Distributional effects of beliefs changes on stock returns

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Abstract

I examine the effects of changes in subjective expectation of stock returns on wealth inequality and how these expectations relate to the different saving motives that shape the wealth distribution. I document several empirical facts that suggest a relevant link between beliefs on equity returns and the wealth distribution, and argue that beliefs shifted in the early 2000s. Furthermore, I posit that these beliefs interact with the bequest motive and saving decisions in retirement, and connect subjective perceptions with the literature on the retirement puzzle. Using externally identified shocks and investor surveys, I document the responsiveness of investors' perception to new information and then estimate the IRFs of the wealth shares, finding non-negligible shifts. To understand this linkage, and building on Benhabib et al. (2019) I estimate a model with heterogeneous agents with stochastic labor income process. I introduce a portfolio problem with a risk-free bond and equity, and the warm-glow bequest motive is derived from the expected value of bequeathable assets. These features help me explain the extensive and intensive margin and differential responses and quantify the strength of the belief channel. I find that changes in beliefs have a relevant distributional effect.

I Introduction

How do beliefs on asset returns shape the wealth distribution? The seminal work of Merton 1969 shows that the expected returns and volatility of assets determine their corresponding optimal portfolio shares, while Giglio et al. (2021) documents the role of beliefs and how they are reflected in their portfolios and trading activity. In this paper, I study how changes in these beliefs, through asset allocation choices, interact with the different saving motives that explain the typical right-thick tail of distributions.

Economists have long recognized the importance of heterogeneous expectations and stock prices (Harrison and Kreps, 1978) and the measurement of subjective expectations (see the survey in Manski (2004, 2018)), and the convergence of a myriad of

factors in the early 2000s warrants a discussion of the role of heterogeneous beliefs. Unique technological advances, abnormal valuation ratios, and weaker forecasting relations were deemed to portend a poor outlook for the stock market (Campbell and Shiller, 2001). As evidence suggests that information technology affected the aggregate valuation of stocks in the early 1970s (Hobijn and Jovanovic, 2001), the surge in accessible computing power in the late 1990s could also contribute to changes in the equity valuation process through the accumulation of intangible assets or the formation of price bubbles (Jorgenson, 2001). Furthermore, greater efficiency in information processing in the financial sector shifts the incentives to acquire fundamental information versus non-fundamental shocks to prices, and evidence suggests that financial analysis and investment strategies have changed Farboodi and Veldkamp (2020), relaxing what Sims (2003) dubs *limited information processing capacity*.

As another relevant factor, the demographic structure of the time made economists wary: Campbell and Shiller (2001) recognized the relationship between the baby boom and stock demand and Poterba (2001) posited and tested the "asset market meltdown" hypothesis, that is, a sharp decline of asset holding associated with the age structure as baby boomers sell all their assets, while Abel 2001 argued that the specification of an altruistic bequest motive generates positive asset demands by retirees in consistence with the lack of evidence supporting the meltdown hypothesis. Although determining the extent of these structural changes is beyond the scope of this paper, these factors have driven subjective beliefs.

Literature Review

Retirement puzzle and the life-cycle: An ample body of work has studied the retirement puzzle. As examined by Banks et al. (1998), fall in consumption in retiring households as a result of informational shocks during retirement. Medical expenses (De Nardi et al., 2010), intergenerational transfers and the importance of the bequest motive (De Nardi, 2004; De Nardi and Fella, 2017) have been found to be the key drivers for saving in retirement. Regarding the effect of aging, Korniotis and Kumar (2011) provide evidence on the detrimental effects of cognitive aging in investment decisions. Abel (2001) explore the role of the bequest motive and stock prices. In

this paper I explore the relationship between beliefs on stocks and this puzzle, as disaving rates in old age may depend on retiree's outlook and subjective perceptions.

Expectations and stock prices: Giglio et al. (2021) document the role of beliefs and how they are reflected in their portfolios and trading activity, while the survey in Choi and Robertson (2020) provides support in favor of several hypothesized factors about financial beliefs and portfolio equity share, and Meeuwis et al. (2022) exploit the outcome of the 2016 U.S. election as an informative public signal in order to study the effect of belief disagreement on portfolio choices. On the general effect of investors' beliefs, Adam et al. (2017) find that capital gains are driven by non-rational beliefs of investors, and the work of Jappelli and Padula (2013) and Lusardi et al. (2017) suggests that financial knowledge and literacy have distributional effects. Kuhn et al. 2020 document the linkage between capital gains and wealth and income inequality.

Portfolio choice and expectations: In Merton 1969,Gomes et al. 2021 the expected return and volatility of assets determine their optimal portfolio share. This is the mechanism through which expectations would enter the model. Vissing-Jørgensen and Attanasio (2003) test several asset-pricing models and argue that having two assets yields helps explaining the equity premium puzzle. Malmendier and Nagel (2011) show that lifetime experience on risky asset returns affect beliefs about future performance and participation in bond and stock market (uses UBS index data). Brunnermeier and Nagel (2008) document the absence of the wealth effect on the risky asset shares and suggest that changing stock market participation rather than time-varying individual aversion may explain the time-varying risk premia in the aggregate. My paper also contribute to the literature explaining stock market participation

Egan et al. (2021) find that expectations play a major role in retirement portfolios. The authors exploit exogenous variation in investment costs to retrieve the distribution of beliefs and risk aversion across investors and find substantial heterogeneity in both risk aversion and beliefs across investors. Moreover, they document that investors beliefs are not rational, overreact to recent news and based on extrapolated past fund returns and from individualized experience based on local economic

conditions and employer performance.

Distributional effects of portfolio choices Kuhn et al. (2020) use long-run US data and document the highly persistent differences in portfolio composition and leverage of households along the wealth and that capital gains and losses shift the wealth distribution through an "asset price channel". Factors related to personal experience and advice are related to portfolio equity shares (Choi and Robertson, 2020). Giglio et al. (2021) posit capital gains as frictions for beliefs pass-through response of portfolios. Adam et al. (2017) model capital gain optimism to explore whether agents behave under rational expectations.

Contribution: Compared to similar work (Kacperczyk et al., 2019, Giusto, 2014, and Lei, 2021), my contribution is to examine a portfolio choice problem driven by heterogeneous beliefs in a life cycle model with incomplete markets. My goal is to quantify the importance of the belief channel, and examine how it drives the dynamics of the wealth distribution. I posit an endogenous mechanism for capital risk and contribute to the existing literature by quantifying the channel of subjective expectations and its link to the main determinants of wealth distribution (De Nardi 2004, Benhabib et al. 2011, Benhabib et al. 2017, and De Nardi and Fella 2017).

The remainder of the paper proceeds as follows. Section II describes our available data on expectations, Section III and IV motivate an empirical analysis of the distributional effects of changes in beliefs. Section V then shows a simple two-period model with belief disagreement and otherwise identical agents to examine the significance of these effects. **??** presents the full model. Section VI concludes.

II Data

UBS Gallup/UBS Poll

I analyze these data and study the responsiveness of investors' perception to new information. The survey ranges from 1996 until 2007 (quarterly 1996-1998, monthly onward) is a sample of a national cross section of head of households or spouse in any household with total savings and investments of $10,000 or more. The survey covers the personal financial and macroeconomic dimension of investment and investor responses are measured on a five-point scale (very optimistic, somewhat optimistic, neither optimistic nor pessimistic, somewhat pessimistic, very pessimistic).

Investors are asked about their optimism about their personal investment goals and also about factors that may affect the overall investment environment, including the performance of the stock market over the next year.
This data set contains an ordinal scale of wealth, age, and education, among others. Prior to 2003, investors reported their expected return of the stock market (although no reference index is defined) and starting in 2001, investors are asked about the return of the own portfolio in the past year and over the next year.

Health and Retirement Study

This is a longitudinal panel study that surveys a representative sample of approximately 20,000 people in America, aged 50 or more. Since 2000, the survey has elicited subjective probabilities pertaining to the return on blue chip stocks. Following Kézdi and Willis (2011), under the assumption of normality, the subjective mean and standard deviation can be identified using questions on stock market performance:

"By next year at this time, what is the percent chance that mutual fund shares invested in blue chip stocks like those in the Dow Jones Industrial Average will be worth more than they are today?"

"By next year at this time, what is the percent chance that mutual fund shares invested in blue-chip stocks like those in the Dow Jones Industrial Average will have gained in value by more than 20 percent compared to what they are worth today?"

