

# Internet Appendix: “Aggregation, Capital Heterogeneity, and the Investment CAPM” (for Online Publication Only)

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## Abstract

This Online Appendix furnishes supplementary results for our manuscript “Aggregation, Capital Heterogeneity, and the Investment CAPM.”

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## A Derivations in the Benchmark 2-capital Model

Let  $q_{it}$  and  $q_{it}^W$  be the Lagrangian multipliers associated with  $K_{it+1} = I_{it} + (1 - \delta_{it})K_{it}$  and  $W_{it+1} = W_{it} + \Delta W_{it}$ , respectively. Form the Lagrangian function:

$$\begin{aligned}
\mathcal{L} = & \dots + (1 - \tau_t)(\Pi_{it} - \Phi_{it}) - I_{it} - \Delta W_{it} + B_{it+1} - r_{it}^B B_{it} + \tau_t \delta_{it} K_{it} + \tau_t (r_{it}^B - 1) B_{it} \\
& - q_{it}(K_{it+1} - (1 - \delta_{it})K_{it} - I_{it}) - q_{it}^W (W_{it+1} - W_{it} - \Delta W_{it}) \\
& + E_t[M_{t+1}[(1 - \tau_{t+1})(\Pi_{it+1} - \Phi_{it+1}) - I_{it+1} - \Delta W_{it+1} + B_{it+2} - r_{it+1}^B B_{it+1} + \tau_{t+1} \delta_{it+1} K_{it+1} \\
& + \tau_{t+1}(r_{it+1}^B - 1) B_{it+1} - q_{it+1}(K_{it+2} - (1 - \delta_{it+1})K_{it+1} - I_{it+1}) - q_{it+1}^W (W_{it+2} - W_{it+1} - \Delta W_{it+1})]] \\
& + \dots
\end{aligned} \tag{A.1}$$

Setting the first-order derivatives of  $\mathcal{L}$  with respect to  $I_{it}$ ,  $\Delta W_{it}$ ,  $K_{it+1}$ ,  $W_{it+1}$ , and  $B_{it+1}$  to zero yields, respectively:

$$q_{it} = 1 + (1 - \tau_t) \frac{\partial \Phi_{it}}{\partial I_{it}} \tag{A.2}$$

$$q_{it}^W = 1 \tag{A.3}$$

$$q_{it} = E_t \left[ M_{t+1} \left[ (1 - \tau_{t+1}) \left[ \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\partial \Phi_{it+1}}{\partial K_{it+1}} \right] + \tau_{t+1} \delta_{it+1} + (1 - \delta_{it+1}) q_{it+1}^K \right] \right] \tag{A.4}$$

$$q_{it}^W = E_t \left[ M_{t+1} \left[ (1 - \tau_{t+1}) \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} + q_{it+1}^W \right] \right] \tag{A.5}$$

$$1 = E_t [M_{t+1} (r_{it+1}^B - (r_{it+1}^B - 1) \tau_{t+1})] = E_t [M_{t+1} r_{it+1}^{Ba}] \tag{A.6}$$

Equations (A.2) and (A.4) yield  $E_t [M_{t+1} r_{it+1}^K] = 1$ , in which  $r_{it+1}^K$  is given by equation (2) in the main text, and equations (A.19) and (A.20) yield  $E_t [M_{t+1} r_{it+1}^W] = 1$ , in which  $r_{it+1}^W$  is given by equation (3).

To prove equation (4), we first show  $P_{it} + B_{it+1} = q_{it} K_{it+1} + W_{it+1}$ . We proceed with a guess-and-verify approach. We first assume that this equation holds for period  $t + 1$ , and then show it also holds for period  $t$ . It then follows that the equation must hold for all periods. We start with:

$$P_{it} + B_{it+1} = E_t [M_{t+1} (P_{it+1} + D_{it+1})] + B_{it+1} \tag{A.7}$$

Using  $P_{it+1} + B_{it+2} = q_{it+1} K_{it+2} + W_{it+2}$  to rewrite the right hand side yields:

$$P_{it} + B_{it+1} = E_t [M_{t+1} (q_{it+1} K_{it+2} + W_{it+2} - B_{it+2} + D_{it+1})] + B_{it+1} \tag{A.8}$$

Using the definition of  $D_{it+1} \equiv (1 - \tau_{t+1})(\Pi_{it+1} - \Phi_{it+1}) - I_{it+1} - \Delta W_{it+1} + B_{it+2} - r_{it+1}^B B_{it+1} +$

$\tau_{t+1}\delta_{it+1}K_{it+1} + \tau_{t+1}(r_{it+1}^B - 1)B_{it+1}$  to write the right hand side yields:

$$\begin{aligned} P_{it} + B_{it+1} &= E_t[M_{t+1}[(1 - \tau_{t+1})(\Pi_{it+1} - \Phi_{it+1}) + \tau_{t+1}\delta_{it+1}K_{it+1} + q_{it+1}K_{it+2} - I_{it+1}]] \\ &+ E_t[M_{t+1}(W_{it+2} - \Delta W_{it+1})] - B_{it+1}E_t[M_{t+1}[r_{it+1}^B - \tau_{t+1}(r_{it+1}^B - 1)]] + B_{it+1} \end{aligned} \quad (\text{A.9})$$

The constant returns to scale for  $\Pi_{it}$  and equation (A.6) then imply:

$$\begin{aligned} P_{it} + B_{it+1} &= E_t \left[ M_{t+1} \left[ K_{it+1}(1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\Phi_{it+1}}{K_{it+1}} \right) + \tau_{t+1}\delta_{it+1}K_{it+1} + q_{it+1}[(1 - \delta_{it+1})K_{it+1} + I_{it+1}] - I_{it+1} \right] \right. \\ &+ E_t \left[ M_{t+1} \left[ W_{it+1}(1 - \tau_{t+1}) \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} + (W_{it+1} + \Delta W_{it+1}) - \Delta W_{it+1} \right] \right] \end{aligned} \quad (\text{A.10})$$

