

Structured Beliefs and Fund Performance: An LLM-Based Approach

Zhenyu Gao, CUHK

Wei Xiong, Princeton, CUHK Shenzhen & ABFER

Jian Yuan, HKUST

Capital Market Development: China and Asia

ABFER

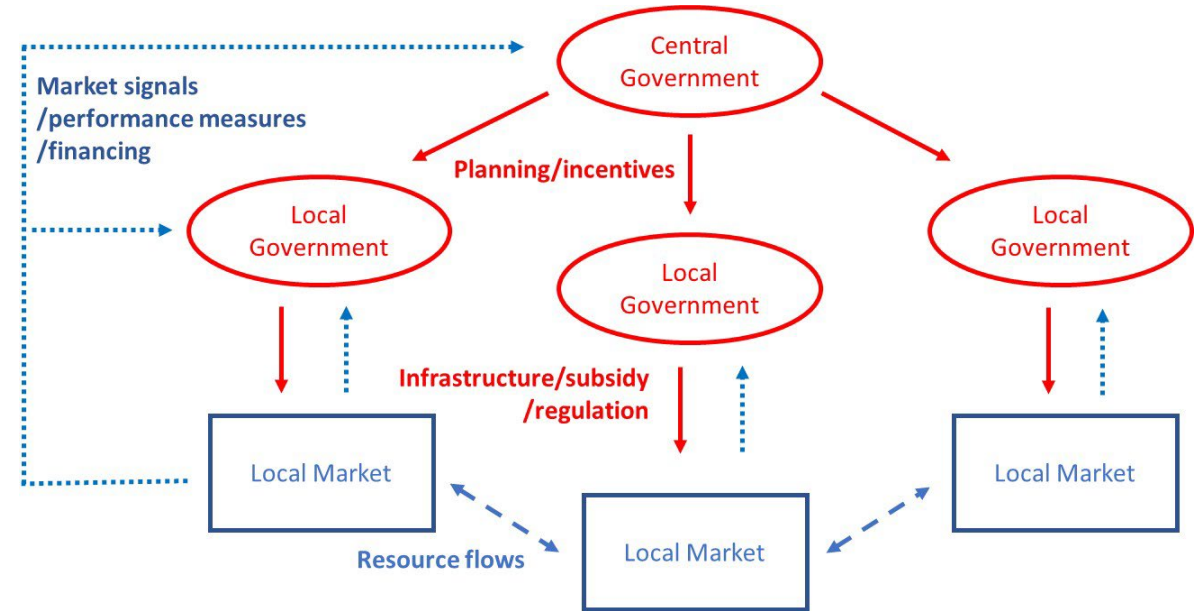
January 16, 2025

Stimulating the Economy through Stock Market

- On September 24, 2024, China's financial leadership announced a new economic stimulus program, including a new liquidity line offered to support the stock market
 - Aiming to stimulate the stock market without a market crash
 - Boosting stock market directly reduces firms' cost of capital and indirectly reduces leverage
 - Such a stimulus may also lead to a speculative frenzy
- This policy measure reflects policymakers' view of market as a tool for implementing state agenda
 - China's economic management model since 1987: “国家调控市场，市场引导企业”
- How do investors choose their investment strategies in China?

China's Hybrid Economy

- The Chinese economy mixes **Economic planning** and **market forces**
 - A result of its gradualist economic reforms
- Central government still uses economic planning
 - sets priority of economic development, guide resource allocation, regulate markets, and ensure stability
 - a top-down approach to direct and motivate local governments
 - Local governments use incentives, regulations and administrative orders to guide firms
- The market economy
 - better incentives for individuals and firms
 - provide taxes, market signals, performance measures to the state system



- “**有效市场、有为政府**” (Efficient market, enabling government)
 - State interventions and market mechanisms may complement each other
 - They may also exacerbate each other's distortions, e.g., Song and Xiong (2023) “The Mandarin Model of Growth”

China's Stock Market

- The Second Largest Stock Market Globally
 - High speculation and volatility (Chen et al., 2019)
 - Retail investor-driven (Cai et al., 2021; Liu et al., 2022)
 - Generally underperforming (Allen et al., 2024)
- Strong Influence of Government Policies
 - Reflects China's hybrid economic model (Song & Xiong, 2018)
 - Frequent state interventions: stamp tax rates, IPO windows & quotas, interest rates, margin requirements, share lending, etc.
 - Involvement of the "national team" during market instability
- Impact of Policy Interventions on Investor Behavior
 - Brunnermeier, Sockin & Xiong (2022): Intensive policy interventions can divert investor attention from economic fundamentals
 - Many anecdotal observations, but systematic evidence remains difficult to establish
 - How can we accurately measure investors' beliefs regarding government policies?



