Inflation and Trading

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Introduction

- Inflation is key risk for financial-market participants
- Negative relation exists empirically b/w inflation and stock returns
  (e.g., de Rubio Cruz et al., 2023; Fama, 1981; Fama and Schwert, 1977; Fang, Liu, and Roussanov, 2022)
- Many theories explain this relation that is at odds with intuition
  (e.g., Bhamra et al., 2023; Campbell, Pflueger, and Viceira, 2020; Modigliani and Cohn, 1979)
- Evidence on how inflation affects investor beliefs and choices scant

This paper

- Study directly how investors respond to inflation
- Exogenous variation in beliefs about inflation and its return impact
  - Randomized information experiment with customers of German bank
  - Mix of info about inflation and returns during past inflation
- Analyze effects of information provision on beliefs and choices
  - Elicit return expectations, mental models, etc. in survey
  - Track investors' trading choices using bank data
- Preview of results:
  - Estimates of return impact of inflation heterogeneous and too high
  - Info $\rightarrow$ return expectations $\downarrow$ b/c beliefs about impact of inflation $\downarrow$
  - Info $\rightarrow$ net purchases of stocks $\downarrow$ in survey and bank data

Plan for the talk

- Data and experimental design
- Prior beliefs about inflation and asset returns
- Treatment effects on return expectations
- Expectations and trading

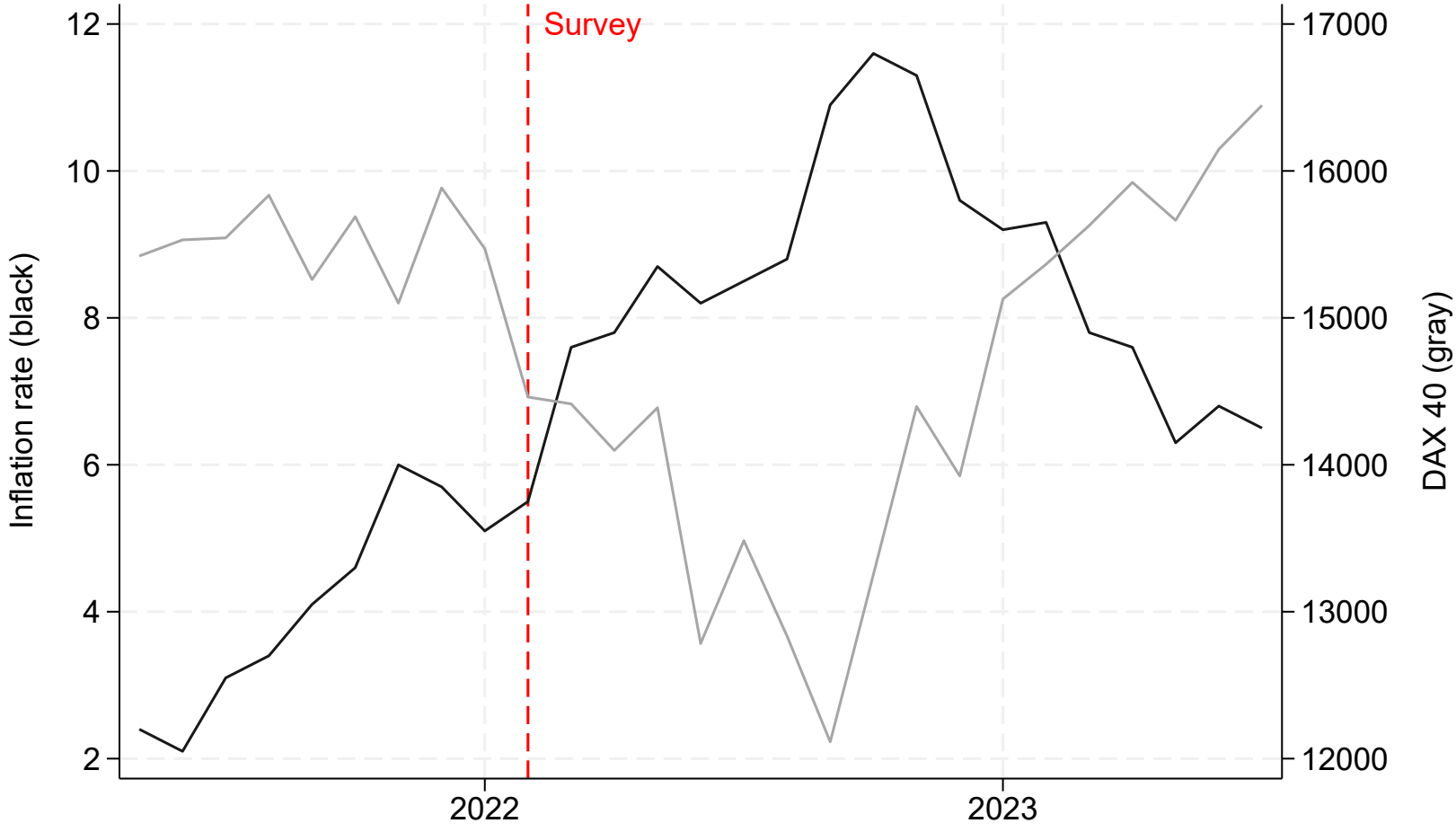
Survey administration

- Online survey experiment with customers of large German bank
- Invitation via short email sent by bank to around 42,000 customers
- Email states survey is on inflation and administered by Uni Frankfurt
- 2,840 completed responses, 6.8% response rate is above average
- Median response time of 18 minutes

Sample selection

- Customers with brokerage account
  - Only 21% state they rely on advisors, 63% w/o any discussions
  - Self-directed trading for unfiltered transmission of beliefs
- Survey-participation incentive through online-shopping voucher
- Take two steps to filter respondents:
  1. Response time of $<$7 or $>$90 minutes (approximately 2% of sample)
  2. Estimates of inflation at 1% tails and returns $<$-10% and $>$20%
- Up to 2,790 customers in filtered sample, lower when returns on LHS

Survey period



$\Rightarrow$ Inflation high and rising at time of and after intervention

Administrative bank data

- Match survey responses to data provided by bank partner
- Set of demographics: age, zip code, marital status, etc.
- Data on each portfolio trade
- 1,990 survey respondents in trading sample
  - Drop in N b/c require at least one trade pre-treatment (1.5 years)
  - Impose at least minimum trading activity

Sample characteristics

Statistics:	Mean	SD	P25	P50	P75
Demographics and portfolio					
University completed (0/1)	0.66	0.47	0.00	1.00	1.00
Gross wealth (€ k)	345.09	302.76	87.50	375.00	750.00
Portfolio value (€ k)	139.61	265.61	7.38	35.96	130.74
Equity share (%)	0.84	0.22	0.76	0.94	1.00
Monthly trades (no.)	2.98	4.04	0.33	1.27	3.83
Monthly net buys (€)	628.01	5142.94	0.00	189.99	1061.07
Perceptions and expectations					
Inflation rate today (%)	4.99	1.62	4.00	5.00	5.00
Inflation rate today relative to 1yr ago (%)	3.12	1.97	2.00	3.00	4.00
Inflation as recent trading motive (0/1)	0.42	0.49	0.00	0.00	1.00
Inflation top financial-market risk (0/1)	0.26	0.44	0.00	0.00	1.00

$\Rightarrow$ Sample: well-off, active, accurate perceptions, inflation matters

Experimental design

1. Pre-treatment section
   - Inflation beliefs and trading motives
   - Past unconditional and inflationary-period asset returns
2. Treatment section
   - Control group receives no information
   - T1: high current inflation and possibility of further rise
   - T2: actual returns during past inflationary periods
   - T3: T1 + T2 + explanations of past returns
3. Post-treatment section
   - Beliefs about inflation and economy, mental models
   - Return expectations and hypothetical portfolio choice

- Track investors over time to investigate actual trading choices

Section 1: past unconditional asset returns

Question: "Please estimate the **annual average returns since 1950** for various asset classes available to an investor in Germany. Please answer this question even for asset classes in which you do not invest, and even if you are not familiar with the topic.

