The Cross-Section of Labor Leverage and Equity Returns

Andres Donangelo
UT Austin

François Gourio
Chicago Fed

Miguel Palacios
Vanderbilt University

Labor and Finance Conference

Capri, September 8, 2016

This Paper

We show that:

1. Labor-capital complementarity and wage smoothness results in labor leverage

This Paper

We show that:

1. Labor-capital complementarity and wage smoothness results in labor leverage
2. Under the same conditions, labor leverage is an increasing function of labor share

This Paper

We show that:

1. Labor-capital complementarity and wage smoothness results in labor leverage
2. Under the same conditions, labor leverage is an increasing function of labor share
3. Assuming a firm's exposure to aggregate shocks is larger than wage's exposure to shocks, the previous results imply a positive relation between labor leverage and expected returns.

This Paper

We find empirical evidence:

1. Wages are smooth (yes, we know this, but we also find labor costs are smooth)

This Paper

We find empirical evidence:

1. Wages are smooth (yes, we know this, but we also find labor costs are smooth)
2. Labor and capital are strictly complements

This Paper

We find empirical evidence:

1. Wages are smooth (yes, we know this, but we also find labor costs are smooth)
2. Labor and capital are strictly complements
3. A positive relation between labor leverage and expected returns
   - Measured by exposure to risk (betas)
   - Measured by average realized returns

This Paper

We calibrate a structural model:

1. We match relevant moments

This Paper

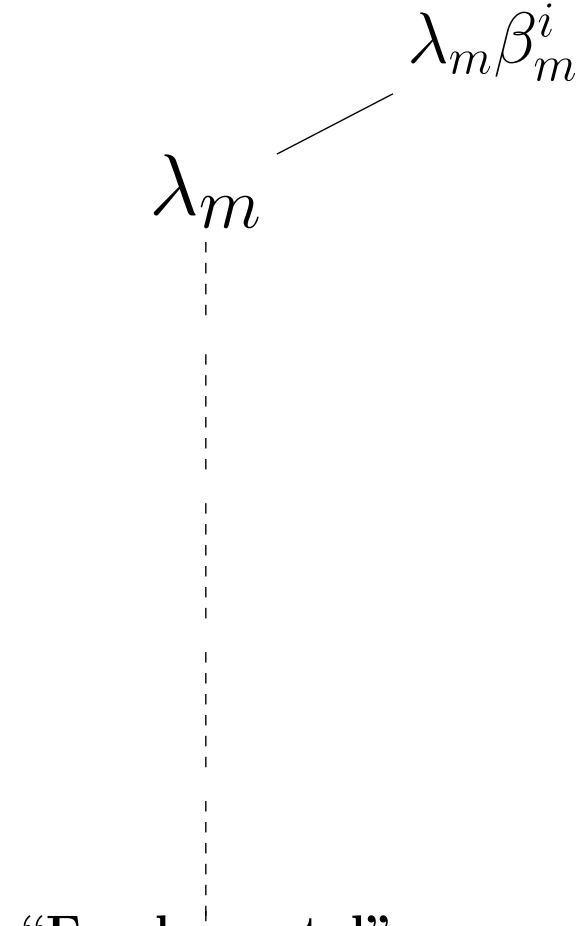
We calibrate a structural model:

