Size Premium Waves

Bernard Herskovic[1] Thilo Kind[2] Howard Kung[3]

[1]UCLA

[2]London Business School

[3]London Business School & CEPR

May 31, 2018

size premium waves

- Size effect: Small firms earn higher expected returns than big firms (size premium $\approx 6\%$).
- The size effect disappeared in the 1980s...but reemerged in the 2000s:

	1961-1980	1981-2000	2001-2017
Avg. Return	9.29	−4.60	6.44
t-statistic	2.38	−1.18	2.08

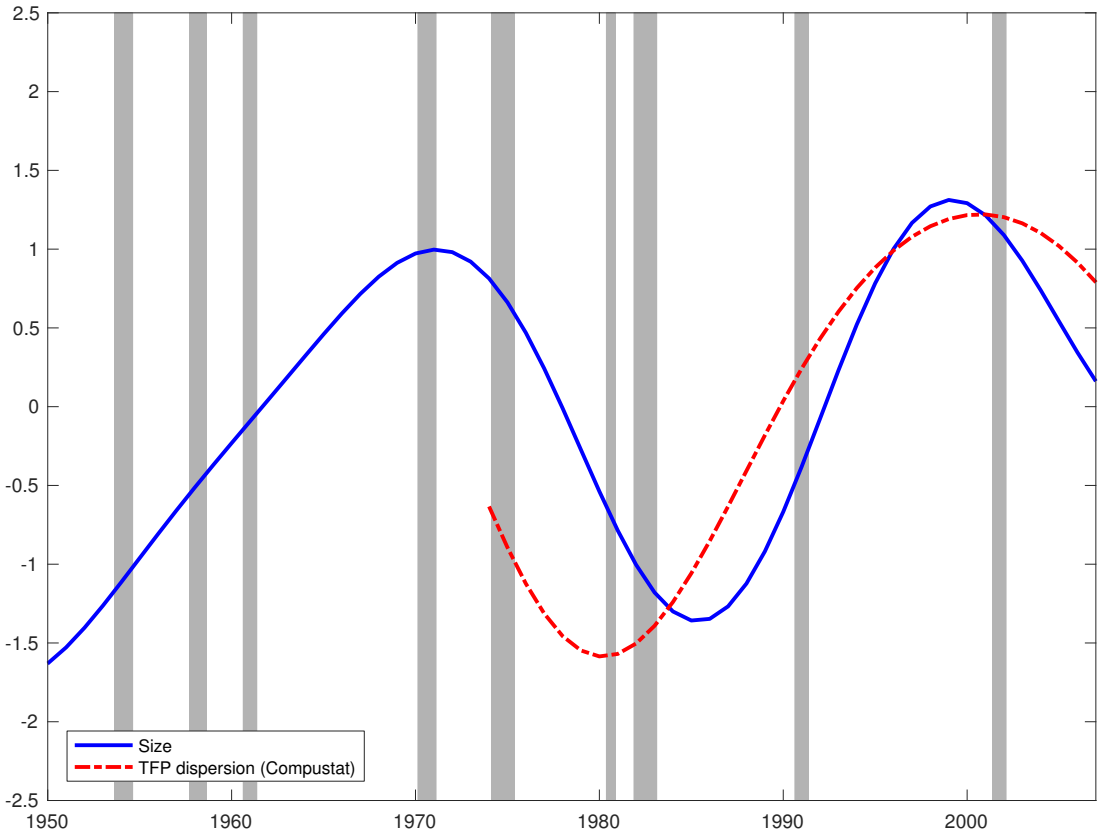
- The size premium has oscillated between periods of significance and insignificance in persistent waves.
- Why does the size premium vary so much over time?
- Starting point: Think about the determinants of firm size...

micro uncertainty

- Large and persistent differences in measured TFP across firms are important for explaining the firm-size distribution.
  - within 4-digit SIC industries, the 90th-% plant has 2x the productivity of the 10th-% plant
- TFP dispersion (micro uncertainty) varies significantly over time.
- Micro uncertainty is strongly correlated with the size premium at low-frequencies (correlation $= 0.74$).

size premium & micro uncertainty

Figure: Plot of the low-frequency component of the size premium and microeconomic uncertainty from the data.