This source provides rich data on wealth, portfolios, income, and bequests, among other aspects.

Survey of Consumer Finances

The Survey of Consumer Finance (SCF) is a triennial survey with detailed information on household finances and portfolios that serves as the basis for the Distributional Finance Accounts of the Fed. The SCF asks on a three-rating scale about the future performance of the US economy. This survey does not elicit subjective perceptions. When considering the unconditional correlation found in the UBS index between perceived performance of the stock market and the economy (approximately 0.5), the data from the UBS survey may be reasonably matched with the SCF. Eco-

nomic expectations, credit attitudes and financial institutions. Miscellaneous opinion variables

Other sources

The RAND American Life Panel (ALP) is a nationally representative longitudinal panel that includes individual characteristics. The module 'Effects of the Financial Crisis' was surveyed from November 2008 to January 2016 for a total of 61 waves, with a monthly frequency starting in May 2009. The survey elicits stock market beliefs through probabilistic statements.

The University of Michigan Survey of Consumers includes one question on the probability of an increase in stock market prices. This monthly series has been available since June 2002. Categorical information on stock investments, housing and income is available.

a Data mapping to the empirical analysis and model

The Gallup/UBS poll is used in a high-frequency identification setup which is to be described in what follows of this paper. As this source allows for a simple characterization of the expected returns on stocks (available from 1996 to 2001) and its unconditional distribution, I used it as a basis for calibrating and analyzing a simple two-period model.

For the multiperiod life-cycle model, the calibration of conditional distributions of beliefs of workers aged 50 or more is possible using the HRS. For younger workers, the corresponding transition matrices will be calibrated using the other available sources.

III Empirical Facts and Analysis

In this section, I document several empirical facts that suggest that beliefs on equity returns have fallen and that stocks remain as one of the main assets in households' portfolio, altogether associated with wealth concentration. A glance at the Distributional Finance Accounts reveals that asset portfolios vary distinctively across wealth profiles.

a Descriptive analysis

Medium-run waves of Optimism and Pessimism

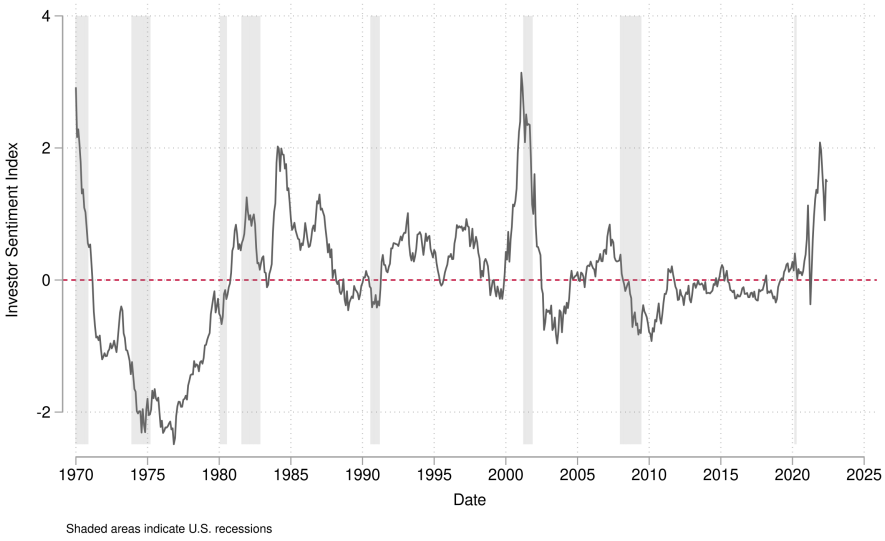


Figure 1: Index of Sentiment Levels, Baker and Wurgler (2006)

Note. This figure shows the first principal component of levels in six measures of sentiment: the closed-end fund discount (CEFD), detrended log turnover (TURN), number of IPOs (NIPO), first-day return on IPOs (RIPO), dividend premium (PDND), and equity share in new issues (S), each standardized and with the effect of macroeconomic conditions removed. Available at `https://pages.stern.nyu.edu/~jwurgler/`

To describe the long-term behavior of beliefs, I consider the sentiment index of Baker and Wurgler (2006) as a proxy. This metric is based on market measures orthogonalized to macroeconomic conditions. Notably, Figure 1 shows that episodes of optimism and pessimism may last for years and characterize certain decades. The optimism of the 1990s, the mean reversion of sentiment in the 2000s after the Internet bubble burst, and the lingering post-crisis pessimism of the 2010s suggest that the differential exposure of different cohorts influenced the wealth distribution through asset allocation choices. Previous work has shown that beliefs are reflected in portfolio choices (Giglio et al. 2021, Choi and Robertson 2020) and personal experiences of aggregate shocks affect the risk-taking behavior of individuals (Malmendier and Nagel, 2011).

To conclude, in what remains of this paper, we take the position that changes in beliefs are transitory. Hudomiet et al. (2011) find a temporary increase in the pop-

ulation average of expectations and with higher significance on uncertainty right after the stock market crash of 2008. Arguably, as proposed by Dominitz and Manski (2011), population can be thought to be composed of three types of agents in how they form their expectations: Random-walk type, Persistence type, and Mean-reversion type.

Wealth stock holding concentration

A glance at the distribution of wealth (net worth) of households (panel a), Figure 2) suggests a link between wealth distribution, investor sentiment, and stock holdings. Although the optimism that characterized the 1990s (as proxied by a prevalent positive Investor Sentiment Index) was associated with higher stockholdings, households in the middle 40th percentile (second row, Figure 2) follow a distinctive pattern in how they "ride the wave" even after the burst of the bubble, which might explain the temporal reversion of the upward trend in wealth concentration by the Top 10th percentile.

For the bottom 50th percentile, housing represents the largest portion of their wealth: between 1989 and 2019, real estate (net of home mortgage) as a share of net worth has soared from 30 percent to 59 percent [1]. Thus, the post-2007 crisis dip of the wealth share and steady decline in aggregate participation on corporate equity shares can be partially explained by the crowding out of housing of stockholdings Cocco (2005). These documented differences may also be due to

b Professional forecasters and Investors' beliefs

Individual responses from the Survey of Professional Forecasters administered by the Philadelphia Fed show that long-run expectations on equity have decreased over time, including the implied real return. Notably, the downward trend in expectations is not reversed with the uptick of the 1-year US Treasury Securities that occurred between 2004 and 2007. For the implied equity premium [2] which displays high dispersion in the late 90s and soars after the Great Financial Crisis and the post-pandemic years, suggestive the responsiveness of agents to economic shocks. Although these data

[1] Own calculation based on the Fed's DFA data

[2] For each individual response, the forecast of the real return and the equity premium can be computed using the respondent's inflation and interest rate forecast over the same period.