1. We match relevant moments
2. We find that the structural model matches many other moments

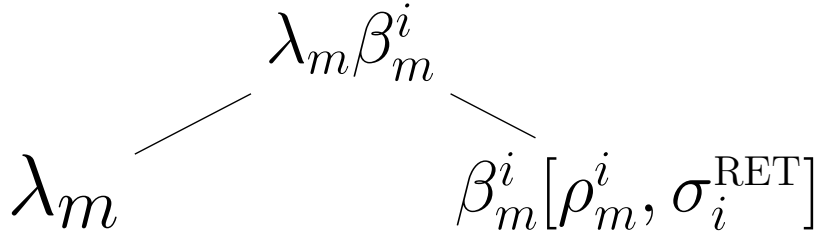
This paper and the literature

$\lambda_m \beta_m^i$

This paper and the literature



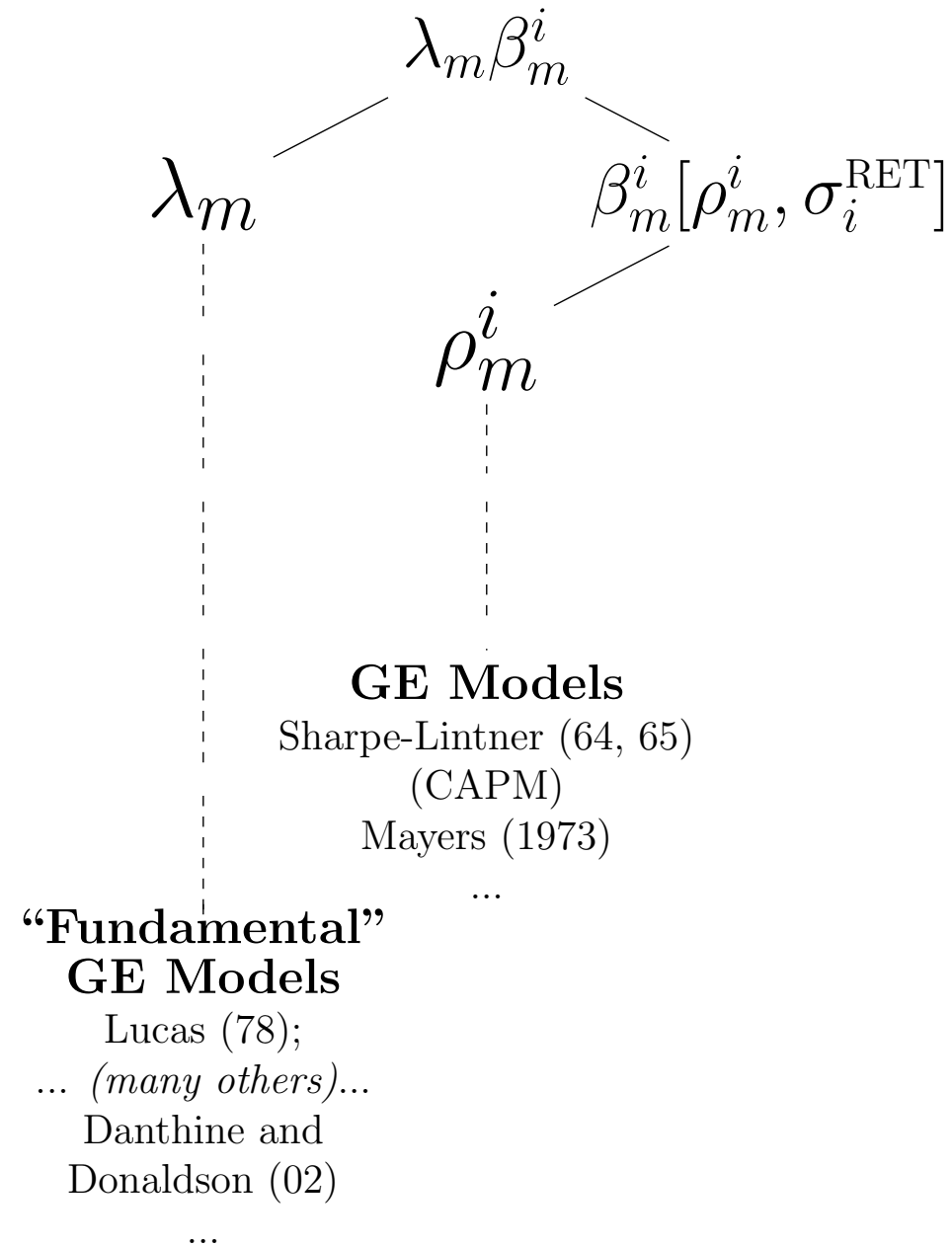
This paper and the literature



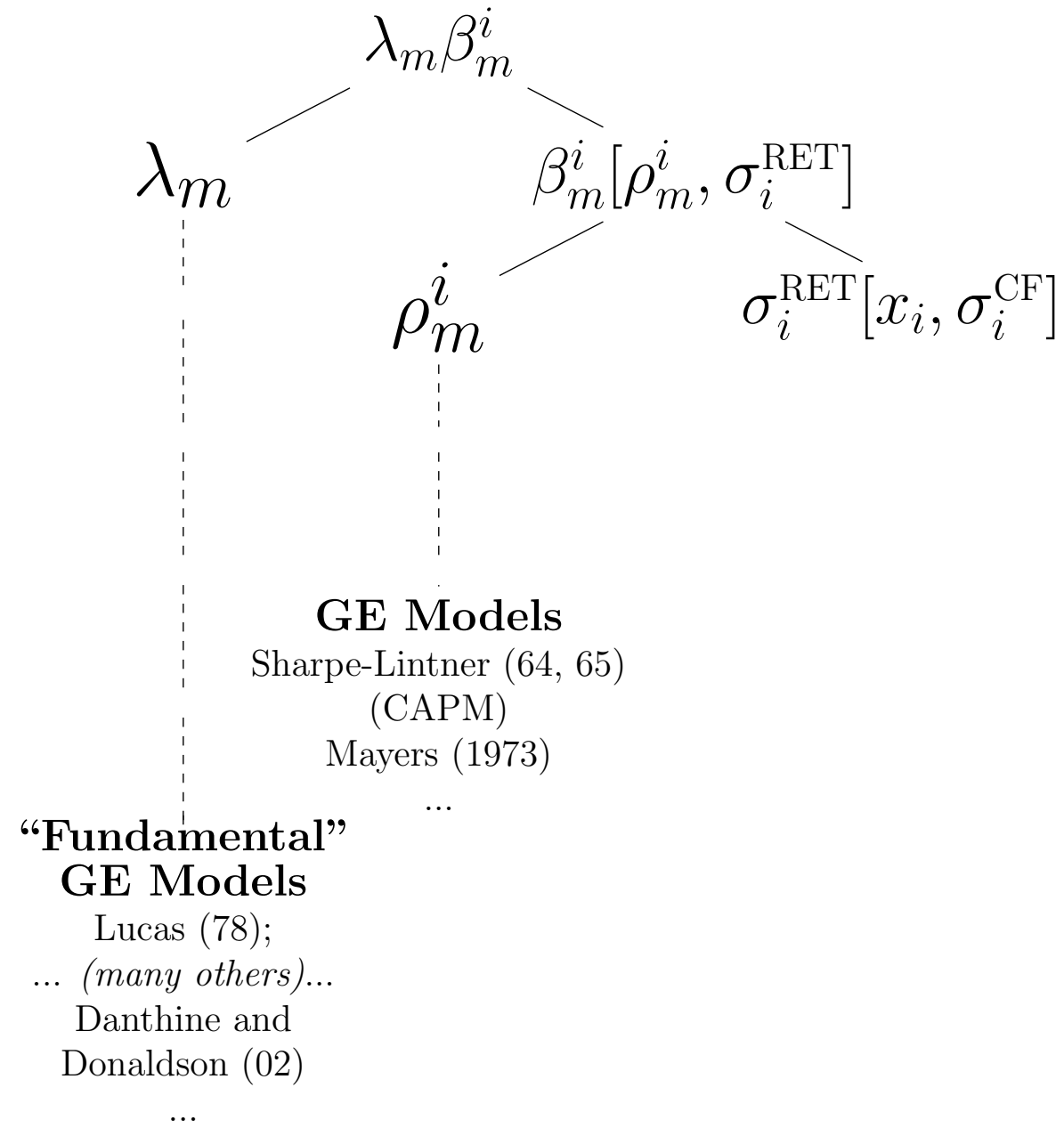
"Fundamental" GE Models

Lucas (78);
... *(many others)*...
Danthine and Donaldson (02)
...

