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Countercyclical Income Risk and Portfolio Choices: Evidence from Sweden

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ABSTRACT

Using Swedish administrative panel data, we document that workers facing higher left-tail income risk when equity markets perform poorly have lower portfolio equity share. In line with theory, the relationship between cyclical skewness and stock holdings increases with the share of human capital in a worker's total wealth and vanishes as workers get closer to retirement. Cyclical skewness also predicts portfolio differences within pairs of identical twins. Our findings show that households hedge against correlated tail risks, an important mechanism in asset pricing and portfolio choice models.

HOW DOES FUTURE LABOR INCOME affect portfolios? One view is that human capital increases the demand for equity because labor income risk is largely uncorrelated with stock returns (Viceira (2001), Cocco, Gomes, and Maenhout (2005)). However, this prediction is at odds with the reluctance of young workers to buy stocks and makes it more difficult to explain the equity premium.

An alternative view is that, although uncorrelated with stock returns, labor income risk is countercyclical, in particular, its skewness fluctuates over the business cycle. Life-cycle models with countercyclical risk explain the level and cross section of stock holdings better (Storesletten, Telmer, and Yaron (2007), Lynch and Tan (2011), Catherine (2022)). Countercyclical income risk also helps asset pricing models match the level, volatility, and cross section of prices (Constantinides and Duffie (1996), Schmidt (2016),

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Constantinides and Ghosh (2017), Ebrahimian and Wachter (2020)). However, while the hypothesis that countercyclical risk explains key empirical puzzles in finance dates back to Mankiw (1986), there is no direct evidence that households facing higher income risk during recessions invest less in stocks.

We fill this gap in the literature by studying portfolios and earnings trajectories in administrative panel data from Sweden. We focus on the portfolio effects of cyclical skewness—tail income risk over the business cycle—for two reasons. First, in theory, equity shares decrease with workers' implicit exposure to stocks through their human capital. This exposure increases with the covariance between returns and human capital shocks, but also fluctuations in the variance and skewness of these shocks over the business cycle. Second, in earnings data, cyclical skewness is the most salient aspect of the business cycle (Guvenen, Ozkan, and Song (2014)), accounting for most of the market beta of human capital (Huggett and Kaplan (2016)).

We document that workers facing higher cyclical skewness have a lower equity share. This effect is driven nearly equally by households' choices not to participate in the stock market and to reduce their allocation to stocks when they do. In our sample, which covers all workers between 20 and 64 years old, a two-standard-deviation increase in cyclical skewness is associated with a 2 to 8 percentage points (pp) decline in equity shares, or an 8% to 29% drop relative to the sample average. We find that the portfolio effect of cyclical skewness is larger for workers in the middle of their careers and for those with low financial wealth. The economic significance of our findings reflects the importance of human capital, which represents 82% of the total wealth of the average worker in our sample.

Is the negative relationship between cyclical skewness and stock holdings evidence of hedging? We explore this interpretation of our findings in two ways. First, following Calvet and Sodini's (2014) empirical strategy, we study portfolio differences within pairs of identical twins to address the concern that stock holdings and occupations are jointly determined by latent variables such as risk preference, general intelligence, upbringing, and expected inheritance. We find that the slope of the relationship between cyclical skewness and equity shares is quantitatively similar within twin-year pairs and across the entire working population.

Second, we test whether this interpretation is consistent with theory. Theory predicts the hedging demand for equity to be an increasing function of the human capital share of wealth. As predicted, in the data, the negative relationship between cyclical skewness and equity shares increases in the human capital-to-wealth ratio with an intercept of zero. The moderating effect of the human capital share supports the interpretation of our findings as evidence of hedging. Indeed, an omitted variable could explain our results only if its effect on equity shares were moderated by the human capital share. In particular, workers whose human capital-to-wealth ratio approaches zero constitute a theoretical placebo group as theory predicts that cyclical skewness should not affect their portfolio. Similarly, theory predicts that the relationship between cyclical skewness and equity shares converges to zero as workers approach retirement. These two predictions are verified in the data.

Theoretically, the human capital share plays a moderating role because it determines the permanent income elasticity of consumption. It captures how human capital returns translate into changes in lifetime consumption. We build on this insight to construct measures of labor-market-implied consumption risk. To do so, we compute moments of the permanent income shock distribution by filtering out transitory shocks. We then adjust these moments to account for the diversification effect of nonhuman wealth. The resulting labor-market-implied consumption risk moments present two advantages. First, strongly guided by theory, they offer an additional challenge to the economic interpretation of our findings. Second, they provide an additional source of variation, as workers with the same education and industry of employment have different labor-market-implied consumption risk depending on whether their human capital risk is diversified by other sources of wealth. Our findings become more significant when cyclical skewness is measured in terms of implied consumption risk and are robust to controlling for both education and industry fixed effects.

Our methodology is as follows. We begin by constructing measures of countercyclical risk for 321 groups of workers sorted by industry of employment and education level. For each of these groups, and for each year from 1983 to 2014, we compute the cross-sectional mean, variance, and skewness of yearly changes in nonfinancial log disposable income. We then regress the time series of these three moments on stock market returns for each group. The coefficients of these regressions measure countercyclical risk (i.e., the level of covariance, countercyclical variance, and cyclical skewness risk for each group). For example, a positive relationship between returns and skewness would indicate that workers face higher left-tail income risk when the stock market performs poorly. These measures indicate the extent to which they can hedge against increases in human capital risk by short-selling the market portfolio.

In a second step, we attribute these measures of risk to workers based on their education level and current industry of employment. We then regress the share of their financial wealth invested in equity on these measures of risk. We find that cyclical skewness is the only measure of countercyclical risk that predicts equity holdings in univariate regressions. Most traditional control variables do not reduce our point estimate. One exception is education: our results remain statistically and economically significant when we introduce education fixed effects, but our point estimates get smaller. This is expected, as more educated workers face less cyclical skewness and invest more in stocks. In fact, using a calibrated life-cycle model, Alan (2012) shows that higher exposure to tail income risk in severe recessions significantly reduces the optimal equity share of less educated workers. Importantly, our measure of cyclical skewness is based on only four recessions. As a result, our estimates of the relationship between stock holdings and cyclical skewness are likely biased toward zero due to measurement error. This bias is expected to be stronger when we control for a good proxy of exposure to tail income risk such as education.

What are the implications of our findings for quantitative models? Because its effect declines with the human capital share, cyclical skewness helps explain why the equity share is not strongly decreasing with age as many life-cycle models predict. Regarding asset prices, our main finding is consistent with the intuition of models in which time-varying tail risk reduces investor's demand for equity. However, we find no relationship between cyclical skewness and equity shares in the top three deciles of the financial wealth distribution. Given the concentration of financial wealth, countercyclical labor income risk is not likely to have a large effect on the aggregate demand for equity and asset prices. This finding does not necessarily reject the core rationale of these asset pricing models; rather, it suggests that researchers need to focus on other sources of countercyclical risk. For example, wealthy entrepreneurs are reluctant to invest in the stock market because they own undiversified stakes in a single private business (Heaton and Lucas (2000)). Recent work shows that, just as workers, businesses face substantial left-tail risk during recessions (Salgado, Guvenen, and Bloom (2019)), with implications for the valuation of public equity (Elenev and Landvoigt (2023)).

Contribution to the literature. Our paper bridges a gap between two branches of the portfolio choice literature. The first strand of papers tries to rationalize the cross section of stock holdings using calibrated portfolio choice models. An important takeaway of this literature is that earnings risk primarily reduces equity shares when it is not independently distributed from stock returns, an intuition that extends to asset prices (Krueger and Lustig (2010)). In particular, optimal equity shares are reduced by the covariance of income growth with returns (Viceira (2001), Cocco, Gomes, and Maenhout (2005), Benzoni, Collin-Dufresne, and Goldstein (2007)) and countercyclical income risk (Storesletten, Telmer, and Yaron (2007), Lynch and Tan (2011), Catherine (2022)).

We seek to connect this literature to reduced-form studies documenting relationships between measures of income risk and equity holdings. Several of these papers focus on variance (Guiso, Jappelli, and Terlizzese (1996), Betermier et al. (2012), Fagereng, Guiso, and Pistaferri (2018), Chang et al. (2022), d'Astous and Shore (2024)). Studies considering the role of statistical dependence focus on the covariance between income shocks and stock market returns and find no evidence of hedging (Vissing-Jorgensen (2002), Massa and Simonov (2006), Calvet and Sodini (2014)), Bonaparte, Korniotis, and Kumar (2014) being the notable exception.

This second strand of papers is somewhat disconnected from quantitative models in which the covariance between income shocks and returns does not play a key role. Theory predicts that covariance reduces the optimal equity share, but the covariance observed in the data is close to zero (Cocco, Gomes, and Maenhout (2005)) and is therefore unlikely to have first-order effects. By contrast, the high cyclicality of skewness in income risk has been documented in administrative data from the United States (Guvenen, Ozkan, and Song (2014)), Germany, Sweden, France (Busch et al. (2022)), Canada (Bowlus et al. (2022)), and Spain (Bonhomme et al. (2022)). Huggett and Kaplan (2016) estimate that countercyclical risk explains two-thirds of the market beta of human capital. Our contribution to the reduced-form literature therefore is to study a measure of income risk that is a salient feature of the data and quantitatively matters in portfolio choice models.

Our paper also relates to recent studies arguing that cyclical skewness in labor income risk can explain the equity premium (Schmidt (2016), Constantinides and Ghosh (2017)). Our findings suggest that cyclical skewness is unlikely to have large asset pricing implications. Indeed, the magnitude of our results is much smaller for households close to retirement, and we find no correlation between cyclical skewness and equity shares in the highest deciles of financial wealth. Importantly, our study focuses on labor income, but many rich households hold most of their wealth in a single private business whose fate is also exposed to cyclical skewness (Salgado, Guvenen, and Bloom (2019)).