Note: please estimate nominal returns, i.e., returns without considering inflation. Example: an investor who invests €100 today will have €110 in one year at a nominal return of 10%.

In the case of an estimated negative return, please enter a negative value. The input of up to one decimal place is possible.

German stock market (similar to DAX) ____%

[...]"

- 1950 to get long TS but w/o WWII and 1948 currency reform
- Asset choice: local stocks for local inflation + "better" alternatives

Section 1: past inflationary-period asset returns

Question: "Please estimate again the **annual average returns since 1950**. However, limit your estimates to periods when the **annual inflation rate in Germany increased and ultimately was above 4%**. There have been a total of six such periods since 1950.

Note: please estimate nominal returns again.

In the case of an estimated negative return, please enter a negative value. The input of up to one decimal place is possible.

German stock market (similar to DAX) ____%

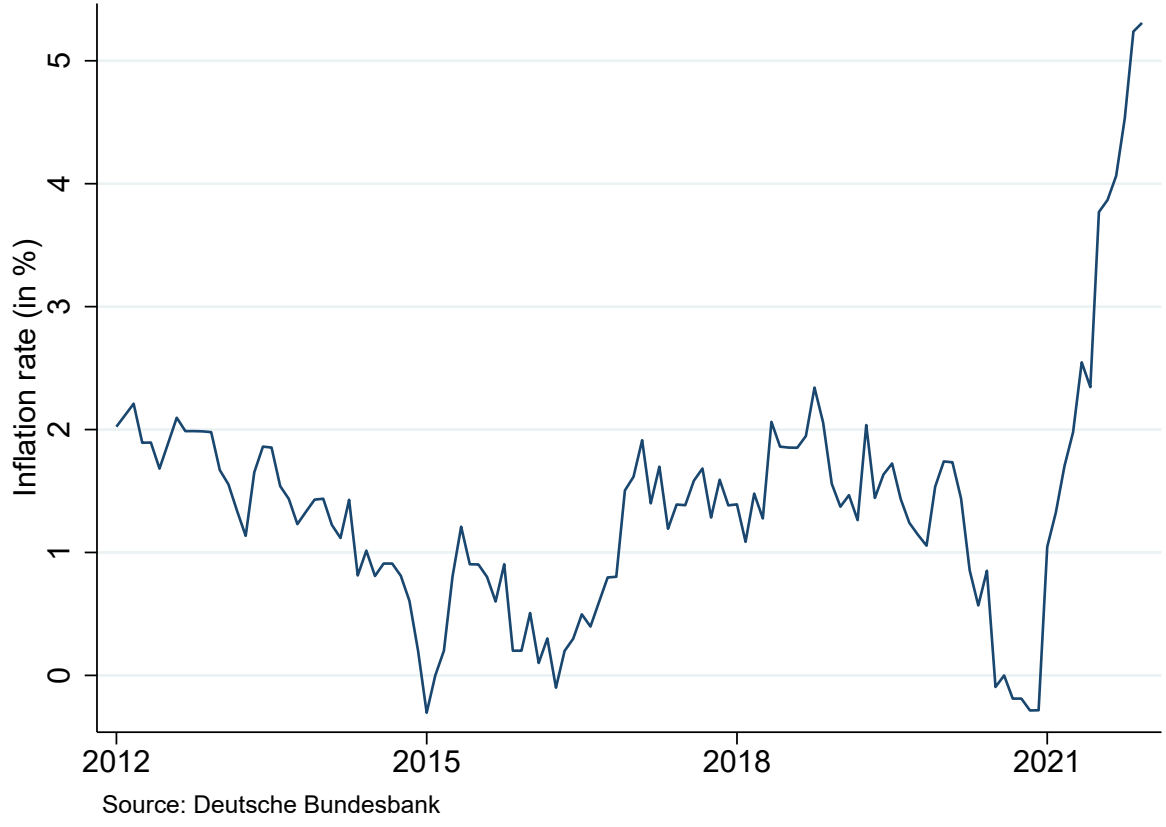
[...]"

- Same estimation but restriction to inflationary periods
- Provide estimates right next to unconditional ones
- Δ between two estimates as measure of perceived return impact

T1: high current inflation and possibly further rise

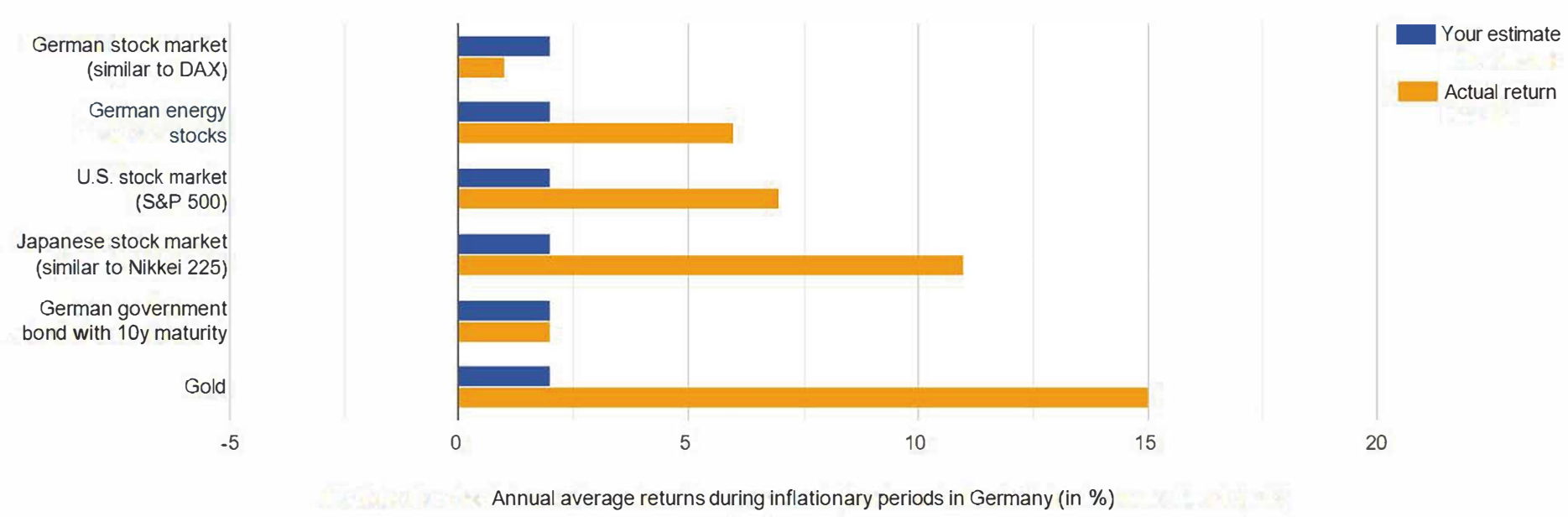
- Inflation 3x higher than 10-year average + figure below
- Policymakers recently discussed possibility of further increase
- List of reasons for inflation surge