Using the first-order conditions in equations (A.2) and (A.19) to rewrite the right hand side yields:

$$\begin{aligned} P_{it} + B_{it+1} &= E_t \left[ M_{t+1} \left[ K_{it+1}(1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\Phi_{it+1}}{K_{it+1}} + \frac{I_{it+1}}{K_{it+1}} \frac{\partial \Phi_{it+1}}{\partial I_{it+1}} \right) + \tau_{t+1}\delta_{it+1}K_{it+1} + q_{it+1}(1 - \delta_{it+1})K_{it+1} \right] \right. \\ &+ E_t \left[ M_{t+1} \left[ W_{it+1}(1 - \tau_{t+1}) \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} + W_{it+1} \right] \right] \end{aligned} \quad (\text{A.11})$$

Constant returns to scale imply that  $\Phi_{it} = I_{it}\partial\Phi_{it}^K/\partial I_{it} + K_{it}\partial\Phi_{it}^K/\partial K_{it}$ . Equation (A.26) becomes:

$$\begin{aligned} P_{it} + B_{it+1} &= K_{it+1}E_t \left[ M_{t+1} \left[ (1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\partial \Phi_{it+1}}{\partial K_{it+1}} \right) + \tau_{t+1}\delta_{it+1} + q_{it+1}(1 - \delta_{it+1}) \right] \right. \\ &+ W_{it+1}E_t \left[ M_{t+1} \left[ (1 - \tau_{t+1}) \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} + 1 \right] \right] = q_{it}K_{it+1} + W_{it+1}, \end{aligned} \quad (\text{A.12})$$

in which the last equality follows from equations (A.4) and (A.20).

Finally, we are ready to prove equation (4),

$$\begin{aligned} w_{it}^B r_{it+1}^{Ba} + (1 - w_{it}^B) r_{it+1}^S &= \frac{B_{it+1}}{P_{it} + B_{it+1}} [r_{it+1}^B - (r_{it+1}^B - 1)\tau_{t+1}] + \frac{P_{it}}{P_{it} + B_{it+1}} \frac{(P_{it+1} + D_{it+1})}{P_{it}} \\ &= \frac{B_{it+1}[r_{it+1}^B - (r_{it+1}^B - 1)\tau_{t+1}] + q_{it+1}K_{it+2} + W_{it+2} - B_{it+2} + D_{it+1}}{P_{it} + B_{it+1}} \end{aligned} \quad (\text{A.13})$$

Using the definition of  $D_{it+1}$  yields:

$$w_{it}^B r_{it+1}^{Ba} + (1 - w_{it}^B) r_{it+1}^S = \frac{(1 - \tau_{t+1})(\Pi_{it+1} - \Phi_{it+1}) + \tau_{t+1}\delta_{it+1}K_{it+1} + q_{it+1}K_{it+2} + W_{it+2} - I_{it+1} - \Delta W_{it+1}}{P_{it} + B_{it+1}} \quad (\text{A.14})$$

Using the constant returns to scale for  $\Pi_{it+1}$  yields:

$$w_{it}^B r_{it+1}^{Ba} + (1 - w_{it}^B) r_{it+1}^S = \frac{K_{it+1}(1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\Phi_{it+1}}{K_{it+1}} \right) + \tau_{t+1} \delta_{it+1} K_{it+1} + q_{it+1} (I_{it+1} + (1 - \delta_{it+1}) K_{it+1}) - I_{it+1}}{P_{it} + B_{it+1}} + \frac{W_{it+1}(1 - \tau_{t+1}) \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} + (W_{it+1} + \Delta W_{it+1}) - \Delta W_{it+1}}{P_{it} + B_{it+1}} \quad (\text{A.15})$$

Using the constant returns to scale for  $\Phi_{it+1}$  and equations (A.2) and (A.19), we obtain:

$$w_{it}^B r_{it+1}^{Ba} + (1 - w_{it}^B) r_{it+1}^S = \frac{K_{it+1}}{q_{it} K_{it+1} + W_{it+1}} \left[ (1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\partial \Phi_{it+1}}{\partial K_{it+1}} \right) + \tau_{t+1} \delta_{it+1} + (1 - \delta_{it+1}) q_{it+1} \right] + \frac{W_{it+1}}{q_{it} K_{it+1} + W_{it+1}} \left[ (1 - \tau_{t+1}) \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} + 1 \right] \quad (\text{A.16})$$

Using equations (A.4) and (A.20) yields the desired result:

$$w_{it}^B r_{it+1}^{Ba} + (1 - w_{it}^B) r_{it+1}^S = \frac{q_{it} K_{it+1}}{q_{it} K_{it+1} + W_{it+1}} r_{it+1}^K + \frac{W_{it+1}}{q_{it} K_{it+1} + W_{it+1}} r_{it+1}^W. \quad (\text{A.17})$$

## B Estimation Results from Testing Deciles Based on All-but-micro Breakpoints and Equal-weighted Returns

In the main text, we report the detailed results with the 40 testing deciles based on NYSE breakpoints and value-weighted returns. In this appendix, we report a parallel set of results with the 40 testing deciles based on all-but-micro breakpoints and equal-weighted returns.

- Table A.1 reports descriptive statistics for the 40 testing deciles formed on book-to-market, prior 11-month returns, asset growth, and return on equity with all-but-micro breakpoints and equal-weighted returns. We exclude microcaps from our sample, sort the remaining stocks into deciles, and calculate equal-weighted returns.
- For the all-but-micro sample, Table A.2 reports descriptive statistics for firm-level accounting variables that appear in the calculation of the fundamental returns.
- Table A.3 shows GMM estimation and tests for the physical capital model estimated at the portfolio level and the benchmark 2-capital model estimated at the firm level, with 40 equal-weighted testing deciles.
- Table A.4 reports comparative statics on the benchmark 2-capital model estimated at the firm level, with equal-weighted testing deciles.