A closely related strand of literature explains asset pricing puzzles by assuming rare macroeconomic disasters that cause large consumption drops across the entire population (Rietz (1988), Barro (2006), Barro and Ursúa (2012), Gabaix (2012), Gourio (2012), Martin (2012), Nakamura et al. (2013), Wachter (2013)). Rare disaster models also rely on the coincidence of consumption disasters and stock market crashes to reduce investors' demand for equity. These models provide no testable cross-sectional predictions in our setting. Sweden did not experience any disaster over our sample period, so we cannot measure individuals' exposure to these events. Nevertheless, our findings support a key mechanism of these models: households hedge against correlated tail risks.

Finally, our study contributes to the literature on the role that heterogenous returns play in the dynamics of wealth inequality (Benhabib, Bisin, and Luo (2019), Bach, Calvet, and Sodini (2020), Fagereng et al. (2021), Hubmer, Krusell, and Smith (2021), Catherine et al. (2022)). Countercyclical income risk disproportionately reduces stock holdings at the bottom of the wealth distribution, thus increasing differences in expected returns between rich and poor.

The paper is organized as follows. Section I presents our theoretical framework and empirical hypothesis. Section II introduces our data. Section III analyzes the relationship between income risk and equity investment at the group and individual levels. Section IV discusses the theory behind consumption risk and equity investment. Section V evaluates the implications of our findings for quantitative models of portfolio choice. Finally, Section VI concludes.

I. Theoretical Framework

In this section, we introduce three measures of human capital exposure to stock market returns: covariance risk, countercyclical variance risk, and cyclical skewness risk. We then discuss why workers exposed to these risks should invest less in the stock market.

A. Income Process

We assume that the log disposable labor income y of worker i is the sum of three components,

$$y_{it} = f(a_{it}, g_{it}) + z_{it} + \xi_{it}, \tag{1}$$

where z is a permanent component, ξ are transitory shocks that fully mean-revert within a year, and f is a deterministic function of the agent's age a and group g. We think of these groups as workers with the same level of education and industry of employment. The permanent component follows a random walk with innovation η:

$$z_{it} = z_{it-1} + \eta_{it}. \tag{2}$$

We do not assume a specific distribution for ξ or η. However, we do assume that, in any given year, workers of the same group draw independent shocks ξ and η from identical distributions. For each group, the moments of ξ and η vary over time. Such variation over time can be correlated with stock market returns. We denote the unexpected shock to disposable income by ε, which is the sum of the permanent shock η and transitory shock ξ:

$$\varepsilon_{it} = \eta_{it} + \xi_{it}. \tag{3}$$

B. Moments of the Income Shock Distribution

For each year and each group of workers, we define the mean, variance, and skewness of income shocks as

$$\text{Mean}(\varepsilon)_{gt} = \mu_{1,gt}(\varepsilon) = \frac{1}{N_{gt}} \sum_{i \in g} \varepsilon_{it}, \tag{4}$$

$$\text{Var}(\varepsilon)_{gt} = \mu_{2,gt}(\varepsilon) = \frac{1}{N_{gt}} \sum_{i \in g} \left(\varepsilon_{it} - \mu_{1,gt}(\varepsilon)\right)^2, \tag{5}$$

$$\text{Skew}(\varepsilon)_{gt} = \mu_{3,gt}(\varepsilon) = \frac{1}{N_{gt}} \sum_{i \in g} \left(\varepsilon_{it} - \mu_{1,gt}(\varepsilon)\right)^3, \tag{6}$$

where N_{gt} is the number of workers in group g in year t. We do not standardize the third moment because standardized skewness is not a meaningful measure of risk in and of itself: a large negative standardized skewness is not worrisome if variance is small.

Theoretically, these moments should covary with macroeconomic conditions and in turn stock returns. For example, negative macroeconomic news might be associated with lower earnings growth for an entire group, higher volatility of individual earnings in that group, or higher left-tail risk. The same macroeconomic news would lead to changes in the prices of assets. To capture the correlations between moments of the income shock distributions and stock market returns, we construct three additional measures: covariance, countercyclical variance, and cyclical skewness risks. We define these comoments as follows:

$$\text{Covariance risk}(\varepsilon)_g = \frac{\text{Cov}(\mu_{1,g}(\varepsilon), r_s)}{\text{Var}(r_s)}, \tag{7}$$

$$\text{Countercyclical Variance risk}(\varepsilon)_g = -\frac{\text{Cov}(\mu_{2,g}(\varepsilon), r_s)}{\text{Var}(r_s)}, \tag{8}$$

$$\text{Cyclical Skewness risk}(\varepsilon)_g = \frac{\text{Cov}(\mu_{3,g}(\varepsilon), r_s)}{\text{Var}(r_s)}, \tag{9}$$

where r_s denotes stock market returns. Covariance risk captures the relationship between stock returns and income shocks. Variance is countercyclical if it increases when the stock market underperforms. Finally, skewness is cyclical if left-tail income risk is higher when market returns are low.

C. Relation to Portfolio Choices

Campbell and Viceira (2002) provide a useful formula to assess how these moments affect portfolio choices. Specifically, the optimal share of wealth invested in the stock market portfolio by an agent with constant relative risk aversion (CRRA) is

$$\pi = \frac{\mu - r}{\gamma \sigma_s^2} + \left(\frac{\mu - r}{\gamma \sigma_s^2} - \beta_H\right)\frac{H}{W}, \tag{10}$$

$$\beta_H = \frac{\text{Cov}(r_{\text{H}}, r_s)}{\sigma_s^2}, \tag{11}$$

where W is financial wealth, H the certainty equivalent of future earnings, that is, the value each worker places on the claim to labor income given optimal behavior, $\text{Cov}(r_{\text{H}}, r_s)$ the covariance between stock market and human capital returns r_H, β_H the market beta of human capital, γ the coefficient of relative risk aversion, $\mu - r$ the equity premium, and σ_s^2 the variance of stock market returns. In dollar terms, equation (10) becomes:

$$\pi W = \frac{\mu - r}{\gamma \sigma_s^2} W + \frac{\mu - r}{\gamma \sigma_s^2} H - \beta_H H. \tag{12}$$

Optimal equity share without income risk. The first term of equation (12) is the optimal equity investment in Merton's (1969) portfolio problem when the agent's only endowment is financial wealth W. The second term represents the effect of riskless human capital. As Merton (1971) explains, the agent's optimal stock holding is a share $\frac{\mu - r}{\gamma \sigma_s^2}$ of his total wealth $W + H$, inclusive of human capital.

Income risk. Labor income risk has two consequences. First, risk reduces the certainty-equivalent value of human capital H. Second, the optimal risky share must be adjusted to offset the implicit share of stocks in the replicating portfolio of human capital. This share is measured by β_H, the slope of the regression of human capital returns onto stock returns. Hence, the third term of equation (12) represents how many dollars of "stocks" are embedded in human capital. If a 10% return on the stock market portfolio translates into a 1%

increase in the value of human capital ($\beta_H = 0.1$), then each dollar of human capital already incorporates 10 cents of the stock market portfolio. As they are substitutes, dollars of stocks embedded in human capital reduce investment in stocks by the same amount. Essentially, the portfolio rule of Merton (1969) applies to the overall exposure of wealth to stock market returns, such that $\frac{\pi W + \beta_H H}{W+H} = \frac{\mu - r}{\gamma \sigma_s^2}$.

Measuring correlated risk. We cannot directly measure β_H in the data because returns on human capital are not observed. Indeed, the return on human capital is

$$r_{H,it} = \frac{H_{it+1} - H_{it} + Y_{it}}{H_{it}}, \tag{13}$$

which cannot easily be computed, as H_{it} is not directly observable either.

To understand how comoments contribute to β_H, consider, for simplicity, an agent that is fully invested in the risk-free asset. We define $H_{t-1,it}$ as the certainty equivalent of H_{it} in period $t-1$. In $t-1$, the agent is indifferent between either the certainty of receiving the deterministic value $H_{t-1,it}$ at time t or the realization of the random variable H_{it}. In the Internet Appendix, we show that for an agent with CRRA,

$$H_{t-1,it} \approx \bar{H}_{it} - \frac{\gamma}{2}\frac{\mathrm{Var}_{t-1}(H_{it})}{W_{it} + \bar{H}_{it}} + \frac{\gamma(\gamma+1)}{6}\frac{\mathrm{Skew}_{t-1}(H_{it})}{\left(W_{it} + \bar{H}_{it}\right)^2}, \tag{14}$$

where $\overline{H}_{it} = \mathbb{E}_{t-1}\left[H_{it}\right]$.[1] Equation (14) shows that uncertainty reduces workers' valuation of their human capital. Workers discount future earnings more if the distribution of H_{it} has greater variance or lower (positive) skewness. The risk premia associated with these moments increases with relative risk aversion and decreases with financial wealth, which acts as a source of diversification.

Now assume that some macroeconomic news affects both the distribution of future firm profits and the moments of the distribution of H_{it}. This news should be immediately reflected in stock prices and workers' valuation of their future income. Taking first differences, the change in the certainty equivalent of human capital is

$$\Delta H_{t-1,it} \approx \Delta \bar{H}_{it} - \frac{\gamma}{2} \cdot \Delta \frac{\mathrm{Var}_{t-1}(H_{it})}{W_t + \bar{H}_{it}} + \frac{\gamma(\gamma+1)}{6} \cdot \Delta \frac{\mathrm{Skew}_{t-1}(H_{it})}{\left(W_t + \bar{H}_t\right)^2}, \tag{15}$$

and the immediate return is

$$\frac{\Delta H_{t-1,it}}{H_{t-1,it}} \approx \frac{\Delta \bar{H}_{it}}{H_{t-1,it}} - \frac{\gamma}{2} \cdot \Delta \mathrm{Var}_{t-1}(\varepsilon_t) \cdot \omega_{H,it} + \frac{\gamma(\gamma+1)}{6} \cdot \Delta \mathrm{Skew}_{t-1}(\varepsilon_t) \cdot \omega_{H,it}^2, \tag{16}$$

where $\omega_{H,it} = \frac{\overline{H}_{it}}{W_{it} + \overline{H}_{it}}$ is the share of human capital in the agent's total wealth and $\epsilon_t = \frac{H_t}{\overline{H}_t}$. Dropping indices for simplicity, it follows that the market beta of

[1] The Internet Appendix may be found in the online version of this article.

human capital is

$$\beta_H = \frac{\text{Cov}\left(\frac{\Delta \bar{H}}{H}, r_s\right)}{\sigma_s^2} - \frac{\gamma}{2}\omega_H \frac{\text{Cov}\left(\Delta\text{Var}(\varepsilon), r_s\right)}{\sigma_s^2} + \frac{\gamma(\gamma+1)}{6}{\omega_H}^2 \frac{\text{Cov}\left(\Delta\text{Skew}(\varepsilon), r_s\right)}{\sigma_s^2}. \tag{17}$$

If the variance and skewness of labor income shocks are time-invariant, the market beta of human capital depends only on the relationship between the growth rate of H and stock market returns $\text{Cov}(\frac{\Delta \bar{H}}{H}, r_s)$. Otherwise, the market beta of human capital also reflects the covariance between market returns and changes in the risk premium that workers apply to their human capital. Importantly, the last two terms make β_H depend on the coefficient of relative risk aversion γ and the human capital share ω_H. As a consequence, with countercyclical risk, the hedging demand for stocks $-\beta_H H$ depends on risk aversion and whether human capital risk is diversified by other sources of wealth. At the limits, a worker with risk-neutral preference ($\gamma = 0$) or whose human capital risk is fully diversified ($\omega_H = 0$) should not care about idiosyncratic income risk. This is not the case for the traditional covariance term.