(Andre et al., 2022)



T2: actual returns during past inflationary periods

- Initially display respondent's past-return estimates (blue bars)
- Click on button to display actual returns one-by-one (orange)
- One sentence contrasting both returns for each asset



T3: T1 + T2 + explanations of past returns

- International diversification can protect against local inflation
- Commodities (such as energy) often drive inflation
- Gold perceived as a safe harbor during inflationary periods
- Calculations and explanations similar to existing work for US
  (Neville et al., 2021)
- Giving context to returns might increase treatment effectiveness
  (Andre et al., 2022; Goetzmann, Kim, and Shiller, 2022; Shiller, 2017)

Section 3: post-treatment questions

- Instantaneous updating of inflation expectations
- Return expectations and hypothetical investment task
- Wide array of other expectations speak to (alternative) channels
- Subjective drivers of stock return-inflation relation
- Same questions across all participants

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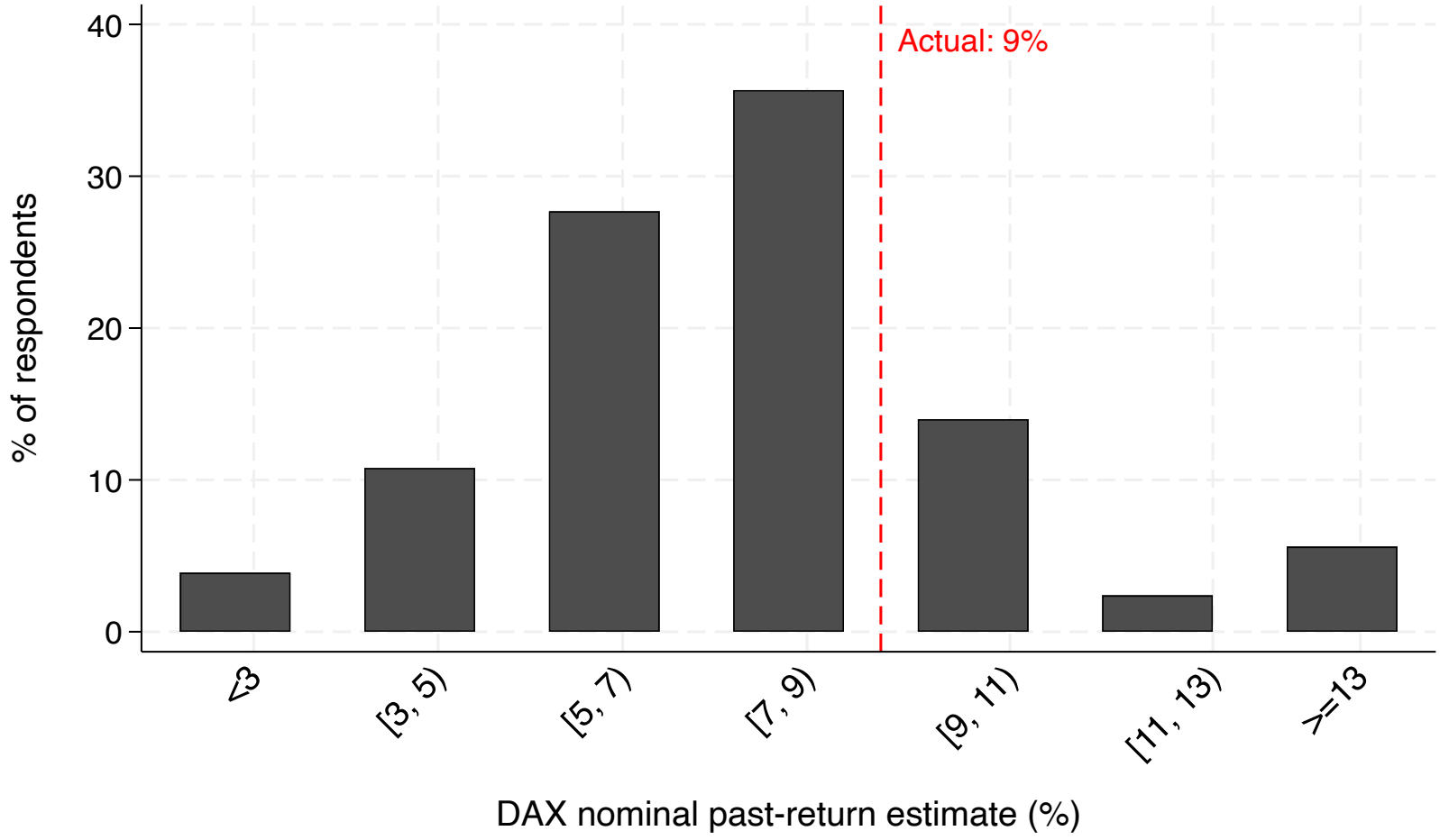
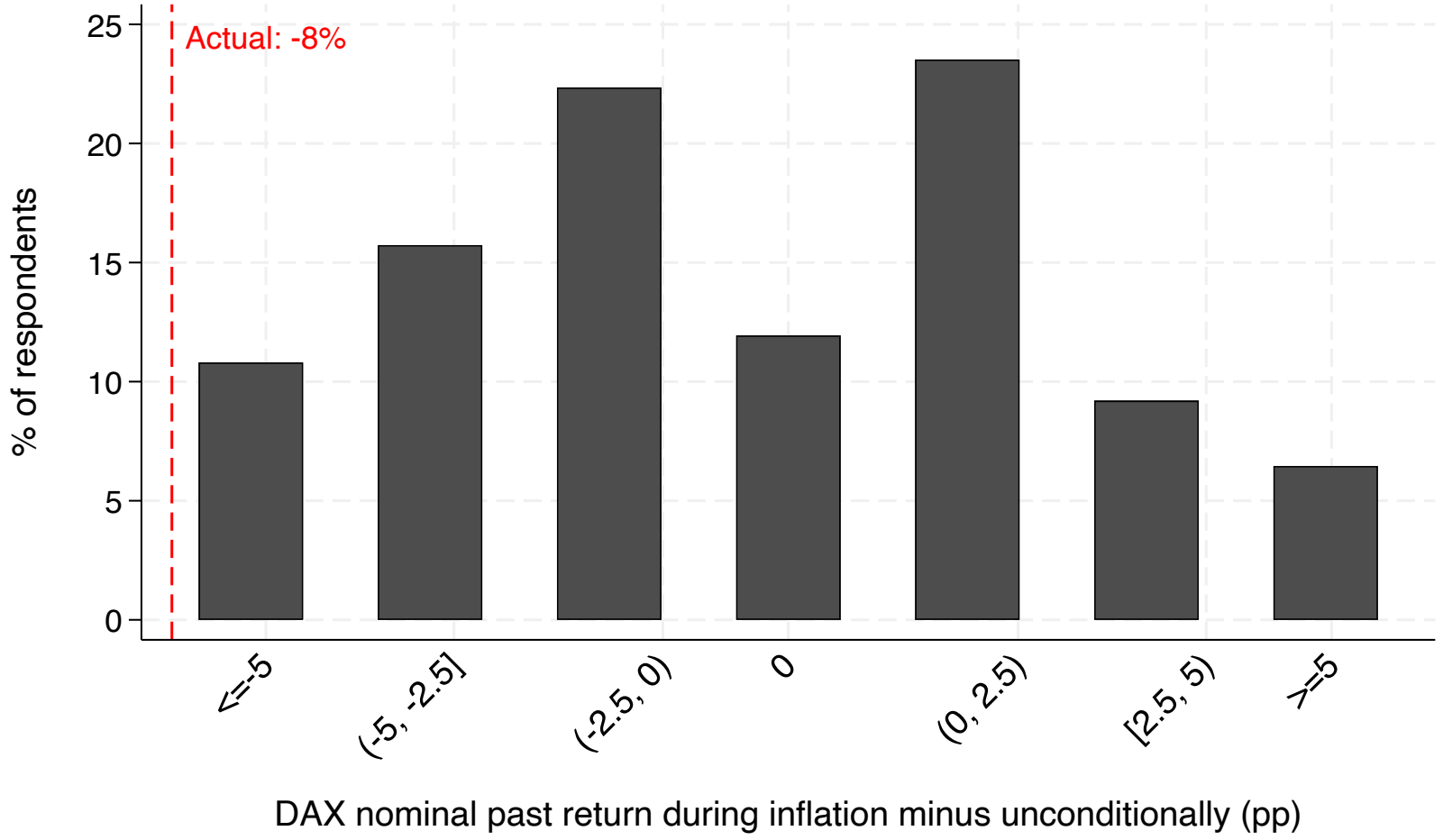
Perceived unconditional historical stock-market returns