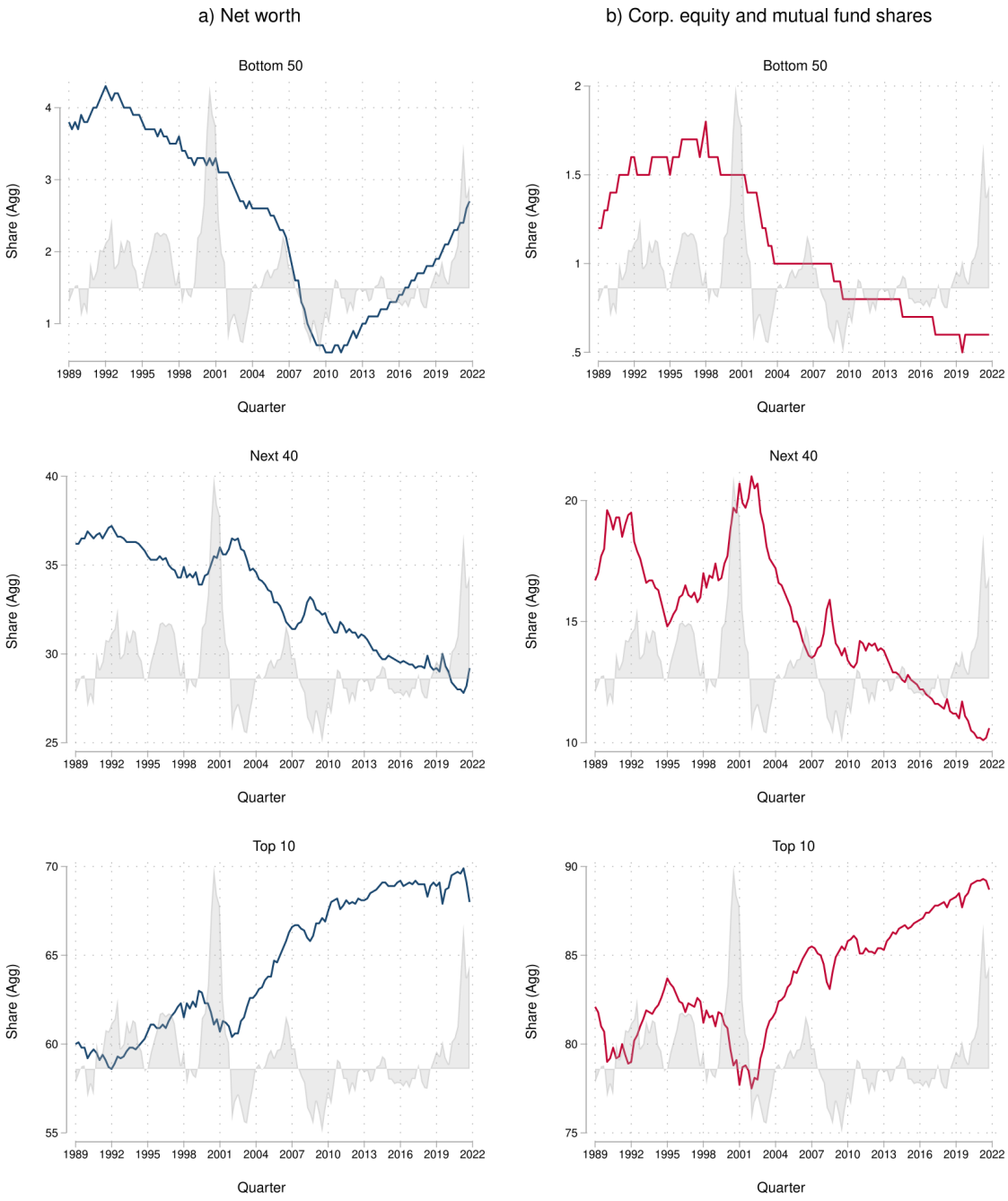
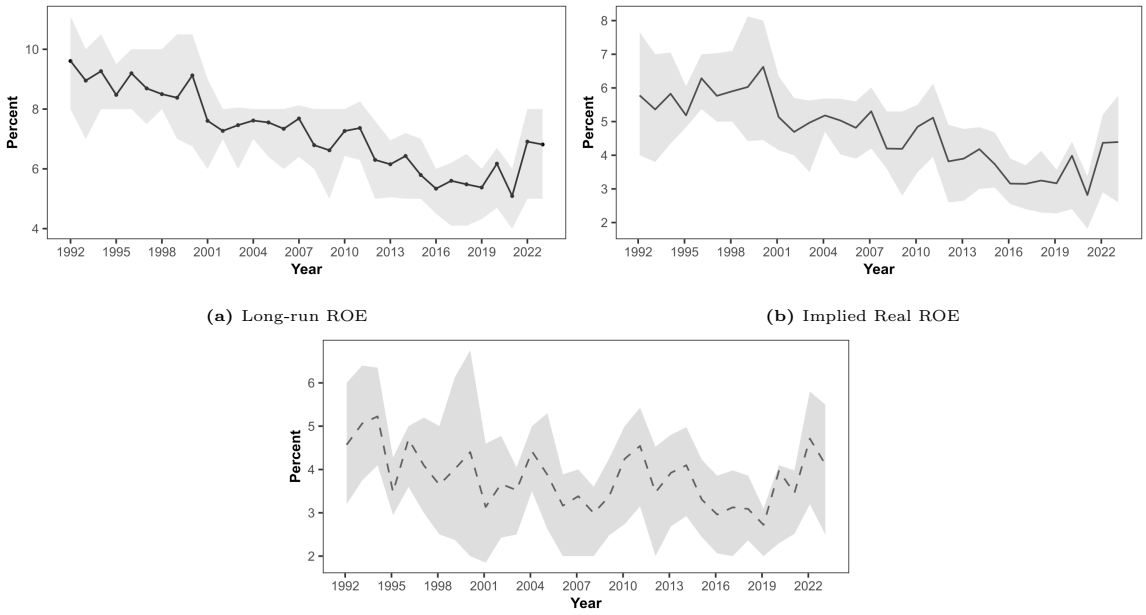


Figure 2: Wealth and Stock holdings (Share of aggregate volume). Fed's Distributional Finance Accounts.

may not be relevant to asset pricing, they are indicative of the market sentiment and trends that investors take into account for their portfolio choices.

A similar outlook is observed when we consider investors' responses from the UBS/Gallup survey. According to their self-reported attitude towards the performance of the stock



(a) Long-run ROE

(b) Implied Real ROE

(c) Implied Equity Premium

Figure 3: Evolution of long-run mean expectations, SPF Philadelphia Fed.

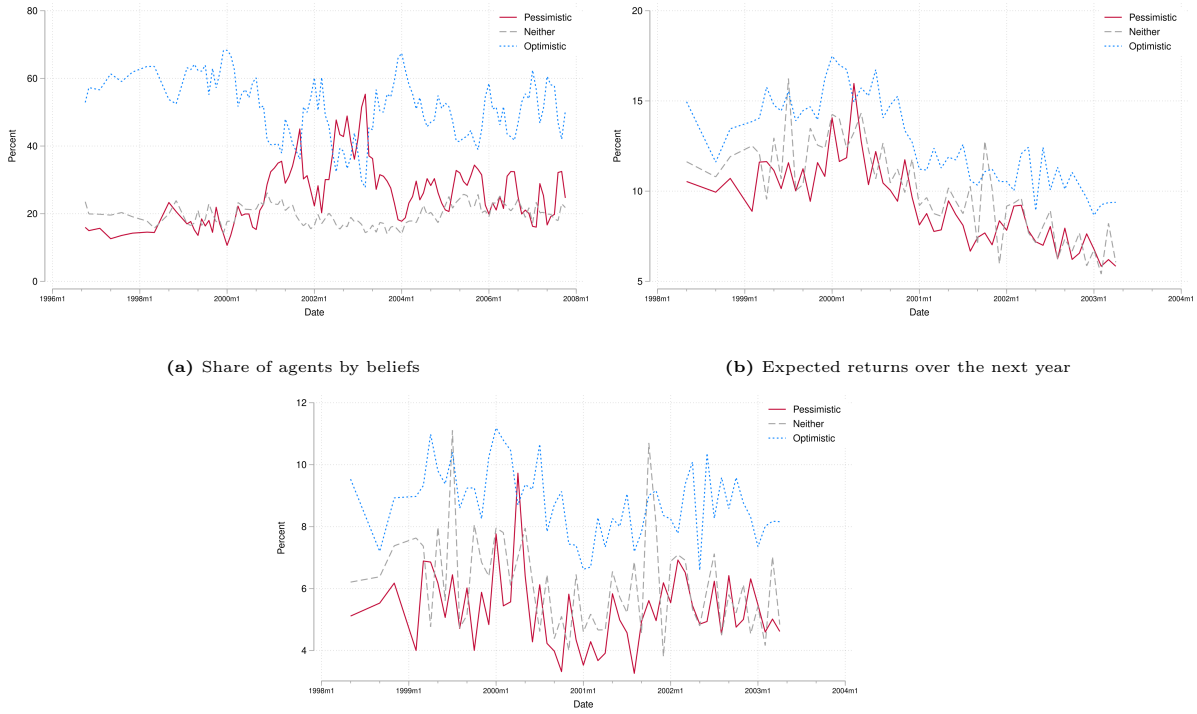
25-75th percentiles

market over the next year, the share of pessimistic agents[3] has experienced a small shift after the Dot-com bubble of 2000 and both the mean expected stock return and the equity premium reflect the self-reported attitude.

c Stock holdings, bequest motive, and beliefs

Is there an interaction between beliefs and the bequest motive? In the early 2000s, Poterba (2001) posited and tested the "asset market meltdown" hypothesis, which predicted a sharp decline in asset holding associated with the age structure due to baby boomers selling without finding strong evidence in its favor, and Abel 2001 taking up this point argued that the bequest motive influenced asset prices. An inspection of terminal portfolios shows that stocks constitute the highest share of decedents' portfolios and have consistently remained above 30% (panel a) Figure 5) and, while liquid and retirement assets are nearly depleted, the latter is consistent with the standard life cycle hypothesis. From the Survey of Consumer Finances, there is a high correlation between stock holdings and having received receiving an

[3]For presentation purposes, I collapse the categories "Very pessimistic" and "Pessimistic", and "Optimistic" and "Very optimistic" into one, respectively.