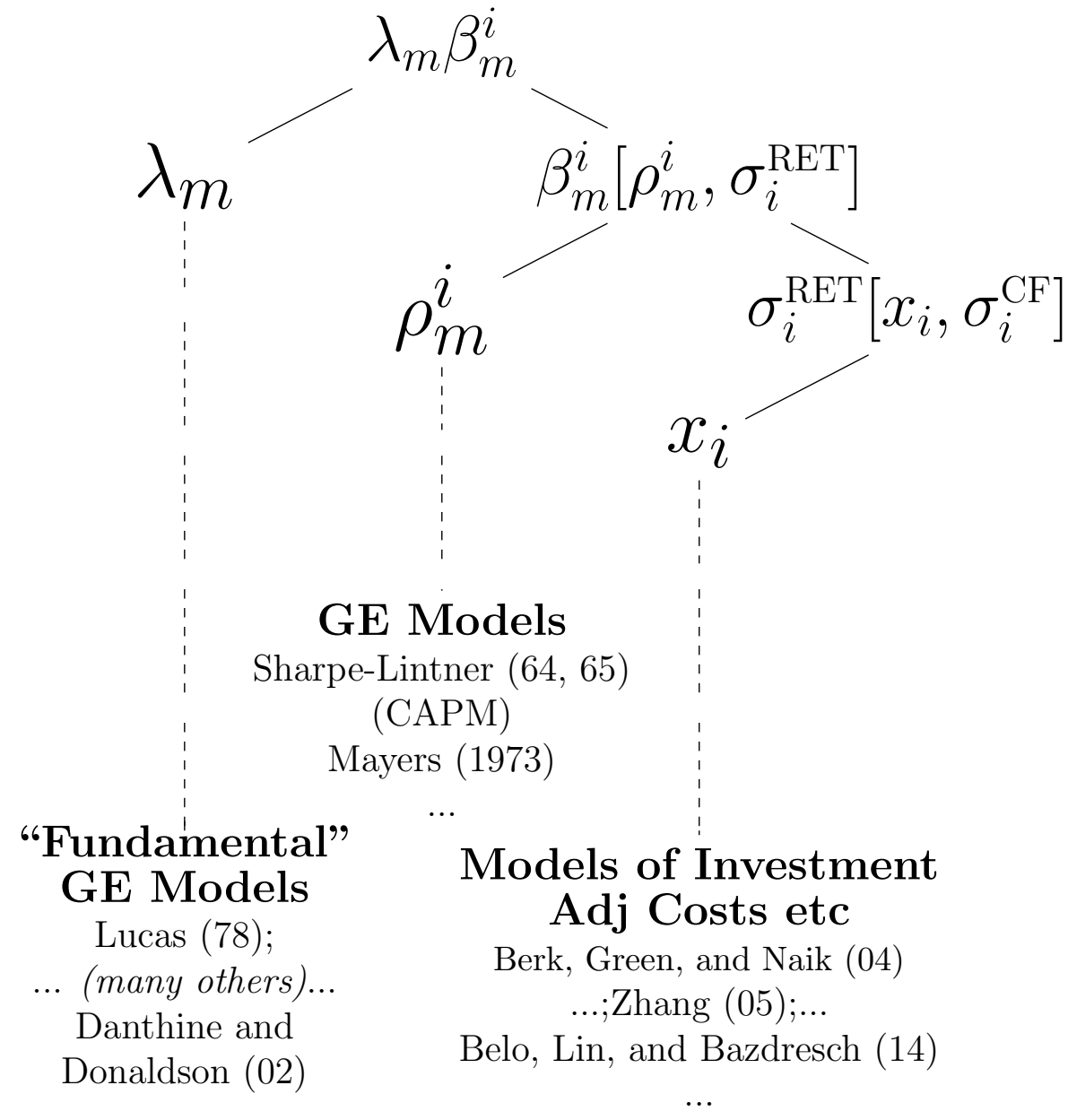
This paper and the literature



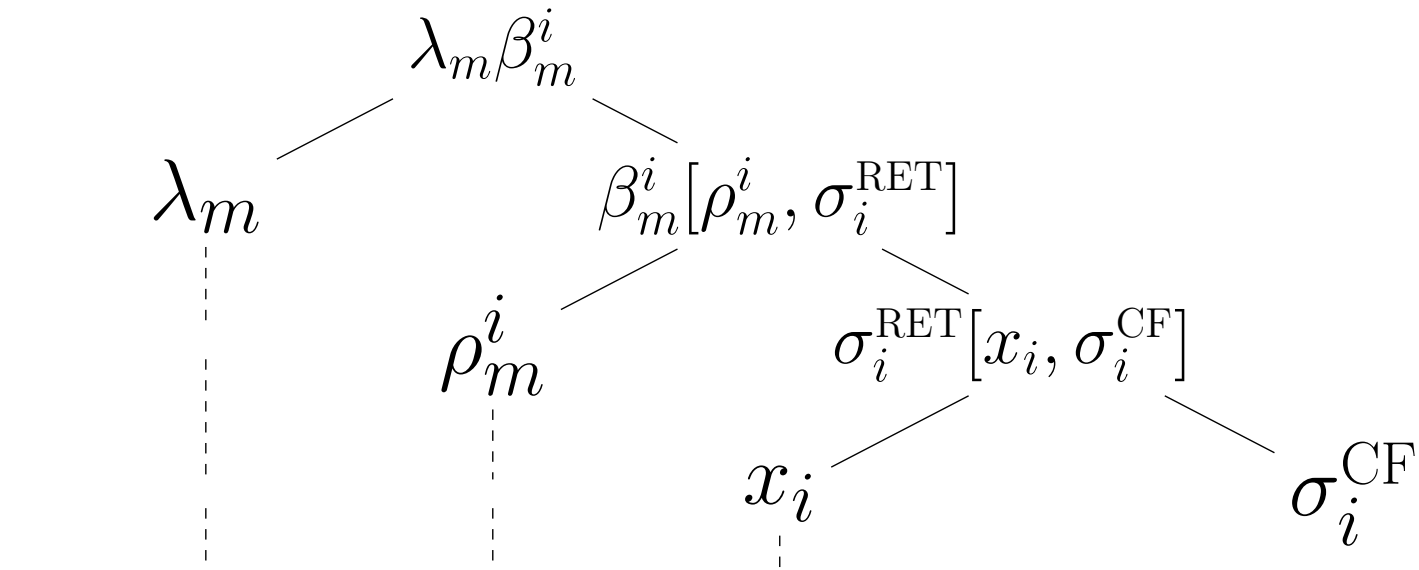
This paper and the literature



This paper and the literature



This paper and the literature

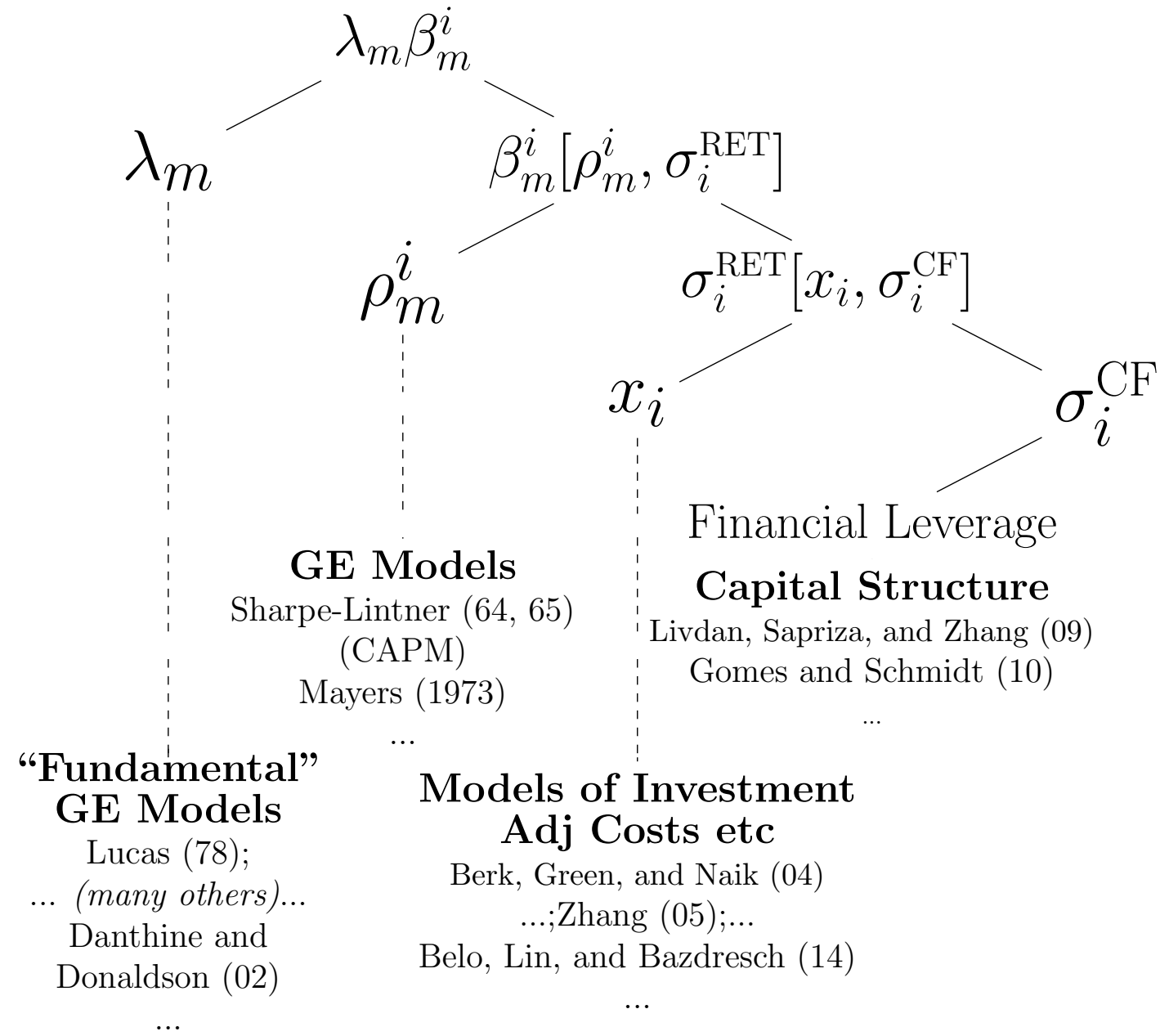


GE Models
Sharpe-Lintner (64, 65)
