Value and Profitability Premium in General Equilibrium

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Introduction

- The coexistence of value/profitability premium presents a challenge to production asset pricing models
  - High market to book ratio (growth) firms earn *lower* average returns than value firms
  - High profits to asset ratio (profitability) firms earn *higher* returns than low profitability firms

- Standard productivity-based asset pricing models: growth firms are also high-profitability firms

Introduction

This paper

- ▷ Empirically, document a two-factor structure in firm productivity
  - Growth firms have a higher permanent component of productivity than value
  - High profitability firms have a higher transitory component than low-profitability firms
- ▷ Theoretically, a heterogeneous firm model in GE
  - incorporate a two-factor structure of productivity: permanent + transitory component
  - jointly explain value and profitability premium
  - composition effect of expected returns in GE

Literature review

Value and profitability premium

- Novy-Marx (2013), Ma and Yan (2018), Bouchaud Krueger Landier and Thesmar (2019), Deng (2020), Dou Ji and Wu (2020), Kogan Li and Zhang (2020), ...

Cross-section of stock returns with production

- Gomes, Kogan and Zhang (2003), Zhang (2005), Papanikolaou (2011), Belo, Lin, and Bazdresch (2014), Favilukis and Lin (2015), Herskovic, Kind, and Kung (2018), Bai, Hou, Kung, Li and Zhang (2019) ,Ai and Bhandari (2020), Gomes and Schmid (2020), Ai, Li and Li (2020), Segal and Grigoris (2022), ...

Asset pricing in production economies

- Jermann (1998), Boldrin Christiano and Fisher (2001), Danthine and Donaldson (2002), Kaltenbrunner Lochstoer (2010), Croce (2014),Kung and Schmid (2015), Kogan Papanikolaou and Stoffman (2018), Corhay Kung and Schmid (2020),...

Empirical findings

The value and profitability premium puzzle

Table: Firm characteristics

Panel A: Market-to-book sorted portfolios

	Value	2	3	4	Growth	Growth-Value
MB	0.588	1.083	1.655	2.683	6.200	5.612
GP/A	0.181	0.219	0.278	0.328	0.336	0.155
ln *TFP*	-3.990	-3.713	-3.524	-3.319	-3.092	0.898
$E[R^e](\%)$	10.115	7.707	7.485	7.019	6.856	-3.259

Panel B: Gross profitability sorted portfolios

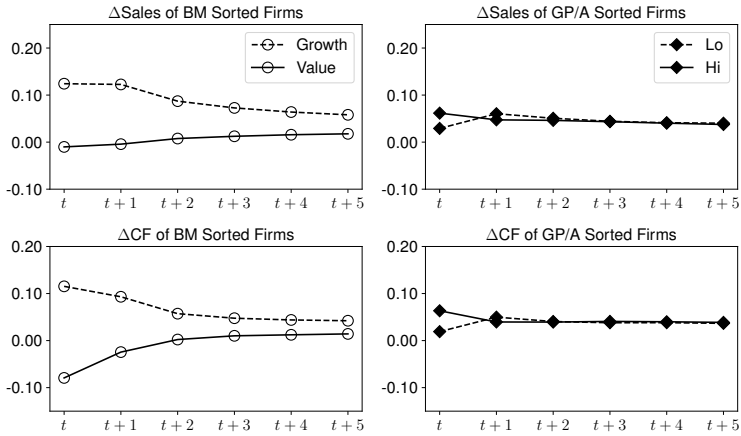
	Low	2	3	4	High	High-Low
MB	1.461	1.205	1.478	1.785	2.251	0.790
GP/A	0.001	0.136	0.265	0.411	0.670	0.669
ln *TFP*	-3.999	-3.938	-3.721	-3.410	-3.210	0.789
$E[R^e](\%)$	4.700	6.333	5.443	7.275	8.018	3.319

Main empirical findings

- ▷ Firm-level productivity has two components: permanent and transitory
- ▷ Growth firms have a higher permanent component of productivity than value
- ▷ High-profitability has a higher transitory component of productivity than low-productivity

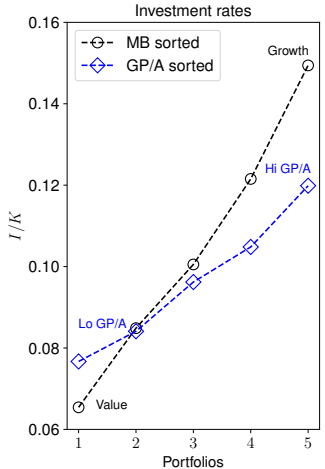
Evidence 1: sales growth and cash flow growth