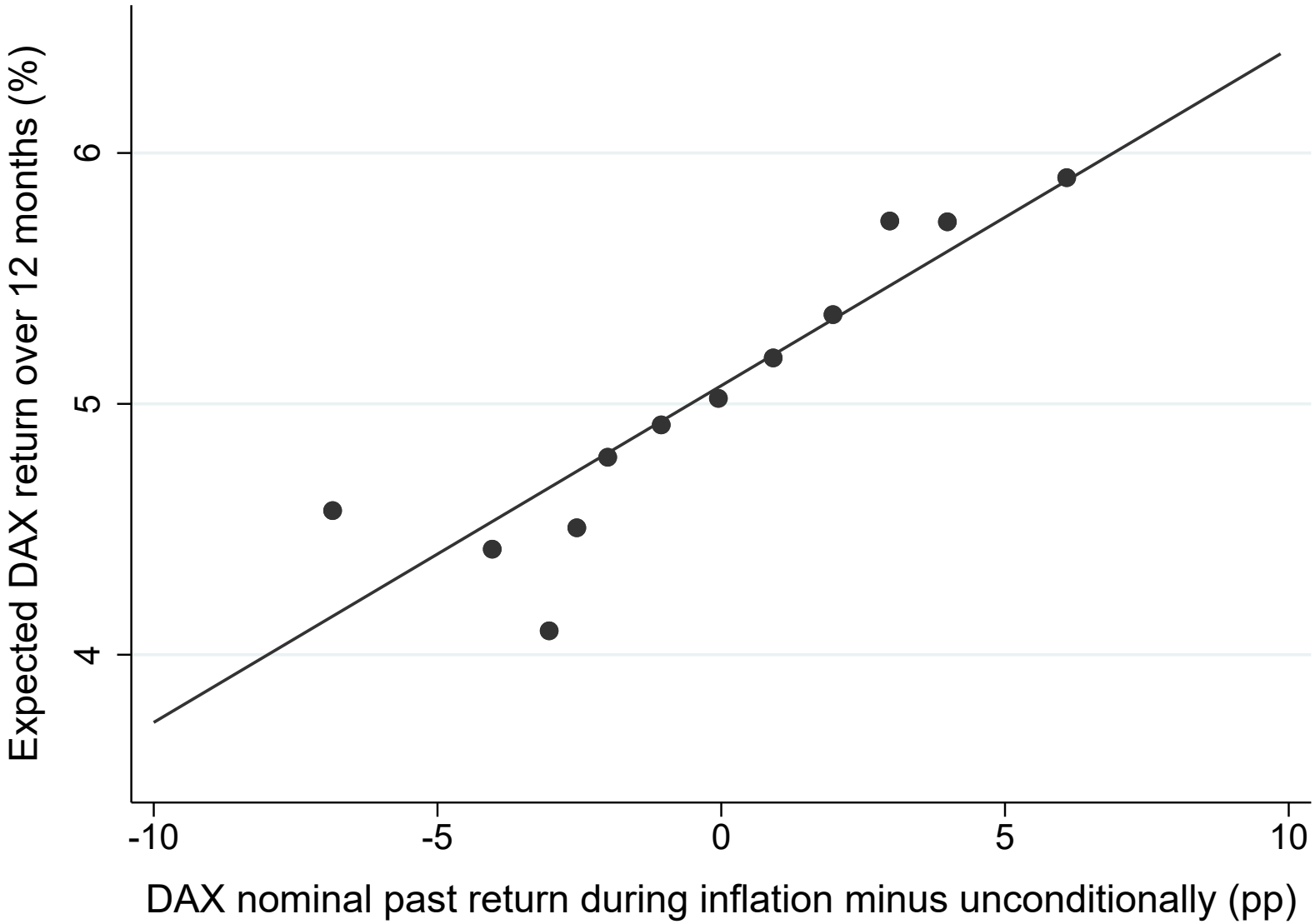
$\Rightarrow$ High awareness of average past stock returns

Perceived historical stock-return impact of inflation



$\Rightarrow$ Disagreement and overoptimism about stock return-inflation relation

Passthrough to return expectations



$\Rightarrow$ Perceived return impact of inflation $\uparrow$ 1 pp $\rightarrow$ expected return $\uparrow$ 0.13 pp