(a) Share of agents by beliefs

(b) Expected returns over the next year

(c) Equity Premium

Figure 4: Mean beliefs by type, UBS/Gallup Survey

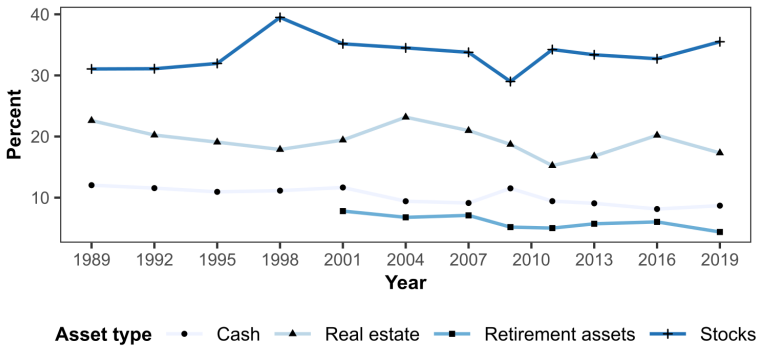
inheritance. In addition, optimism about economic performance is associated with the reported likelihood of bequeathing assets.[4] Although differential background risk (Gomes et al., 2021), the positive relationship between health and risky asset shares in retirement (Yogo, 2016), or strategic bequests to reward informal caregivers (Bernheim et al., 1985; French et al., 2023) explain these facts, terminal portfolios continue to highlight the importance of equity instruments in retirement.

IV Empirical analysis

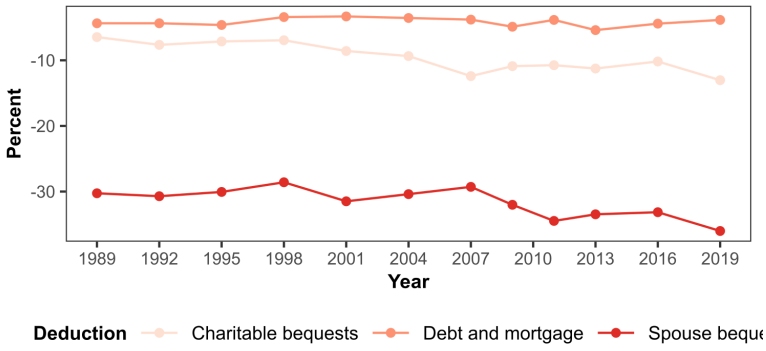
In this section, I set out to examine the empirical relationship between beliefs about the stock market and wealth distribution by studying the implications of an exogenous variation in beliefs. I use the "Central Bank Information" (CBI) structural shocks identified according to Jarociński and Karadi 2020, combining high-frequency identification [5]

[4]To add annex

[5]Based on a 30-min narrow window around the FOMC announcements and using changes in the three-month fed funds futures and in the S&P 500 index. This restriction is grounded on the fact that Jarociński and Karadi 2020 document: in some cases, interest rate and stock prices comove



(a) Gross Assets



(b) Deductions

Figure 5: Percent of gross assets, all decedents

First, I analyze investors' attitudes regarding their personal finances and the stock market performance in light of new information. Using responses from the UBS/Gallup data set within two days of the CBI shock, I run an ordered logit model for the ordinal responses:

$$Pr(Y_{jt} = i) = Pr\left(\kappa_{i-1} < \alpha D_{jt} \times CBI_t + \beta X_{jt} + \gamma Z_{jt} \times CBI_t + u_{jt} < \kappa_i\right) \qquad (1)$$

where Y_{jt} is the response of the investor j in time t, D_{jt} is an indicator variable of whether the respondent responded after the realization of the CBI shock CBI_t, X_{jt} is a set of control variables and Z_{jt} a subset of X_{jt} interacting with the shock. The coefficients α, β, γ and cutoffs κ_i are estimated using a Maximum Likelihood Estimator under the assumption that the error term u_{jt} is logit distributed. I report the odds ratio $P(Y \leq k)/P(Y > k)$. Under the null hypothesis, the odd ratio is equal regardless of whether the respondent has observed the CBI shock. Given data availability, this analysis is capturing the effect of changes occuring in the early 2000s.

positively, in opposition to the inverse relationship predicted by textbook economics.

Having explored the first stage of beliefs changes, we then examine the response of the aggregate wealth distribution using high-frequency data on the wealth distribution by Blanchet et al. (2022). To this end, and following the implementation of Adämmer (2019) with an externally identified shock I estimate the impulse response function using local projections (Jordà, 2005) of the wealth shares:

$$y_{t+h} = \alpha^h + \beta_h CBI_t + \gamma_h MP_t + u^h_{t+h} \tag{2}$$

Provided that investors revise their expectations after an exogenous information shock on the economic outlook and the stock market, the wealth distribution may respond if agents rebalance their portfolios and adjust their savings and consumption.

a Investor optimism and new information

Table 1 provides supporting evidence that investors' beliefs respond to exogenous information about the economic outlook. Recall that we use only survey responses the deUpon learning a positive Fed information shock, investors are more likely to report being more optimistic about the expected performance of the stock market over the next year. These results support the method used by Jarociński and Karadi (2020), in that the monetary policy shocks identified by the authors are orthogonal to the informational content of the central bank announcement and do not act through a belief channel.

Our results also suggest that active workers are more optimistic and that past portfolio returns are positively correlated with optimistic attitudes. To conclude, we also tested for statistically different responses to CBI shocks across wealth levels[6]. The p-value of these tests shows that for all specifications considered, the null hypothesis of equal responses is rejected. Appendix A presents the results of conditional regressions of the expected equity premium on CBI shocks and other regressors conditional on investors' attitudes. I find that information shocks about the economic outlook do not induce a revision of the expected premium and that, overall, active workers tend to expect higher equity premia. Together, these results suggest that the beliefs of investors respond differently throughout their life cycle and wealth levels.

[6]Since wealth is reported as an ordinal variable, I interact wealth and year to account for inflation.

Table 1: Ordered logistic regressions: Expected Performance of Stock Market

	(1)	(2)	(3)	(4)	(5)	(6)
CBI shock	1.031*	1.016*	1.568***	1.250***	1.259***	1.516***
	(2.49)	(2.44)	(12.90)	(4.77)	(4.87)	(7.30)
MP shock		0.997	0.994	0.995	0.997	0.997
		(-0.76)	(-1.09)	(-0.88)	(-0.57)	(-0.41)
Business env. index		0.588***	0.605***	0.602***	0.599***	0.652***
		(-8.16)	(-4.96)	(-4.71)	(-5.44)	(-3.99)
Retired = No			0.757***	0.748***	0.747***	0.745***
			(-4.64)	(-4.63)	(-4.65)	(-3.77)
Retired = Don't know / Refused			2.394	3.096	3.124	3.201
			(1.37)	(1.50)	(1.51)	(0.85)
(Retired = No)×CBI shock			0.970	0.968	0.968	0.959**
			(-1.39)	(-1.73)	(-1.73)	(-3.14)
(Retired = DK / Refused) × CBI shock			1.065	1.075	1.075	1.209
			(0.38)	(0.46)	(0.46)	(1.10)
Portfolio return (past 12m)						1.012***
						(4.92)
CBI shock × Portfolio return						1.000
						(-0.83)
Wealth x Shocks	No	No	Yes	Yes	Yes	Yes
Annual Income	No	No	No	Yes	Yes	Yes
Education	No	No	No	Yes	Yes	Yes
Year fixed effect	No	No	Yes	Yes	Yes	Yes
Macro var.	No	No	No	No	Yes	Yes
N	11744	11744	11744	10443	10443	6758
p-val: Post-shock x Savings x Year = 0			0	0	0	0

Exponentiated coefficients. CBI shock: Central Bank Information shock

b Wealth distribution and information shocks

To motivate the discussion, I examine whether exogenous information to households has any relevant distributional effect. The textbook valuation model predicts that a positive shock on the outlook on dividends raises stock prices. As shown in the previous section, information shocks affect investor attitudes and we now turn to the distributional effects.[7]. Appendix B shows the IRFs. I include the Business Investment and Sentiment Index to account for an external measure [8] which responds simultaneously to the shock. A positive information shock (as in Jarociński and Karadi 2020) results in a transitory medium-run redistribution (right panel Figure 6) which is qualitatively different from a monetary policy shock 7. The response of the top 50% is consistent with the documented fact that wealthier and better

[7]The macroeconomic effects have been studied in Jarociński and Karadi 2020, Nakamura and Steinsson 2018

[8]Equity Market Volatility Tracker: Macroeconomic News and Outlook: Business Investment And Sentiment from Baker et al. (2023)

educated households display lesser sluggish behavior (Campbell, 2006).
Costly observation and costly transaction have been posited to determine the state-dependency of portfolio adjustment Abel et al. (2013)

V Two-period OLG model

To better understand the role of belief changes about stock markets in shaping the wealth distribution, I analyze a simple two-period model with the basic ingredients, namely, i) the existence of a risk-free asset and a risky asset, ii) subjective beliefs, and iii) stochastic bequest motive. Introducing the portfolio problem allows for weaker restrictions on beliefs [9]. I assume dogmatic agents as well, that is, retirees preserve their beliefs. I also assume a fixed fraction of young workers ω_y.

