$
$$m_t = \varrho_m m_{t-1}$$

Household problem and results

Household problem

$$V_i^{\kappa}(a_i) = \max_{a'} \left\{ u(w + R\,a_i + \tau_i - a') + \beta \min_{\gamma_m, \gamma_z \in \{0,1\}} \widehat{V}_i(a', \gamma_m, \gamma_z) \right\}$$

Results

1. Wealthier households are more likely to dislike expansionary monetary and real shocks.

2. Under KU, beliefs about Π are **distorted** by households' preferences for monetary ($\pi_{mn} < 0$) and real ($\pi_{zn} > 0$) shocks:

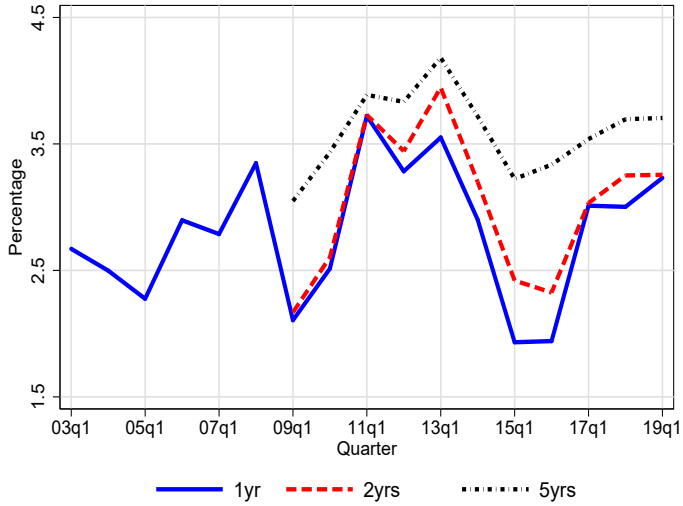
$$E_{it_0}^{\kappa}(\Pi_{t_0+n}) = E_{it_0}^{\sigma}(\Pi_{t_0+n}) + \overline{\pi}_{mn}\, m_i^* + \overline{\pi}_{zn}\, z_i^*$$

   with $\overline{\pi}_{mn} > 0$ and $\overline{\pi}_{zn} < 0$, and worst case beliefs m_i^* and z_i^*

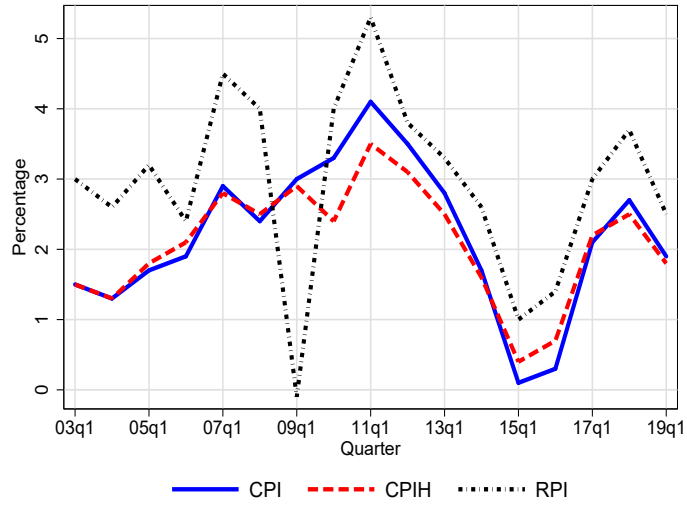
3. The effects of preference dummies on beliefs **measure** KU:

$$E_{it_0}^{\kappa}(\Pi_{t_0+n}) = E_{it_0}^{\sigma}(\Pi_{t_0+n}) - \overline{\pi}_{mn}\,\hat{m}\,d_{im} + \overline{\pi}_{zn}\,\hat{z}\,d_{ir}$$