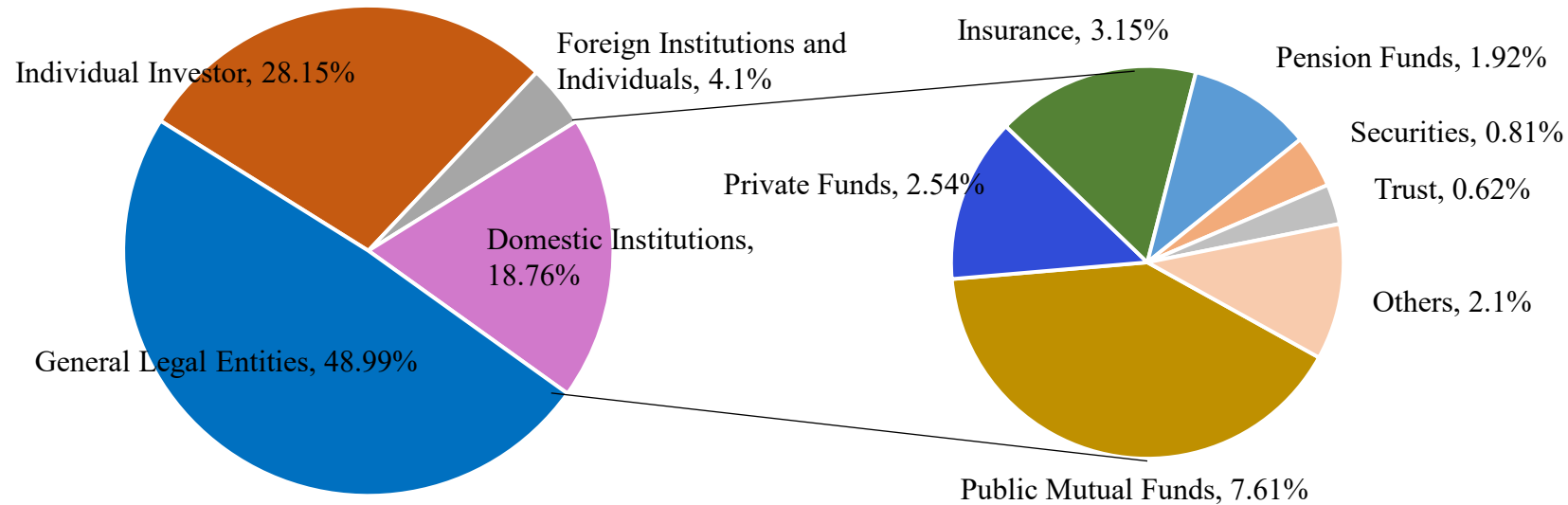
Measuring Beliefs

- What are beliefs of Chinese investors about government policy? How are their investment decisions affected by such beliefs?
- Challenging to measure beliefs directly
 - Empirical tests often depend on indirect inference and structural estimation methods
- Commonly used survey data have notable limitations
 - Shiller (2000), Manski (2004), Greenwood & Shleifer (2014), Coibion & Gorodnichenko (2015), Giglio et al. (2021), Nagel & Xu (2022)
 - Issues include respondent presentiveness, consistency, sample continuity, and depth
- Even harder to measure structured beliefs regarding how different economic forces interact
 - When investors anticipate weak economic fundamentals, they may expect government policy to stimulate the economy, offsetting the weak fundamentals

Chinese Mutual Fund Industry

- Jiang (2020): Mutual funds in China tend to outperform market indices, in contrast to the U.S.