The economy lasts for two periods, $t = 0, 1$. There are N_b types of otherwise agents with heterogeneous beliefs. Type i believes that (log) returns on the risky asset asset follow a normal distribution $\log(R_i^k) \sim \mathcal{N}(log(R^r) + \mu_i, \sigma_k)$. The mass of agents type i is ω_i with $\sum \omega_i = 1$ Agents of type i rank consumption stream according to

$$U_t^{i,t} = u(c_t^{i,t}) + \beta E^i\big(u(c_{t+1}^{i,t}) + \beta e(a_{t+2}^{i,t})\big) \tag{3}$$

where $e(a)$ denotes a warm-glow motive. In the initial period, wealth a_t is identical across agents. The maximization problem is given by

$$\max_{\substack{c_t^{i,t}, c_{t+1}^{i,t}, \\ k_{t+1}^{i,t}, b_{t+1}^{i,t}, k_{t+2}^{i,t}, b_{t+2}^{i,t}}} \quad u(c_t^{i,t}) + \beta E_t^i\big(u(c_{t+1}^{i,t}) + \beta e(a_{t+2}^{i,t})\big)$$

$$\text{s.t.} \quad c_t^{i,t} + k_{t+1}^{i,t} + b_{t+1}^{i,t} = a_t^{i,t}$$
$$a_{t+1}^{i,t} = R_t^s b_{t+1}^{i,t} + R_{t+1}^k k_{t+1}^{i,t} + y_{t+1}^{i,t}$$

With $u(c_t) = c_t^{1-\sigma}/(1-\sigma)$, and $e(a_t) = A(a_t)^{1-\mu}/(1-\mu)$ and a_t denotes total wealth after earnings, $y_t^{i,t}$ is the agent's earnings in period t: workers earn wages on their labor endowment w_t, and pensioners receive a pension payment which is equal to the product of the replacement rate $\bar{rr}$ and past wage w_{t-1}. Returns on risky assets are log-normal with $\log(R^k) \sim \mathcal{N}(log(R^r) + \mu_k, \sigma_k)$. For the non-stochastic equilibrium

[9] With a single asset, overly optimistic or pessimistic agents might not save

I consider, this process is relevant only in that agents acknowledge the uncertainty via their subjective beliefs.

General Equilibrium: A non-stochastic equilibrium is given by an interest rate R^s_{t+1} and wage w_t, allocations $\{c^{i,t}(a_t), b^{i,t}(a_t), k^{i,t}(a_t)\}$, government tax rate τ_l and transfers p^{t-1}_t, and a constant fraction of young agents ω_y

a) Given their subjective beliefs on aggregate risk, households optimize

b) Labor and capital earn the their marginal product.

c) Markets clear:

$$\text{Capital market:} \quad \sum_{i\in\{bel\}} \omega_y k^{t,i}_t + \sum_{j\in\{bel\}} (1-\omega_y) k^{t-1,j}_t = K_{t+1} \tag{4}$$

$$\text{Bond market:} \quad \sum_{i\in\{bel\}} \omega_y b^{t,i}_t + \sum_{j\in\{bel\}} (1-\omega_y) b^{t-1,j}_t = B_{t+1} \tag{5}$$

$$\text{Labor market:} \quad L_t = \omega_y \tag{6}$$

$$\text{Agg. const:} \quad \sum_{i\in\{bel\}} \omega_y c^{t,i}_t + \sum_{j\in\{bel\}} (1-\omega_y) c^{t-1,j}_t + K_{t+1} + G_t = AK^\alpha_t L_t \tag{7}$$

d) The government budget constraint balances every period:

$$G_t = R^s_t B_t - B_{t+1} + (1-\omega_y) p^{t-1}_t = \tau_l \omega_y w_t$$

e) Young agents' initial wealth is consistent with the bequeathed assets by the retirees of the previous generation.

In this setup, households believe that aggregate risk exists which leads to different consumption and saving decisions.

Calibration: The model period is set 30 years. I set the annual discount factor at $\beta_y = 1.06^{-1}$, so that the model-period discount factor is $\beta = \beta^n_y$. The risk aversion parameter is 2.0, a standard value in the literature. I set the risk-free interest annual rate at 6% which implies an Output-to-Capital ratio of 19 (30 years of output, annual output-to-capital 0.65). Risk premium: 2.08 (1% annual, $R^s_{t+1}\exp(0.01n) - R^s_{t+1}$). I collapse the distribution of beliefs into four types of agents with beliefs μ_{bi} such that the risk premium is given by $R^s_{t+1}\exp(\mu_{bi}n) - R^s_{t+1}$.

Table 2: Aggregate Moments of the Model

	Capital	Labor	Int. rate†	Wage	Output	Bonds	Labor tax	Bequest (%)‡
Base	0.0649	0.87	1.0600	1.0000	1.2428	0.0071	0.1134	0.56
Alt	0.0225	0.87	1.0924	0.6787	0.9049	0.0064	0.1914	0.55

Notes. TFP = 3.1121. † Annual gross interest rate. ‡ Aggregate bequests as percentage of Output

	Pre-2001	Post-2001	p	N
Bottom 25th	0.1111	0.1287	.9470	54
Mid 25th	4.3961	3.4181	0.0000	53
Upper-middle	8.2358	6.6700	0.0000	53
Top 75th	24.8441	22.7507	.03518	54

Notes. Pooled by percentile per month

Results

The base calibration suggests that heterogeneous subjective beliefs induce wealth inequality among otherwise identical agents. A pessimistic shift that emulates the 2001-2002 leads in a steep decline in capital and wages (Table 2) and subsequently a substantial increase in interest rates. While the market yield on US 30-yr treasury securities remained close to 5% between 2000 and 2007, the stabilization of the downward trend observed in the 1990s suggests that the pressure on interest rate fueled by beliefs as implied by this framework might have been in place.

Pessimistic retirees save the most as they underestimate the utility of bequeathing stocks. The saving rate and wealth share of overly optimistic workers (Type IV, Table 3)[10] are sensitive to beliefs and interest rate changes, while the pessimistic agents whose beliefs remain unchanged (Type I) are affected through price changes. The model predicts that with more pessimistic agents, capital becomes concentrated within these agents (Table 4). These predictions are consistent with the documented wealth and stock concentration associated with lower expected returns on equity, and the fact that wealthier respondents are more pessimistic Giglio et al. (2021). Provided there is a change in beliefs, these exercises suggest that waves of pessimism

[10]To examine non-linearities in extremes

Table 3: Model moments by agent type: Base and alternative

	Beliefs			Saving rate			Wealth share		
	Type	Eq. prem.†	Share	Workers	Retirees	Total	Workers	Retirees	Total
Base	I	0.001	0.25	7.552	10.811	7.936	21.266	4.413	25.68
	II	0.041	0.25	6.221	7.357	6.269	17.519	2.767	20.29
	III	0.075	0.25	4.525	5.019	4.457	12.741	1.682	14.42
	IV	0.211	0.25	13.808	1.301	12.242	38.884	0.728	39.61
Alt	I	0.001	0.25	6.739	8.078	7.282	31.898	8.542	40.44
	II	0.032	0.25	5.137	5.863	5.325	24.319	5.257	29.58
	III	0.066	0.25	3.525	3.883	3.518	16.686	2.854	19.54
	IV	0.195	0.25	2.094	0.895	1.88	9.915	0.529	10.44

† Equity premium (multiplicative)

Table 4: Capital (stock) holdings: Base and alternative

	Type	Beliefs			Stock holdings
Base	I	0.031	0.001	0.25	17.556
	II	1.22	0.041	0.25	22.503
	III	2.246	0.075	0.25	15.999
	IV	6.316	0.211	0.25	43.942
Alt	I	0.031	0.001	0.25	23.522
	II	0.947	0.032	0.25	37.977
	III	1.982	0.066	0.25	25.091
	IV	5.854	0.195	0.25	13.41

induce higher saving rates and non-negligible distributional effects. The intuition behind this mechanism is that optimists derive a higher expected utility of one unit of capital and optimally do not need to save as much as their pessimistic counterparts. Moreover, the asymmetric effect of belief changes can further exacerbate wealth inequality. The question of whether agents have the correct beliefs is absent from this discussion. For a calibrated model with an (multiplicative) premium of 0.015, approximately 60% of the time equity return exceeds the base rate of 6%, which implies that pessimistic agents tend to better more frequently.