- Table A.5 reports GMM estimation and tests for the 2-capital model estimated at the portfolio level and the physical capital model at the firm level, with equal-weighted deciles.
- Table A.6 shows correlations between stock and fundamental returns using the all-but-micro sample and equal-weighted deciles.
- Table A.7 reports the variation of equal-weighted factor premiums across the market states in the all-but-micro sample.
- Table A.8 reports the higher moments for the equal-weighted deciles.
- Figure A.1 plots average predicted stock returns versus average realized stock returns for the physical capital model estimated at the portfolio level, with equal-weighted deciles.
- Figure A.2 plots average predicted stock returns versus average realized stock returns for the benchmark 2-capital model estimated at the firm level, with equal-weighted deciles.
- Figure A.3 plots average predicted stock returns versus average realized stock returns for the benchmark 2-capital model estimated at the portfolio level, with equal-weighted deciles.
- Figure A.4 plots average predicted stock returns versus average realized stock returns for the physical capital model estimated at the firm level, with equal-weighted deciles.
- Figure A.5 plots the stock and fundamental returns of the high and low deciles from the 40 equal-weighted testing deciles for 36 months after the portfolio formation.
- Figure A.6 plots the marginal  $q_{it}$  growth of the high and low deciles from the 40 testing deciles for 36 months after the portfolio formation, both value- and equal-weighted.
- Figure A.7 plots the time series of the stock and fundamental returns of the factor premiums, equal-weighted.

## C Results in the No-large-M&A Sample

Table A.9 shows the descriptive properties of the absolute residual from the capital accumulation equation as a percentage of physical capital. M&As are from SDC and Compustat (item AQC).

Table A.10 shows the results from estimating the benchmark 2-capital model at the firm level in the no-large-M&A sample, with both value- and equal-weighted testing deciles. In particular, we

construct the no-large-M&A sample by excluding firms with sizeable M&As, in which the target assets are at least 15% of the acquirer assets. The 15% cutoff follows Whited (1992).

Figure A.8 plots average predicted stock returns versus average realized stock returns, both value- and equal-weighted, for the benchmark 2-capital model estimated at the firm level in the no-large-M&A sample.

## D Results with Imputed Costs of Debt

Instead of measuring the pre-tax costs of debt,  $r_{it+1}^B$ , as the ratio of total interest and related expenses (Compustat annual item XINT) divided by total debt (item DLTT plus item DLC, zero if missing) in the main text, we use the imputed costs of debt from prior work (Liu, Whited, and Zhang 2009; Liu and Zhang 2014). The basic idea is to impute credit ratings for firms with no credit ratings data in Compustat and then assign the corporate bond returns for a given credit rating to all the firms with the same imputed credit rating.<sup>1</sup>

Table A.11 shows the results from estimating the benchmark 2-capital model at the firm level with the imputed costs of debt, with both value- and equal-weighted testing deciles.

Figure A.9 plots average predicted stock returns versus average realized stock returns, both value- and equal-weighted, for the benchmark 2-capital model estimated at the firm level with the imputed costs of debt.

## E An Extended 2-capital Model with Adjustment Costs on the Working Capital Investment

We examine an extended 2-capital model with adjustment costs on working capital. We lay out the model in Appendix E.1 and present its estimation results in Appendix E.2.

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<sup>1</sup>Specifically, an ordered probit model for credit ratings is first estimated on firms with credit ratings data. The fitted value is used to calculate the cutoff value for each rating. For firms without credit ratings, their scores are computed with the coefficients from the ordered probit model, and their credit ratings are imputed by applying the cutoff values of different credit ratings. The corporate bond returns for a given credit rating are assigned to the firms with the same rating. The explanatory variables in the ordered probit model include: interest coverage, operating income after depreciation plus interest expense over interest expense; the operating margin, operating income before depreciation over sales; long-term leverage, long-term debt over assets; total leverage, long-term debt plus debt in current liabilities plus short-term borrowing over assets; the natural logarithm of the market value of equity deflated to 1973 by the consumer price index; as well as the market beta and residual volatility from the market regression estimated for each firm in each calendar year with at least 200 daily returns from CRSP. One leading and one lagged values of the market return are used to account for nonsynchronous trading.

## E.1 The Model

We build on the benchmark 2-capital model described in Section 2 in the main text. However, we assume that the adjustment costs function depends on working capital and their investment. For simplicity, we adopt the quadratic functional form, which is separate in the two capital inputs:

$$\Phi_{it} \equiv \Phi(I_{it}, K_{it}, \Delta W_{it}, W_{it}) = \Phi^K(I_{it}, K_{it}) + \Phi^W(\Delta W_{it}, W_{it}) = \frac{a}{2} \left( \frac{I_{it}}{K_{it}} \right)^2 K_{it} + \frac{b}{2} \left( \frac{\Delta W_{it}}{W_{it}} \right)^2 W_{it}, \quad (\text{A.18})$$

The first-order conditions with respect to  $I_{it}$  and  $K_{it+1}$  are identical to those in the benchmark model. However, the first-order conditions for  $\Delta W_{it}$  and  $W_{it+1}$  become:

$$q_{it}^W = 1 + (1 - \tau_t) \frac{\partial \Phi_{it}}{\partial \Delta W_{it}} \quad (\text{A.19})$$

$$q_{it}^W = E_t \left[ M_{t+1} \left[ (1 - \tau_{t+1}) \left[ \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} - \frac{\partial \Phi_{it+1}}{\partial W_{it+1}} \right] + q_{it+1}^W \right] \right] \quad (\text{A.20})$$

Combining the two equations yields  $E_t[M_{t+1}r_{it+1}^W] = 1$ , in which  $r_{it+1}^W$  is given by:

$$r_{it+1}^W \equiv \frac{1 + (1 - \tau_{t+1}) \left[ \gamma_W \frac{Y_{it+1}}{W_{it+1}} + b \left( \frac{\Delta W_{it+1}}{W_{it+1}} \right) + \frac{b}{2} \left( \frac{\Delta W_{it+1}}{W_{it+1}} \right)^2 \right]}{1 + (1 - \tau_t) b \left( \frac{\Delta W_{it}}{W_{it}} \right)}. \quad (\text{A.21})$$