- This paper: Link size premium waves to time-varying micro risks in a neoclassical investment framework.

quantitative approach

- Long-run risks + neoclassical investment model
- Firm-level productivity:
  1. idiosyncratic component: mean-reverting shocks with stochastic volatility (time-varying micro uncertainty)
  2. aggregate component: exposed to long-run consumption risks with time-varying volatility (time-varying macro uncertainty)

equilibrium size premium

- The size effect arises from the mean-reverting idiosyncratic shocks.
  1. small firms are subjected to a recent history of bad idiosyncratic shocks
  2. near-term payouts are low, but due to mean reversion, long-term payouts are expected to be higher
  3. big firms have the opposite cash flow pattern
  4. small firms are more exposed aggregate long-run risks than big firms, and therefore earn higher expected returns

equilibrium size premium

- The size premium waves arise from time-varying microeconomic risks.
  1. when micro uncertainty is higher, small firms are subject to larger negative idiosyncratic shocks
  2. small firms derive even more of their market value from long-term payouts $\Rightarrow$ exposure to long-run risks $\uparrow$
  3. big firms decrease their exposure to long-run risks
  4. larger dispersion in long-run risk betas increases the size premium

main results

- The model can explain:
  1. size premium waves: statistically significant (insignificant) size premium in high (low) micro uncertainty states
  2. mean and standard deviation of the size, value, and equity premia
  3. comovement between size, value, and equity premia:
     * `correlation`(size, value) = 0.67
     * `correlation`(size, market) = -0.48
     * `correlation`(value, market) = -0.50
- Micro uncertainty drives the dynamics of size and value premia.
- Macro uncertainty drives the dynamics of the equity premium.
- Micro and macro uncertainty are negatively related at low frequencies (correlation = -0.72)

model

- Rep agent has recursive preferences defined over aggregate consumption.
  - averse to uncertainty about long-term growth prospects
- Consumption growth follows:

$$\begin{aligned} \Delta c_{t+1} &= \mu + x_t + \sigma_{ct}\epsilon_{ct+1} \\ x_{t+1} &= \rho x_t + \sigma_x \sigma_{ct}\epsilon_{x,t+1} \end{aligned}$$

- σ_{ct} follows a two-state markov chain and captures time-varying macro uncertainty
- This framework implies a pricing kernel with three sources of priced risks: short-run risks, long-run risks, macro volatility risks.

model

- Heterogeneous competitive firms producing a single good using capital:

$$Y_{it} = A_{it}^{1-\alpha} K_{it}^{\alpha} - f \cdot K_{it}$$

- Measured productivity consists of two components: $A_{it} \equiv C_t \cdot Z_{it}$.
  - exposure to macroeconomic risks through C_t
  - mean-reverting idiosyncratic component:

$$\log(Z_{it+1}) = \rho_z \log(Z_{it}) + \sigma_{zt} \epsilon_{it}$$

  - σ_{zt} follows a two-state markov chain and captures time-varying microeconomic uncertainty
- $f \cdot K_{it}$ captures proportional operating costs

model

- Capital accumulation:

$$K_{it+1} = (1 - \delta)K_{it} + I_{it}$$

- Faces asymmetric quadratic capital adjustment costs $H(I_{it}/K_{it})$.
- Source of funds:

$$D_{it} = Y_{it} - I_{it} - H(I_{it}/K_{it})$$

- Firm objective: Maximize shareholder wealth.

calibration

- ▷ Preference parameters and consumption process are set to standard values in the long-run risks literature.
- ▷ Production technology are set to standard values in the production-based asset pricing literature.
- ▷ Idiosyncratic productivity shocks are calibrated to match the dispersion in book-to-market ratios.
- ▷ Calibrate the micro and macro uncertainty processes to the explain the dynamics of the low-frequency components.
  - * target standard deviation and first autocorrelation
  - * match the correlation between the two processes (= -0.72)

unconditional risk premia

Table: Unconditional financial moments from the data and the model.