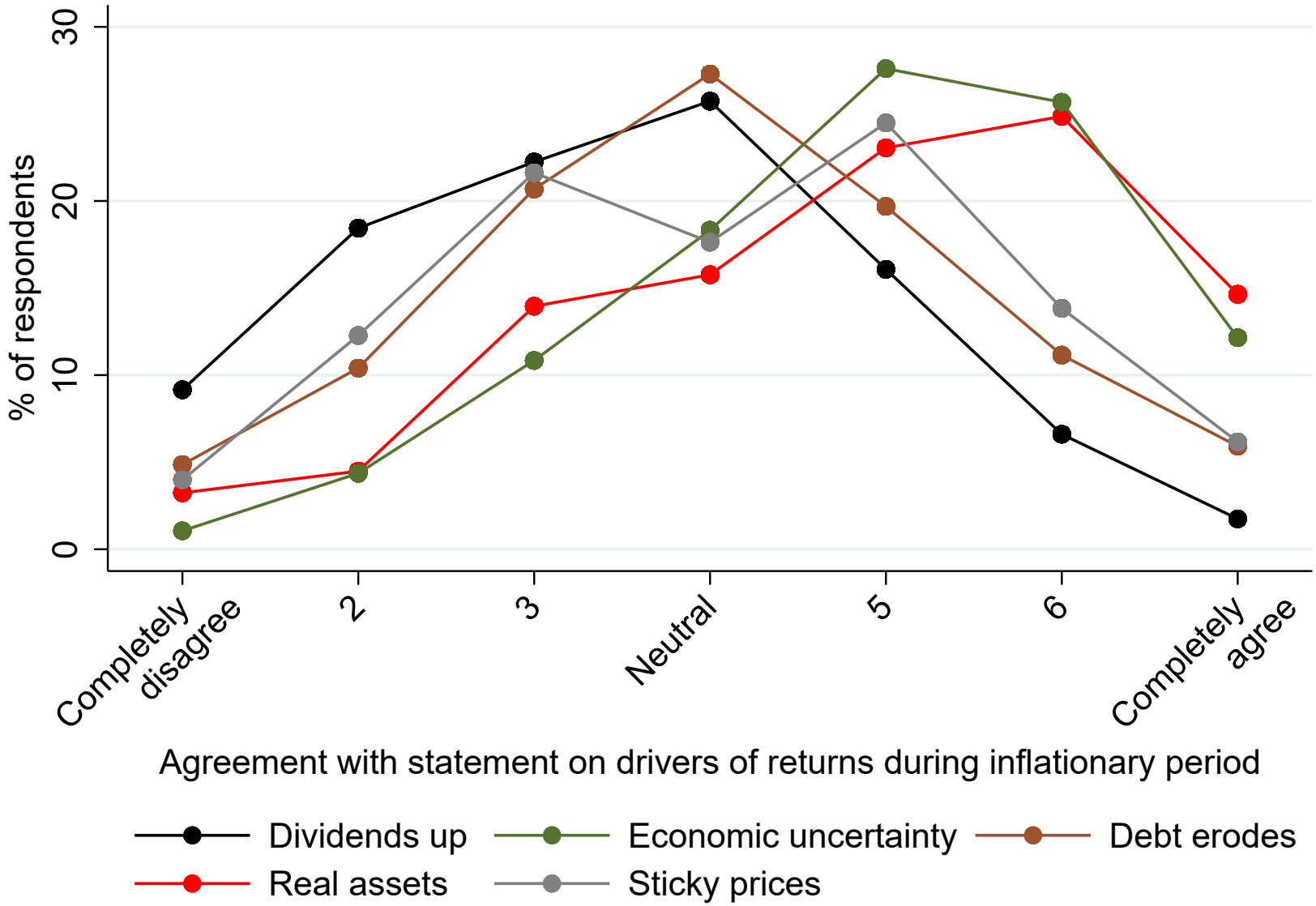
Passthrough to return expectations

- Passthrough <1 from perceived impact to expectations plausible
- Study perceived return impact instead of perceived realized return
- Investors likely base expectations not purely on returns
- Past return-inflation relation might seem only partially predictive
- Measurement error in return beliefs might lead to attenuation bias
- Investors might realize prices have adjusted to inflation already

Mental models behind return impact of inflation

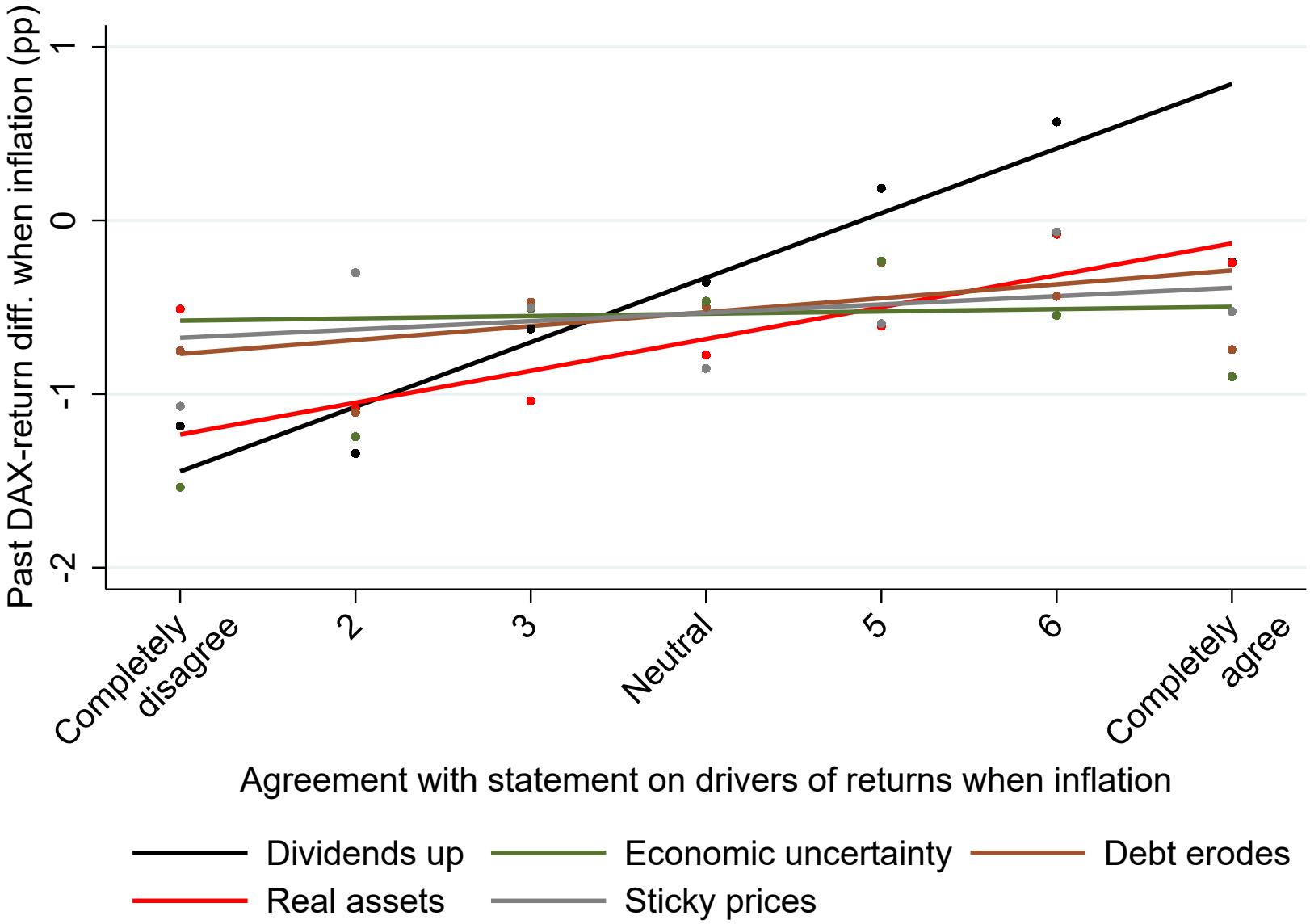
- Elicit agreement with theories on stock return-inflation relation
- Real assets protect against money erosion
  (e.g., Fang, Liu, and Roussanov, 2022)
- Fisher channel: inflation erodes nominal debt
  (e.g., Doepke and Schneider, 2006; Fisher, 1933; Schnorpfeil, Weber, and Hackethal, 2023)
- Money illusion: constant nominal CF discounted w/ higher rate
  (e.g., Cohen, Polk, and Vuolteenaho, 2005; Modigliani and Cohn, 1979)
- Inflation precedes economic uncertainty
  (e.g., Boons et al., 2020; Campbell, Pflueger, and Viceira, 2020; Fama, 1981)
- Firms have limited ability to raise prices
  (e.g., Bhamra et al., 2023; Gorodnichenko and Weber, 2016; Weber, 2015)