2024Q2 A-Share Market Investor Structure



Source: Wind, HUAXI Securities

Mutual Fund Reports

- Since 2008, the CSRC has required all mutual funds to include **reviews** and **outlooks** for the economy and financial markets in their semi-annual and annual reports
- Advantages of this data sample:
 - Large sample size
 - Representative and continuous coverage of all mutual funds in China
 - Systematic inclusion reviews and outlooks
 - Naturally linked with fund investment and performance data

Year	Semi	Annual	Total
2008	282	333	615
2009	389	448	837
2010	486	532	1018
2011	592	674	1266
2012	748	862	1610
2013	983	1130	2113
2014	1264	1413	2677
2015	1589	1968	3557
2016	2245	2596	4841
2017	2749	3408	6157
2018	3742	4017	7759
2019	4252	4402	8654
2020	4398	4367	8765
2021	4342	4308	8650
2022	4303	4256	8559
2023	4208	4162	8370
Total	36572	38876	75448

An Example of Fund Outlook

- 展望2016年，**宏观政策**方面最大的看点就是供给侧改革，如果去产能、去库存、去杠杆、降成本、补短板的政策真的能够落地，那么2016年将是**中国经济向死而生的一年**。随着市场真正出清的完成，长期来看，中国经济前景充满光明。对应到股市上，2016年需要**降低预期收益率**。首先，在经济出清的过程中，企业盈利短期会承受压力，局部的刚性兑付可能会被打破，这个过程中**投资者的风险偏好会下降**；其次，人民币汇率始终面临压力。在美国进入加息周期，美元持续走强的大背景下，人民币不贬值会面临资本外逃的压力，人民币贬值则牵制国内的货币政策无法放水，这个死结短期内很难解开；第三，注册制的实施会给市场带来长远的结构性变化，随着股票供给的增加，小盘股的壳资源价值会逐步消失，以创业板为代表的并购增长模式也会随着上市门槛的降低而变得越来越困难，因此中国股市长期存在的小盘股大幅溢价情况将会出现趋势性的变化。综上所述，**2016年股市整体上将是休养生息的一年**，机会更多的体现在波段操作以及“自下而上”的结构性机会上。2016年，**本基金将采取积极防御的策略**，重点把握以下几类投资机会：(1)积极进行波段操作，积小胜为大胜，努力谋求赚取市场波动的钱；(2)深入挖掘供给侧改革中蕴含的投资机会，如果国企改革政策能够破冰，可能会有较好盈利机会；(3)“自下而上”挖掘能够超越牛熊周期的真正经典成长股并长期持有，获取企业EPS增长的钱；(4)保留足够的现金，为下一轮牛市储备好充足的粮草。珍惜基金份额持有人的每一分投资和每一份信任，本基金将继续奉行华夏基金管理有限公司“为信任奉献回报”的经营理念，规范运作，审慎投资，勤勉尽责地为基金份额持有人谋求长期、稳定的回报。

An Example of Fund Outlook

Looking ahead to 2016, the **biggest focus in macroeconomic policy is supply-side reform**. If the policies of reducing overcapacity, destocking, deleveraging, lowering costs, and addressing weaknesses can be effectively implemented, then 2016 will be **a year of revival for China's economy**. Once the market fully clears, the long-term prospects for China's economy are bright.

In terms of the stock market, **the expected return rate needs to be lowered in 2016**. First, during the economic clearing process, **corporate profits will face short-term pressure**, and some rigid payments might be disrupted, leading to a decrease in investor risk appetite. Second, the **RMB exchange rate is consistently under pressure**. In the context of the **U.S. entering a rate hike cycle** and the continued strengthening of the dollar, if the RMB does not depreciate, it will face capital outflow pressure. If it does depreciate, it will **constrain domestic monetary policy, making it difficult to ease in the short term**. Third, **the implementation of the registration system** will bring long-term structural changes to the market. With the increase in stock supply, the value of small-cap shell resources will gradually disappear. The merger and acquisition growth model, represented by the ChiNext, will become increasingly challenging as listing thresholds are lowered. Therefore, the substantial premium on small-cap stocks, long present in the Chinese stock market, will undergo a trend change.

In summary, 2016 will **be a year of recovery for the stock market**, with opportunities primarily in short-term trading and bottom-up structural opportunities. In 2016, this fund will adopt an actively defensive strategy, focusing on several key areas. First, active short-term trading, accumulating small gains for larger profits. Second, exploring investment opportunities in supply-side reforms, particularly if state-owned enterprise reform policies break new ground. Third, bottom-up selection of true classic growth stocks that can transcend market cycles, aiming to benefit from EPS growth. Fourth, maintaining sufficient cash reserves for the next bull market.