	Data	Model
A. Mean		
Equity premium	7.96 %	8.5 %
Size premium	6.13 %	6.64 %
Value premium	5.73 %	5.09 %
B. Volatility		
Equity premium	18.51 %	19.92 %
Size premium	25.63 %	29.0 %
Value premium	22.15 %	22.3 %

- ▷ Model generates large and variable size, value, and equity premia.

conditional risk premia

Table: Size and value premia conditional on low and high microeconomic uncertainty from the model.

Micro uncertainty	σ_z^L	σ_z^H
Size premium	3.33	10.0
t-stat	(1.41)	(4.23)
Value premium	4.06	6.36
t-stat	(2.20)	(3.56)

- ▷ Both the size and value premia increase when micro uncertainty is high.
- ▷ Model reproduces the size premium wave patterns (statistically insignificant when micro uncertainty is low).
- ▷ Persistent micro uncertainty is the key driver of the low-frequency fluctuations in size and value premia.

conditional risk premia

Table: Equity premium and riskfree rate conditional on low and high macro uncertainty from the model.

Macro uncertainty	σ_x^L	σ_x^H
Equity premium	5.2	10.8
Riskfree rate	2.31	1.90

- ▷ The equity premium increases when macro uncertainty is high.
- ▷ Size and value premia are less sensitive to changes in macro uncertainty.
- ▷ Persistent macro uncertainty is the key driver of low-frequency changes in the equity premium.

aggregate mechanisms

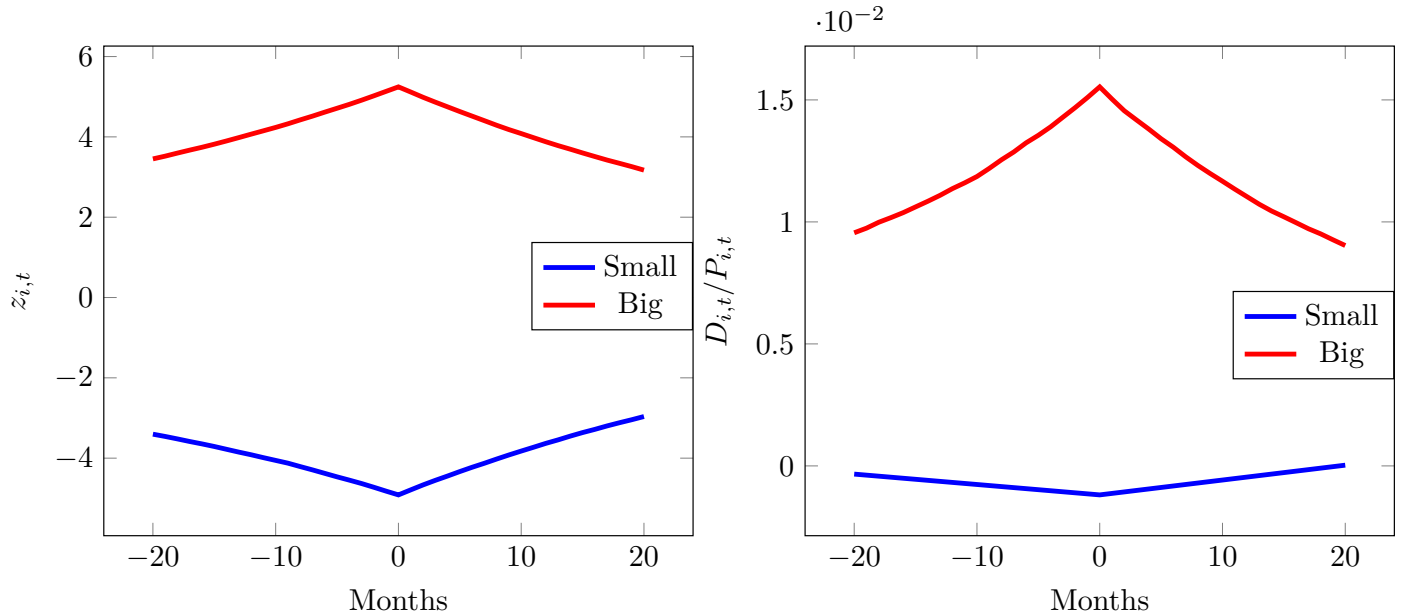
- Aggregate dividends are exposed to long-run risks through productivity $\Rightarrow$ sizable average equity premium.
- Presence of long-run consumption risks leads to strong precautionary savings motive $\Rightarrow$ low average riskfree rate.
- $\uparrow$ macro uncertainty:
  - $\uparrow$ precautionary savings motive $\Rightarrow \downarrow$ the riskfree rate
  - $\uparrow |\texttt{covariance}(\text{pricing kernel, dividend growth})| \Rightarrow \uparrow$ equity premium