Figure: Firm characteristics around portfolio formation



Evidence 2: investment

Figure: Investment rates



Evidence 3: A formal statistical decomposition

- A formal stats decomposition to validate two-factor structure

$$\ln TFP_{j,t} = x_{j,t} + z_{j,t}$$

- Permanent component $x_{j,t}$

$$x_{j,t} = \mu_j + x_{j,t-1} + \sigma_{x,j}\varepsilon_{j,t}$$

- Transitory component $z_{j,t}$

$$z_{j,t} = \rho_{z,j} z_{j,t-1} + \sigma_{z,j}\eta_{j,t}$$

- Follow Harvey (1985) to estimate the two components

Permanent and transitory components of TFP

Table: Permanent and transitory component

Panel A: Market-to-book sorted portfolios

	Value	2	3	4	Growth	Growth-Value
MB	0.588	1.083	1.655	2.683	6.200	5.612
ln *TFP*	-3.990	-3.713	-3.524	-3.319	-3.092	0.898
ln X	-3.828	-3.618	-3.458	-3.273	-3.054	0.774
ln Z	-0.024	-0.008	0.000	0.003	0.009	0.033

Panel B: Gross profitability sorted portfolios

	Low	2	3	4	High	High-Low
GP/A	0.001	0.136	0.265	0.411	0.670	0.669
ln *TFP*	-3.999	-3.938	-3.721	-3.410	-3.210	0.789
ln X	-3.807	-3.749	-3.608	-3.358	-3.183	0.624
ln Z	-0.042	-0.013	-0.005	0.000	0.006	0.048

▷ Variation in MB ratio is driven by variation in permanent productivity x

Model

Model setup

Households

- Rep consumer with recursive preference

$$\mathbf{U}_t = \left\{ (1-\beta)\mathbf{C}_t^{1-\frac{1}{\psi}} + \beta \left(E_t \left[\mathbf{U}_{t+1}^{1-\gamma} \right] \right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}} \right\}^{\frac{1}{1-\frac{1}{\psi}}}, \tag{1}$$

- Max utility subject to budget constraint

$$\mathbf{C}_t + \int \omega_{j,t} \left(V_{j,t} - D_{j,t} \right) dj + B_t = W_t \int L_{j,t} dj + R_{f,t-1} B_{t-1} + \int \omega_{j,t-1} V_{j,t} dj, \tag{2}$$

Model setup

Production technology

- Cobb-Douglas production function:

$$Y = A\left[\left(XZ\right)^{1-\nu}\left(uK\right)^{\nu}\right]^{\alpha} L^{1-\alpha}$$

  where u is the capital utilization rate

- Two-factor structure of productivity

$$\ln TFP_{j,t} = x_{j,t} + z_{j,t}$$

- Aggregate productivity A
  - Long run risk as in Bansal Yaron (2004), Croce (2014)

Model setup

Firm maximization problem

- Firm's maximization problem

$$V(K, X, Z|S) = \max_{I,u} D + (1 - \kappa_D)\mathbb{E}_t \left[M' V(K', X', Z'|S') \right]$$

subject to

$$K' = (1 - \delta(u, \theta'))K + I$$

$$D \leq \underbrace{\pi(X, Z, K|S)}_{\text{operating profit}} - I - \underbrace{H(I, K)}_{\text{adjustment cost}}$$

- Aggregate state S includes A, θ, and the distribution of firms over (K, X, Z)

- Profit function defined by:

$$\Pi(K_{j,t}, Z_{j,t}, X_{j,t}; S_t \| u_{j,t}) = \max_{L_{j,t}} A_t^{1-\alpha\nu} \left[(X_{j,t} Z_{j,t})^{1-\nu} (u_{j,t} K_{j,t})^{\nu} \right]^{\alpha} L_{j,t}^{1-\alpha} - W_t L_{j,t}. \quad (3)$$

Model setup

Entry and exit

- Existing firms die with probability κ
- New firms enter:

$$\Pi\left(K_{j,t}, Z_{j,t}, X_{j,t}; S_t \| u_{j,t}\right) = \max_{L_{j,t}} A_t^{1-\alpha\nu}\left[\left(X_{j,t}Z_{j,t}\right)^{1-\nu}\left(u_{j,t}K_{j,t}\right)^{\nu}\right]^{\alpha} L_{j,t}^{1-\alpha} - W_t L_{j,t}. \tag{4}$$

- Define a summary measure $m(\frac{K}{X}, Z)$
  - Firm distribution: $\Gamma(k, X, Z)$
  - Summary measure:

$$m(k, Z) = \int X\Gamma(k, X, Z)dX$$

  - Explicitly derive the law of motion of m

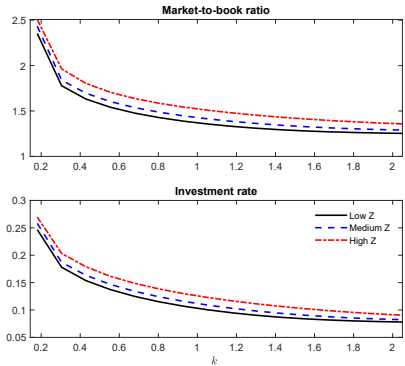
Model implications

Model implication I

Sorting on BM identifies permanent component X

- ▷ Sorting on BM identifies permanent component of productivity (not transitory component)
- ▷ Investment depends mostly on permanent component
- ▷ Heterogeneity in investment gives rise to value premium