VI Discussion and Future Research

This paper provides evidence that both short-run fluctuations and long-run changes in beliefs on stock returns have non-negligible effects on the wealth distribution. The empirical evidence and analysis presented in this study align with the perspective that subjective beliefs about stock returns are related to both the life cycle and wealth distribution. The rising trend in wealth inequality has been accompanied by concentrated stock holdings, and the final portfolios of decedents indicate that retirees exhaust their cash reserves while maintaining a consistent stock portfolio share, exceeding 30%. Explanations for stock market participation based on preferences do not account for short-term variations, and a declining equity risk premium is expected to reduce the likelihood of individuals investing in stocks. (Gomes et al., 2021).

In our simple counterfactual with a reduction in the expected risk premium, the model predicts a steep reduction in physical capital, production, bond supply, and aggregate bequest, driven by an overall reduction in saving rates. As the expected risk premium of the most optimistic agents falls, wealth is concentrated among relatively pessimistic agents.

More work on the belief formation process and the relationship between short-run fluctuations and long-run trends is warranted. Our model can be further extended to explore the link between beliefs and the optimality of beliefs Brunnermeier and Parker (2005) in a boundedly rational setting. Moreover, I leave for future research the study of the beliefs changes on entrepreneurship, and the extent to which this behavioral aspect may crowd out investment in human capital.

Appendix

A Ordered Logistic Regressions: Expected equity premium

Table 5: Implied expected equity premium: Pessimistic agents

	(1)	(2)	(3)	(4)	(5)	(6)
CBI shock	1.004	1.246	0.224	0.550	2.101	5.751
	(0.34)	(0.40)	(0.09)	(0.21)	(0.88)	(2.01)
$Year > 2000 = 1$	-0.403	-0.509	-0.644	-4.349	-4.775	1.973
	(-1.10)	(-1.02)	(-1.21)	(-1.38)	(-1.44)	(1.11)
MP shock	2.803*	2.751*	1.335	1.399	1.935	3.394**
	(2.52)	(2.42)	(1.18)	(1.20)	(1.70)	(2.94)
Business env. index		0.192	0.0338	0.0762	0.301	1.169**
		(0.40)	(0.07)	(0.15)	(0.58)	(2.83)
Retired			ref.	ref.	ref.	ref.
No			1.074**	1.910***	1.928***	1.255**
			(3.25)	(5.17)	(5.13)	(3.41)
Don't know / Refused			-1.284	-0.403	-0.303	-0.751
			(-1.26)	(-0.34)	(-0.27)	(-0.73)
Portfolio return (past 12m)						0.136*
						(2.36)
$Year > 2000 = 1 \times$ Portfolio return (past 12m)						-0.0655
						(-1.11)
Constant	5.536***	5.456***	5.908***	10.37***	11.97***	3.911**
	(17.02)	(16.07)	(9.60)	(3.74)	(4.01)	(2.72)
Wealth x Post-2000	No	No	Yes	Yes	Yes	Yes
Annual Income x Post-2000	No	No	No	Yes	Yes	Yes
Education	No	No	No	Yes	Yes	Yes
Macro var.	No	No	No	No	Yes	Yes
N	11766	11766	11686	11686	11686	8103

Table 6: Implied expected equity premium: Neither

	(1)	(2)	(3)	(4)	(5)	(6)
CBI shock	-3.888	-4.244	-5.257	-5.136	-3.609	-6.808
	(-1.01)	(-1.10)	(-1.41)	(-1.29)	(-0.94)	(-1.32)
$Year > 2000 = 1$	-0.698	-0.555	-0.801	-4.617	-4.677	-3.501
	(-1.78)	(-1.01)	(-0.85)	(-1.08)	(-1.08)	(-0.54)
PM shock	2.381	2.379	1.908	1.980	2.846	0.459
	(1.66)	(1.69)	(1.63)	(1.43)	(1.92)	(0.18)
Business env. index		-0.278	-0.302	-0.305	-0.501	-0.237
		(-0.46)	(-0.49)	(-0.48)	(-0.99)	(-0.35)
Retired						
No			1.442**	2.145***	2.144***	1.100*
			(2.95)	(4.42)	(4.46)	(2.37)
Don't know / Refused			2.049	3.276	3.324	3.787*
			(0.90)	(1.41)	(1.44)	(2.60)
Portfolio return (past 12m)						0.303***
						(4.55)
$Year > 2000 = 1 \times$ Portfolio return (past 12m)						-0.259**
						(-3.56)
Constant	6.430***	6.543***	6.356***	9.011*	9.754*	9.160
	(21.39)	(18.53)	(5.94)	(2.16)	(2.22)	(1.44)
Wealth x Post-2000	No	No	Yes	Yes	Yes	Yes
Annual Income x Post-2000	No	No	No	Yes	Yes	Yes
Education	No	No	No	Yes	Yes	Yes
Macro var.	No	No	No	No	Yes	Yes
N	8402	8402	8292	8292	8292	5135

Table 7: Implied expected equity premium: Optimistic

	(1) (1)	(2) (2)	(3) (3)	(4) (4)	(5) (5)	(6) (6)
CBI shock	-3.335	-4.144	-5.285	-4.557	-4.666	-4.720
	(-0.84)	(-1.09)	(-1.49)	(-1.25)	(-1.32)	(-1.63)
Year ¿2000=1	-1.056**	-0.664	0.921	0.273	0.388	3.706
	(-3.43)	(-1.41)	(1.78)	(0.14)	(0.20)	(1.39)
PM shock	0.236	0.383	-0.808	-0.148	-0.244	1.366
	(0.14)	(0.26)	(-0.51)	(-0.09)	(-0.14)	(0.92)
Business env. index		-0.763	-0.451	-0.354	-0.0778	1.276*
		(-1.34)	(-0.82)	(-0.63)	(-0.13)	(2.40)
Retired			ref.	ref.	ref.	ref.
No			1.975***	2.392***	2.396***	1.650***
			(7.57)	(7.94)	(7.98)	(6.21)
Don't know / Refused			-1.436	-1.322	-1.384	-0.398
			(-1.00)	(-0.93)	(-0.96)	(-0.27)
Portfolio return (past 12m)						0.381***
						(10.76)
$Year > 2000 = 1 \times$ Portfolio return (past 12m)						-0.254***
						(-6.91)
Wealth x Post-2000	No	No	Yes	Yes	Yes	Yes
Annual Income x Post-2000	No	No	No	Yes	Yes	Yes
Education	No	No	No	Yes	Yes	Yes
Macro var.	No	No	No	No	Yes	Yes
N	22411	22411	21819	21819	21819	12135