Note that, in the data, we cannot observe H, and therefore we also cannot see ϵ. Hence, we empirically approximate comoments using equations (7) to (9).

D. Predictions

The previous section shows that the beta of human capital depends on the covariance between stock market returns and changes in the moments of the distribution of human capital shocks. Moreover, standard portfolio theory predicts that the demand for stocks should be reduced by the product of the market beta and value of human capital, as illustrated by the last term of equation (12). We rely on these two arguments to guide our empirical analysis with two predictions.

- PREDICTION 1: *Higher covariance, countercyclical variance, and cyclical skewness risks reduce equity shares.*
- PREDICTION 2: *The portfolio effect of countercyclical risk increases in the share of human capital in total wealth. Consequently, it also decreases over the life cycle.*

Portfolio effects of unconditional moments. By contrast, there is no clear theoretical prediction regarding the effect of unconditional variance and skewness. Indeed, equation (10) shows that the hedging demand for stock is the product of the value of human capital H and $\frac{\mu - r}{\gamma\sigma_s^2} - \beta_H$, which determines the portfolio substitution effect per dollar of H. If $\frac{\mu - r}{\gamma\sigma_s^2} > \beta_H$, then H is insufficiently exposed to stocks given the agent's overall target $\frac{\mu - r}{\gamma\sigma_s^2}$ and H is a substitute for bonds, increasing the optimal allocation of financial wealth to stocks. The reverse is true if $\frac{\mu - r}{\gamma\sigma_s^2} < \beta_H$. Equation (14) shows that unconditional variance and (left) skewness unambiguously reduce H as long as workers are not risk-neutral or fully diversified. However, the effect on π is ambiguous because it depends on the sign of $\frac{\mu-r}{\gamma\sigma_s^2} - \beta_H$, which itself depends on risk aversion and the market beta of human capital β_H.

The life-cycle literature offers examples of both types of effects. Cocco, Gomes, and Maenhout (2005) provide an example in which human capital has a market beta of zero and in which higher idiosyncratic volatility reduces the optimal equity share. By contrast, in Benzoni, Collin-Dufresne, and Goldstein (2007), because cointegration between the stock and labor markets implies a larger beta for human capital, the optimal equity share increases with unconditional volatility.[2] For similar reasons, optimal equity shares can also increase with unconditional volatility in the presence of countercyclical risk (Catherine (2022)).

II. Data

A. Swedish Wealth and Income Registry

The Swedish Wealth and Income Registry is an administrative panel of households. Because Swedes paid taxes on wealth until 2007, the national Statistics Central Bureau had a parliamentary mandate to collect highly detailed information on every resident's income and wealth. We observe households' balance sheet from 1999 to 2007 and income data from 1982 to 2015.

Demographic information includes age, gender, nationality, retirement status, student status, entrepreneurship status, and education level. For labor income, the database reports gross labor income, business sector, unemployment benefits, and pensions. The disaggregated wealth data contain the assets owned worldwide by each resident on December 31, including bank accounts, mutual funds, and holdings of stocks, bonds, derivatives, real estate, and debts.

This comprehensive data set offers significant advantages for our study. The first advantage is the ability to observe labor income trajectories for millions of workers over several decades, which allows us to compute the cross-sectional skewness of income shocks for many subgroups of the population. The size of our data set is a critical advantage because higher moments can be highly sensitive to outliers. Similar data sets such as the U.S. Social Security Master Earnings File (MEF) exist in other countries but, in general, do not include important demographic variables such as education and are restricted to wage income. Our ability to observe government transfers allows us to take into ac-

[2] Their figure 9 shows that a higher variance of permanent idiosyncratic shocks increases the demand for equity for workers below age 50. In their model, cointegration between the labor and stock markets makes human capital stock-like for workers who are more than a decade away from retirement. For them, $\beta_H > \frac{\mu-r}{\gamma\sigma_s^2}$, and therefore higher volatility reduces the optimal equity share by reducing H. Older workers have shorter horizons on the labor market and are not that exposed to cointegration. For them, $\beta_H < \frac{\mu-r}{\gamma\sigma_s^2}$ and a reduction of H caused by higher idiosyncratic variance reduces their equity share. As Panel B of their figure 5 illustrates, the correlation between stock returns and returns to human capital drops rapidly after age 50.

count the social safety net when measuring income tail risk. More importantly, other administrative panel data such as the MEF are not matched with portfolio data. The Swedish portfolio data are also significantly better than surveys used in other studies. For example, the U.S. Survey of Consumer Finances does not provide detailed holdings on each asset, and many nonresponses are imputed. In contrast, the detailed information on individual asset holdings, including stocks and funds, enables us to precisely compute equity shares in individual portfolios.

We restrict our analysis sample in several ways. We first exclude students and retirees, as they are presumably not exposed to income risk, and we remove individuals for which industry of employment or education is missing. We also remove observations for which annual disposable income is below 1,000 kr, drop the top 0.01% of earners, and only retain workers between 20 and 64 years old.[3] Finally, we drop the first and last years of each uninterrupted working span of each individual.

B. Portfolios and Returns

Returns. The risk-free rate is represented by the monthly average yield on the one-month Swedish Treasury bill. We use the All Country World Index (henceforth "world index") compiled by Morgan Stanley Capital International (MSCI) expressed in Swedish Kronor as our proxy for the stock market portfolio. As Sweden is a small and open economy, many funds specialize in investing in the global market. On average, participating Swedish households hold 71% of their risky financial assets in more than four mutual funds (Betermier, Calvet, and Sodini (2017)) and earn a higher Sharpe ratio than the local stock market index (Calvet, Campbell, and Sodini (2007)).

Portfolios. We focus on holdings of cash and risky assets, excluding defined contribution pension accounts. Cash consists of bank account balances and Swedish money market funds. The risky portfolio contains risky financial assets that are directly held in stocks and risky mutual funds. Within the financial portfolio, the average participant has a risky share of 40%, owns four different mutual funds, and directly invests in two or three firms. These estimates are similar to the average number of stocks in U.S. household portfolios. The vast majority of risky asset participants (90%) hold mutual funds, while 60% of them own stocks directly. We construct our measures of equity shares as in Calvet, Campbell, and Sodini (2007), that is, as the share of stocks and risky mutual funds divided by financial wealth. Financial wealth is defined as the sum of cash, stocks, funds, bonds, derivatives, capital insurance, and other financial wealth.

[3] To study the effect over the life cycle in Figure 3, we also consider individuals aged 65 to 70 as the last age bin.

C. Income Risk

Our measures of countercyclical income risk are constructed in three steps. First, we sort workers by education × industry group. Second, we compute the first three moments of the distribution of income shocks for each group and year. Third, for each group, we regress these moments on stock market excess returns.

To measure labor income risk, we follow Guvenen et al. (2021) and focus on individuals whose job market participation is less contaminated by early retirement decisions and further restrict our age requirement between 20 and 60.

Education × industry groups. We sort workers using 71 industry codes and five levels of academic achievement: (i) high-school dropouts, (ii) high school, (iii) post-high-school education other than university, (iv) college (Bachelor), and (v) postgraduate education. Because measuring higher moments in small samples is challenging, we drop groups in years for which we have fewer than 100 observations. We next retain only those groups that have at least 10 years of data. We end up with 321 groups. We allow workers to move from one group to another, which occurs when they switch employment.

Moments. In a second step, we compute the mean, variance, and skewness of log disposable income growth innovations for each year from 1983 to 2014 and each group of workers. Disposable income is the sum of all nonfinancial sources of after-tax income, including social transfers. We deflate this variable using the Consumer Price Index (CPI) of 2009.

We assume that workers correctly anticipate the expected growth of their log disposable income conditional on their group and age. Accordingly, we start by regressing yearly changes in log disposable income on a polynomial of age. We estimate an ordinary least squares (OLS) regression for each of our 321 industry × education groups, which captures the heterogeneity in life-cycle profiles of earnings across groups. Specifically, we estimate

$$y_{it} - y_{it-1} = \dot{f}(a_{it-1}, g_{it-1}) + \hat{\varepsilon}_{it}, \tag{18}$$

where $\dot{f}(a, g)$ is a third-order polynomial estimated for each group that captures the expected growth rate of earnings. We use the residuals of these regressions, $\hat{\varepsilon}_{it}$, as our empirical measure of ε_{it}, that is, the unexpected change in log disposable income.

Finally, for each year and industry × education group, we compute the mean, variance, and skewness of the distribution of observed shocks $\hat{\varepsilon}_{it}$ using equations (4) to (6). Overall, our methodology largely follows Guvenen, Ozkan, and Song's (2014) study of U.S. workers with two differences. First, we compute cross-sectional moments within industry and educational groups, whereas Guvenen, Ozkan, and Song (2014) pool all prime-age male workers. Second, we use disposable income rather than labor income, which is a better measure of what households can use for consumption. When we compute these moments using pretax earnings, we find that skewness varies over the business cycle in ways quantitatively similar to the United States. However, magnitudes are smaller for disposable income because of redistribution, unemployment insurance, and progressive taxation.