Figure: Investment and market-to-book ratio

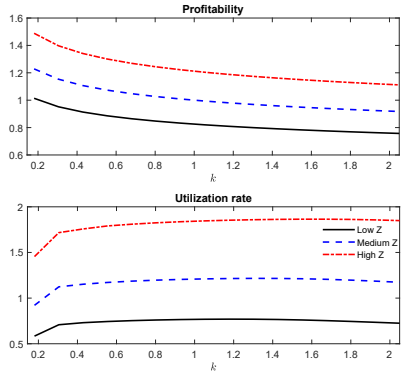


Model implication II

Sorting on profitability identifies transitory component Z

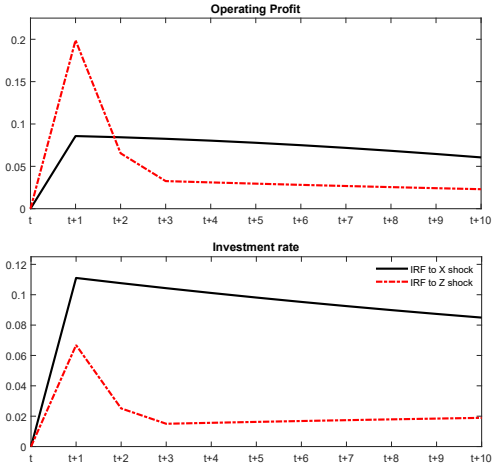
- ▷ Sorting on Profitability identifies transitory component of productivity (not permanent component)
- ▷ Utilization depends mostly on permanent component
- ▷ Heterogeneity in utilization gives rise to profitability premium

Figure: Utilization and profitability



The impact of persistence

Figure: Impulse response functions for transitory and permanent shocks



Model implication III

Value and profitability premium

Table: Cross-sectional moments

Panel A: Market-to-book sorted portfolios

	Value	2	3	4	Growth	Growth-Value
MB	1.32	1.41	1.58	1.79	2.50	1.18
GP/A	0.15	0.17	0.18	0.18	0.19	0.04
I/K	0.07	0.09	0.12	0.16	0.24	0.17
ln TFP	-0.10	-0.08	0.02	0.15	0.77	0.87
ln X	-0.15	-0.09	0.03	0.16	0.33	0.48
ln Z	0.01	-0.04	-0.03	-0.06	0.23	0.23
$E[R^e](\%)$	6.12	4.85	3.51	2.83	-0.73	-6.85

Model implication III

Value and profitability premium

Table: Cross-sectional moments

Panel B: Gross profitability sorted portfolios

	Low	2	3	4	High	High-Low
MB	1.41	1.63	1.51	1.65	1.65	0.24
GP/A	0.11	0.15	0.18	0.20	0.26	0.11
I/K	0.09	0.13	0.11	0.13	0.13	0.04
ln TFP	-0.89	-0.31	0.09	0.68	1.11	2.00
ln X	0.17	0.18	0.09	0.17	0.07	-0.10
ln Z	-1.04	-0.40	0.00	0.51	1.07	2.11
$E[R^e](\%)$	3.49	4.06	4.23	5.37	5.76	2.27

Model implication IV

Double sorted portfolios

Table: Double sorted portfolios using model-simulated data

Panel B: Model

	GP/A1	GP/A2	GP/A3	GP/A4	GP/A5	H-L	(t)
MB1	4.48	5.99	5.52	7.93	10.41	5.94	(9.11)
MB2	3.65	2.29	4.89	6.97	7.11	3.46	(7.18)
MB3	2.06	2.59	3.75	3.72	4.96	2.90	(7.69)
MB4	0.99	1.99	2.24	3.48	4.49	3.54	(10.87)
MB5	0.48	-1.32	-0.69	-2.82	0.13	0.81	(2.19)
H-L	-4.74	-7.01	-7.70	-10.75	-10.36		
(t)	(4.99)	(8.31)	(6.70)	(20.49)	(38.12)		

Model implication V

The composition effect of risk premium: model

Table: Distribution and risk premium in the model

	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$
Relative share of high k firms	0.003	0.006	0.009	0.012	0.014	0.017
R^2	0.77	0.77	0.77	0.76	0.76	0.75
Relative share of high Z firms	0.001	0.002	0.003	0.004	0.005	0.006
R^2	0.11	0.11	0.11	0.11	0.11	0.11

Model implication V

The composition effect of risk premium: data

Table: Return predictability in the data

	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$
Relative share of value firms	0.015	0.077	0.109	0.122	0.126	0.151
(t)	(0.70)	(2.39)	(3.12)	(3.61)	(3.23)	(2.77)
R^2	0.06	0.15	0.11	0.15	0.20	0.21
Relative share of profitable firms	0.072	0.146	0.173	0.217	0.277	0.290
(t)	(3.95)	(5.23)	(4.44)	(3.85)	(3.93)	(3.30)
R^2	0.14	0.26	0.19	0.25	0.33	0.29

Conclusion

- ▷ We document a two-factor structure of productivity that distinguishes value from profitability
- ▷ We build a GE model to incorporate the two factor structure
  - Productivity-based model that distinguishes value from profitability
  - Explains both value and profitability premium
  - General equilibrium: jointly explains prices and quantities; identifies a risk composition effect