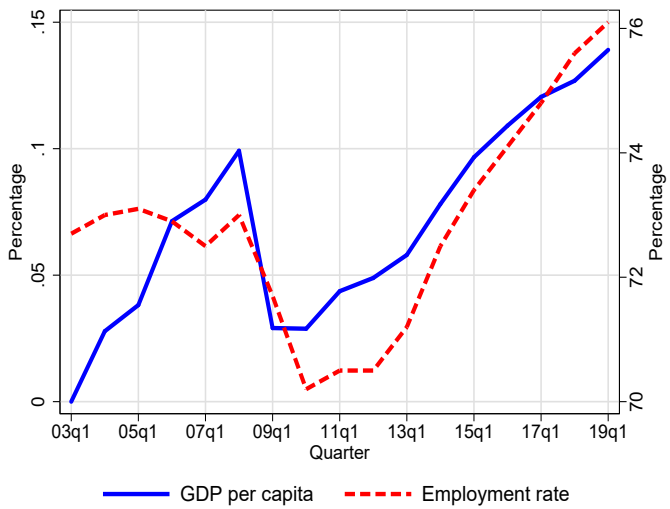
The UK economy



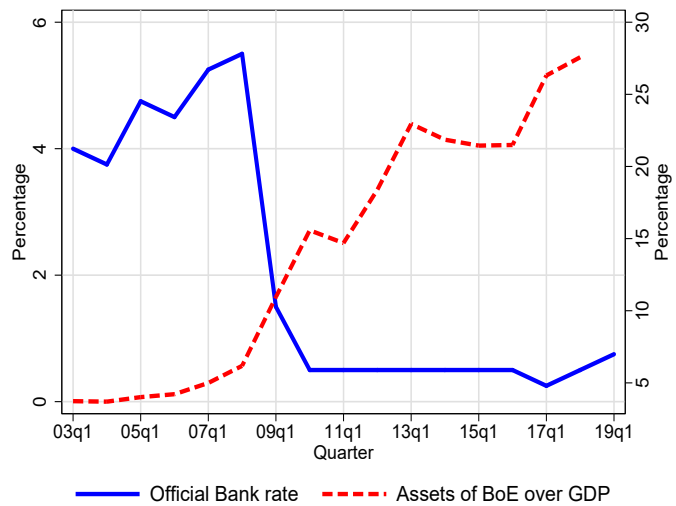
(a) Expected inflation



(b) Inflation



(c) GDP and employment

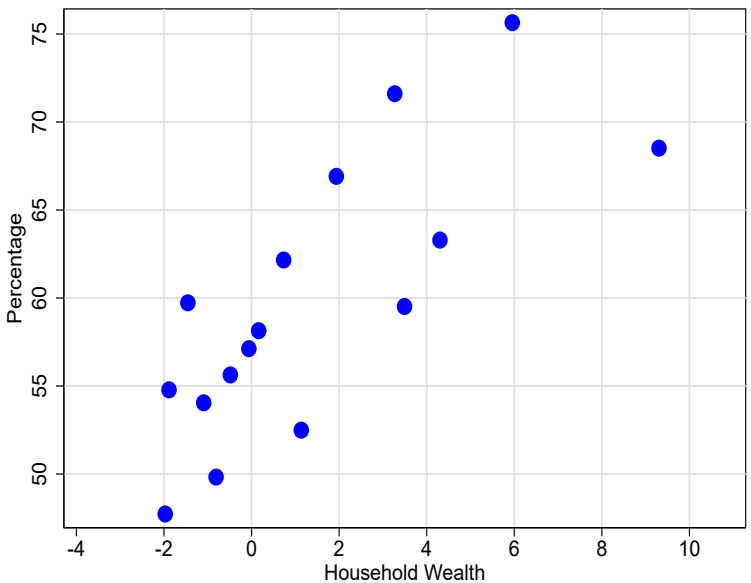


(d) Monetary policy

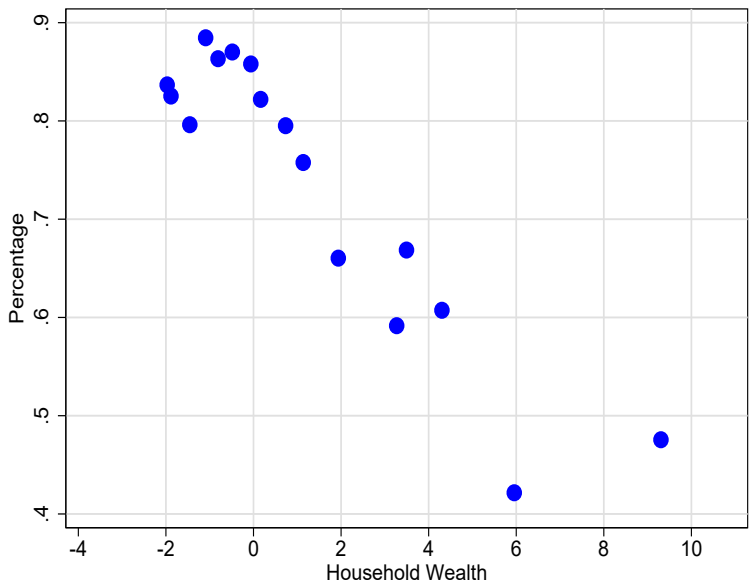
Wealth & preferences

Impute wealth for 16 groups of households:

- 4 social class variables from NRS $\sim$ quartile of wealth distrib.
- households below/above 25,000 pounds
- Have/not a mortgage



(a) likes monetary $R \uparrow$ $(d_{im} = 0)$



(b) likes real $R \downarrow$ $(d_{iR} = 0 | d_{im} = 0)$

Wealth & preferences for m

VARIABLES	(1) Likes tightening	(2) Likes loosening	(3) doesn't know
Top Wealthy HH	0.10***	0.01*	-0.11***
	(0.01)	(0.01)	(0.00)
Upper Middle Wealthy HH	0.07***	0.00	-0.08***
	(0.01)	(0.00)	(0.00)
Lower Middle Wealthy HH	0.04***	0.01	-0.04***
	(0.01)	(0.00)	(0.00)
Household with mortgage	-0.08***	0.10***	-0.03***
	(0.00)	(0.00)	(0.00)
Observations	68,425	68,425	68,425

SE in parentheses; *** p<0.01, ** p<0.05, * p<0.10

The table reports the average marginal effects on the probability of the three categorical variables for preferences for policy after estimating a Multinomial logit. All regressions contain a full set of time dummies. 5 geographical dummies for leaving in Scotland, Wales, Northern Ireland, Midlands or South of England, six age dummies, a dummy for gender, dummy for being employed, five income group dummies, and educational dummies for Less than high school, High school degree and for having a College degree or more. The omitted category is the "Poor" household category.

Wealth & preferences for R

VARIABLES	(1) $R\uparrow$	(2) $R\downarrow$	(3) $R\approx$	(4) Indifferent	(5) Not_know
likes tightening	0.15***	-0.01*	-0.01**	0.03***	-0.16***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
likes loosening	0.00	0.09***	0.05***	-0.06***	-0.07***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
Top Wealthy HH	0.16***	-0.05***	-0.03***	-0.05***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Upper Middle Wealthy HH	0.12***	-0.04***	-0.01**	-0.04***	-0.02***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
Lower Middle Wealthy HH	0.08***	-0.03***	-0.00	-0.04***	-0.01***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
Household with mortgage	-0.12***	0.11***	0.10***	-0.07***	-0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	68,425	68,425	68,425	68,425	68,425

SE in parentheses; *** p<0.01, ** p<0.05, * p<0.10

The table reports the average marginal effects from estimating a Multinomial logit on the probability of the five categorical variables for preferences for interest changes All regressions contain a full set of time dummies. 5 geographical dummies (for leaving in Scotland, Wales, Northern Ireland, Midlands or South of England), 6 age dummies, a dummy for gender, a dummy for being employed, 5 income group dummies, and 3 educational dummies (for Less than high school, High school degree and for having a College degree or more).