cross-sectional mechanisms

- Positive size premium arises from the persistent mean-reverting idiosyncratic productivity shocks.
  - small firms: bad history of shocks + small capital stock
  - near-term payouts are low, but long-term ones are high
  - big firms: have the opposite payout pattern
  - small firms are more exposed to long-run risks than big firms

cross-sectional mechanisms

Figure: Dynamics of small and big firms before and after portfolio formation from the model.



- ▷ Small firms derive more of their value from longer-term cash flows ⇒ more exposed to long-run risks.

cross-sectional mechanisms

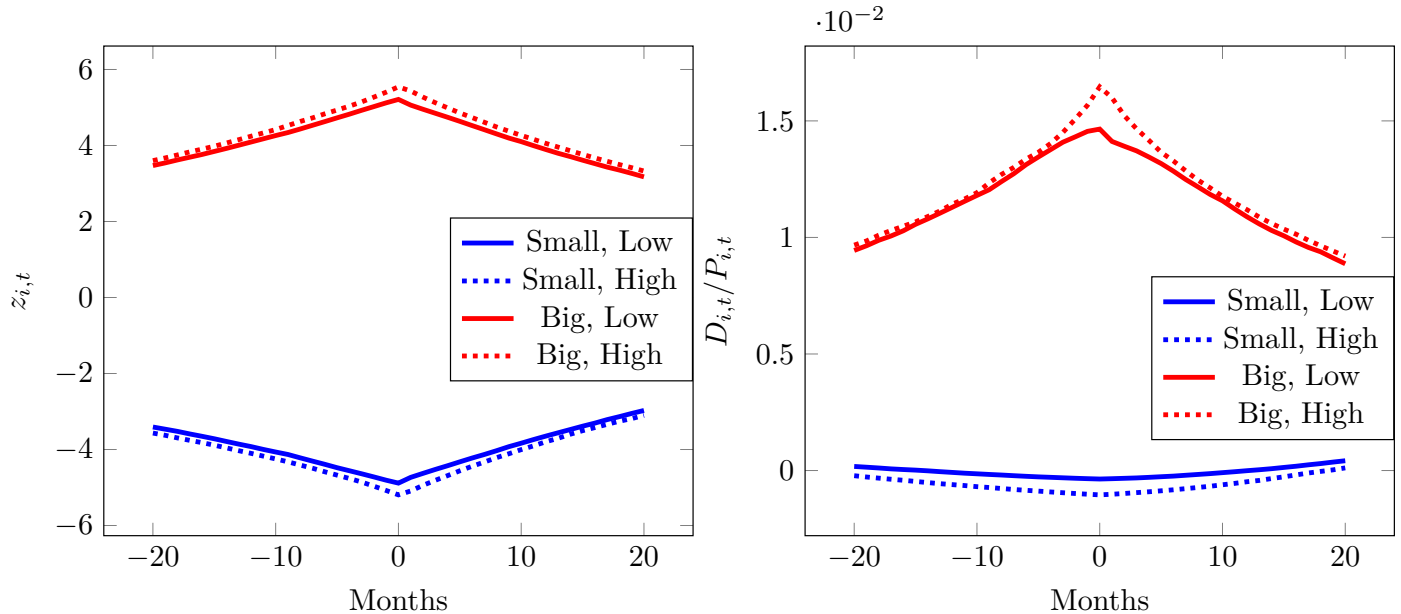
Table: Value-weighted TFP as a percentage of average TFP in size-sorted decile portfolios from the data.