B Local projections

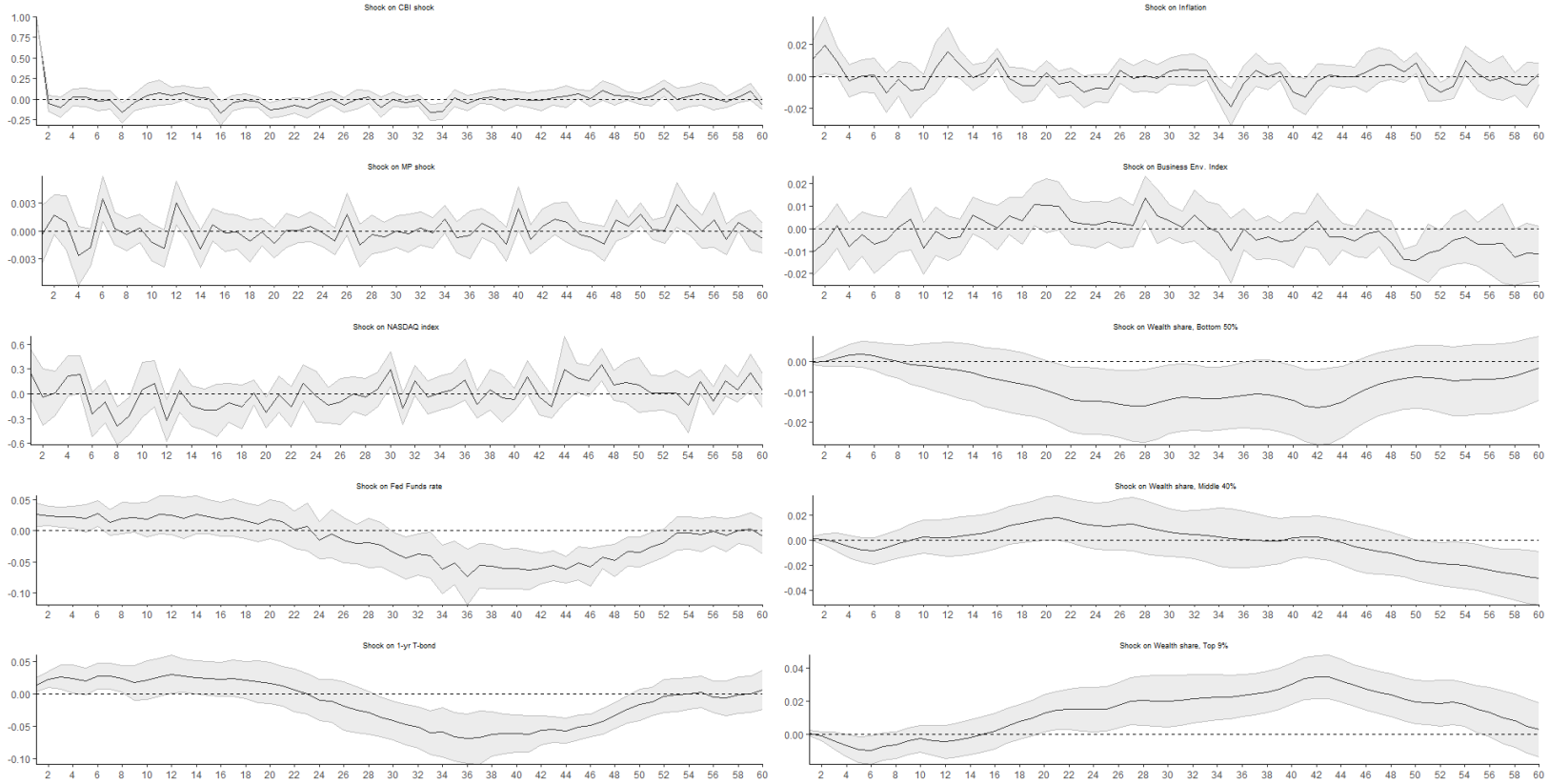


Figure 6: Central Bank Information shock

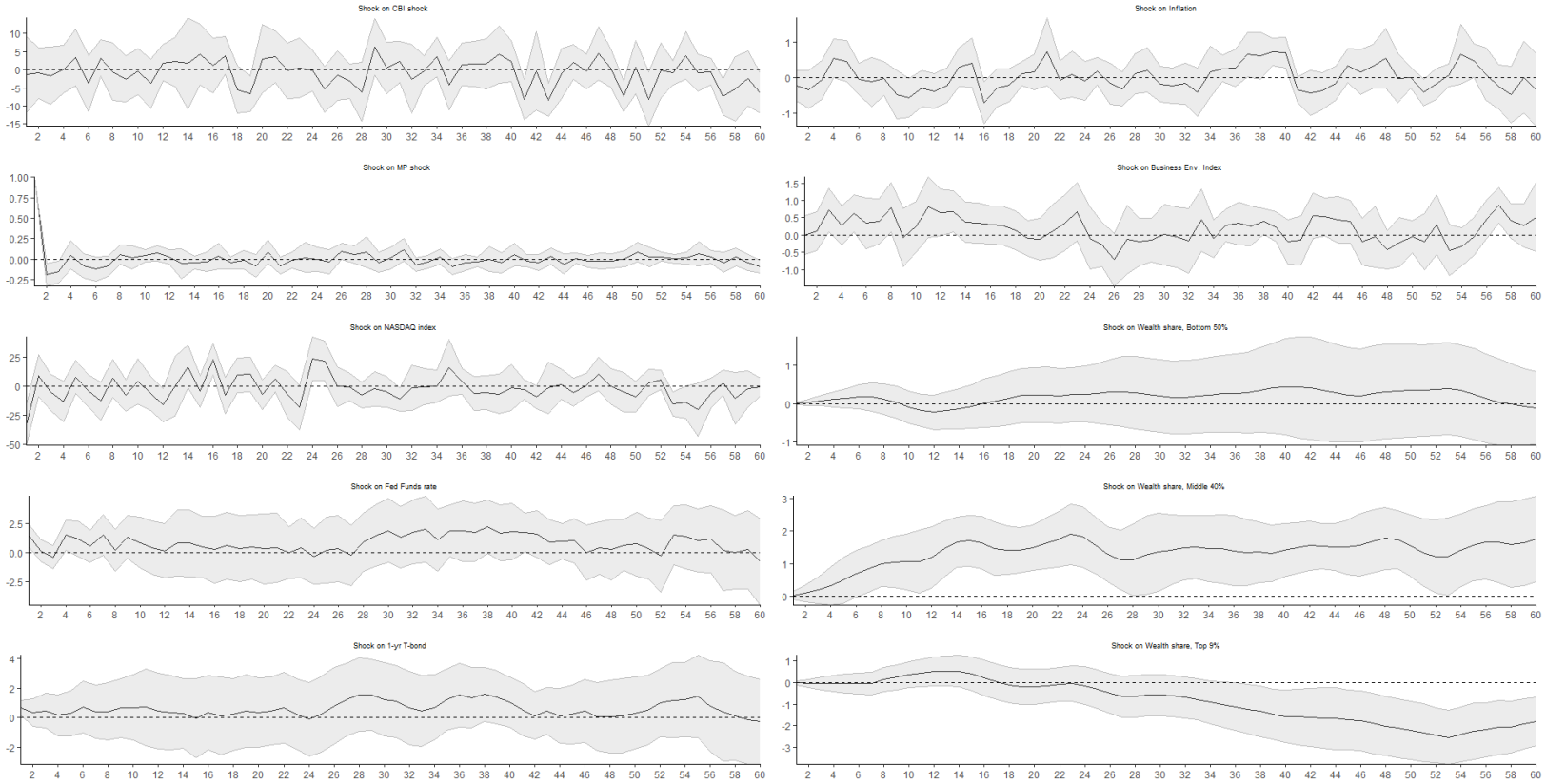


Figure 7: Monetary policy shock

C Logistic Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
	(1)	(2)	(3)	(4)	(5)	(6)
Post x CBI shock	1.029***	1.007	0.264***	0.276***	0.275***	1.133*
	(3.84)	(0.72)	(-39.71)	(-28.40)	(-27.35)	(2.20)
Year ¿2000	0.529***	0.546***	0.654***	1.507***	1.308*	0.859
	(-9.83)	(-13.02)	(-6.95)	(4.26)	(2.31)	(-0.19)
Post x PM shock		0.987*	0.986**	0.986**	0.985***	0.988**
		(-2.34)	(-2.71)	(-2.91)	(-4.59)	(-2.76)
Business env. index		0.653***	0.690**	0.709*	0.678***	0.741**
		(-4.84)	(-2.96)	(-2.50)	(-5.64)	(-3.06)
Retired			ref.	ref.	ref.	ref.
No			0.790***	0.733***	0.734***	0.775**
			(-4.29)	(-4.97)	(-4.97)	(-3.21)
Don't know / Refused			2.826	2.841	2.881	5.340
			(1.43)	(1.15)	(1.17)	(0.98)
Retired x Post-shock			ref.	ref.	ref.	ref.
No × Post x CBI shock			1.002	1.003	1.003	1.004
			(0.18)	(0.27)	(0.25)	(0.27)
Don't know / Refused × Post x CBI shock			1.192	1.181	1.178	1.371
			(1.05)	(0.95)	(0.93)	(1.89)
Portfolio return (past 12m)						1.020***
						(5.85)
Post x CBI shock × Portfolio return (past 12m)						1.000
						(-0.50)
Wealth x Shocks	No	No	Yes	Yes	Yes	Yes
Annual Income	No	No	No	Yes	Yes	Yes
Education	No	No	No	Yes	Yes	Yes
Year fixed effect	No	No	Yes	Yes	Yes	Yes
Macro var.	No	No	No	No	Yes	Yes
N	11744	11744	11744	10443	10443	6758
p-val: Post-shock x Savings x Year = 0			0	0	0	0