Preferences on expected inflation

$$E_{it}(\Pi_{t+1}) = \bar{\pi}_t + \beta^m \, d^m_{it} + \beta^r \, d^r_{it} + B \, D_{it} + \epsilon_{it}.$$

VARIABLES	Π^e	Π^e	Π^e	Π^e
d_{im}: prefers loosening ($m \uparrow$)	-0.18***	-0.14***	-0.15***	-0.13***
	(0.02)	(0.02)	(0.02)	(0.02)
d_{ir}: prefers R up ($\Pi \uparrow$ due to z)			-0.13***	-0.08***
			(0.02)	(0.02)
HH is indifferent on i			-0.06**	-0.03
BoE sets i				-0.13***
HH knows Monetary Cmte.				-0.05**
BoE is independent				-0.11***
UK econ. needs loosening				-0.42***
UK econ. is indifferent on loosening				-0.33***
Don't know if UK needs loosening				-0.30***
Controls	No	Yes	Yes	Yes
R^2	0.08	0.09	0.09	0.10

The regressions in columns 2-4 also control for a full set of time dummies, 5 geographical dummies (for leaving in Scotland, Wales, Northern Ireland, Midlands or South of England), 6 age dummies, a dummy for gender, a dummy for being employed, 5 income group dummies, and 3 educational dummies (for less than high school, high school degree or a college degree or more). In columns 1-2, the excluded category is a household who likes $m \downarrow$. In columns 3-4, it is a household who likes $m \downarrow$ and $R \uparrow$.

Robustness: quantile regressions

VARIABLES	(1) Bottom Π^e	(2) Bottom Π^e	(3) Median Π^e	(4) Median Π^e	(5) Top Π^e	(6) Top Π^e
prefers $m \uparrow$	-0.07***	-0.07***	-0.11***	-0.11***	-0.10***	-0.11***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
prefers $R \uparrow$		-0.03**		-0.06**		-0.10***
		(0.02)		(0.03)		(0.03)
prefers $R \approx$		-0.05***		-0.12***		-0.12***
		(0.01)		(0.03)		(0.03)
indiff on R		-0.01		-0.02		-0.04
		(0.01)		(0.03)		(0.03)
Observations	47,273	45,715	47,273	45,715	47,273	45,715
Method	OLS	OLS	OLS	OLS	OLS	OLS
Controls	YES	YES	YES	YES	YES	YES
Wald test	0.00	0.00	0.00	0.00	0.00	0.00

Robust SE in parentheses; *** p<0.01, ** p<0.05, * p<0.10

The table reports the coefficients of quantile regressions where dependent variable is expected inflation at a 1 year time horizon. The controls are the same as above. The coefficients on preferences are listed by rows. The last row reports the p-value for the null hypothesis that all preference coefficients are equal to zero.

Robustness: selection and IV

VARIABLES	(1) Π^e	(2) Π^e	(3) Π^e	(4) Π^e	(5) Π^e
Prefers $m \uparrow$	-0.14***	-0.20***	-0.19***	-3.06***	-3.05***
	(0.03)	(0.03)	(0.03)	(0.62)	(0.62)
Prefers $R \uparrow$	-0.07***	-0.22***	-0.21***	-2.40***	-2.40***
	(0.03)	(0.04)	(0.04)	(0.65)	(0.65)
Inverse Mill's ratio, probit		-0.19***		-0.26***	
		(0.05)		(0.08)	
Inverse Mill's ratio, logit			-0.18***		-0.26***
			(0.05)		(0.08)
Observations	21,495	37,031	37,031	37,031	37,031
Selection	Understand MP	Probit	Logit	Probit	Logit
2nd stage	OLS	OLS	OLS	IV	IV
Wald test	0.00	0.00	0.00	0.00	0.00

Robust SE in parentheses; *** p<0.01, ** p<0.05, * p<0.10

The dependent variable is 1 year expected inflation. Columns 2 and 4 deal with selection into reporting expectations and preferences by using a Probit model as in Heckman 79, columns 3 and 5 using a logit model as in Lee 79. The controls are the same as above. The instruments for selections are given by three dummies: one for whether the household does not provide an estimates for how prices have changed over the last 12 months and one for whether she agrees or strongly agrees with the statement that "a rise in interest rates would make prices in the high street rise more slowly in the short term (say a month or two)" and a third one for whether she agrees on the statement that"a rise in interest rates would make prices in the high street rise more slowly in the medium term (say a year or two). Columns 3 and 5 instrument household's preferences for inflation and interest rates using information on household's portfolios as measured by 4 dummy variables for household's wealth together with the dummy for whether the household has a mortgage.