(CAPM)
Mayers (1973)
...

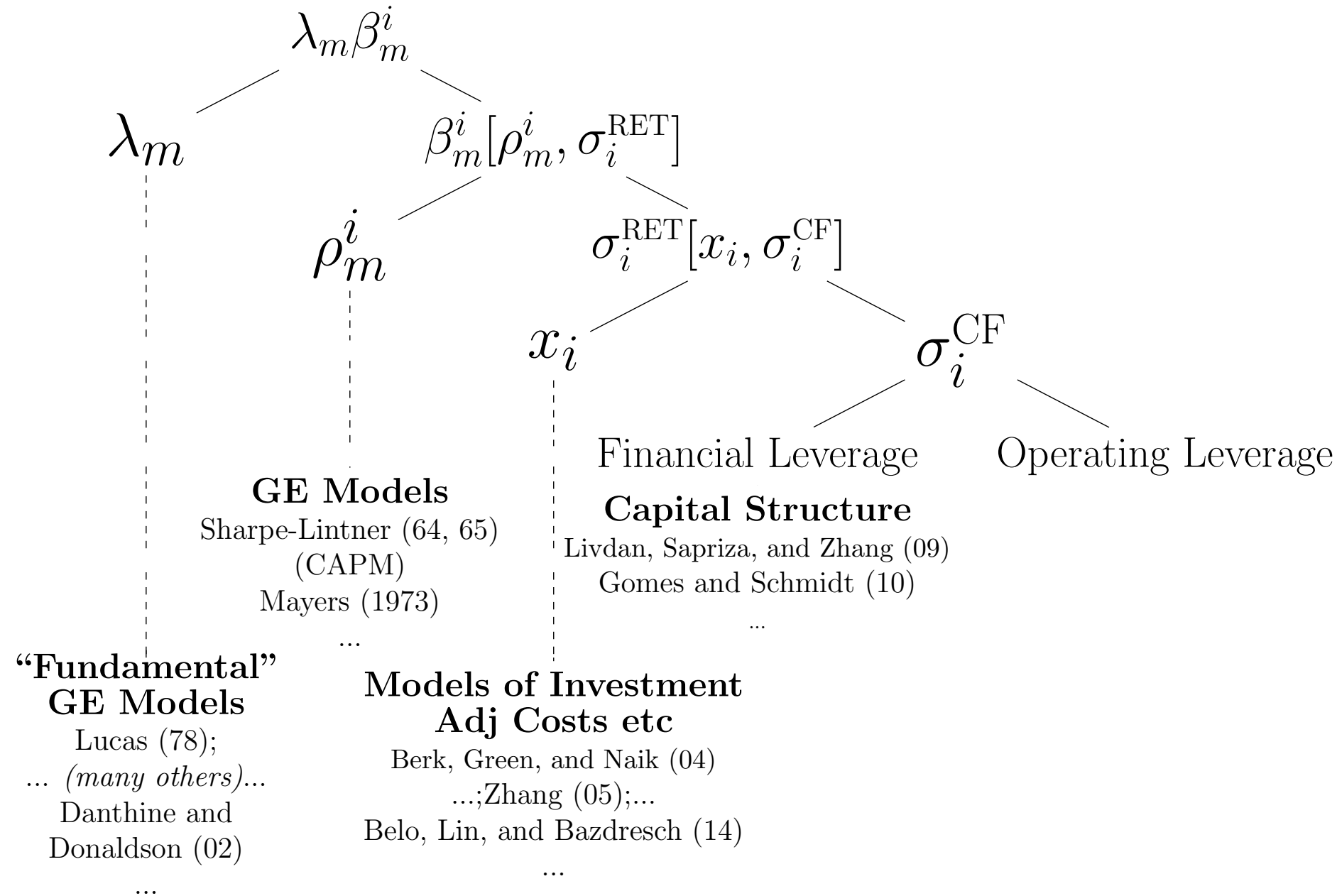
"Fundamental" GE Models
Lucas (78);
... *(many others)*...
Danthine and Donaldson (02)
...

Models of Investment Adj Costs etc
Berk, Green, and Naik (04)
...;Zhang (05);...
Belo, Lin, and Bazdresch (14)
...