Cyclicality of moments. In a third step, we estimate the cyclicality of each moment by regressing its time series on contemporaneous and lagged yearly stock market returns. Denoting by μ_n the n^{th} moment of the income shock, where $n \in \{1, 2, 3\}$, for each group of workers g, we estimate

$$\mu_{n,gt} = \beta_{n,1,g} \cdot r_{s,t} + \beta_{n,2,g} \cdot r_{s,t-1} + u_{n,gt}. \tag{19}$$

We define the cyclicality of the n^{th} moment as $\beta_{n,1,g} + \beta_{n,2,g}$. We say that Covariance is the cyclicality of the first moment, Countercyclical variance is the negative of the cyclicality of the second moment, and Cyclical Skewness is the cyclicality of the third moment.

We include lag returns on the right-hand side because the stock market may react faster to economic news than the labor market. Indeed, in contrast to the United States, the Swedish labor market tends to follow trends in the world stock market with a one-year lag. For example, our economy-wide measure of skewness drops from 0.06 in 2007 to −0.08 in 2008 and −0.34 in 2009. During that recession, left-tail income risk peaked one year after the stock market crash. From an economic point of view, it makes sense that asset prices react to a change in economic risk before that risk actually materializes. From the perspective of investors, the fact that negative stock market returns precede higher labor income risk is sufficient to increase the covariance between stock and human capital returns. Indeed, news that the distribution of income shocks will worsen in the coming year immediately reduces the present value of human capital.

D. Human Capital and Pension Wealth

Human capital. Equation (10) tells us that the effect of countercyclical income risk depends on the relative importance of human capital relative to wealth. To test this prediction, we build a simple measure of human capital, defined as the present value of expected future earnings. We compute the value of human capital as

$$H_{it} = \sum_{k=0}^{T_i} s_{i,t+k} \frac{\mathrm{E}[Y_{i,t+k}]}{(1+r)^k}, \tag{20}$$

where T_i denotes the number of years before worker i retires, which we assume to be at age 65, and $s_{i,t+k}$ is his survival probability up to year k. Survival probabilities are imputed from life tables computed by the National Statistics Central Bureau. Future expected earnings are determined by current earnings and age/group-specific growth rates from our estimate of equation (18). Our definition of human capital does not include future pensions, which are not exposed to similar risk. Following Calvet et al. (2021), we discount future earnings at $r = 4.1\%$.

Table I
Summary Statistics

This table reports the main income, financial, and demographic characteristics of all Swedish population members (columns (1) and (2)) and market participants (columns (3) and (4)) at the end of 2003. Financial wealth consists of cash, direct stock holding, fund holding, bond holding, derivatives, capital insurance, and other financial wealth. Gross wealth is the sum of financial and real estate wealths. Income is inflation-adjusted, using the 2009 CPI index of 2009.

	All		Participants	
	Mean	Standard Deviation	Mean	Standard Deviation
Income				
Nonfinancial disposable income ($)	27,683	13,045	29,934	14,241
Entrepreneur (%)	9.13%		10.75%	
Variance	0.081	0.036	0.081	0.036
Skewness	−0.007	0.008	−0.007	0.008
Covariance	−0.013	0.024	−0.013	0.024
Countercyclical variance	0.013	0.018	0.013	0.018
Cyclical skewness	0.023	0.029	0.021	0.029
Wealth				
Financial wealth ($)	21,437	68,816	33,497	87,873
Real estate wealth ($)	77,496	153,831	100,107	182,144
Gross wealth ($)	99,163	193,402	133,984	233,699
Debt ($)	40,177	71,828	44,772	81,714
Accrued pension ($)	75,914	65,887	84,999	69,681
Human capital share	0.82	0.21	0.77	0.22
Equity share	0.25	0.31	0.43	0.29
Demographic characteristics				
Age	43.43	11.65	44.73	11.56
Sex	1.48	0.50	1.46	0.50
High-school dummy	0.84	0.37	0.87	0.34
Post-high-school dummy	0.36	0.48	0.42	0.49
Immigration dummy	0.12	0.33	0.07	0.26
Family size	2.60	1.41	2.58	1.35
Observations	3,775,902	3,775,902	2,143,906	2,143,906

Pension wealth. We estimate pension wealth as the present discounted value of accrued benefits. First, we compute the mean nonfinancial income of retired workers for each education × industry group to estimate expected benefits in retirement. We then multiply this expectation by the fraction of a typical working life each worker has already completed. To do so, we assume a starting age of 20 years old and a retirement age of 65 years old. Second, we estimate the present value of the corresponding annuity, assuming the same discount rate as for human capital and accounting for conditional survival probabilities.

E. Summary Statistics

Table I reports summary statistics for all workers (first two columns) and risky asset market participants (last two columns) at the end of 2003. Market participants do not differ from nonparticipants in terms of age, sex, and

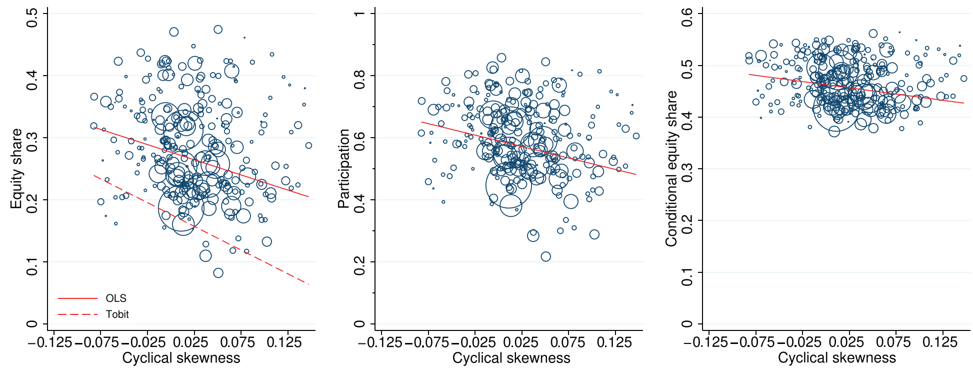

Figure 1. Cyclical skewness and equity holdings. This figure reports the relationship between our measure of cyclical skewness, estimated for each education × industry group, and the average equity share of these groups (left panel), their participation rate (center), and the average equity share of participants (right). Circles reflect group size. Red lines represent OLS regressions weighted by group size. On the left panel, the red dashed line adjustment displays the predicted value of a Tobit regression with a zero lower bound, which is obtained after collapsing the data by group and participation status. (Color figure can be viewed at wileyonlinelibrary.com)

family size. Participants have a slightly higher level of education compared to nonparticipants and are relatively wealthier. The table also reports summary statistics regarding our income shock moments and comoments.

In the data, the three comoments display similar levels of variation but theory suggests that cyclical skewness should generate significantly greater variation in equity shares. This is because the theoretical effect of each comoment on equity shares is proportional to its influence on the market beta of human capital. Equation (17) shows that this influence depends on relative risk aversion γ and the share of human capital in total wealth (ω_H). For example, assuming $\gamma = 6$[4] and $\omega_H = 0.8$, variations in countercyclical variance and cyclical skewness theoretically translate into 2.4 and 13.4 higher variations in optimal equity shares than variations in the covariance term.

III. Income Risk and Equity Investment

A. Group-Level Analysis

Figure 1 offers an overview of the relationship between cyclical skewness and stock holdings at the group level, measured by its average equity share (left panel), its participation rate (center), and the average equity share of stock market participants (right). Regression lines in red suggest that groups of workers facing higher cyclical skewness invest less in stocks.

Do we observe similar patterns for other comoments? Columns (2) and (3) of Table II show that our measures of covariance risk and countercyclical

[4] Note that $\gamma = 6$ is consistent with recent estimates derived from portfolio choice models (Benzoni, Collin-Dufresne, and Goldstein (2007), Lynch and Tan (2011), Catherine (2022)).

Table II

Equity Share and Countercyclical Risk at the Group Level

This table reports the result of Tobit regressions of the equity share on measures of countercyclical income risk. All variables are collapsed by industry × education group. Regressions use the number of observations per group as analytical weights. Absolute t-statistics are reported in parentheses.

	(1)	(2)	(3)	(4)
Cyclical skewness	−0.311			−0.317
	(3.41)			(3.12)
Countercyclical variance		−0.348		−0.269
		(1.97)		(1.44)
Covariance			−0.154	0.137
			(1.06)	(0.83)
Observations	321	321	321	321
Adjusted R^2	0.032	0.009	0.000	0.033

volatility are not correlated with equity shares. Theoretically, these moments are important for optimal portfolios, but previous studies argue that, in the overall population, the correlation between individual income growth and stock market returns is close to zero (Cocco, Gomes, and Maenhout (2005)), and the variance of income shocks is not cyclical (Guvenen, Ozkan, and Song (2014), Busch et al. (2022)). Heterogeneity across different groups of workers does not seem to matter, after all, workers in groups with the highest covariance risk (≈0.075) expect their earnings to fall by only 3% when the stock market loses 40%. The lack of correlation between equity share and covariance risk is consistent with previous work on Swedish data (Calvet and Sodini (2014)). In column (4), we include all three comoments. The coefficient for cyclical skewness remains significant and is quantitatively close to that of the univariate regression.

B. Microlevel Analysis

In the rest of this section, we run microlevel regressions in which the left-hand-side variable is the equity share. The right-hand-side variables are our measures of income risk comoments as well as year fixed effects and demographic and economic control variables. We estimate equations of the type

$$\begin{aligned} Stock\ Holdings_{it} &= b_1 \cdot Covariance_{g(it)} + b_2 \cdot Countercyclical\ variance_{g(it)} \\ &\quad + b_3 \cdot Cyclical\ skewness_{g(it)} + b_c \cdot Controls_{it} + v_t + \varepsilon_{it}. \end{aligned} \tag{21}$$

Our control variables include the average variance and unscaled skewness of income growth (see equations (5) to (6)), age, gender, household size, and dummy variables identifying entrepreneurs and immigrants. We also control for the composition of workers' overall endowment by including the value of financial assets, real estate, pension wealth, and human capital. We assume that workers have CRRA and therefore scale these variables by total wealth, which is the sum of financial and real estate wealth, human capital, and pension wealth. As portfolio weights sum to one, we omit one of the components of wealth: the human capital share. We additionally control for the leverage ratio (debt scaled by total wealth). As shown in equation (10), with CRRA preferences, the optimal equity share is a function of the wealth composition of the agent in relative terms. Nonetheless, in the presence of frictions such as fixed participation costs, the level of investable wealth matters. We also control for total assets, the sum of financial and real estate wealth. We further examine the role of financial wealth in Section V.B.