Mental models behind return impact of inflation



⇒ Large heterogeneity in reasoning behind stock return-inflation relation

Mental models behind return impact of inflation



⇒ Money illusion appears to be strongest predictor of return beliefs

Plan for the talk

- Data and experimental design
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Equation to estimate treatment effects on return beliefs

$$\hat{y}_i = \alpha + \sum_{k=1}^{3} \beta_k I(x_i = x^k) + \theta \boldsymbol{X}_i + \epsilon_i,$$

with

- $\hat{y}_i$ = post-treatment belief or choice of respondent i
- $I(x_i = x^k)$ = indicator that respondent i receives treatment k
- $\boldsymbol{X}_i$ denotes set of controls from survey and bank data:
  - Age, risk tolerance, inflation and return perceptions, wealth and debt
  - Dummies for gender, marital status, education, financial literacy, financial advice, trading activity, timing of survey participation

Treatment effects on 12-month return expectations

$$\hat{y}_i = \alpha + \sum_{k=1}^{3} \beta_k I(x_i = x^k) + \theta \boldsymbol{X}_i + \epsilon_i$$

Dependent variable:	DAX	DE energy	S&P 500	Nikkei 225	Bunds 10y	Gold
	(1)	(2)	(3)	(4)	(5)	(6)
T1: inflation	0.092	0.243	0.051	−0.163	−0.087	−0.026
	(0.181)	(0.189)	(0.203)	(0.166)	(0.103)	(0.170)
T2: past returns	−0.684***	0.505***	−0.035	1.066***	0.123	1.909***
	(0.184)	(0.189)	(0.205)	(0.200)	(0.102)	(0.214)
T3: 1+2+reason	−1.049***	0.429**	−0.114	1.490***	0.164	2.354***
	(0.185)	(0.180)	(0.205)	(0.194)	(0.109)	(0.219)
Observations	2,568	2,572	2,499	2,578	2,644	2,525
R-squared	0.14	0.10	0.16	0.18	0.16	0.22
Controls	Y	Y	Y	Y	Y	Y
Avg. Y control group	5.0	4.6	5.9	4.1	1.4	4.0

- Inflation treatment has no effect on return expectations
- Info on low German stock returns reduces expectations
- Info on high returns of other assets has large effects

Treatment effects on return beliefs by perception gaps

- Learning might be stronger when priors deviate more from signals
- Focus on degree of updating as function of news in signal:

$$\hat{y}_i = \sum_{k=1}^{3} \beta_k I(x_i = x^k)\,(x^{ret} - \hat{x}^{ret}_{i,prior}) + \mu_k I(x_i = x^k) + \delta_k (x^{ret} - \hat{x}^{ret}_{i,prior}) + \theta \boldsymbol{X}_i + \epsilon_i$$

- $(x^{ret} - \hat{x}^{ret}_{i,prior}) =$ gap b/w realized return and prior estimate
- μ_k measures treat effects that are independent of priors
- δ_k captures posteriors across respondents w/ different priors

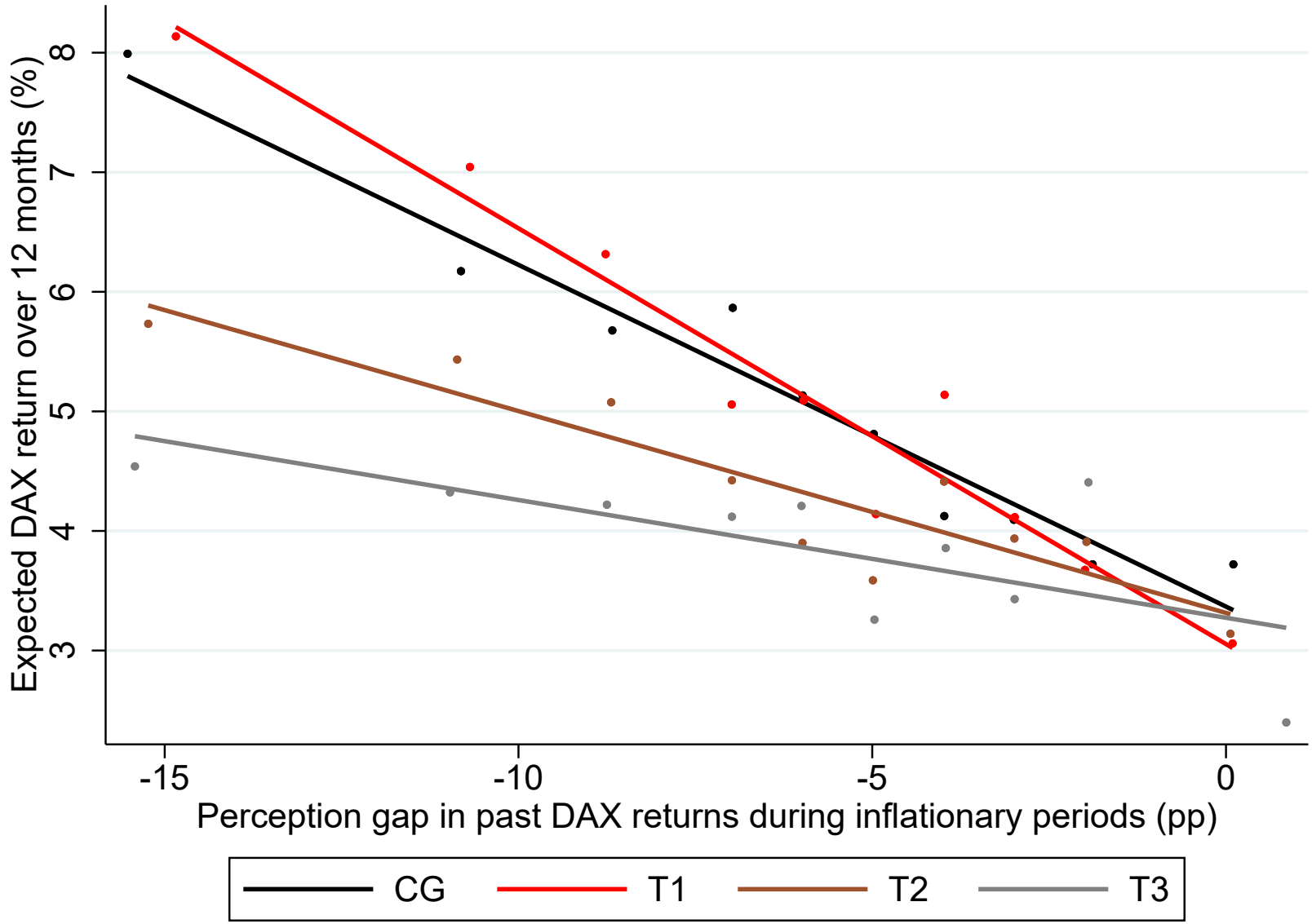
Treatment effects on return beliefs by perception gaps