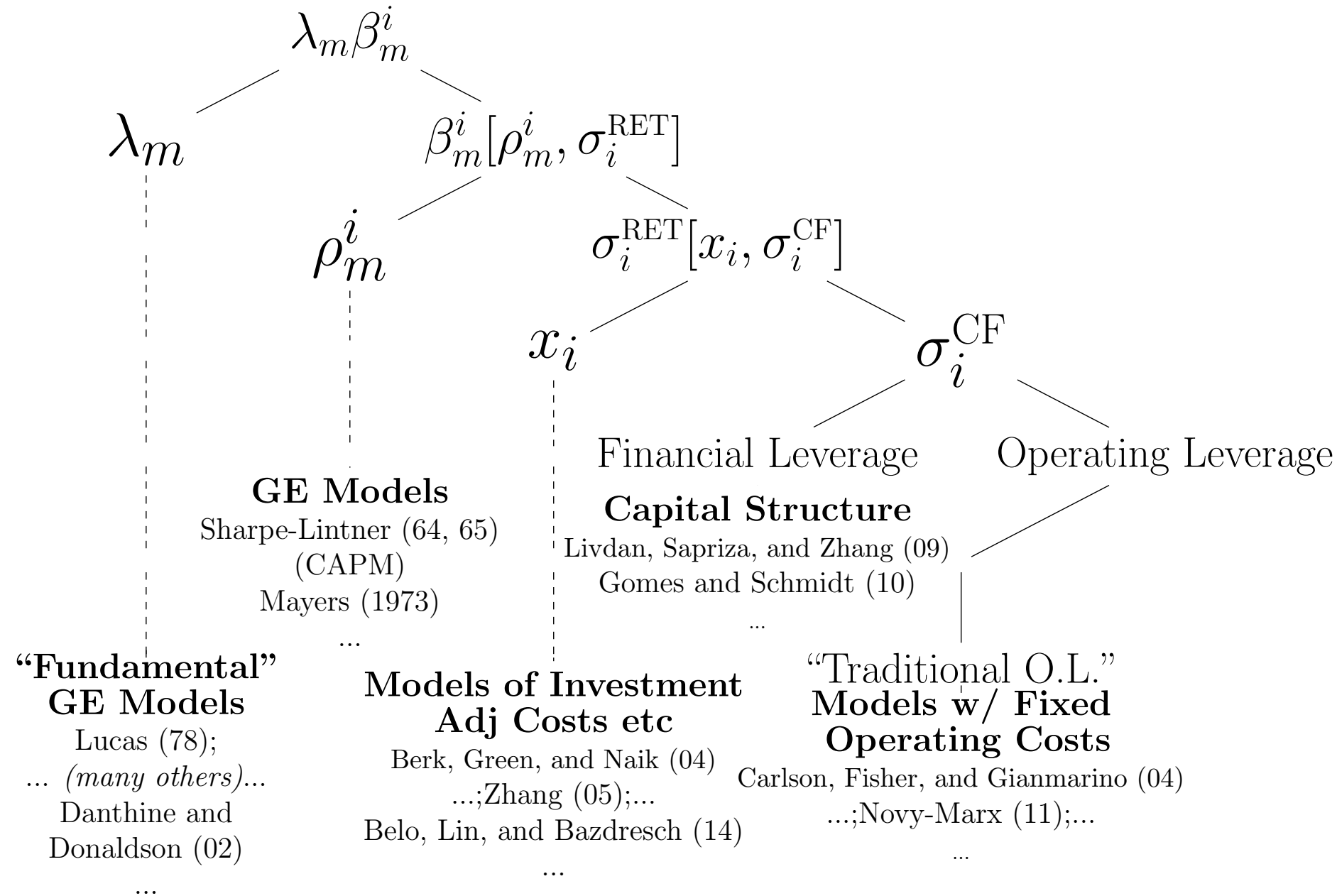
This paper and the literature



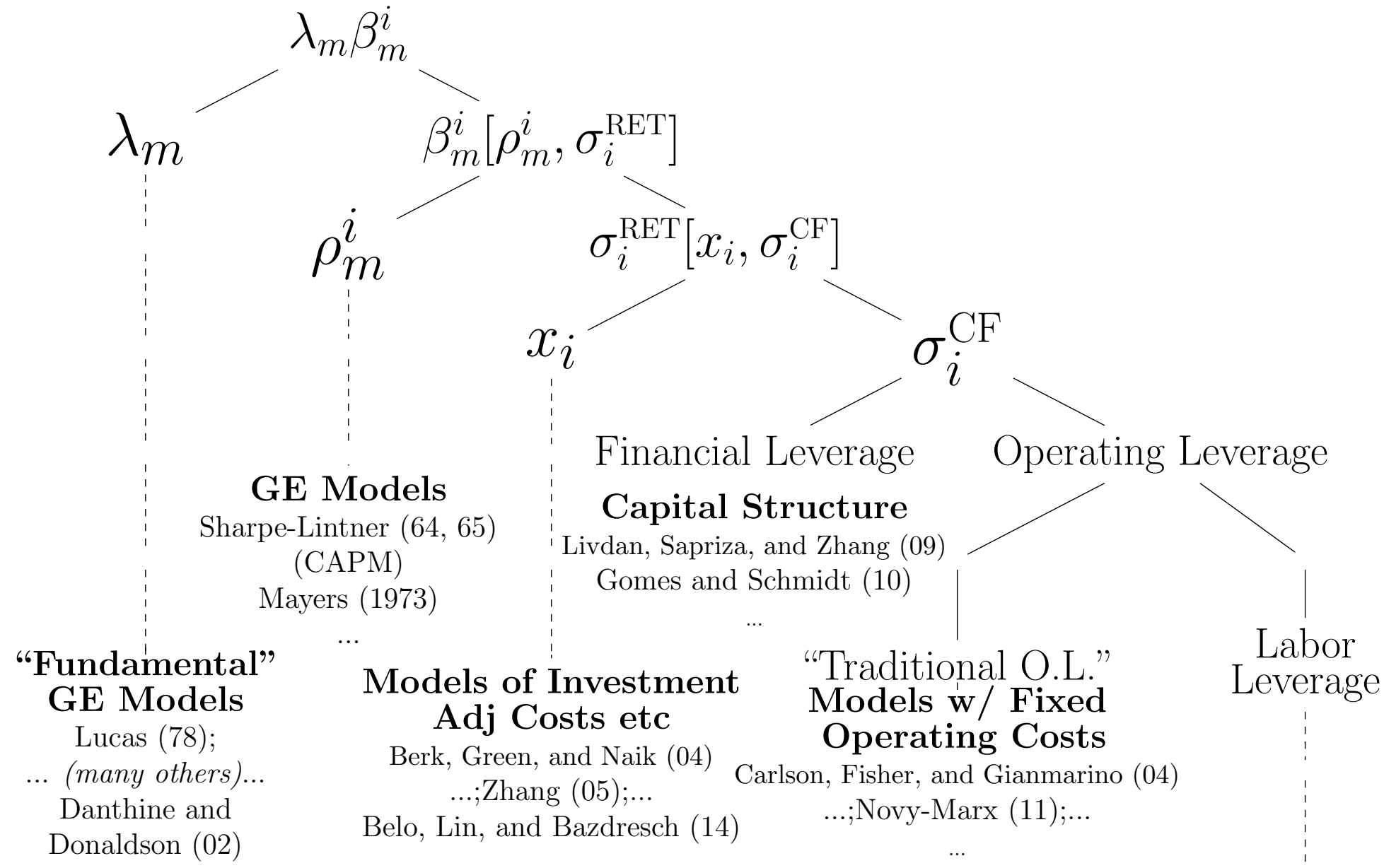
This paper and the literature



This paper and the literature



This paper and the literature



This paper and the literature

1. Note: We are not explaining anomalies
2. We are pointing out the relevance for labor leverage in the cross-section of expected returns

What is Labor Leverage?

- Cash flow risk amplification due to labor costs

What is Labor Leverage?