B.1. Equity Share

Table III reports results of Tobit regressions in which the dependent variable is the unconditional equity share. First, we regress the unconditional equity share against each comoment separately. As reported in columns (1) to (3), only cyclical skewness is significantly correlated with equity shares. In column (4), we include all labor income risk moments, including unconditional variance and skewness, in the regression as well as controls, except for education. Neither the point estimate nor the significance of cyclical skewness falls substantially. Since education is correlated with financial risk-taking (Vissing-Jorgensen (2002)), it is important to control for it to obtain an unbiased estimate of the relationship between cyclical skewness and equity shares. In column (5), we include education dummies, and our main coefficient of interest drops from -0.878 to -0.298.

We can think of two possible explanations for this result. First, education can increase equity shares because it reduces countercyclical income risk. Education significantly increases reemployment rates of the unemployed (Riddell and Song (2011)), and Alan (2012) shows that, in a calibrated model, differential exposure to countercyclical tail risk helps explain portfolio differences between education groups. In principle, this should not be a concern because we control for measures of countercyclical income risk. In practice, these variables are measured with error, as they are based on a handful of recessions. Second, we would expect the correlation between cyclical skewness and equity shares to be lower within education groups if workers with higher risk aversion choose industries with lower income risk (Bonin et al. (2007), Fouarge, Kriechel, and Dohmen (2014)). If risk aversion plays an important role in determining an individual's industry of employment but not his education level, then endogeneity could be more problematic within education groups, and introducing education fixed effects would bias our results toward zero. In terms of economic magnitudes, a two-standard-deviation change in cyclical skewness reduces equity shares by 2 to 8 pp.

Interestingly, without education fixed effects, there is a positive and statistically significant relationship between equity shares and the variance of income shocks. This relationship becomes insignificant with education fixed effects. In Sweden, the variance of income shocks increases with education (Calvet et al. (2021)), as does stock market participation. This generates a spurious corre-

Table III

Equity Share and Countercyclical Income Risk

This table reports results of Tobit regressions of the equity share on measures of countercyclical income risk, controlling for worker and households characteristics. Absolute t-statistics reported in parentheses are clustered by industry × education group.

	(1)	(2)	(3)	(4)	(5)
Cyclical skewness	−1.113			−0.878	−0.298
	(2.92)			(5.17)	(3.22)
Count. variance		−0.647		−0.216	0.532
		(0.84)		(0.69)	(2.64)
Covariance			−0.517	−0.445	0.168
			(0.70)	(1.45)	(0.94)
Skewness				−1.969	−1.765
				(3.18)	(5.49)
Variance				0.675	−0.039
				(4.34)	(0.42)
Age				−0.002	−0.001
				(7.64)	(2.76)
Sex				−0.003	−0.008
				(0.44)	(2.25)
Immigrant				−0.141	−0.143
				(28.64)	(30.54)
Household size				−0.009	−0.009
				(10.83)	(14.63)
Entrepreneur				−0.009	−0.004
				(2.07)	(1.14)
Log Total assets				0.136	0.124
				(40.56)	(48.58)
Financial/Total wealth				1.403	1.440
				(32.09)	(33.66)
Real estate/Total wealth				−0.540	−0.459
				(23.24)	(24.00)
Pension/Total wealth				0.025	0.013
				(1.77)	(0.96)
Debt/Total wealth				−0.487	−0.504
				(10.81)	(10.62)
Education FE					Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	32,934,044	32,934,044	32,934,044	32,933,774	32,933,774
Pseudo R^2	0.006	0.004	0.004	0.190	0.198

lation between variance and equity holdings that disappears when we control for education.

Columns (4) and (5) also show that workers with higher skewness invest less in stocks. This is inconsistent with the intuition that background risk discourages financial risk-taking since occupations with (right) skewness are safer. One possible explanation is that workers with higher risk aversion choose professions with lower left-tail risk and invest less in stocks. A similar interpretation might explain why higher variance does not reduce financial risk-taking.

Fagereng, Guiso, and Pistaferri (2018) and d'Astous and Shore (2024) find that endogeneity biases the relationship between variance and stock holdings. Section III.C.1 provides support for this conjecture.

B.2. Role of Short-Selling Constraint and Participation Costs

The theoretical discussion in Section I abstracts from financial constraints that interact with the effect of cyclical skewness on equity shares. First, the negative effect of cyclical skewness on equity shares is bounded by short-selling constraints. Second, observed stock holdings are also affected by frictions reducing stock market participation. For example, in the presence of a fixed per-period cost of participating in the stock market, workers will not hold any stock ($\pi = 0$) when their desired stock holdings (π^*) fall below a certain threshold. The minimum desired equity share above which workers participate is individual-specific and likely depends on wealth, financial sophistication, and risk aversion.

Empirically, the marginal effect of cyclical skewness (denoted here by x for brevity) on equity shares can be decomposed into two parts, as in McDonald and Moffitt (1980):

$$\frac{\partial \mathrm{E}(\pi|x)}{\partial x} = \underbrace{\frac{\partial P(\pi > 0|x)}{\partial x}\mathrm{E}(\pi|x, \pi > 0)}_{\substack{\text{marginal effect from} \\ \text{participation}}} + \underbrace{P(\pi > 0|x)\frac{\partial \mathrm{E}(\pi|x, \pi > 0)}{\partial x}}_{\substack{\text{marginal effect from} \\ \text{equity share of participants}}}. \tag{22}$$

The first component of equation (22) represents the marginal effect on equity shares through the decision not to participate. When cyclical skewness increases, the optimal equity share of some workers crosses the frontier of the nonparticipation zone, inducing a drop to zero. In this case, participation frictions and cyclical skewness interact, amplifying the marginal effect of the latter.

The second component of equation (22) represents the marginal effect on the equity share of workers in the participation zone. Theoretically, it should be the product of the marginal effect in the frictionless world multiplied by the share of participants.

Rearranging equation (22), we can dissagregate the Tobit coefficient into two parts:

$$\underbrace{\frac{\frac{\partial \mathrm{E}(\pi|x)}{\partial x}}{P(\pi > 0|x)}}_{\substack{\text{Tobit} \\ \text{coefficient}}} = \underbrace{\frac{\partial \mathrm{E}(\pi|x, \pi > 0)}{\partial x}}_{\substack{\text{Unconstrained} \\ \text{marginal effect}}} + \underbrace{\frac{\frac{\partial P(\pi > 0|x)}{\partial x}}{P(\pi > 0|x)}\mathrm{E}(\pi|x, \pi > 0)}_{\substack{\text{Interaction effect} \\ \text{with participation frictions}}}. \tag{23}$$

The Tobit coefficient can be broadly interpreted as the marginal effect of cyclical skewness in the absence of the short-selling constraint. It is the sum of the unconstrained marginal effect and its interaction with the fixed

Table IV

Equity Share and Countercyclical Income Risk

This table reports the decomposition of the unconditional effect of cyclical skewness as in equation (23). Each of the three columns correspond to columns (1), (4), and (5) in Table III. Four components are reported in the table. Bootstrapped absolute t-statistics are reported in parentheses.

	(1)	(4)	(5)
$\frac{\partial \mathrm{E}(y\|x,y>0)}{\partial x}$	−0.464	−0.385	−0.131
	(2.80)	(5.21)	(3.21)
$\frac{\frac{\partial P(y>0\|x)}{\partial x}}{P(y>0\|x)}$	−1.460	−1.153	−0.393
	(3.14)	(4.69)	(3.05)
$\mathrm{E}(y\|x, y>0)$	0.444	0.406	0.404
	(20.43)	(3.15)	(3.05)
$\frac{\frac{\partial P(y>0\|x)}{\partial x}}{P(y>0\|x)}\mathrm{E}(y\|x, y>0)$	−0.648	−0.468	−0.159
	(3.10)	(4.75)	(3.04)

participation cost. This interaction effect is caused by marginal participants whose equity share would discontinuously fall to zero if they faced more cyclical skewness.

Table IV reports the decomposition of the Tobit coefficient of cyclical skewness for columns (1), (4), and (5) of Table III and shows that these two effects play quantitatively equivalent roles. The marginal effect of cyclical skewness on the participation probability change is −0.393 (−1.46 for univariate specification), meaning that a two-standard-deviation change in cyclical skewness corresponds to a 2.3 to 8.5 pp change in participation probability. As the average risky share for participants is about 40.4%, the product of the first two terms is −0.159, which explains about 55% of the overall marginal effect on the equity share. The marginal effect of cyclical skewness on the risky share for participants is −0.131. In terms of economic magnitude, a two-standard-deviation change in cyclical skewness reduces the equity shares of participants by 0.9 to 3.3 pp.[5]

The importance of the extensive margin is consistent with the economic intuition developed in Section I. The effect of cyclical skewness should be greater for workers with high human-capital-to-wealth ratios ω_H. Because they have limited financial wealth, the desired stock holdings of these workers is more likely to be on the edge of the participation threshold.

C. Economic Interpretation

Above document a negative relationship between cyclical skewness and stock holdings. Is this relationship evidence of hedging?

[5] Noticeably, the sum of the two parts is −0.29, which is slightly different from the Tobit coefficient of −0.298 in Table III. This is because for each of the terms, we report the average partial effect instead of the partial effect evaluated at each point.