We first use  $P_{it+1} + B_{it+2} = q_{it+1}K_{it+2} + q_{it+1}^W W_{it+2}$  to rewrite:

$$P_{it} + B_{it+1} = E_t[M_{t+1}(P_{it+1} + D_{it+1})] + B_{it+1} \quad (\text{A.22})$$

$$= E_t[M_{t+1}(q_{it+1}K_{it+2} + q_{it+1}^W W_{it+2} - B_{it+2} + D_{it+1})] + B_{it+1} \quad (\text{A.23})$$

Using the definition of  $D_{it+1} \equiv (1 - \tau_{t+1})(\Pi_{it+1} - \Phi_{it+1}) - I_{it+1} - J_{it+1} + B_{it+2} - r_{it+1}^B B_{it+1} + \tau_{t+1} \delta_{it+1} K_{it+1} + \tau_{t+1} (r_{it+1}^B - 1) B_{it+1}$  to rewrite the right hand side yields:

$$\begin{aligned} P_{it} + B_{it+1} &= E_t[M_{t+1}[(1 - \tau_{t+1})(\Pi_{it+1} - \Phi_{it+1}) + \tau_{t+1} \delta_{it+1} K_{it+1} + q_{it+1}^K K_{it+2} - I_{it+1}]] \\ &+ E_t[M_{t+1}(q_{it+1}^W W_{it+2} - \Delta W_{it+1})] - B_{it+1} E_t[M_{t+1}[r_{it+1}^B - \tau_{t+1} (r_{it+1}^B - 1)]] + B_{it+1} \end{aligned} \quad (\text{A.24})$$

The constant returns to scale for  $\Pi_{it}$  and the first-order condition for  $B_{it+1}$  then imply:

$$\begin{aligned} P_{it} + B_{it+1} &= E_t \left[ M_{t+1} \left[ K_{it+1} (1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\Phi_{it+1}^K}{K_{it+1}} \right) + \tau_{t+1} \delta_{it+1} K_{it+1} + q_{it+1} [(1 - \delta_{it+1}) K_{it+1} + I_{it+1}] - I_{it+1} \right] \right] \\ &+ E_t \left[ M_{t+1} \left[ W_{it+1} (1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} - \frac{\Phi_{it+1}^W}{W_{it+1}} \right) + q_{it+1}^W (W_{it+1} + \Delta W_{it+1}) - \Delta W_{it+1} \right] \right]. \end{aligned} \quad (\text{A.25})$$

Using the first-order condition for  $I_{it}$  and equation (A.19) to rewrite the right hand side yields:

$$P_{it} + B_{it+1} = E_t \left[ M_{t+1} \left[ K_{it+1}(1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\Phi_{it+1}^K}{K_{it+1}} + \frac{I_{it+1}}{K_{it+1}} \frac{\partial \Phi_{it+1}}{\partial I_{it+1}} \right) + \tau_{t+1} \delta_{it+1} K_{it+1} + q_{it+1}(1 - \delta_{it+1}) K_{it+1} \right] \right. \\ \left. + E_t \left[ M_{t+1} \left[ W_{it+1}(1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} - \frac{\Phi_{it+1}^W}{W_{it+1}} + \frac{\Delta W_{it+1}}{W_{it+1}} \frac{\partial \Phi_{it+1}}{\partial \Delta W_{it+1}} \right) + q_{it+1}^W W_{it+1} \right] \right] \right]. \quad (\text{A.26})$$

The constant returns to scale for  $\Phi_{it}$  mean that  $\Phi_{it}^K = I_{it} \partial \Phi_{it}^K / \partial I_{it} + K_{it} \partial \Phi_{it}^K / \partial K_{it}$  and  $\Phi_{it}^W = \Delta W_{it} \partial \Phi_{it}^W / \partial \Delta W_{it} + W_{it} \partial \Phi_{it}^W / \partial W_{it}$ . As such, equation (A.26) becomes:

$$P_{it} + B_{it+1} = K_{it+1} E_t \left[ M_{t+1} \left[ (1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\partial \Phi_{it+1}}{\partial K_{it+1}} \right) + \tau_{t+1} \delta_{it+1} + q_{it+1}^K (1 - \delta_{it+1}) \right] \right] \\ + W_{it+1} E_t \left[ M_{t+1} \left[ (1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} - \frac{\partial \Phi_{it+1}}{\partial W_{it+1}} \right) + q_{it+1}^W \right] \right] \quad (\text{A.27})$$

$$= q_{it} K_{it+1} + q_{it}^W W_{it+1}, \quad (\text{A.28})$$

in which the last equality follows from the first-order condition for  $K_{it+1}$  and equation (A.20).

Finally,

$$w_{it}^B r_{it+1}^{Ba} + (1 - w_{it}^B) r_{it+1}^S = \frac{B_{it+1}}{P_{it} + B_{it+1}} [r_{it+1}^B - (r_{it+1}^B - 1) \tau_{t+1}] + \frac{P_{it}}{P_{it} + B_{it+1}} \frac{(P_{it+1} + D_{it+1})}{P_{it}} \\ = \frac{B_{it+1} [r_{it+1}^B - (r_{it+1}^B - 1) \tau_{t+1}] + q_{it+1} K_{it+2} + q_{it+1}^W W_{it+2} - B_{it+2} + D_{it+1}}{P_{it} + B_{it+1}}. \quad (\text{A.29})$$

Using the definition of  $D_{it+1}$  yields:

$$w_{it}^B r_{it+1}^{Ba} + (1 - w_{it}^B) r_{it+1}^S = \frac{(1 - \tau_{t+1})(\Pi_{it+1} - \Phi_{it+1}) + \tau_{t+1} \delta_{it+1} K_{it+1} + q_{it+1} K_{it+2} + q_{it+1}^W W_{it+2} - I_{it+1} - \Delta W_{it+1}}{P_{it} + B_{it+1}} \quad (\text{A.30})$$