- Cash flow risk amplification due to labor costs
- What is special about labor costs?
  - Main operating cost for firms
  - Smoother than other costs:

What is Labor Leverage?

- Cash flow risk amplification due to labor costs
- What is special about labor costs?
  - Main operating cost for firms
  - Smoother than other costs:

	Cost (Dependent Variable)					
	Δlc	Δnlc	Δtc	lc^g(%)	nlc^g(%)	tc^g(%)
Δsale	0.09***	0.72***	0.81***			
	(0.01)	(0.03)	(0.03)			
$sale^g$(%)				0.43***	1.46***	1.07***
				(0.16)	(0.28)	(0.12)
Firm FE	Y	Y	Y	Y	Y	Y
R-sq. (%)	19.23	72.88	76.69	0.00	9.96	59.25
Obs.	8,173	8,173	8,173	8,173	8,173	8,173

What causes Labor Leverage?

- "Keynesian" mechanisms (i.e., driven by K-L relations):
  - Labor Risk Insurance: ...; Danthine and Donaldson (2002); Parlour and Walden (2011); Berk and Walden (2013); (Mindy) Zhang (2014); ...
  - Unions: Chen, Kacperczyk, and Ortiz-Molina (2011);...
  - Job Search and Wage Bargaining: Petrosky-Nadeau, Zhang, and Kuehn (2013); ...
  - Wage Rigidity: Favilukis and Lin (2015a,b); ...

- "Neo-Classical" mechanisms (i.e., technology driven):
  - L-K Complementarity: Gourio (2007) (now subsumed by this paper); Palacios (2012)
  - Labor Mobility: Donangelo (2014);

A Broad Definition of Labor Leverage

- Value Added: $Y[X_t, W_t]$
- Operating Profits: $\Pi[X_t, W_t]$

(X_t is TFP or price of good produced, W_t is wage rate)

A Broad Definition of Labor Leverage

- Value Added: $Y[X_t, W_t]$
- Operating Profits: $\Pi[X_t, W_t]$

(X_t is TFP or price of good produced, W_t is wage rate)

- Labor Leverage (ℓ)

$$\ell \equiv \frac{d\Delta\pi_t / d\Delta x_t}{d\Delta y_t / d\Delta x_t} - 1$$

(π, x, and y denote the logs of Π, X, and Y)

Link Between Labor Share and Labor Leverage

- Adding some structure:

$$Y_t = X_t F[K, L_t] \qquad \text{(value added)}$$

$$\Pi_t = \max_{L_t} \{X_t F[K, L_t] - L_t W_t\} \qquad \text{(operating profits)}$$

Link Between Labor Share and Labor Leverage

- Adding some structure:

$$Y_t = X_t F[K, L_t] \qquad \text{(value added)}$$
$$\Pi_t = \max_{L_t}\{X_t F[K, L_t] - L_t W_t\} \qquad \text{(operating profits)}$$

- Labor Leverage: $\ell = \dfrac{(1-\gamma)\frac{S_t}{1-S_t}\left(1-\frac{\partial \Delta w_t}{\partial \Delta x_t}\right)}{1+\gamma\frac{S_t}{1-S_t}\left(1-\frac{\partial \Delta w_t}{\partial \Delta x_t}\right)}$

$$\gamma \equiv \frac{F_{\mathrm{K}}[K,L]F_{\mathrm{L}}[K,L]}{F[K,L]F_{\mathrm{KL}}[K,L]} \text{ (K-L Elasticity of Substitution)}$$

Link Between Labor Share and Labor Leverage

- Adding some structure:

$$Y_t = X_t F[K, L_t] \qquad \text{(value added)}$$
$$\Pi_t = \max_{L_t}\{X_t F[K, L_t] - L_t W_t\} \qquad \text{(operating profits)}$$

- Labor Leverage: $\ell = \dfrac{(1-\gamma)\frac{S_t}{1-S_t}\left(1-\frac{\partial \Delta w_t}{\partial \Delta x_t}\right)}{1+\gamma\frac{S_t}{1-S_t}\left(1-\frac{\partial \Delta w_t}{\partial \Delta x_t}\right)}$

$$\gamma \equiv \frac{F_{\mathrm{K}}[K,L]F_{\mathrm{L}}[K,L]}{F[K,L]F_{\mathrm{KL}}[K,L]} \text{ (K-L Elasticity of Substitution)}$$

- Labor Leverage is increasing in Labor Share (S) when:
  - Wages are sufficiently smooth: $\frac{\partial \Delta w_t}{\partial \Delta x_t} < 1$
  - K and L are strictly complements: $\gamma < 1$

Link Between Labor Share and Labor Leverage

- Adding some structure:

$$Y_t = X_t F[K, L_t] \qquad \text{(value added)}$$
$$\Pi_t = \max_{L_t} \{X_t F[K, L_t] - L_t W_t\} \qquad \text{(operating profits)}$$

- Labor Leverage: $\ell = \dfrac{(1-\gamma)\frac{S_t}{1-S_t}\left(1-\frac{\partial \Delta w_t}{\partial \Delta x_t}\right)}{1+\gamma\frac{S_t}{1-S_t}\left(1-\frac{\partial \Delta w_t}{\partial \Delta x_t}\right)}$

$$\gamma \equiv \frac{F_{\mathrm{K}}[K,L]F_{\mathrm{L}}[K,L]}{F[K,L]F_{\mathrm{KL}}[K,L]} \text{ (K-L Elasticity of Substitution)}$$

- Labor Leverage is increasing in Labor Share (S) when:
  - Wages are sufficiently smooth: $\frac{\partial \Delta w_t}{\partial \Delta x_t} < 1$
  - K and L are strictly complements: $\gamma < 1$

Link Between Labor Share and Labor Leverage

- Adding some structure:

$$Y_t = X_t F[K, L_t] \qquad \text{(value added)}$$
$$\Pi_t = \max_{L_t}\{X_t F[K, L_t] - L_t W_t\} \qquad \text{(operating profits)}$$

- Labor Leverage: $\ell = \dfrac{(1-\gamma)\frac{S_t}{1-S_t}\left(1-\frac{\partial \Delta w_t}{\partial \Delta x_t}\right)}{1+\gamma\frac{S_t}{1-S_t}\left(1-\frac{\partial \Delta w_t}{\partial \Delta x_t}\right)}$

$\gamma \equiv \frac{F_{\mathrm{K}}[K,L]F_{\mathrm{L}}[K,L]}{F[K,L]F_{\mathrm{KL}}[K,L]}$ (K-L Elasticity of Substitution)

- Labor Leverage is increasing in Labor Share (S) when:
  - Wages are sufficiently smooth: $\frac{\partial \Delta w_t}{\partial \Delta x_t} < 1$
  - K and L are strictly complements: $\gamma < 1$