C.1. Portfolio Differences between Identical Twins

A possible interpretation of our findings is that employment and stock holdings are jointly determined by omitted variables such as risk preferences, upbringing, economic literacy, or general intelligence. To address this concern, we study differences in equity shares within pairs of identical twins. Identical twins share both their genes and early lives, which means that they are highly similar when their first industries of employment are determined. We refer to Calvet and Sodini (2014) for a detailed discussion of the Swedish twin sample and the use of twin pairs as an empirical strategy to study portfolio choices.

To study differences within twin pairs, we estimate the Tobit model

$$\begin{aligned}\Delta\pi^*_{jt} &= b_1 \cdot \Delta \mathit{Covariance}_{jt} + b_2 \cdot \Delta \mathit{Countercyclical\ variance}_{jt} \\ &\quad + b_3 \cdot \Delta \mathit{Cyclical\ skewness}_{jt} + b_c \cdot \Delta \mathit{Controls}_{jt} + u + \varepsilon_{jt}, \end{aligned} \tag{24}$$

$$\begin{array}{lll} \Delta\pi_{jt} = & 1-\pi_{1,jt} & \text{if } \Delta\pi^*_{jt} > 1-\pi_{1,jt} \\ \Delta\pi_{jt} = & \Delta\pi^*_{jt} & \text{if } -\pi_{1,jt} < \Delta\pi^*_{jt} < 1-\pi_{1,jt} \\ \Delta\pi_{jt} = & -\pi_{1,jt} & \text{if } \Delta\pi^*_{jt} < -\pi_{1,jt}, \end{array}$$

where $\Delta x_{jt} = x_{2,jt} - x_{1,jt}$ is the difference in variable x between two identical twins in year t. Although our sample is now restricted to identical twins, we use the same group-level estimates of income risk moments as in our analysis of the full sample. Our methodology presumes that any worker in each industry $\times$ education group faces the same income risk, and we see no reason why twins should be treated differently. In addition, large samples are required to compute higher moments accurately.

Table V shows that our findings are robust. In particular, columns (5) from Tables III and V, which are most directly comparable, show that the coefficients for cyclical skewness are quantitatively similar, whereas none of the coefficients associated with other measures of income risk are close to statistically significant. These results confirm that cyclical skewness is remarkable as a measure of income risk in its ability to predict equity holdings and that our findings would go through if we controlled for a host of potential latent variables.

Looking at differences within twin-year pairs controls for a lot of unobserved characteristics but comes at a cost. First, our sample size is reduced to only 6,161 twin pairs, with each pair observed for 4.6 years on average. Moreover, we assume that the difference in income risk between two twins is as large as that between two randomly selected workers in the same education $\times$ industry groups, but in reality it is likely to be smaller. Overestimating differences in cyclical skewness would bias the associated coefficient toward zero. In addition, twin portfolios are similar not just because of shared genes and upbringing but also because twins influence each other. Calvet and Sodini (2014) show that communication plays an important role in the similarity of their portfolios, which reduces the degree of variation on the left-hand side of our

Table V

Equity Shares within Identical Twin-Year Pairs

This table reports results of Tobit regressions in which the dependent variable is the within-twin-year difference in equity shares and the independent variables are the within-twin-year differences in measures of income risk, total assets, composition of total wealth, and households characteristics. In columns (6) and (7), the sample is restricted to twin pairs for which the high school and program of study are known. Absolute t-statistics reported in parentheses are clustered by industry × education group pairs.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ Cyclical skewness	−0.311			−0.501	−0.422	−0.525	−0.570
	(1.80)			(2.66)	(2.23)	(2.11)	(2.25)
Δ Count. variance		0.129		0.378	0.504	0.773	0.686
		(0.46)		(1.18)	(1.57)	(1.86)	(1.63)
Δ Covariance			0.108	−0.063	0.081	0.160	0.374
			(0.50)	(0.24)	(0.30)	(0.46)	(0.98)
Δ Skewness				−0.658	−0.628	−0.575	−0.427
				(1.20)	(1.15)	(0.81)	(0.57)
Δ Variance				−0.024	−0.126	−0.390	−0.504
				(0.12)	(0.65)	(1.47)	(1.91)
Δ Household size				−0.002	−0.002	−0.003	0.001
				(0.61)	(0.57)	(0.74)	(0.11)
Δ Entrepreneur				−0.006	−0.006	−0.004	0.007
				(0.42)	(0.37)	(0.17)	(0.28)
Δ Log Assets				0.046	0.045	0.031	0.028
				(10.97)	(10.76)	(5.84)	(5.56)
Shares of total wealth:							
Δ Financial				1.229	1.233	1.351	1.207
				(12.55)	(12.67)	(7.80)	(7.24)
Δ Real Estate				−0.126	−0.123	−0.111	−0.083
				(2.02)	(1.98)	(1.14)	(0.90)
Δ Debt				−0.317	−0.320	−0.344	−0.369
				(5.13)	(5.16)	(3.06)	(3.30)
Δ Pension				−0.190	−0.228	−0.182	−0.142
				(2.20)	(2.61)	(0.80)	(0.61)
Δ Education FE					Yes	Yes	Yes
Δ Program FE							Yes
Δ School FE							Yes
Observations	34,460	34,460	34,460	34,460	34,460	15,862	15,862
Pseudo R^2	0.000	0.000	0.000	0.044	0.045	0.025	0.119

regressions. The combination of these factors likely makes it more difficult to find significant results.

Finally, the regression coefficients for unconditional skewness are three times smaller than in our baseline results and are no longer statistically significant. This change would be expected if the coefficient in Table III was the result of risk-averse workers avoiding stocks and occupations with high left-tail risk. The evolution of the regression coefficients associated with unconditional variance, which become more negative within twin pairs than in Table III, is also consistent with this interpretation and confirms the empirical finding that background risk reduces financial risk-taking (Guiso, Jappelli, and Terlizzese (1996), Betermier et al. (2012), Chang et al. (2022)).

By including twin $\times$ year fixed effects, we hope to eliminate the effect of unobserved variables that influence both occupational choices and portfolio decisions. Although we cannot prove that the sources of within-twin variation in income risk are uncorrelated with portfolio choices, we can use additional information available for subsamples of twins on educational background, intellectual ability, and physical ability to predict cyclical skewness within twin pairs. The only variables that robustly predict cyclical skewness within pairs of twins are the high school they attended and the program of study in that school. In column (7), we include school and program fixed effects in our regression and find results similar to those in column (6), which runs our preferred specification in the same subsample.[6]

C.2. Moderating Role of the Human Capital Share

To provide further evidence on the causal interpretation of our findings, we now turn to the moderating role of the share of human capital in households' wealth. Equation (10) shows that, in theory, the effect of countercyclical income risk depends on the importance of human capital relative to other forms of wealth. Specifically, the hedging demand for equity should increase with the human capital-to-wealth ratio. In particular, households for which human capital represents a negligible share of future consumption do not need to hedge against labor income risk and thus constitute a theoretical placebo group.

To test these predictions, we cut our sample into five groups based on the size of human capital relative to total assets. Specifically, we define the human capital-to-wealth ratio as human capital divided by the sum of itself and total assets. We then run Tobit regressions of the equity shares within each subsample and display the coefficients for cyclical skewness in Figure 2.

We find that when the human capital-to-wealth ratio represents less than 20% of wealth, cyclical skewness and equity share are not correlated. In fact, our point estimate is close to zero with a small standard error. We think of this group as our placebo group. As predicted by equation (10), the relationship between cyclical skewness and the equity share becomes steeper and statistically significant as we move to subsamples with higher human capital shares. It is strongest for households whose human capital-to-wealth ratio exceeds 80%, which represents 65% of our sample. In our sample, the mean human capital share is 82%.

Figure 2 is key to the economic interpretation of our results. If the relationship between cyclical skewness and equity holdings is explained by hedging motives, then the strength of this relationship should increase with the relative weight of human capital. This is what we observe in the data.

[6] These additional variables are available for cohorts born after 1955 and for individuals who went to high school.

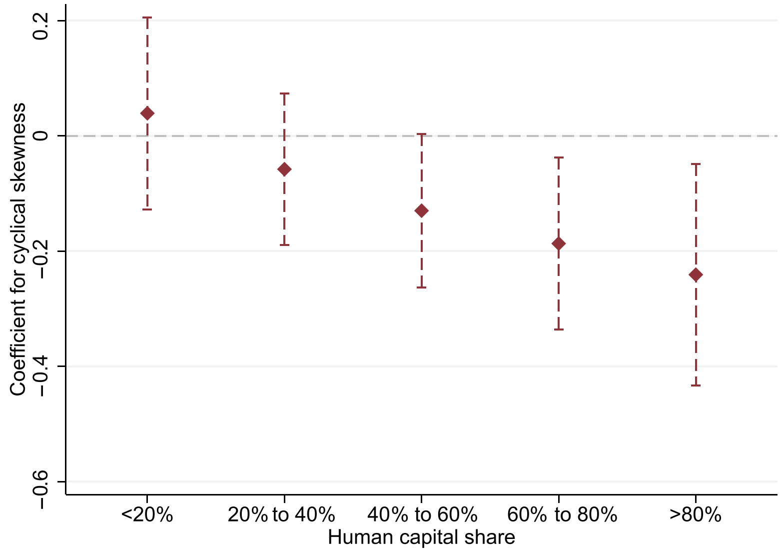

Figure 2. Effect of cyclical skewness by human capital share level. This figure displays the regression coefficients of the equity share on cyclical skewness when we run the same Tobit regressions as in column (5) of Table III in subsamples of workers with different levels of human capital-to-wealth ratio. Dashed lines represent 95% confidence intervals. Standard errors are clustered by industry × education group. (Color figure can be viewed at wileyonlinelibrary.com)

D. Household-Level Portfolios

Most of our empirical study focuses on the investment choices of individuals. Table VI expands this analysis to portfolios aggregated at the household level. To do so, we use the occupational group of the highest earner in each household to determine its exposure to our three measures of countercyclical risk. Otherwise, we follow the same empirical specification as column (5) of Table III for four categories of households: single-person households, couples with only one earner, and two-earner couples, where we split the last category into two subgroups depending on whether the industry × education group of the second earner has lower or higher cyclical skewness than that of the highest earner.