The fund will continue to uphold the company's philosophy of "delivering returns for trust," operating compliantly, investing prudently, and diligently seeking long-term, stable returns for fund shareholders.

Extracting Beliefs

- Bag-of-words approach, e.g., Tetlock (2007), Loughran & McDonald (2011)
 - Counting positive & negative words to measure sentiment
- Latent Dirichlet Allocation (LDA) approach to construct topical themes, e.g., Bybee et al. (2020)
- Large Language Models (LLM)
 - Capable of sorting out complex structure of mutual issues in the same text
 - Extensive use for sentiment analysis, albeit not structure of beliefs, e.g., Chen et al. (2022), Lopez-Lira and Tang (2023) and Bybee (2023)

Quantifying Reviews and Outlooks

Instruction for ChatGPT-4:

*Your task is to assess the **review** (or **outlook**) section of a mutual fund's periodic report. Evaluate each of the following dimensions:*

(1) domestic fiscal policy; (2) domestic monetary policy; (3) domestic regulatory policy; (4) domestic macroeconomic fundamentals; (5) global macroeconomic fundamentals; (6) domestic equity market; (7) domestic bond market; (8) overall assessment for fund investors.

Respond with 'Positive', 'Weakly Positive', 'Neutral', 'Weakly Negative', 'Negative', or 'Not Mentioned' (not applicable for the overall assessment). Follow each response with a concise, one-sentence elaboration in Chinese.

Extracted Beliefs from the Example

1. Fiscal Policy: Positive
 - Supply-side reforms are expected to drive economic improvement
2. Monetary Policy: Weakly Negative
 - The RMB faces depreciation pressure, limiting the flexibility of monetary policy
3. Regulatory Policy: Neutral
 - The implementation of the registration system will bring structural changes, but long-term effects are unclear
4. National Macroeconomic Fundamental: Positive
 - Supply-side reforms are expected to achieve economic "rebirth through adversity"
5. Global Macroeconomic Fundamental: Weakly Negative
 - The US dollar interest rate hike cycle puts pressure on the RMB
6. Equity Market: Neutral
 - The stock market will be in a period of consolidation, but structural opportunities exist
7. Bonds Market: Not Mentioned
8. Overall Assessment of the Section for the Fund Investors: Weakly Positive
 - The overall outlook shows a cautiously optimistic attitude, emphasizing defensive strategies and structural opportunities

Data Summary

	Mean	Sd	Min	P25	Med	P75	Max
Review:							
fiscal_policy	0.155	0.401	-1	0	0	0	1
monetary_policy	0.383	0.527	-1	0	0	1	1
regulatory_policy	0.012	0.43	-1	0	0	0	1
national_macroecconomy	0.012	0.593	-1	-0.5	0	0.5	1
equity_market	0.087	0.666	-1	-0.5	0	0.5	1
bonds_market	0.23	0.516	-1	0	0	1	1
Outlook:							
fiscal_policy	0.329	0.477	-1	0	0	1	1
monetary_policy	0.374	0.477	-1	0	0.5	1	1
regulatory_policy	0.135	0.437	-1	0	0	0	1
national_macroecconomy	0.187	0.584	-1	-0.5	0.5	0.5	1
equity_market	0.38	0.492	-1	0	0.5	1	1
bonds_market	0.181	0.42	-1	0	0	0.5	1

Lookahead Bias

- Glasserman and Lin (2024) and Sarkar and Vafa (2024) highlighted concerns regarding lookahead bias in outputs generated by LLMs
 - This bias may arise because an LLM's pretraining data can include information from the future
- This is not an issue for our analysis, as we use GPT primarily for text summarization, not for prediction.
 - To ensure robustness, we implemented measures such as removing year references and shifting dates by 5 or 10 years. The output consistency rate remains above 90%.