$$\hat{y}_i = \sum_{k=1}^{3} \beta_k I(x_i = x^k)\,(x^{ret} - \hat{x}^{ret}_{i,prior}) + \mu_k I(x_i = x^k) + \delta_k(x^{ret} - \hat{x}^{ret}_{i,prior}) + \theta \boldsymbol{X}_i + \epsilon_i$$

Dependent variable:	DAX	DE energy	S&P 500	Nikkei 225	Bunds 10y	Gold
	(1)	(2)	(3)	(4)	(5)	(6)
Perception gap	−0.191***	−0.271***	−0.206***	−0.184***	−0.101***	−0.171***
	(0.040)	(0.038)	(0.044)	(0.049)	(0.033)	(0.036)
T1: inflation	−0.222	0.345*	0.061	−0.123	−0.031	0.891*
	(0.304)	(0.193)	(0.197)	(0.401)	(0.113)	(0.515)
T2: past returns	0.006	0.547***	0.112	0.571	0.169	1.679***
	(0.310)	(0.193)	(0.202)	(0.450)	(0.110)	(0.530)
T3: 1+2+reason	−0.196	0.395**	0.054	0.846*	0.315***	2.479***
	(0.317)	(0.178)	(0.205)	(0.459)	(0.115)	(0.586)
T1 x perception gap	−0.037	−0.039	−0.075	−0.004	0.044	−0.107**
	(0.052)	(0.057)	(0.054)	(0.056)	(0.048)	(0.048)
T2 x perception gap	0.131**	0.215***	0.109**	0.103	0.020	0.029
	(0.051)	(0.051)	(0.055)	(0.065)	(0.045)	(0.053)
T3 x perception gap	0.172***	0.145***	0.155***	0.129**	0.070	−0.017
	(0.054)	(0.050)	(0.053)	(0.066)	(0.052)	(0.058)

- Learning increases with gap b/w actual returns and priors
- Some treatment effects that are independent of priors

Treatment effects on return beliefs by perception gaps



$\Rightarrow$ Return info (T2/T3) weakens association b/w prior and posterior

Treatment effects on mental models

$$\hat{y}_i = \alpha + \sum_{k=1}^{3} \beta_k I(x_i = x^k) + \theta \boldsymbol{X}_i + \epsilon_i$$

Dependent variable:	Dividends up	Real assets	Debt erodes	Econ. proxy	Sticky prices
	(1)	(2)	(3)	(4)	(5)
T2 or T3	0.048	−0.012	0.014	0.172***	0.070*
	(0.039)	(0.038)	(0.039)	(0.039)	(0.039)
Controls	Y	Y	Y	Y	Y
Avg. Y control group	3.6	4.9	4.1	5.2	4.2
Observations	2,690	2,690	2,690	2,690	2,690
R-squared	0.03	0.07	0.04	0.02	0.02

$\Rightarrow$ Low-return info leads to reasoning based on economic uncertainty

Inflation beliefs and return expectations

- Inflation info (T1/T3) $\rightarrow$ 12m inflation expectations $\uparrow$ by 0.5 pp
  ▸ Table
- Info does not tighten relation b/w priors and return expectations
  ▸ Table
- Return-info effect similar when paired w/ higher inflation f/cast (T3)
  ▸ Table

$\Rightarrow$ When inflation high, small inflation f/cast shifts w/ limited effects

(Andrade, Gautier, and Mengus, 2023; Pfäuti, 2024)

Taking stock

- Disagreement and overoptimism about stock return-inflation relation
- Subjective reasoning based on econ uncertainty and money illusion
- Info on past inflationary-period returns shapes beliefs and reasoning
- Learning driven by investors with larger perception gaps
- Small shifts in inflation forecasts have limited effects

Plan for the talk

- Data and experimental design
- Prior beliefs about inflation and asset returns
- Treatment effects on return expectations
- Expectations and trading

Treatment effects on hypothetical trading

- Hypothetical portfolio-choice task post-treatment
- Invest €10,000 windfall into various assets
- Passthrough from belief changes to actual trading might be low
  (Ameriks et al., 2019; Giglio et al., 2021)
- Stylized decision allows to abstract from frictions
  (Beutel and Weber, 2023)

Treatment effects on hypothetical trading

$$\hat{y}_i = \alpha + \sum_{k=1}^{3} \beta_k I(x_i = x^k) + \theta \boldsymbol{X}_i + \epsilon_i$$

Dependent variable:	DAX	DE energy	S&P 500	Nikkei 225	Bunds 10y	Gold
	(1)	(2)	(3)	(4)	(5)	(6)
T1: inflation	−73.6	42.8	−50.5	−58.4	−25.8	−3.7
	(120.5)	(61.8)	(121.0)	(41.3)	(41.2)	(83.5)
T2: past returns	−830.6***	155.3**	−231.1*	383.4***	30.7	397.3***
	(123.7)	(63.7)	(124.8)	(55.9)	(40.3)	(94.9)
T3: 1+2+reason	−1288.1***	372.0***	−125.8	522.3***	21.2	456.8***
	(120.8)	(65.8)	(123.0)	(57.8)	(40.1)	(91.1)
Observations	2,597	2,594	2,529	2,599	2,648	2,549
R-squared	0.11	0.06	0.16	0.09	0.04	0.09
Controls	Y	Y	Y	Y	Y	Y
Avg. Y control group	3,444.3	771.8	2,963.2	488.0	264.9	1,024.4

- Inflation treatment has no effect on hypothetical trading
- Return info alters allocations in expected direction (except US)
- T3 effects larger; in particular, 1/3 less invest in German market

Treatment effects on actual trading

- Actual trading post-treatment relative to three months pre-treatment
- Focus is on treatment effects on German equities
  - Interested in perceived sensitivity of stocks to inflation in Germany
  - Frictions impeding passthrough should be smallest for German stocks
- Check whether respondents follow through when expectations change
- Change in actual trading rules out survey demand effects
  (Haaland, Roth, and Wohlfart, 2023)