Our findings confirm the results from Table III. Cyclical skewness is the only measure of countercyclical risk that is consistently associated with lower stock holdings. Moreover, differences in the coefficient associated with cyclical skewness are consistent with economic intuition. First, the coefficient for cyclical skewness is larger for earners with a dependent spouse than for single-person households. This seems consistent with the idea that a dependent spouse acts as a consumption commitment that increases effective risk aversion (Calvet and Sodini (2014)). Second, among households with two earners, the effect of cyclical skewness is nearly twice as large when the second earner faces more income tail risk during a recession than the highest earner.

Table VI

Equity Shares at the Household Level

This table reports regression coefficients of the equity share on measures of countercylical risk when we run the same Tobit regressions as in column (5) of Table III for different categories of households. Unlike in Table III, portfolio shares are aggregated at the household level. The same applies to control variables such as wealth, human capital, and pension wealth. Measures of income risk refer to the industry × education group of the highest earner. The same applies to individual-specific demographic variables such as age or immigration status. In column (4), the sample is restricted to two-earner households in which the second earner faces lower cyclical skewness than the highest earner, whereas column (5) corresponds to the opposite case. Absolute t-statistics reported in parentheses are clustered by industry × education group of the highest earner.

	Single Person	One-Earner Couple	Two Earners Spouse Cyclical Skewness:	
			Lower	Higher
	(1)	(2)	(3)	(4)
Cyclical skewness	−0.280	−0.316	−0.209	−0.371
	(2.97)	(2.64)	(2.20)	(4.32)
Countercyclical variance	0.415	0.490	0.116	0.320
	(2.09)	(1.71)	(1.02)	(1.75)
Covariance	0.282	0.267	−0.094	0.021
	(1.61)	(1.24)	(0.80)	(0.10)
Demographics (head)	Yes	Yes	Yes	Yes
Wealth composition (household-level)	Yes	Yes	Yes	Yes
Education FE (head)	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	11,949,315	166,817	4,006,106	3,271,029
Pseudo R^2	0.226	0.255	0.252	0.267

IV. Consumption Risk and Equity Investment

For our findings to be consistent with theory, the relationship between cyclical skewness and equity holdings must be an increasing function of the human capital-to-wealth ratio and must be driven by permanent income shocks. In this section, we rely on these economic intuitions to build measures of labor-market-implied consumption risk and test whether these measures predict portfolios.

A. Theory

Our measure of labor-market-implied consumption risk can be understood by rearranging equation (10) as

$$\pi W = \left(\frac{\mu - r}{\gamma \sigma_s^2} - \beta_C\right)(W + H), \tag{25}$$

$$\beta_C = \frac{\beta_H H}{W + H}, \tag{26}$$

where β_C is the market beta of consumption implied by income shocks. This beta represents the linear relationship between the pp change in the certainty equivalent of total wealth $W + H$ and stock market returns implied by the market beta of human capital. If the agent has isoelastic utility, his consumption at a given age is a linear function of total wealth $H + W$. Therefore, if future labor earnings represent 50% of total wealth, an unexpected 1% shock to human capital translates into a 0.5% shock to total wealth and therefore to lifetime consumption. In other words, β_C is a measure of a worker's exposure to the stock market through labor income risk adjusted for his reliance on labor to finance his lifetime consumption.

B. Labor-Market-Implied Consumption Risk

We construct labor-market-implied consumption risk measures in two steps. First, we build a measure of permanent income risk. Second, we adjust these measures to account for the diversification effect of other forms of wealth.

B.1. Permanent Income Shocks

Because we cannot observe the permanent and transitory components of earnings in the data, we construct an approximate measure of permanent disposable income. Previous studies use a rolling average of log income to create such proxy (Kopczuk, Saez, and Song (2010), Bonaparte, Korniotis, and Kumar (2014)) by computing the average log disposable labor income over a k-year window. More recently, Busch et al. (2022) use this method to decompose cyclical skewness. We follow this methodology using a three-year window and show that this proxy skims away most of transitory shocks from our measures of countercyclical income risk. Our proxy for log permanent income is

$$\hat{z}_{it} = \frac{y_{it-1} + y_{it} + y_{it+1}}{3}. \tag{27}$$

Assuming the income process of Section I.A, our empirical measure of permanent income shocks is therefore

$$\hat{\eta}_{it} = \hat{z}_{it} - \hat{z}_{it-1} = \frac{\eta_{it+1} + \eta_{it} + \eta_{it-1} + \epsilon_{it+1} - \epsilon_{it-2}}{3}. \tag{28}$$

If η_{it-1} to η_{it+1}, ϵ_{it-2}, and ϵ_{it+1} are independently distributed, and μ_n denotes the n^{th} moment of a distribution, then for $n \leq 3$,

$$\mu_{n,t}(\hat{\eta}) = \frac{\mu_{n,t+1}(\eta) + \mu_{n,t}(\eta) + \mu_{n,t-1}(\eta) + \mu_{n,t+1}(\epsilon) - \mu_{n,t-2}(\epsilon)}{3^n}. \tag{29}$$

As before, we assume a linear relationship between cross-sectional moments and contemporaneous and lag market returns. That is, for permanent shocks, we have

$$\mu_{n,t}(\eta) = \beta_{\eta,n,1} \cdot r_{s,t} + \beta_{\eta,n,2} \cdot r_{s,t} + u_{\eta,n,t}, \tag{30}$$

and similarly for transitory shocks. Assuming that the distribution of income shocks does not depend on returns from two or more years prior, we can replace all moments in equation (29) as linear functions of returns to obtain

$$\mu_{n,t}(\hat{\eta}) = \frac{(\beta_{\eta,n,1} + \beta_{\eta,n,2} + \beta_{\xi,n,2}) \cdot r_{s,t} + (\beta_{\eta,n,1} + \beta_{\eta,n,2}) \cdot r_{s,t-1}}{3^n} + v_{\eta,n,t}, \tag{31}$$

where $v_{\eta,n,t}$ is a random variable independent of contemporaneous and lag returns. Equation (31) shows that if we measure permanent cyclical skewness by regressing our moments of $\hat{\eta}$ on market returns and lag market returns, we need to multiply the resulting coefficients by $3^3/2$. More generally, our measure of the cyclicality of the n^{th} moment will be

$$\frac{3^n}{2}\left(\beta_{\hat{\eta},n,1} + \beta_{\hat{\eta},n,2}\right) = \beta_{\eta,n,1} + \beta_{\eta,n,2} + \frac{\beta_{\xi,n,2}}{2}. \tag{32}$$

This measure should capture 100% of the cyclicality of permanent shocks $(\beta_{\eta,n,1} + \beta_{\eta,n,2})$ and, relative to our previous countercylical risk measures, skims away roughly three quarters of transitory shocks. Indeed, the remaining term $\frac{\beta_{\xi,n,2}}{2}$ represents one quarter of transitory cyclical skewness $(\beta_{\xi,n,1} + \beta_{\xi,n,2})$ provided that $\beta_{\xi,n,1} \approx \beta_{\xi,n,2}$.

B.2. Countercyclical Consumption Risk

Our measures of permanent income risk can be used to examine the role of consumption risk. Indeed, a permanent drop in income reduces lifetime consumption in proportion to the human-capital-to-wealth ratio. This shock to consumption might be attenuated or amplified by returns on other assets, depending on a worker's portfolio. For this reason, actual consumption risk is an endogenous regressor: among other things, it depends crucially on equity holdings. We build our measures of consumption risk under the assumption that wealth is invested entirely in the risk-free asset. In that case, the n^{th} moment of the distribution of lifetime consumption shocks is

$$\mu_{n,it}(\dot{c}) = \left(\frac{H_{it}}{W_{it} + H_{it}}\right)^n \mu_{n,g(i)t}(\eta), \tag{33}$$

where $\dot{c}_{it}$ is the unexpected change in log lifetime consumption. The same logic applies to comoments. For example, the cyclical skewness of consumption shocks would be

$$\textit{Cyclical Skewness}(\dot{c})_{it} = \left(\frac{H_{it}}{W_{it} + H_{it}}\right)^3 \textit{Cyclical Skewness}(\eta)_{g(i)}. \tag{34}$$

Table VII

Equity Share and Labor-Market-Implied Consumption Risk

This table reports results of Tobit regressions in which the dependent variable is a measure of equity holdings and the explanatory variables are measures of countercyclical consumption risk and other worker characteristics. Demographic controls include age, sex, household size, and dummies identifying immigrants and entrepreneurs. Wealth composition variables control for the share of human capital, financial wealth, real estate, pension wealth, and debt in total wealth. Education fixed effects control for the five levels of educational attainment used to sort workers into industry × education groups. Absolute t-statistics reported in parentheses are clustered by industry × education group.

	(1)	(2)	(3)	(4)	(5)	(6)
Cyclical skewness	−2.519			−1.236	−0.412	−0.553
	(8.38)			(4.15)	(2.67)	(4.55)
Countercyclical variance		−3.387		0.370	0.520	0.000
		(3.51)		(0.53)	(1.25)	(0.00)
Covariance			0.698	0.486	1.173	1.756
			(1.08)	(0.99)	(4.22)	(5.82)
Skewness				−3.116	−2.053	2.821
				(1.93)	(2.15)	(2.94)
Variance				−0.012	−0.908	−1.627
				(0.03)	(4.57)	(4.86)
Demographics				Yes	Yes	Yes
Wealth composition				Yes	Yes	Yes
Education FE					Yes	Yes
Industry FE						Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,936,703	32,936,703	32,936,703	32,933,774	32,933,774	32,933,774
Pseudo R^2	0.017	0.008	0.004	0.126	0.148	0.156

C. Equity Holdings

With our proxy for permanent income shocks, we can run Tobit regressions of the equity share on measures of countercyclical consumption risk. Table VII reports our findings. The coefficients of these regressions should theoretically be higher, as consumption shocks reflect returns on an agent's entire wealth, inclusive of human capital. We find that this prediction is verified in each specification. One explanation could be that we multiplied the right-hand-side variables by numbers between zero and one, which would mechanically increase the associated coefficient. However, we note that our t-statistics for cyclical skewness also increase substantially.