Countercyclical Policy Expectations

X = fiscal, monetary, or regulatory

- *CCPn_X*: a manager believes that the economy is currently in a downturn (*review_national_macro_economic* = -1) but the government to adopt easing policy in *X* to support the economy (*expect_policy* ≥ 0).
- *CCPp_X*: a manager believes that the economy is performing well (*review_national_macro_economic* = 1) but expects the government to implement a tightening policy in *X* (*expect_policy* ≤ 0).
- *CCP_X*: a manager expects the government policy in *X* to counter the current economic conditions in either direction, i.e., either *CCPn_X* or *CCPp_X* equals 1.
- *CCP*: This indicator is set to 1 if a manager displays countercyclical policy expectations in any of the three policy areas.

Summary of Expectations

Panel A: Countercyclical Policy Expect Summary

	Mean	Sd	Min	P25	Med	P75	Max
CCP_fiscal	0.175	0.38	0	0	0	0	1
CCP_monetary	0.159	0.366	0	0	0	0	1
CCP_regulatory	0.183	0.387	0	0	0	0	1
CCP	0.214	0.41	0	0	0	0	1

Panel B: Variation Decomposition

	Fund FE	Time FE	Fund+Time FE
CCP_fiscal	0.087	0.103	0.182
CCP_monetary	0.087	0.094	0.175
CCP_regulatory	0.088	0.085	0.167
CCP	0.090	0.122	0.204
expectation_equity_market	0.314	0.057	0.376
expectation_bonds_market	0.243	0.038	0.279

Countercyclical Policy Funds

- A fund is labeled a "countercyclical policy fund" (CCP fund) if the fraction of its countercyclical policy expectations is above 20%.

Panel A: Summary Statistics

	Mean	Sd	Min	P25	Med	P75	Max
fra_CCP	0.202	0.123	0	0.105	0.2	0.286	0.8
CCP_fund	0.505	0.5	0	0	1	1	1

Performance of CCP Funds

Panel B: CCP Funds				
	Equal weighted		Value weighted	
Alpha	0.495*** (3.37)	0.471*** (3.03)	0.350*** (2.62)	0.294** (2.51)
MKTRF	0.511*** (23.82)	0.516*** (27.07)	0.458*** (9.70)	0.469*** (10.53)
Smb	0.0150 (0.36)	0.00873 (0.22)	0.00548 (0.14)	-0.00904 (-0.24)
Vmg	-0.183*** (-3.81)	-0.182*** (-3.74)	-0.138*** (-2.80)	-0.134*** (-2.85)
Pmo		0.0337 (1.04)		0.0777 (1.56)
N	186	186	186	186
R-sq	0.915	0.916	0.836	0.842

Panel C: Non-CCP Funds				
	Equal weighted		Value weighted	
Alpha	0.348*** (3.33)	0.344*** (3.27)	0.163 (1.51)	0.129 (1.39)
MKTRF	0.378*** (16.93)	0.379*** (17.00)	0.270*** (5.44)	0.277*** (5.76)
SMB	0.00958 (0.39)	0.00852 (0.36)	-0.0157 (-0.49)	-0.0246 (-0.72)
VMG	-0.128*** (-4.42)	-0.128*** (-4.35)	-0.0669** (-2.02)	-0.0648** (-2.14)
PMO		0.00571 (0.26)		0.0479 (1.08)
N	186	186	186	186
R-sq	0.907	0.907	0.699	0.704

Liu, Stambaugh, and Yuan (2019): 3 or 4 factors for Chinese equity returns

Panel Regression of Fund Returns

Dep. variable	(1)	(2)	(3)	(4)	(5)	(6)
		Ret		alpha_ch3	alpha_ch4	
CCP_fund	0.0807*** (7.52)	0.0662*** (5.95)	0.0619*** (5.32)	0.0590*** (4.93)	0.0688*** (6.15)	0.0672*** (5.83)
log_tna		-0.0364*** (-11.30)		-0.0126*** (-4.07)		-0.00754** (-2.49)
flow		0.00483 (0.69)		0.0237*** (4.71)		0.0318*** (6.34)
age		0.000559*** (4.48)		0.000102 (0.71)		0.0000786 (0.57)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
N	428284	428284	428286	428286	428286	428286
R-sq	0.415	0.415	0.097	0.097	0.072	0.072

How Do CCP Funds Outperform Non-CCP Funds?