Using the constant returns to scale for  $\Pi_{it+1}$  yields:

$$w_{it}^B r_{it+1}^{Ba} + (1 - w_{it}^B) r_{it+1}^S = \frac{K_{it+1}(1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\Phi_{it+1}^K}{K_{it+1}} \right) + \tau_{t+1} \delta_{it+1} K_{it+1} + q_{it+1} (I_{it+1} + (1 - \delta_{it+1}) K_{it+1}) - I_{it+1}}{P_{it} + B_{it+1}} \\ + \frac{W_{it+1}(1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} - \frac{\Phi_{it+1}^W}{W_{it+1}} \right) + q_{it+1}^W (W_{it+1} + \Delta W_{it+1}) - \Delta W_{it+1}}{P_{it} + B_{it+1}} \quad (\text{A.31})$$



Using the constant returns for  $\Phi_{it+1}$  and the first-order conditions for  $I_{it}$  and  $\Delta W_{it}$ , we obtain:

$$w_{it}^B r_{it+1}^{Ba} + (1 - w_{it}^B) r_{it+1}^S = \frac{K_{it+1}}{q_{it} K_{it+1} + q_{it}^W W_{it+1}} \left[ (1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial K_{it+1}} - \frac{\partial \Phi_{it+1}}{\partial K_{it+1}} \right) + \tau_{t+1} \delta_{it+1} + (1 - \delta_{it+1}) q_{it+1} \right] \\ + \frac{W_{it+1}}{q_{it} K_{it+1} + q_{it}^W W_{it+1}} \left[ (1 - \tau_{t+1}) \left( \frac{\partial \Pi_{it+1}}{\partial W_{it+1}} - \frac{\partial \Phi_{it+1}}{\partial W_{it+1}} \right) + q_{it+1}^W \right] \quad (\text{A.32})$$

$$= \frac{q_{it} K_{it+1}}{q_{it} K_{it+1} + q_{it}^W W_{it+1}} r_{it+1}^K + \frac{q_{it}^W W_{it+1}}{q_{it} K_{it+1} + q_{it}^W W_{it+1}} r_{it+1}^W. \quad (\text{A.33})$$

## E.2 Estimation Results

We continue to test the moment condition given by:

$$E[r_{pt+1}^S - r_{pt+1}^F] = 0, \quad (\text{A.34})$$

in which  $r_{pt+1}^S$  is the stock return of testing portfolio  $p$ , and  $r_{pt+1}^F$  is portfolio  $p$ 's fundamental return:

$$r_{it+1}^F = \frac{w_{it}^K r_{it+1}^{Kk} + (1 - w_{it}^K) r_{it+1}^W - w_{it}^B r_{it+1}^{Ba}}{1 - w_{it}^B}, \quad (\text{A.35})$$

except that the working capital investment return is now given by equation (A.21).

Table A.12 reports GMM estimation and tests of the extended 2-capital model. The table shows that many estimates of the adjustment costs parameter,  $b$ , for working capital are insignificant, including six out of seven estimates with equal-weighted deciles and three out of seven with value-weighted deciles. In particular, in the joint estimation of value and momentum, the  $b$  estimate is 3.1, with a standard error of zero, with value-weights, but is 1.1, with a standard error of 0.66, with equal-weights. With all 40 testing deciles,  $b$  is never significant: 0.4 with a standard error of 0.96 with value-weights and 0.07 with a standard error of 0.58 with equal-weights. The marginal product parameter,  $\gamma$ , and the adjustment costs parameter,  $a$ , for physical capital are largely similar to those in the benchmark estimation without  $b$  as a separate parameter.

The mean absolute errors, m.a.e., and average absolute high-minus-low errors,  $|\overline{\alpha_{H-L}}|$ , are also largely comparable. In particular, when estimating value and momentum jointly, the m.a.e. is 0.63% per annum, and  $|\overline{\alpha_{H-L}}|$  1.22% with value-weights, and the errors are 0.66% and 0.75%, respectively, with equal-weights. These errors are largely comparable those in the benchmark estimation without working capital adjustment costs. When all 40 testing deciles are included in the joint estimation, the m.a.e. is 1.27%, and  $|\overline{\alpha_{H-L}}|$  2.07% with value-weights, and with equal-weights the errors are 0.91% and 2.24%, respectively. These errors are again largely comparable with those

in the benchmark estimation.

Figure A.10 reports detailed individual pricing errors by plotting average predicted stock returns against average realized stock returns. Similar to the benchmark estimation, the scatter points are all largely aligned with the 45-degree line. As such, adding the extra parameter,  $b$ , does not yield a significant improvement in the model's performance. The evidence lends support to our modeling choice of setting  $b = 0$  in the benchmark estimation for parsimony.

## F Results on Out-of-sample Tests

Table A.13 reports cross-sectional forecasting regressions of 1-year-ahead investment-to-physical capital and annual sales growth from June 1967 to December 2017. We report both weighted least squares in the full sample and ordinary least squares in the all-but-micro sample.

Table A.14 reports the properties of the deciles formed on the expected return estimates from the 2-capital model estimated at the firm level, the physical capital model estimated at the portfolio level, the  $q$ -factor model, and the Fama-French 5-factor model, all with all-but-micro breakpoints and equal-weighted returns.

Figure A.11 plots the time series of recursive parameters from both the benchmark 2-capital model and the physical capital model in the joint estimation with all 40 testing deciles. The sample is from July 1980 to December 2017.

Figure A.12 reports the 1-step-ahead fit via recursive estimation with all-but-micro breakpoints and equal-weighted returns.

## References

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**Table A.1 : Descriptive Properties of Testing Deciles, All-but-micro Breakpoints and Equal-weighted Returns, January 1967–June 2017**

For each decile, we report the monthly average return in excess of the 1-month Treasury bill rate,  $\bar{R}$ , and its  $t$ -value adjusted for heteroscedasticity and autocorrelations,  $t_{\bar{R}}$ . L denotes the low decile, H the high decile, and H–L the high-minus-low decile. Testing deciles are formed with all-but-micro breakpoints and equal-weighted returns.