V. Implications for Quantitative Models

Countercyclical income risk has received attention in the finance literature because it helps quantitative models solve important empirical puzzles. First, life-cycle models with countercyclical income risk can generate an equity share that does not decrease with age (Storesletten, Telmer, and Yaron (2007), Lynch and Tan (2011), Catherine (2022)). Second, asset pricing models with counter-

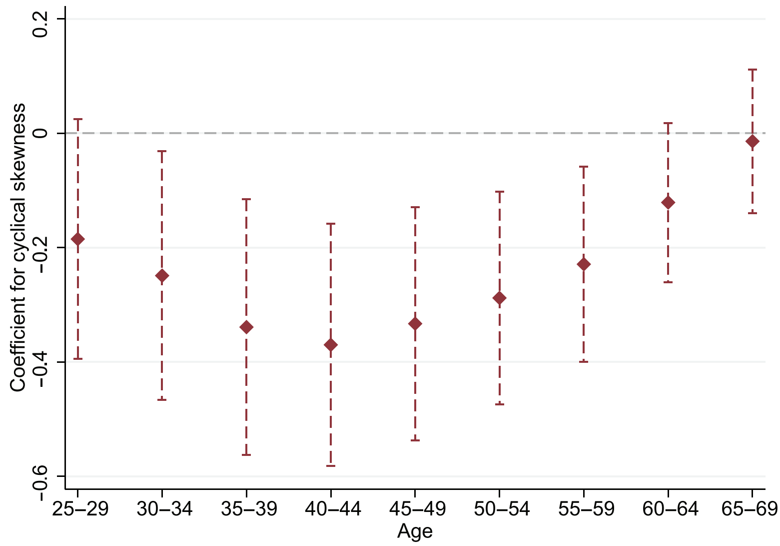

Figure 3. Cyclical skewness and equity share over the life cycle. This figure displays the regression coefficients of the equity share on cyclical skewness when we run the same Tobit regressions as in column (5) of Table III for different age groups. Dashed lines represent 95% confidence intervals. Standard errors are clustered by industry × education group. (Color figure can be viewed at wileyonlinelibrary.com)

cyclical risk generate a higher equity premium and greater volatility (Schmidt (2016), Constantinides and Ghosh (2017)). In this section, we expand our empirical analysis to shed light on the predictions of these models.

A. Portfolio Choices

Portfolio choice models generally struggle to match three aspects of the data: (i) the low average equity share, (ii) the lack of a strong positive relationship between equity shares and the main state variable, namely, the human capital-to-wealth ratio, and (iii) an equity share that does not fall with age. Our findings show that cyclical skewness can help models match the data along these three dimensions.

We already document above that cyclical skewness helps solve the first two issues. In particular, workers with a high human capital-to-wealth ratio may be discouraged from owning stocks because cyclical skewness is a greater concern to them.

To explore how countercyclical income risk might shape the life-cycle profile of the equity share, we run our main Tobit regression by age group. Figure 3 shows that the coefficients for cyclical skewness display a U-shaped pattern, being close to zero for households in their 20s, reaching a trough in their early 40s, and converging back to zero as they get closer to retirement.

Catherine (2022) shows that, in a realistic life-cycle model, the effect of cyclical skewness follows this pattern[7] if households must pay a fixed cost to participate in the stock market. In the presence of a fixed cost, young households do not invest in stocks regardless of countercyclical income risk. As they start accumulating financial wealth, paying the fixed cost becomes worthwhile for workers without cyclical skewness who want to invest most of their savings in stocks but not for those with cyclical skewness who have lower optimal equity shares. Thus, a fixed participation cost can explain why the role of cyclical skewness initially grows with age. However, at some point the decline in the human capital-to-wealth ratio becomes the dominant force and explains why cyclical skewness reduces stock holdings less as workers get closer to retirement.

Around age 40 to 44, a two-standard-deviation difference in cyclical skewness translates into a 3 pp difference in observed equity shares. By comparison, the equity share of households in their early 20s is 2.5 pp lower than those in their late 40s. Countercyclical risk can therefore plausibly contribute to life-cycle patterns meaningfully.

B. Asset Prices

Recent theoretical studies by Constantinides and Ghosh (2017) and Schmidt (2016) argue that countercyclical income risk can explain the equity premium and excess volatility puzzles. A common assumption in these papers is that consumption risk is equally distributed across households. This is true if they face the same labor income risk and have the same human capital-to-wealth ratio. Catherine (2022) shows that, in a realistic life-cycle model in which the human capital-to-wealth ratio varies greatly, countercyclical consumption risk is not equally distributed. Rather, it is concentrated among young households who have too little wealth for their portfolio choice to affect prices. For older households with substantial financial wealth, countercyclical income risk plays a lesser role in determining optimal portfolios because tail income shocks do not translate into tail consumption shocks.

To test this hypothesis, we run our main Tobit regression by decile of financial wealth. Panel A of Figure 4 shows that cyclical skewness has no statistically significant effect on the equity share of households in the three highest deciles of financial wealth. In addition to being statistically insignificant, our point estimate is close to zero and 25 times lower than in the first decile. As Panel B illustrates, the top three deciles own 87% of total financial wealth. It is unlikely that cyclical skewness could have large implications for asset prices. Fagereng, Guiso, and Pistaferri (2018) find that the portfolio response to their measure of uninsurable wage risk also vanishes as financial wealth is accumulated and argue that income risk is therefore unlikely to impact stock prices. Our findings complement theirs in the sense that their

[7] See Panel B.2 of figure 7 in Catherine (2022).

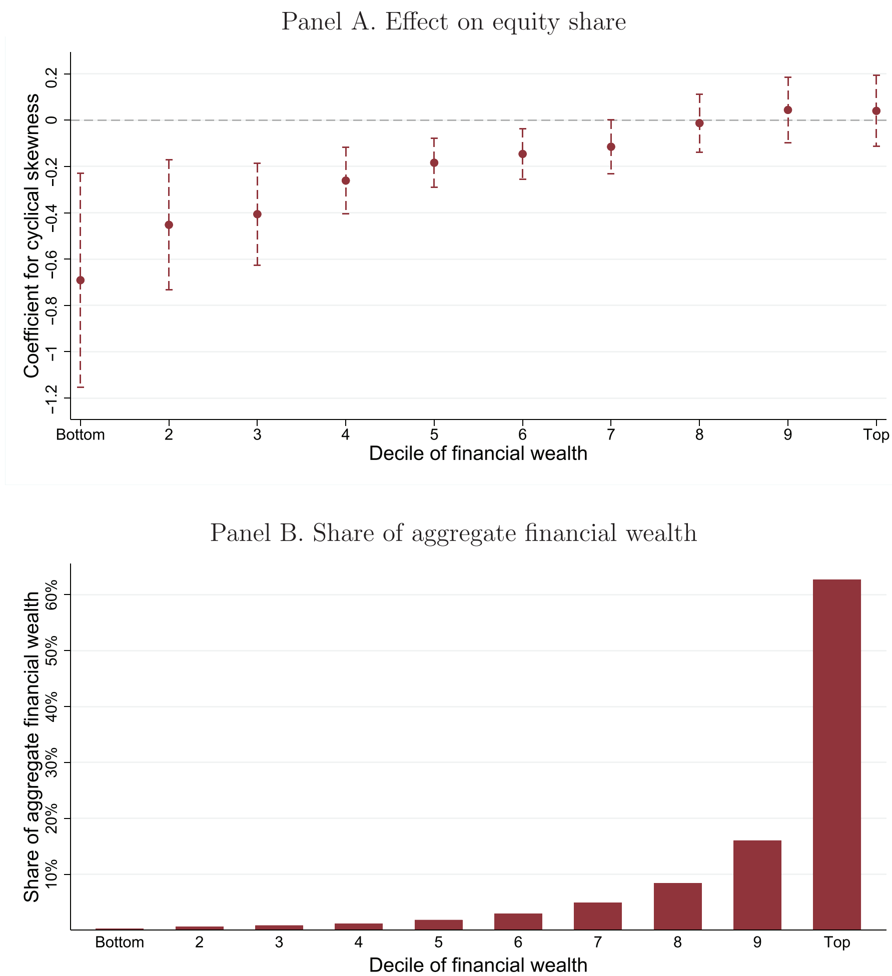

Figure 4. Cyclical skewness and equity share by decile of financial wealth. Panel A displays the regression coefficients of the equity share on cyclical skewness when we run the same Tobit regressions as in column (5) of Table III for different deciles of financial wealth. Dashed lines represent 95% confidence intervals. Standard errors are clustered by industry × education group. Panel B displays the share of aggregate financial wealth held by each decile in the sample. (Color figure can be viewed at wileyonlinelibrary.com)

measure of income risk is orthogonal to stock market returns, which makes our measure a priori more likely to generate a hedging motive.

Importantly, high-wealth individuals are exposed to other forms of tail shocks during recessions, for example, entrepreneurial risk. Salgado, Guvenen, and Bloom (2019) document a high level of cyclical skewness in various business performance measures, which may reduce wealthy private business owners' demand for publicly traded stocks. Heaton and Lucas (2000) show that entrepreneurial risk affects their portfolios.

VI. Conclusion

In this paper, we document that workers who face more left-tail income risk following low stock market returns hold lower portfolio equity shares. We show that the relationship between cyclical skewness and equity holdings is stronger when human capital represents a larger share of total wealth, as predicted by theory.

Cyclical skewness has been proposed as a solution to important empirical puzzles in household finance. The first is the low stock market participation rate. We find that cyclical skewness reduces the willingness of workers to invest in stocks. A second puzzle is that the share of wealth that households invest in stocks does not fall with age as standard life-cycle models predict. We show that cyclical skewness reduces the stock holdings of young workers more, and thus contributes to explaining the life-cycle profile of the equity share.

In contrast, our findings suggest that countercyclical labor income risk has no effect on the equity share of wealthy investors and therefore is unlikely to explain asset pricing puzzles on its own. Importantly, many wealthy investors are exposed to other sources of tail risk during recessions, in particular, capital losses on undiversified investments in private businesses. It is therefore possible that, despite our findings, tail consumption risk is important for asset pricing.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Appendix S1: Internet Appendix.
Replication Code.