Effects of expectations on choices

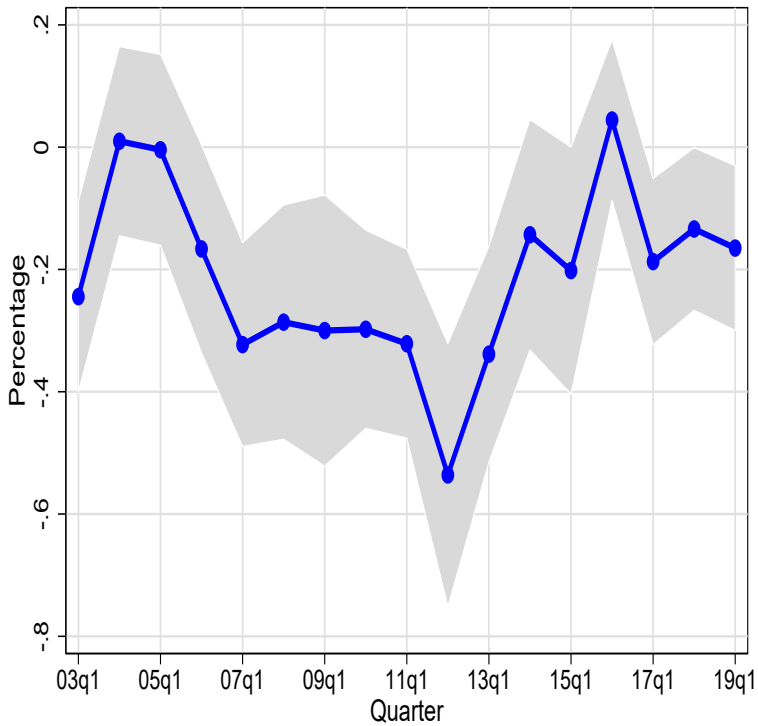
VARIABLES	(1) Major	(2) Major	(3) Cut Spend.	(4) Cut Spend.	(5) Shop	(6) Shop	(7) Pay	(8) Pay
Expected infl.	0.00	0.01	0.02***	0.40***	0.01***	0.49***	0.00***	0.04
	(0.00)	(0.02)	(0.00)	(0.10)	(0.00)	(0.12)	(0.00)	(0.04)
Observations	17,400	17,400	18,086	18,086	18,298	18,298	17,395	17,395
Method	OLS	IV	OLS	IV	OLS	IV	OLS	IV
R^2	0.12	0.12	0.15		0.12		0.13	
Durbin		0.73		0.00		0.00		0.36
Wu-Hausman		0.73		0.00		0.00		0.36

VARIABLES	(1) Income	(2) Income	(3) Save	(4) Save	(5) Other	(6) Other	(7) No act.	(8) No act.
Expected infl.	0.01***	0.18***	-0.00	-0.05	-0.02***	-0.33***	-0.00	-0.09***
	(0.00)	(0.06)	(0.00)	(0.04)	(0.00)	(0.09)	(0.00)	(0.03)
Observations	17,620	17,620	17,496	17,496	17,294	17,294	14,804	14,804
Method	OLS	IV	OLS	IV	OLS	IV	OLS	IV
R^2	0.18		0.13		0.12		0.17	
Durbin		0.00		0.14		0.00		0.00
Wu-Hausman		0.00		0.14		0.00		0.00