	L	2	3	4	5	6	7	8	9	H	H–L
	Panel A: Book-to-market, Bm										
$\bar{R}$	0.27	0.38	0.53	0.58	0.64	0.72	0.75	0.73	0.75	0.92	0.66
$t_{\bar{R}}$	0.89	1.47	2.21	2.57	2.87	3.47	3.69	3.53	3.65	4.10	2.89
	Panel B: Momentum, $R^{11}$										
$\bar{R}$	−0.01	0.41	0.53	0.53	0.57	0.64	0.71	0.77	1.00	1.18	1.20
$t_{\bar{R}}$	−0.04	1.60	2.35	2.51	2.94	3.36	3.68	3.70	4.06	3.72	4.05
	Panel C: Asset growth, I/A										
$\bar{R}$	0.71	0.78	0.80	0.72	0.76	0.74	0.66	0.62	0.48	0.19	−0.52
$t_{\bar{R}}$	2.79	3.93	4.23	3.91	3.83	3.88	3.12	2.76	1.91	0.65	−3.42
	Panel D: Return on equity, Roe										
$\bar{R}$	0.14	0.34	0.52	0.52	0.63	0.63	0.73	0.76	0.84	1.07	0.93
$t_{\bar{R}}$	0.40	1.22	2.44	2.64	3.17	3.01	3.67	3.57	3.89	4.38	4.16

**Table A.2 : Descriptive Statistics of Firm-level Accounting Variables in the Fundamental Return, the All-but-micro Sample, June 1967–December 2016**

This table reports the time series averages of cross-sectional statistics, including mean, standard deviation ( $\sigma$ ), percentiles (5th, 25th, 50th, 75th, and 95th), and pairwise correlations.  $I_{it}/K_{it}$  is period- $t$  physical investment-to-physical capital,  $\Delta W_{it}/W_{it}$  the period- $t$  ratio of working capital investment over working capital,  $Y_{it+1}/K_{it+1}$  the sales-to-physical capital in period  $t + 1$ ,  $Y_{it+1}/W_{it+1}$  the sales-to-working capital in period  $t + 1$ ,  $K_{it+1}/(K_{it+1} + W_{it+1})$  the fraction of physical capital in total capital,  $\delta_{it+1}$  the rate of physical capital depreciation, and  $r_{it+1}^B$  the pre-tax cost of debt in percent per annum. The sample for the fundamental returns is from June 1967 to December 2016. However, the accounting variables underlying the fundamental returns for June 1967 can come from the fiscal year ending in calendar year as early as 1966, and the accounting variables underlying the fundamental returns for December 2016 as late as 2018. The descriptive statistics are computed after winsorizing 5% of the extreme observations at the portfolio formation. We winsorize unbounded variables, including  $I_{it}/K_{it}$ ,  $I_{it+1}/K_{it+1}$ ,  $\Delta W_{it}/W_{it}$ , and  $\Delta W_{it+1}/W_{it+1}$  at the 2.5–97.5% level. For variables bounded below at zero, including  $Y_{it+1}/K_{it+1}$ ,  $Y_{it+1}/W_{it+1}$ ,  $Y_{it+1}/(K_{it+1} + W_{it+1})$ ,  $\delta_{it+1}$ , and  $r_{it+1}^B$ , we use the 0–95% winsorization. Finally, we do not winsorize  $K_{it+1}/(K_{it+1} + W_{it+1})$ , or the market leverage,  $w_{it}^B$ , both of which are bounded between zero and one.

Panel A: Mean, standard deviation, and percentiles

	Mean	$\sigma$	5th	25th	50th	75th	95th
$I_{it}/K_{it}$	0.35	0.39	0.02	0.13	0.23	0.42	1.14
$\Delta W_{it}/W_{it}$	0.16	0.30	-0.21	-0.01	0.10	0.24	0.81
$Y_{it+1}/K_{it+1}$	6.44	7.30	0.44	1.83	4.32	7.75	22.36
$Y_{it+1}/W_{it+1}$	3.28	1.89	1.05	1.97	2.84	4.05	7.35
$Y_{it+1}/(K_{it+1} + W_{it+1})$	1.55	0.89	0.34	0.91	1.44	2.00	3.55
$K_{it+1}/(K_{it+1} + W_{it+1})$	0.44	0.25	0.10	0.24	0.38	0.64	0.90
$w_{it}^B$	0.25	0.20	0.00	0.07	0.21	0.38	0.61
$\delta_{it+1}$	0.17	0.10	0.04	0.10	0.14	0.21	0.40
$r_{it+1}^B$	8.57	5.09	1.38	6.10	7.85	9.98	20.34

Panel B: Cross-sectional correlations

	$\frac{I_{it+1}}{K_{it+1}}$	$\frac{\Delta W_{it}}{W_{it}}$	$\frac{\Delta W_{it+1}}{W_{it+1}}$	$\frac{Y_{it+1}}{K_{it+1}}$	$\frac{Y_{it+1}}{W_{it+1}}$	$\frac{Y_{it+1}}{K_{it+1}+W_{it+1}}$	$\frac{K_{it+1}}{K_{it+1}+W_{it+1}}$	$w_{it}^B$	$\delta_{it+1}$	$r_{it+1}^B$
$I_{it}/K_{it}$	0.41	0.36	0.13	0.23	-0.09	0.09	-0.24	-0.22	0.37	0.06
$I_{it+1}/K_{it+1}$		0.28	0.32	0.38	-0.03	0.21	-0.32	-0.33	0.58	0.18
$\Delta W_{it}/W_{it}$			0.04	0.11	-0.09	0.00	-0.11	-0.10	0.13	0.03
$\Delta W_{it+1}/W_{it+1}$				0.11	0.21	0.16	0.03	-0.13	0.12	0.15
$Y_{it+1}/K_{it+1}$					0.05	0.65	-0.67	-0.30	0.54	0.04
$Y_{it+1}/W_{it+1}$						0.47	0.47	0.18	-0.22	0.05
$Y_{it+1}/(K_{it+1} + W_{it+1})$							-0.43	-0.24	0.28	0.11
$K_{it+1}/(K_{it+1} + W_{it+1})$								0.49	-0.61	-0.03
$w_{it}^B$									-0.41	-0.02
$\delta_{it+1}$										0.07