Sidenote

- Model implies $\gamma = \frac{\partial \Delta y_t / \partial \Delta x_t - 1}{\partial \Delta \pi_t / \partial \Delta x_t - 1}$. Thus, labor leverage present if

$$\partial \Delta \pi_t / \partial \Delta x_t > \partial \Delta y_t / \partial \Delta x_t$$

- We will use this result to verify the conditions for labor leverage are met

Empirical Results

Measure of Firm-Level Labor Share

Two constructed measures of labor share:

1. Main measure of labor share (LS):

$$\text{LS}_{it} \equiv \frac{\text{XLR}_{it}}{\text{OIBDP}_{it}+\text{XLR}_{it}+\text{INVFG}_{it}-\text{INVFG}_{it-1}}$$

Measure of Firm-Level Labor Share

Two constructed measures of labor share:

1. Main measure of labor share (LS):

$$\text{LS}_{it} \equiv \frac{\text{XLR}_{it}}{\text{OIBDP}_{it}+\text{XLR}_{it}+\text{INVFG}_{it}-\text{INVFG}_{it-1}}$$

2. Extended measure of labor share (ELS):

$$\text{ELS}_{it} \equiv \begin{cases} \text{LS}_{it} & \text{if LS}_{it} \text{ is non-missing} \\ \dfrac{\text{LABEX}_{it}}{\text{OIBDP}_{it}+\text{LABEX}_{it}+\text{INVFG}_{it}-\text{INVFG}_{it-1}} & \text{if LS}_{it} \text{ is missing,} \end{cases}$$

where LABEX = EMP x Industry Average of (XLR/EMP)

Characteristics of Firms Sorted by Labor Share

	1	2	3	4	5	6	7	8	9	10	11
	LS	ELS	Log. L/K	B/M	Log. Size	Log. Asset	Tang.	Org. Cap.	Lev.	Prof.	Obs/ Year
All	0.62	0.65	3.01	0.62	6.48	6.69	0.31	1.23	0.50	0.34	1632
L	0.33	0.32	0.81	0.63	7.22	7.43	0.59	0.63	0.58	0.21	326
2	0.53	0.53	2.60	0.49	6.89	6.83	0.32	1.17	0.47	0.39	327
3	0.65	0.65	3.09	0.57	6.56	6.64	0.30	1.28	0.47	0.40	327
4	0.74	0.74	3.31	0.69	6.22	6.53	0.28	1.37	0.49	0.37	327
H	0.85	0.85	3.63	0.82	5.74	6.28	0.27	1.43	0.52	0.33	326

Cyclicality of Labor Share

Validation of LS and ELS as Measures of Labor Leverage

	Proxy for Labor Share (S)					
	LS			ELS		
	I	II	III	I	II	III
gdp_t^g	-0.33***			-0.46***		
	(0.12)			(0.10)		
tfp_t^g		-0.43*			-0.52**	
		(0.25)			(0.23)	
mkt_t^g			-0.03*			-0.06***
			(0.02)			(0.02)
Firm FE	Y	Y	Y	Y	Y	Y
R-sq. (%)	0.54	0.30	0.16	0.34	0.14	0.25
Obs.	13,508	13,508	13,508	75,720	75,720	75,720

Sensitivity of Operating Profit Growth to Shocks

Validation of LS and ELS as Measures of Labor Leverage

	S=LS			S=ELS		
	Aggregate Shock			Aggregate Shock		
	gdp^g	tfp^g	mkt^g	gdp^g	tfp^g	mkt^g
shock_t	1.96***	2.83***	0.18***	2.37***	2.79***	0.28***
	(0.23)	(0.59)	(0.05)	(0.26)	(0.67)	(0.06)
$\text{S}_{it-1} \times \text{shock}_t$	1.15***	1.53***	0.12***	0.54***	0.90***	0.06*
	(0.21)	(0.45)	(0.04)	(0.26)	(0.03)	
S_{it-1}	0.13***	0.14***	0.16***	0.16***	0.16***	0.18***
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Firm FE	Y	Y	Y	Y	Y	Y
R-sq. (%)	10.89	9.11	6.80	8.59	6.98	7.21
Obs.	13,530	13,530	13,530	68,873	68,873	68,873

Elasticity of Profits and Value Added

Validation of LS and ELS as Measures of Labor Leverage

	Elasticities of profits and value added					
	$\hat{\Theta}^{\Pi}$			$\hat{\Theta}^{Y}$		
	I	II	III	I	II	III
gdp_t^g	9.29^{***}			7.55^{***}		
	(0.17)			(0.15)		
tfp_t^g						
		16.01^{***}			12.50^{***}	
		(0.30)			(0.23)	
MKT_t			1.18^{***}			0.85^{***}
			(0.02)			(0.01)
R-sq. (%)	0.09	0.07	0.04	0.07	0.05	0.03
Obs.	54,406	54,406	54,406	54,406	54,406	54,406

Labor Share and Measures of Risk

	Portfolio					
Factor	L	2	3	4	H	H-L
	Panel B: Average Betas of Portfolios Sorted on ELS					
MKT	1.05***	1.31***	1.37***	1.44***	1.52***	0.47***
	(0.07)	(0.05)	(0.05)	(0.05)	(0.07)	(0.07)
SMB	0.73***	1.05***	1.21***	1.32***	1.56***	0.83***
	(0.13)	(0.12)	(0.13)	(0.14)	(0.13)	(0.05)
HML	-0.43***	-0.67***	-0.60**	-0.57**	-0.55**	-0.12
	(0.15)	(0.21)	(0.23)	(0.23)	(0.24)	(0.10)
tfp^{g}	3.81	4.93*	5.15**	5.38**	5.93**	2.12**
	(2.41)	(2.44)	(2.26)	(2.39)	(2.43)	(0.80)
gdp^{g}	1.78	2.17	2.86	2.88	3.56	1.78**
	(1.93)	(2.13)	(2.00)	(1.96)	(2.20)	(0.83)
$wage^{g}$	0.84	0.18	4.02	3.14	3.66	2.83
	(1.82)	(3.38)	(3.19)	(2.93)	(3.36)	(2.09)

Labor Share and Stock Returns

Excess Stock Returns (VW), Firms Sorted on Labor Share, 1963-2012

	Portfolio					
	L	2	3	4	H	H-L
LS_{t-2}	6.11***	7.80***	6.26***	5.73**	10.18***	4.06*
	(1.91)	(1.90)	(2.01)	(2.67)	(2.46)	(2.20)
ELS_{t-2}	6.98***	7.36***	7.00***	7.47***	10.23***	3.25*
	(1.79)	(1.78)	(1.74)	(2.11)	(2.54)	(1.92)

Structural Model

If we have time...