	Small									Big
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
TFP	−43.4	−27.2	−17.9	−11.6	−4.6	−0.9	3.9	7.2	9.0	85.5

- ▷ Strong positive relation between market cap and productivity in the data.

cross-sectional mechanisms

Figure: Dynamics of small and big firms before and after portfolio formation conditional on low and high micro uncertainty from the model.



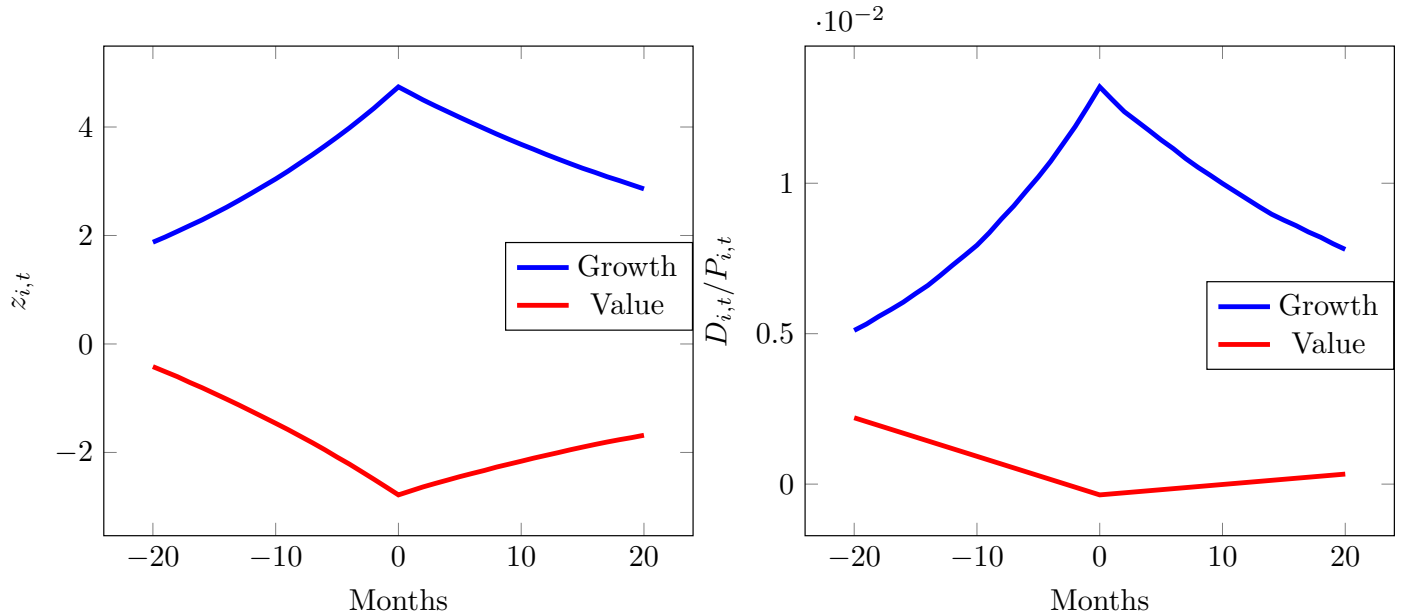
- ▷ ↑ micro uncertainty: ↑ (↓) exposure of small (big) firms to long-run risks
- ▷ size premium is increasing with micro uncertainty