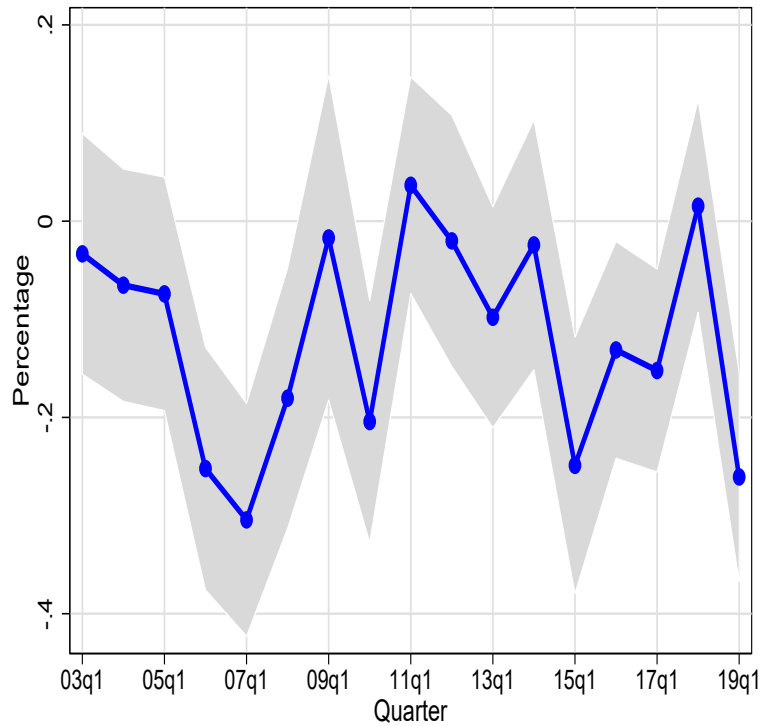
Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.10

Time series of cross-sectional regressions

$$E_{it}(\Pi_{t+1}) = \bar{\pi}_t + \beta_t^m \, d_{it}^m + \beta_t^r \, d_{it}^r + B \, D_{it} + \epsilon_{it}.$$



(c) Monetary: β_t^m

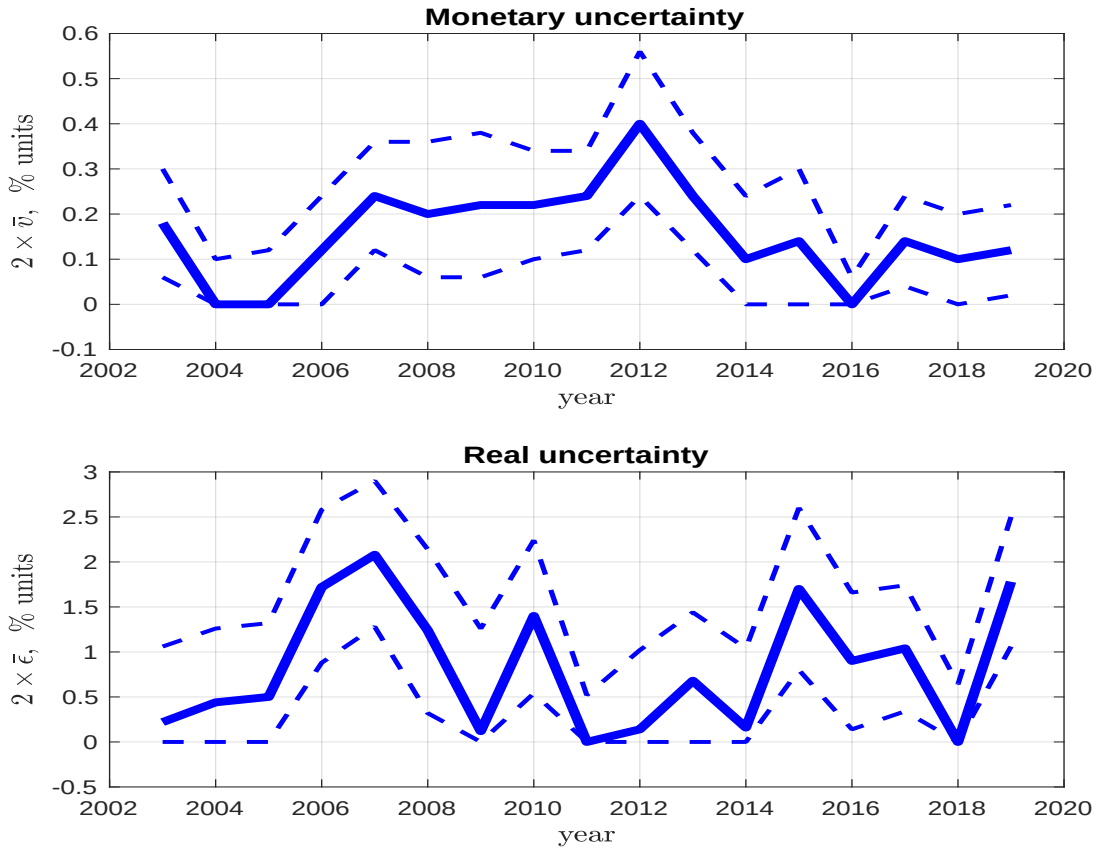


(d) Real: β_t^r

The controls are the same as above, including selection.