1. Prediction of Future Returns

- CCP funds' ability to predict future returns of equity and bond market indices, relative to non-CCP funds

2. Relationship Between Expectations and Asset Allocations

- Relationship between funds' asset allocation and beliefs

3. Reliability of Investment Decisions

- Can their trading predict returns?

4. Impact of Countercyclical Policy Expectations

Predictability of Funds' Market Expectations

$$RI_equity_{t+1} = \alpha_i + \beta_t + \beta expect_equity_market_{i,t} \times CCP_fund_i + \gamma expect_equity_market_{i,t} + \delta X_{i,t} + \varepsilon_{i,t+1}$$

	(1)	(2)	(3)	(4)
	hs300_index	bond_index	hs300_index	bond_index
expect_equity_market	0.199*** (6.63)		0.131*** (2.93)	
expect_bonds_market		0.00435 (1.05)		-0.00425 (-0.76)
expect_equity_market x CCP_fund			0.111* (1.89)	
expect_bonds_market x CCP_fund				0.0177** (2.14)
Fund FE	Yes	Yes	Yes	Yes
N	214562	214562	214562	214562
R-sq	0.009	0.006	0.009	0.006

Market Expectations and Fund Holdings

$$\begin{aligned}
 \text{stock_ratio}_{i,t} = & \alpha_i + \beta_t + \gamma \text{expect_equity_market}_{i,t} \\
 & + \theta \text{expect_equity_market}_{i,t} \times \text{CCP_fund}_i + \delta X_{i,t} + \varepsilon_{i,t}
 \end{aligned}$$

	(1)	(2)	(3)	(4)
	stock_ratio	bond_ratio	stock_ratio	bond_ratio
expect_equity_market	1.944*** (14.14)		1.814*** (8.20)	
expect_bonds_market		1.852*** (10.38)		1.206*** (5.55)
expect_equity_market x CCP_fund			0.214 (0.72)	
expect_bonds_market x CCP_fund				1.348*** (3.79)
Fund FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	75129	75129	75129	75129
R-sq	0.928	0.928	0.928	0.928

Trading and Subsequent 3-Month Returns

$$RI_{equity_{t+1}} = \alpha_i + \beta \Delta stock_{ratio_{i,t}} \times CCP_{fund_i} + \gamma \Delta stock_{ratio_{i,t}} + \delta X_{i,t} + \varepsilon_{i,t+1}$$

	(1)	(2)	(3)	(4)
	hs300_index	bond_index	hs300_index	bond_index
$\Delta stock_ratio$	0.00659*** (3.76)		0.00117 (0.42)	
$\Delta bond_ratio$		0.00148*** (7.83)		0.000821*** (3.07)
$\Delta stock_ratio \times$ CCP_fund			0.00859** (2.42)	
$\Delta bond_ratio \times$ CCP_fund				0.00123*** (3.26)
Fund FE	Yes	Yes	Yes	Yes
N	214524	214524	214524	214524
R-sq	0.009	0.006	0.009	0.006

Role of CCP Beliefs - All Funds

Panel A: CCP belief and Market Index Prediction				
	(1)	(2)	(3)	(4)
	hs300_index	bond_index	hs300_index	bond_index
expect_equity_market	0.207*** (5.23)		0.102** (2.24)	
expect_bonds_market		0.0128** (2.09)		0.0145* (1.92)
expect_equity_market x CCP			0.353*** (4.56)	
expect_bonds_market x CCP				-0.00458 (-0.39)
CCP			-0.767*** (-15.76)	0.00700 (1.54)
Fund FE	Yes	Yes	Yes	Yes
N	118070	118070	118070	118070
R-sq	0.007	0.006	0.010	0.006

Role of CCP Beliefs – CCP Funds

Panel B: CCP belief and Performance			
	(1)	(2)	(3)
	Ret	alpha_ch3	alpha_ch4
CCP	0.0704*** (4.21)	0.0538*** (3.68)	0.0330** (2.36)
Fund FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
N	235643	235643	235643
R-sq	0.485	0.139	0.108

Summary

- Analyzing government policy plays a key role in driving mutual fund managers' investment policies
 - Systematic evidence of CCP-related beliefs among fund managers in China
 - Helps to explain the superior returns achieved by fund managers
- The LLM approach is effective in extracting beliefs from complex reports
 - Demonstrates significant potential for the systematic analysis of structured beliefs