Model Setup
Economic environment

- Pricing kernel:

$$\frac{d\Lambda_t}{\Lambda_t} = -r dt - \eta dZ_t^{\lambda}$$

- Wages:

$$\frac{dW_t}{W_t} = \mu_{\mathrm{w}} dt + \sigma_{\mathrm{w}} \rho_{\mathrm{w}} dZ^{\lambda} + \sigma_{\mathrm{w}} \sqrt{1 - \rho_{\mathrm{w}}^2} dZ^{\mathrm{w}},$$

Model Setup
Output and Productivity

- Value added: $Y_t = X_t \left(\alpha L_t^{\rho} + (1-\alpha) K_t^{\rho}\right)^{\frac{1}{\rho}}$,

Model Setup
Output and Productivity

- Value added: $Y_t = X_t \left(\alpha L_t^{\rho} + (1-\alpha) K_t^{\rho}\right)^{\frac{1}{\rho}}$,
  $\gamma = \frac{1}{1-\rho}$ K-L Elasticity of Substitution

Model Setup
Output and Productivity

- Value added: $Y_t = X_t \left(\alpha L_t^{\rho} + (1-\alpha) K_t^{\rho}\right)^{\frac{1}{\rho}}$,
  $\gamma = \frac{1}{1-\rho}$ K-L Elasticity of Substitution

- Productivity:
$$\frac{dX_t}{X_t} = \mu_{\text{x}} dt + \sigma_{\text{x}} \rho_{\text{x}} dZ^{\lambda} + \sigma_{\text{x}} \sqrt{1-\rho_{\text{x}}^2} dZ^{\text{x}}.$$

Model Setup

Labor Share and Operating Profits

Labor Share dynamics:

$$\frac{dS_t}{S_t} = \mu_{\mathrm{s}} dt + \sigma_{\mathrm{s}\lambda} dZ^{\lambda} + \sigma_{\mathrm{sw}} dZ^{\mathrm{w}} + \sigma_{\mathrm{sx}} dZ^{\mathrm{x}}$$

Model Setup

Labor Share and Operating Profits

Labor Share dynamics:

$$\frac{dS_t}{S_t} = \mu_{\mathrm{s}} dt + \sigma_{\mathrm{s}\lambda} dZ^{\lambda} + \sigma_{\mathrm{sw}} dZ^{\mathrm{w}} + \sigma_{\mathrm{sx}} dZ^{\mathrm{x}}$$

Strict L-K complementarity $(0 < \gamma < 1)$ implies X-S relations:

$$\sigma_{\mathrm{sx}} = -(1-\gamma)\,\sigma_{\mathrm{x}}\sqrt{1-\rho_{\mathrm{x}}^2} < 0, \quad \text{(LS lower in high productivity firms (X-S))}$$

$$\sigma_{\mathrm{sw}} = (1-\gamma)\,\sigma_{\mathrm{w}}\sqrt{1-\rho_{\mathrm{w}}^2} > 0, \quad \text{(LS higher in high-wage paying firms (X-S))}$$

Model Setup

Labor Share and Operating Profits

Labor Share dynamics:

$$\frac{dS_t}{S_t} = \mu_{\mathrm{s}} dt + \sigma_{\mathrm{s}\lambda} dZ^{\lambda} + \sigma_{\mathrm{sw}} dZ^{\mathrm{w}} + \sigma_{\mathrm{sx}} dZ^{\mathrm{x}}$$

Strict L-K complementarity $(0 < \gamma < 1)$ implies X-S relations:

$$\sigma_{\mathrm{sx}} = -(1-\gamma)\,\sigma_{\mathrm{x}}\sqrt{1-\rho_{\mathrm{x}}^2} < 0, \qquad \text{(LS lower in high productivity firms (X-S))}$$

$$\sigma_{\mathrm{sw}} = (1-\gamma)\,\sigma_{\mathrm{w}}\sqrt{1-\rho_{\mathrm{w}}^2} > 0, \qquad \text{(LS higher in high-wage paying firms (X-S))}$$

+ Relative smoothness of wages implies

$$\sigma_{\mathrm{s}\lambda} = -(1-\gamma)\,(\rho_{\mathrm{x}}\sigma_{\mathrm{x}} - \rho_{\mathrm{w}}\sigma_{\mathrm{w}}) < 0, \qquad \text{(LS is countercyclical (T-S))}$$

Model Calibration

Model Calibration

- Motivation:
  1. Use model as a proof-of-concept for theory
  2. Study relation between endogenously determined LS and labor leverage and stock returns

Model Calibration

- Motivation:
  1. Use model as a proof-of-concept for theory
  2. Study relation between endogenously determined LS and labor leverage and stock returns
- SMM details:
  - Number of simulations per calibration pass: 10,000
  - Number of firms per simulation: 10,000
  - Number of years per simulations: 100
  - Number of periods per year: 12

Calibration Results

	Data				Model			
Panel A: Smoothness and Cyclicality of Macroeconomic Variables								
Variable	gdp^g	tfp^g	$wage^g$	$profit^g$	gdp^g	tfp^g	$wage^g$	$profit^g$
gdp^g	1.000				1.000			
tfp^g	**0.862**	1.000			0.983	1.000		
$wage^g$	**0.275**	**0.480**	1.000		0.256	0.367	1.000	
$profit^g$	0.628	0.621	-0.063	1.000	0.995	0.959	0.190	1.000
σ	**0.030**	**0.017**	**0.015**	0.105	0.030	0.024	0.020	0.036
Slope on gdp^g *	1.000	0.494	0.141	2.222	1.000	0.784	0.171	1.183
Panel B: CS Std. Dev. of Firm-Level Value-Added Growth								
	0.131				0.151			
Panel C: Mean and Cross-Sectional Standard Deviation of Labor Share								
Mean	**0.594**				0.583			
σ	**0.186**				0.181			
Panel D: Elasticity of Substitution Between Labor and Capital								
	$\hat{\Theta}^{\Pi}$	$\hat{\Theta}^{Y}$	$\hat{\rho}$	EOS	$\hat{\Theta}^{\Pi}$	$\hat{\Theta}^{Y}$	$\hat{\rho}$	EOS
	10.19	5.68	-1.50	0.40	2.17	1.47	-1.45	0.405
Panel E: Sensitivity of Operating Profit Growth to GDP and TFP Shocks								
	gdp^g		tfp^g		gdp^g		tfp^g	
gdp^g_t	**1.96**				1.88			
$S_{it-1} \times gdp^g_t$	**1.15**				0.80			
tfp^g_t			**1.53**				2.17	
$S_{it-1} \times tfp^g_t$			**2.83**				0.84	
S_{it-1}	0.13		0.14		-0.01		-0.01	

Calibration Results

	Data	Model
Portfolio Sorts (Unlevered Stock Returns / Asset Returns)		
L	**2.83**	2.45
2	3.69	2.93
3	4.69	3.28
4	4.14	3.67
H	**4.72**	4.38
H-L	**1.89**	1.93

Conclusion

Conclusion

1. L-K Complementarity + Smooth Wages $\Rightarrow$ Labor-Induced Form of Operating Leverage ("Labor Leverage")
2. Novel theoretically motivated measure of firm-level labor leverage
3. Evidence for the economic significance of labor leverage for cash flows and for equity returns