Recovering uncertainty

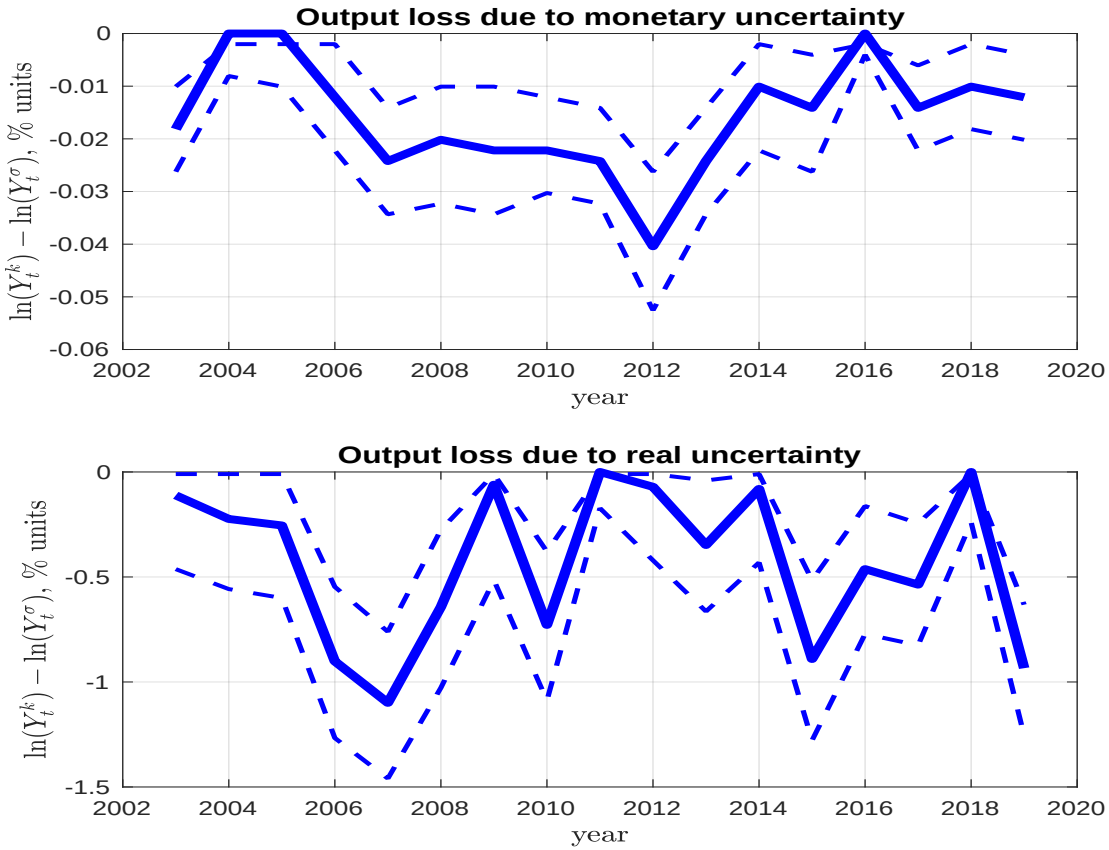
Recover uncertainty (MIT shocks) by indirect inference



- Real uncertainty peaks around Lehman and Brexit
- Monetary uncertainty peaks around the Euro crisis
- Little correlation with other measures of risk/uncertainty (Bloom)

Implications for output

- Compute output effect of uncertainty shock
- Real uncertainty $\Longrightarrow$ strong negative bias
- Monetary uncertainty causes little effects on output



Conclusions

- Novel method to measure KU
- BoE data support KU
- Measured KU substantial around significative episodes (Lehman, Brexit)
- Real uncertainty much more important economically that monetary uncertainty