Treatment effects on actual trading

$$\hat{y}_i = \alpha + \sum_{k=1}^{3} \beta_k I(x_i = x^k) + \theta \boldsymbol{X}_i + \epsilon_i$$

DV:	Number German equities				German equities in EUR			
Trades:	Gross buys		Net buys		Gross buys		Net buys	
Post:	2m	4m	2m	4m	2m	4m	2m	4m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
T1	−0.05	−0.04	−0.03	−0.01	−24.55	−89.58	37.19	46.06
	(0.05)	(0.04)	(0.05)	(0.04)	(292.96)	(201.89)	(275.04)	(211.29)
T2	−0.02	−0.01	0.00	0.01	−261.13	−209.77	−103.66	−150.14
	(0.05)	(0.04)	(0.05)	(0.04)	(296.61)	(212.80)	(272.08)	(210.64)
T3	−0.15***	−0.09**	−0.13***	−0.07*	−693.94***	−388.77*	−229.40	−91.79
	(0.05)	(0.04)	(0.05)	(0.04)	(265.69)	(203.70)	(251.07)	(200.70)
N	1,994	1,994	1,994	1,994	1,994	1,994	1,994	1,994
Y	0.55	0.49	0.34	0.31	1,823.67	1,415.51	550.27	428.34

- Hypothetical trading translates into actual trading
- Effect operates primarily through adjustments in gross buys

(e.g., Calvet, Campbell, and Sodini, 2009)

Changes in return expectations and actual trading

- Study return expectations as link b/w info provision and trading
- Estimate following model:

$$a_i = \delta + \kappa \hat{y}_i + \theta \boldsymbol{X}_i + \epsilon_i$$

- Instrument for return expectation, $\hat{y}_i$, using T3 indicator
- Info does not affect set of expectations about economic conditions

▸ Table

Changes in return expectations and actual trading

$$a_i = \delta + \kappa \hat{y}_i + \theta \boldsymbol{X}_i + \epsilon_i$$

DV:	Number German equities				German equities in EUR			
Trades:	Gross buys		Net buys		Gross buys		Net buys	
Post-treat:	2m	4m	2m	4m	2m	4m	2m	4m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
12m DAX	0.12***	0.07**	0.11**	0.06*	536.22**	287.46*	165.20	55.92
	(0.04)	(0.03)	(0.04)	(0.03)	(234.14)	(169.85)	(204.38)	(162.34)
N	1,001	1,001	1,001	1,001	1,001	1,001	1,001	1,001
F-stat	29.71	29.71	29.71	29.71	29.71	29.71	29.71	29.71
Y	0.55	0.49	0.34	0.31	1,823.67	1,415.51	550.27	428.34

$\Rightarrow$ Significant passthrough from subjective return expectations to trading

Conclusion

- Study investors' return beliefs and trading in context of inflation
- In inflationary regime, behavior appears inelastic to infl. expectations
- Heterogeneity and overoptimism about return impact of inflation
- Shifting return beliefs alters expectations and trading
- Results informative for household finance, asset pricing, and macro
  - HF: investors care about inflation but are unaware of hedging
  - AP: shed light on which subjective models guide investor behavior
  - Macro: implications of HH inflation expectations for investments

Appendix

Treatment effects on inflation expectations

$$\hat{y}_i = \alpha + \sum_{k=1}^{3} \beta_k I(x_i = x^k) + \theta \boldsymbol{X}_i + \epsilon_i$$

Dependent variable:	1yr forecast		Revision 1yr forecast		5yr forecast	
	(1)	(2)	(3)	(4)	(5)	(6)
T1: inflation	0.395***	0.488***	0.532***	0.540***	0.294***	0.344***
	(0.101)	(0.089)	(0.094)	(0.092)	(0.096)	(0.087)
T2: past returns	−0.189*	−0.093	−0.198**	−0.176**	−0.140	−0.067
	(0.105)	(0.087)	(0.088)	(0.086)	(0.101)	(0.091)
T3: 1+2+reason	0.417***	0.475***	0.331***	0.410***	0.202**	0.296***
	(0.109)	(0.093)	(0.101)	(0.098)	(0.097)	(0.090)
Controls	N	Y	N	Y	N	Y
Avg. Y control group	5.0	5.0	0.4	0.3	3.7	3.7
Observations	2,747	2,660	2,704	2,631	2,751	2,663
R-squared	0.02	0.27	0.02	0.09	0.01	0.18

◂ Back

Shift in inflation f/cast x prior beliefs about return impact

Dependent variable:	DAX	DE energy	S&P 500	Nikkei 225	Bunds 10y	Gold
	(1)	(2)	(3)	(4)	(5)	(6)
T1: inflation	−0.023	0.339*	0.212	−0.094	−0.106	−0.108
	(0.185)	(0.190)	(0.204)	(0.168)	(0.113)	(0.183)
Return Δ when inflation	0.210***	0.284***	0.174***	0.154***	0.068*	0.171***
	(0.045)	(0.045)	(0.052)	(0.047)	(0.041)	(0.046)
T1 x return Δ	−0.025	−0.029	0.101	0.070	0.002	0.073
	(0.061)	(0.071)	(0.077)	(0.073)	(0.065)	(0.071)
Controls	N	Y	N	Y	N	Y
Observations	1,402	1,387	1,343	1,389	1,424	1,340
R-squared	0.19	0.20	0.24	0.22	0.21	0.24

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Shift in inflation forecast within T3 respondents

Dependent variable:	DAX	DE energy	S&P 500	Nikkei 225	Bunds 10y	Gold
	(1)	(2)	(3)	(4)	(5)	(6)
Inflation-forecast revision	−0.038	−0.073	0.013	0.004	0.057	−0.011
	(0.090)	(0.086)	(0.095)	(0.109)	(0.060)	(0.131)
Controls	N	Y	N	Y	N	Y
Observations	538	542	530	544	557	529
R-squared	0.15	0.13	0.15	0.18	0.13	0.15

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Treatment effects on other expectations

$$\hat{y}_i = \alpha + \sum_{k=1}^{3} \beta_k I(x_i = x^k) + \theta \boldsymbol{X}_i + \epsilon_i$$

DV:	Own salary		Own portfolio		Unemployment		Economic growth	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
T1	0.003	−0.004	−0.034	−0.067	−0.049	−0.064	0.006	−0.018
	(0.040)	(0.040)	(0.047)	(0.045)	(0.045)	(0.045)	(0.051)	(0.050)
T2	−0.014	−0.003	0.118**	0.078*	0.020	−0.028	0.056	0.018
	(0.042)	(0.041)	(0.048)	(0.046)	(0.049)	(0.049)	(0.054)	(0.053)
T3	0.004	0.018	0.039	−0.009	−0.042	−0.077	−0.081	−0.128**
	(0.041)	(0.040)	(0.048)	(0.047)	(0.048)	(0.049)	(0.053)	(0.053)
Controls	N	Y	N	Y	N	Y	N	Y
Avg. Y	3.3	3.3	3.5	3.5	2.9	2.9	3.1	3.1
N	2,792	2,690	2,792	2,690	2,792	2,690	2,792	2,690
R2	0.00	0.09	0.00	0.10	0.00	0.05	0.00	0.07

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