**Table A.3 : GMM Estimation and Tests, the Physical Capital Model Estimated at the Portfolio Level and the Benchmark 2-capital Model Estimated at the Firm Level, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

This table uses the 40 testing deciles formed on book-to-market (Bm), prior 11-month returns ( $R^{11}$ ), asset growth (I/A), and return on equity (Roe), separately and jointly (Bm and  $R^{11}$ , I/A and Roe, and all 40 deciles together). The testing deciles are formed with all-but-micro breakpoints and equal-weighted returns. d.f. is the degrees of freedom in the GMM test of overidentification.  $\gamma_K$  is the technological parameter on the marginal product of physical capital as a fraction of sales-to-physical capital,  $Y_{it+1}/K_{it+1}$ .  $\gamma$  is the technological parameter on the marginal product of total capital as a fraction of sales-to-total capital,  $Y_{it+1}/(K_{it+1} + W_{it+1})$ .  $a$  is the adjustment costs parameter of physical capital.  $[\gamma]$ ,  $[\gamma_K]$ , and  $[a]$  are the standard errors of the point estimates.  $|\bar{\alpha}|$  is the mean absolute alpha across the testing portfolios,  $|\bar{\alpha}_{H-L}|$  is the average absolute high-minus-low alpha, and  $p$  is the  $p$ -value of the overidentification test across a given set of testing portfolios.  $\gamma$ ,  $\gamma_K$ ,  $[\gamma]$ ,  $[\gamma_K]$ , and  $p$ -values are in percent, and  $|\bar{\alpha}|$  and  $|\bar{\alpha}_{H-L}|$  are in percent per annum.

Panel A: The physical capital model estimated at the portfolio level								
	d.f.	$\gamma_K$	$[\gamma_K]$	$a$	$[a]$	$ \bar{\alpha} $	$ \bar{\alpha}_{H-L} $	$p$
Bm	8	25.09	5.85	15.03	5.54	3.83	3.25	0.12
$R^{11}$	8	12.84	1.29	1.34	0.61	1.28	0.12	21.03
I/A	8	14.50	1.43	2.16	0.52	2.62	0.51	0.00
Roe	8	11.44	1.11	0.00	0.03	3.00	0.36	0.00
Bm- $R^{11}$	18	14.23	1.43	3.19	0.57	4.06	12.49	0.00
I/A-Roe	18	13.41	1.27	1.57	0.39	3.11	2.46	0.00
Bm- $R^{11}$ -I/A-Roe	38	13.98	1.33	2.55	0.38	3.57	6.84	0.00
Panel B: The benchmark 2-capital model estimated at the firm level								
	d.f.	$\gamma$	$[\gamma]$	$a$	$[a]$	$ \bar{\alpha} $	$ \bar{\alpha}_{H-L} $	$p$
Bm	8	16.74	2.09	3.93	0.60	0.71	0.56	35.21
$R^{11}$	8	16.46	1.94	3.02	1.20	0.69	0.63	15.30
I/A	8	17.07	1.74	2.07	0.51	0.67	0.55	0.79
Roe	8	14.63	2.22	6.38	0.01	0.65	1.68	61.18
Bm- $R^{11}$	18	16.50	2.06	3.74	0.45	0.83	1.23	0.00
I/A-Roe	18	16.76	1.79	2.08	0.48	0.75	1.58	0.00
Bm- $R^{11}$ -I/A-Roe	38	16.72	1.94	3.08	0.36	0.93	2.14	0.00

**Table A.4 : Comparative Statics, the Benchmark 2-capital Model Estimated at the Firm Level, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

This table reports the investment CAPM alphas from three comparative statics:  $\overline{I_{it}/K_{it}}$ ,  $\overline{I_{it+1}/K_{it+1}}$ , and  $\overline{Y_{it+1}/(K_{it+1} + W_{it+1})}$ . In the experiment denoted  $\overline{I_{it}/K_{it}}$ ,  $I_{it}/K_{it}$  is set to be its cross-sectional median at period  $t$  across all the firms. The parameters from the benchmark GMM estimation (with all 40 Bm,  $R^{11}$ , I/A, and Roe deciles together) are used to reconstruct the fundamental returns, with all the other characteristics unchanged. The other experiments are designed analogously. The alpha is the average difference between portfolio stock returns and reconstructed fundamental returns. The “Benchmark” rows report the benchmark model’s alphas.