cross-sectional mechanisms

- A positive value premium arises due to persistent mean-reverting idiosyncratic productivity shocks + investment frictions.
  - value firms: bad history of shocks + large capital stock
  - strong incentives to disinvest unproductive capital stock
  - asymmetric adjustment costs prevent aggressive disinvestment
  - face high operating leverage ($f * K_{it}$)
  - lower near-term payouts, but higher long-term ones
  - growth firms: have the opposite payout pattern
  - value firms are more exposed to long-run risks than growth firms

cross-sectional mechanisms

Figure: Dynamics of growth and value firms before and after portfolio formation from the model.



- Value firms derive more of the their value from longer-term cash flows $\Rightarrow$ more exposed to long-run risks.

cross-sectional mechanisms

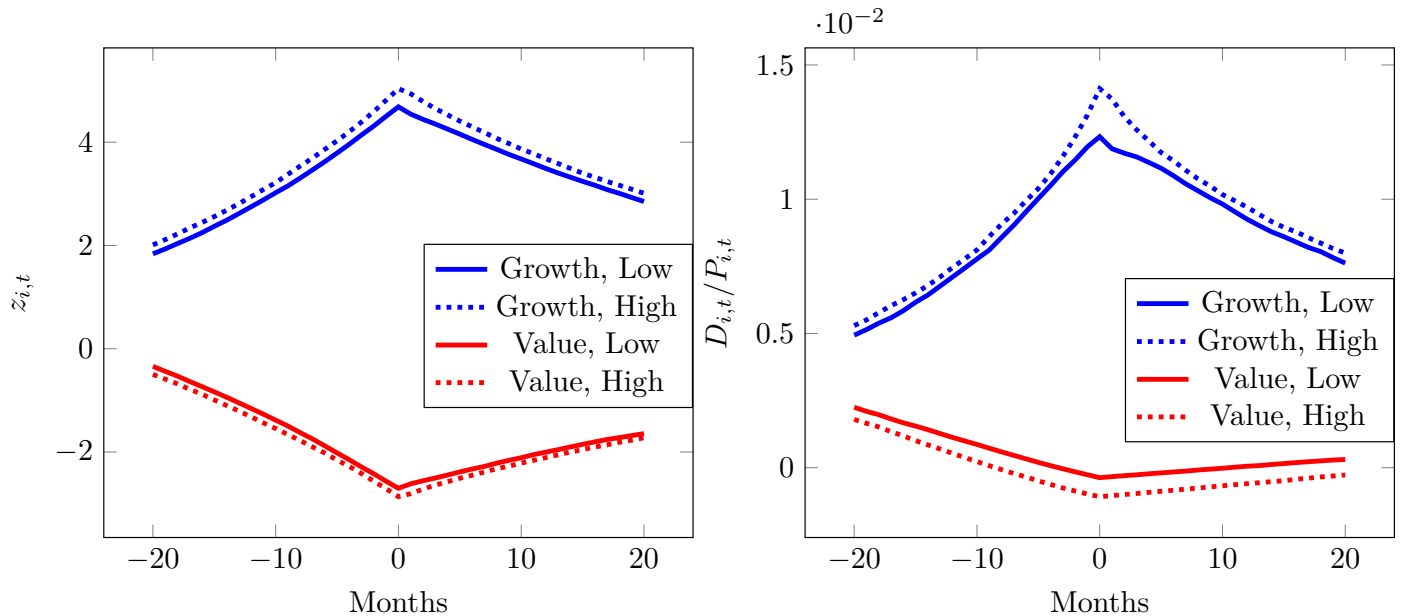
Table: Value-weighted TFP as a percentage of average TFP in B/M-sorted decile portfolios from the data.