Exponentiated coefficients

Table 8: Investment Target - Next 12 months

	(1)	(2)	(3)	(4)	(5)	(6)
Post x CBI shock	1.006	0.993	0.340***	0.385***	0.384***	1.142**
	(0.82)	(-0.76)	(-36.61)	(-22.85)	(-22.52)	(3.11)
Year 2000	0.622***	0.610***	0.850	1.402***	1.305*	0.366
	(-7.14)	(-7.63)	(-1.29)	(4.66)	(2.35)	(-0.86)
Post x PM shock		0.988**	0.992	0.993	0.993	0.993
		(-3.15)	(-1.41)	(-1.26)	(-1.35)	(-0.91)
Business env. index		0.962	0.788***	0.843*	0.857*	0.815*
		(-0.49)	(-3.34)	(-2.38)	(-2.12)	(-2.39)
Retired			ref.	ref.	ref.	ref.
No			0.950	0.839*	0.840*	0.872
			(-0.86)	(-2.46)	(-2.45)	(-1.29)
Don't know / Refused			0.719	0.717	0.718	0.608
			(-0.62)	(-0.61)	(-0.61)	(-1.06)
Retired x Post-shock			ref.	ref.	ref.	ref.
No × Post x CBI shock			1.018	1.020	1.020	1.015
			(1.36)	(1.36)	(1.36)	(0.76)
Don't know / Refused × Post x CBI shock			1.203	1.201	1.199	1.244**
			(1.38)	(1.17)	(1.16)	(2.64)
Portfolio return (past 12m)						1.014***
						(6.97)
Post x CBI shock × Portfolio return (past 12m)						1.000
						(-0.75)
Wealth x Shocks	No	No	Yes	Yes	Yes	Yes
Annual Income	No	No	No	Yes	Yes	Yes
Education	No	No	No	Yes	Yes	Yes
Year fixed effect	No	No	Yes	Yes	Yes	Yes
Macro var.	No	No	No	No	Yes	Yes
N	11744	11744	11744	10443	10443	6758
p-val: Post-shock x Savings x Year = 0			0	0	0	0

Exponentiated coefficients

Table 9: Investment Target - Next 5 years

D Linear approximation of the bequest motive

For a model with certain life span, with $u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}$ and $e(a_t) = A\frac{a_t^{1-\mu}}{1-\mu}$ the FOC in the last period are given by

$$k_t^{i,t} \qquad \left(c_t^{i,t}\right)^{-\sigma} \geq A\beta E_t^i R_{t+1}^k \left(R_t^s b_{t+1}^{i,t} + R_{t+1}^k k_{t+1}^{i,t}\right)^{-\mu} \tag{8}$$

$$b_t^{i,t} \qquad \left(c_t^{i,t}\right)^{-\sigma} \geq A\beta R_t^s E_t^i \left(R_t^s b_{t+1}^{i,t} + R_{t+1}^k k_{t+1}^{i,t}\right)^{-\mu} \tag{9}$$

The policy functions can be written as $c_t^{i,t} = c^{i,t}(a_t)$, $b_{t+1}^{i,t} = b^{i,t}(a_t)$, and $k_{t+1}^{i,t} = k^{i,t}(a_t)$. Guess that $c^{i,t}(a_t) = \gamma_t a_t$, $k^{i,t}(a_t) = (1-\gamma_t)\kappa_t a_t$, and $b^{i,t}(a_t) = (1-\gamma_t)(1-\kappa_t)a_t$

Consider $f(x) = \exp(\log(x(\left(R_t^s(1-\kappa_t) + x\kappa_t\right)^{-\mu}))$. Then

$$f'(x) = f(x)\left(\frac{1}{x} - \frac{\mu\kappa_t}{R_t^s(1-\kappa_t) + x\kappa_t}\right)$$

$$\begin{aligned} f''(x) &= f(x)\left[\left(\frac{1}{x} - \frac{\mu\kappa_t}{R_t^s(1-\kappa_t) + x\kappa_t}\right)^2 + \frac{\mu\kappa_t^2}{(R_t^s(1-\kappa_t) + x\kappa_t)^2} - \frac{1}{x^2}\right] \\ &= f(x)\left[\frac{\mu}{R_t^s(1-\kappa_t) + x\kappa_t}\left(\frac{(1+\mu)\kappa_t^2}{R_t^s(1-\kappa_t) + x\kappa_t} - \frac{2\kappa_t}{x}\right)\right] \end{aligned} \tag{10}$$

Expanding around the expected return and taking expectations:

$$\begin{aligned} &E^i[R_{t+1}^k\left(R_t^s(1-\kappa_t) + R_{t+1}^k\kappa_t\right)^{-\mu}] \approx \\ &[\bar{R}_{t+1}^k\left(R_t^s(1-\kappa_t) + \bar{R}_{t+1}^k\kappa_t\right)^{-\mu}]\left[1 + \frac{Var^i(R^k)\mu}{2(R_t^s(1-\kappa_t) + \bar{R}_{t+1}^k\kappa_t)}\left(\frac{(1+\mu)\kappa_t^2}{R_t^s(1-\kappa_t) + \bar{R}_{t+1}^k\kappa_t} - \frac{2\kappa_t}{\bar{R}_{t+1}^k}\right)\right] \end{aligned} \tag{11}$$

Consider $f(x) = \exp(\log(\left(R_t^s(1-\kappa_t) + x\kappa_t\right)^{-\mu})$. Then

$$f'(x) = f(x)\frac{-\mu\kappa_t}{R_t^s(1-\kappa_t) + x\kappa_t}$$

$$f''(x) = f(x)\left(\frac{\mu\kappa_t^2}{(R_t^s(1-\kappa_t) + x\kappa_t)^2} + \left(\frac{-\mu\kappa_t}{R_t^s(1-\kappa_t) + x\kappa_t}\right)^2\right) \tag{12}$$

Expanding around the expected return and taking expectations:

$$E^i[\left(R^s_t(1-\kappa_t)+R^k_{t+1}\kappa_t\right)^{-\mu}] \approx$$

$$\left(R^s_t(1-\kappa_t)+\bar{R}^k_{t+1}\kappa_t\right)^{-\mu}\left[1+\frac{Var^i(R^k)\mu(1+\mu)\kappa^2}{2(R^s_t(1-\kappa_t)+\bar{R}^k_{t+1}\kappa_t)^2}\right] \quad (13)$$

Retirees bequeath stocks if

$$(\gamma_t a_t)^{-\sigma} = A\beta\{(1-\gamma_t)a_t\}^{-\mu}(\bar{R}^k_{t+1})^{1-\mu}\left[1-\frac{Var^i(R^k)\mu(1-\mu)}{2(\bar{R}^k_{t+1})^2}\right] \quad (14)$$

$$> A\beta\{(1-\gamma_t)a_t\}^{-\mu}R^s_{t+1}\left(\bar{R}^k_{t+1}\right)^{-\mu}\left[1+\frac{Var^i(R^k)\mu(1+\mu)}{2(\bar{R}^k_{t+1})^2}\right] \quad (15)$$

or

$$\bar{R}^k_{t+1}\left[1-\frac{Var^i(R^k)\mu(1-\mu)}{2(\bar{R}^k_{t+1})^2}\right] > R^s_{t+1}\left[1+\frac{Var^i(R^k)\mu(1+\mu)}{2(\bar{R}^k_{t+1})^2}\right] \quad (16)$$

$$\bar{R}^k_{t+1} > R^s_{t+1}\left[\frac{(\bar{R}^k_{t+1})^2+Var^i(R^k)\mu(1+\mu)}{(\bar{R}^k_{t+1})^2+Var^i(R^k)\mu(1-\mu)}\right] \quad (17)$$

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