	Growth									Value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
TFP	63.1	40.0	25.8	5.4	1.8	−12.3	−21.7	−29.2	−33.5	−39.4

- ▷ Strong negative relation between productivity and B/M in the data.

cross-sectional mechanisms

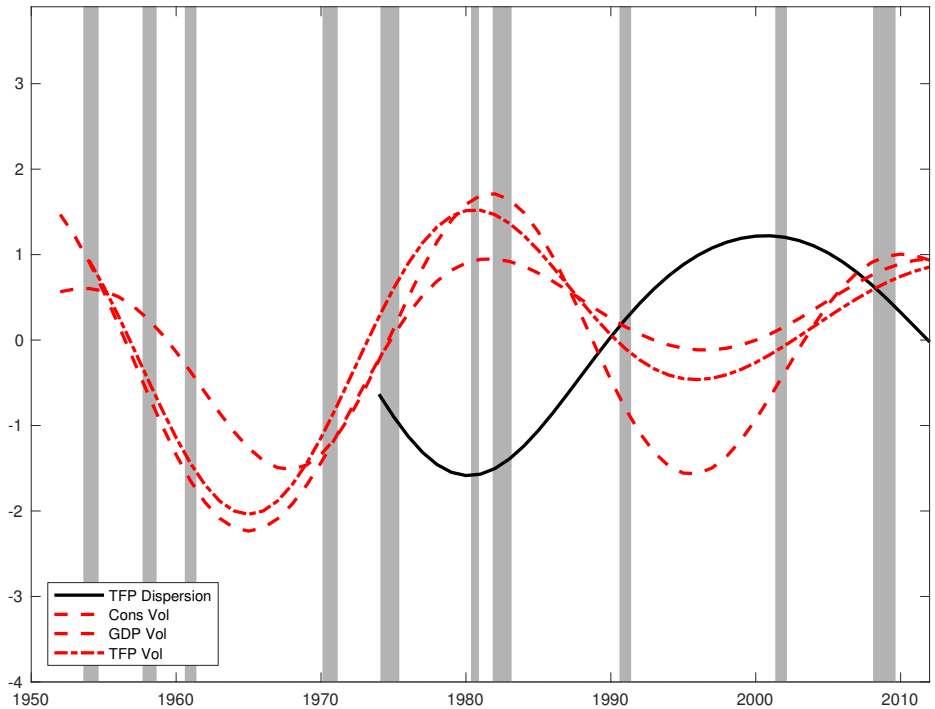
Figure: Dynamics of growth and value firms before and after portfolio formation conditional on low and high micro uncertainty from the model.



- ↑ micro uncertainty ↑ (↓) exposure of value (growth) firms to long-run risks
- Value premium is increasing with micro uncertainty

micro & macro uncertainty

Figure: Low-frequency dynamics of micro and macro uncertainty from the data.



- Micro and macro uncertainty are strongly negatively correlated at low frequencies.
- These dynamics have important implications for the comovement between size, value, and market strategies.

comovement

Table: Low-frequency correlations from the model and the data.

	Size	Value	Market	TFP	Micro	Macro
Size	1.00	0.67	−0.48	0.55	0.74	−0.80
Value	0.73	1.00	−0.50	0.44	0.22	−0.43
Market	−0.60	−0.59	1.00	−0.51	−0.64	0.76
TFP	0.84	0.72	−0.55	1.00	0.64	−0.89
Micro Uncertainty	0.73	0.70	−0.64	0.77	1.00	−0.72
Macro Uncertainty	−0.52	−0.56	0.67	−0.58	-0.72	1.00

- ▷ Calibrated the micro and macro uncertainty processes in the model to match the correlation in the data (= -0.72).
- ▷ Model generates a positive low-frequency relation between size and value, but both have a negative relation with the equity premium.

conclusion

- ▷ We provide a neoclassical explanation for the size premium waves.
- ▷ The common low-frequency movements in size and value premia are driven by persistent micro uncertainty.
- ▷ Low-frequency movements in the equity premium are driven by persistent macro uncertainty.
- ▷ Negative link between micro and macro uncertainty generates a negative link between the equity premium and both size and value premia.
- ▷ Distinguishing between micro- and macro-economic uncertainty is important for explaining asset price dynamics.