	L	2	3	4	5	6	7	8	9	H	H–L
Panel A: Book-to-market, Bm											
Benchmark	−1.53	−1.35	0.06	−0.39	−0.62	1.32	1.26	1.56	1.32	1.96	3.49
$\overline{I_{it}/K_{it}}$	−18.10	−13.20	−9.67	−7.05	−3.89	−0.28	3.21	8.11	13.36	27.20	45.29
$\overline{I_{it+1}/K_{it+1}}$	9.33	7.23	7.16	4.78	2.71	2.26	0.19	−4.20	−8.69	−22.55	−31.87
$\overline{Y_{it+1}/(K_{it+1} + W_{it+1})}$	0.20	0.76	2.23	2.19	1.40	2.53	1.31	−0.01	−2.13	−4.06	−4.26
Panel B: Momentum, $R^{11}$											
Benchmark	0.32	0.48	0.13	−1.13	−1.05	−0.88	−1.06	−0.98	0.05	0.84	0.51
$\overline{I_{it}/K_{it}}$	1.21	1.05	1.67	1.12	1.50	1.05	−0.64	−3.00	−5.46	−11.12	−12.33
$\overline{I_{it+1}/K_{it+1}}$	−8.96	−3.14	−2.64	−3.46	−3.09	−1.87	0.10	2.70	8.11	14.97	23.93
$\overline{Y_{it+1}/(K_{it+1} + W_{it+1})}$	−1.74	−0.12	−0.25	−1.45	−1.29	−0.81	−0.41	0.37	2.19	3.65	5.39
Panel C: Asset growth, I/A											
Benchmark	−1.76	−0.85	−0.40	−0.44	1.55	2.17	1.56	0.90	0.83	0.04	1.80
$\overline{I_{it}/K_{it}}$	8.52	9.96	9.74	6.73	5.19	2.95	−1.20	−5.01	−9.78	−17.84	−26.36
$\overline{I_{it+1}/K_{it+1}}$	−8.78	−8.66	−7.41	−5.43	−1.40	0.66	2.65	4.58	7.40	9.11	17.90
$\overline{Y_{it+1}/(K_{it+1} + W_{it+1})}$	−2.90	−1.41	−1.56	−1.03	1.27	2.57	2.45	2.21	1.87	0.42	3.31
Panel D: Return on equity, Roe											
Benchmark	−1.78	−0.28	0.79	−0.36	0.07	−1.16	−1.32	−1.27	−0.31	0.97	2.75
$\overline{I_{it}/K_{it}}$	2.72	4.62	5.75	3.29	0.56	−2.50	−4.75	−6.60	−7.99	−8.46	−11.18
$\overline{I_{it+1}/K_{it+1}}$	−9.31	−6.98	−4.84	−4.07	−0.65	0.77	3.04	4.46	7.25	10.69	20.00
$\overline{Y_{it+1}/(K_{it+1} + W_{it+1})}$	−5.80	−3.37	−1.61	−1.71	0.27	0.06	1.08	1.86	3.38	5.45	11.25

**Table A.5 : GMM Estimation and Tests, the 2-capital Model Estimated at the Portfolio Level and the Physical Capital Model Estimated at the Firm Level, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

This table uses the 40 testing deciles formed on book-to-market (Bm), prior 11-month returns ( $R^{11}$ ), asset growth (I/A), and return on equity (Roe), separately and jointly (Bm and  $R^{11}$ , I/A and Roe, and all 40 deciles together). The testing deciles are formed with all-but-micro breakpoints and equal-weighted returns. d.f. is the degrees of freedom in the GMM test of overidentification.  $\gamma_K$  is the technological parameter on the marginal product of physical capital as a fraction of sales-to-physical capital,  $Y_{it+1}/K_{it+1}$ .  $\gamma$  is the technological parameter on the marginal product of total capital as a fraction of sales-to-total capital,  $Y_{it+1}/(K_{it+1} + W_{it+1})$ .  $a$  is the adjustment costs parameter of physical capital.  $[\gamma]$ ,  $[\gamma_K]$ , and  $[a]$  are the standard errors of the point estimates.  $|\bar{\alpha}|$  is the mean absolute alpha across the testing portfolios,  $|\overline{\alpha_{H-L}}|$  is the average absolute high-minus-low alpha, and  $p$  is the  $p$ -value of the overidentification test across a given set of testing portfolios.  $\gamma$ ,  $\gamma_K$ ,  $[\gamma]$ ,  $[\gamma_K]$ , and  $p$ -values are in percent, and  $|\bar{\alpha}|$  and  $|\overline{\alpha_{H-L}}|$  are in percent per annum.

Panel A: The 2-capital model estimated at the portfolio level								
	d.f.	$\gamma$	$[\gamma]$	$a$	$[a]$	$ \bar{\alpha} $	$ \overline{\alpha_{H-L}} $	$p$
Bm	8	27.79	4.19	9.74	3.65	2.88	5.51	0.06
$R^{11}$	8	21.60	2.66	3.44	1.15	0.60	1.40	10.76
I/A	8	21.94	2.25	2.83	0.71	1.82	1.57	0.02
Roe	8	19.96	2.48	1.60	1.33	1.50	5.26	0.00
Bm- $R^{11}$	18	22.36	2.51	4.23	0.97	2.06	5.15	0.00
I/A-Roe	18	21.21	2.20	2.50	0.55	1.68	3.32	0.00
Bm- $R^{11}$ -I/A-Roe	38	21.87	2.31	3.42	0.62	1.93	4.07	0.00
Panel B: The physical capital model estimated at the firm level								
	d.f.	$\gamma_K$	$[\gamma_K]$	$a$	$[a]$	$ \bar{\alpha} $	$ \overline{\alpha_{H-L}} $	$p$
Bm	8	4.89	0.81	3.78	0.31	1.37	3.36	0.19
$R^{11}$	8	5.94	0.51	0.45	0.33	0.50	0.42	33.41
I/A	8	6.28	0.59	1.67	0.24	1.69	0.04	0.05
Roe	8	5.12	0.69	3.06	0.48	1.60	2.03	0.02
Bm- $R^{11}$	18	6.17	0.55	1.21	0.31	2.60	11.92	0.00
I/A-Roe	18	6.04	0.60	1.88	0.27	2.01	2.93	0.00
Bm- $R^{11}$ -I/A-Roe	38	6.14	0.57	1.51	0.17	2.37	7.84	0.00

**Table A.6 : Correlations between Stock Returns and Fundamental Returns, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

Panel A reports the firm-level (all-but-micro) and portfolio-level correlations between the stock returns of various leads and lags and fundamental returns,  $r_{it}^F$ . The column denoted “ $r_{it}^S$ ” reports contemporaneous correlations, and the column “ $r_{it-3}^S$ ” the correlations between 3-month-lagged stock returns and fundamental returns. Other columns are defined analogously. Portfolio-level correlations are calculated with the 40 portfolios formed on book-to-market, prior 11-month returns, asset growth, and return on equity with all-but-micro breakpoints and equal-weighted returns. The correlations are time series averages of cross-sectional correlations, and their  $p$ -values are calculated as the Fama-MacBeth  $p$ -values adjusted for autocorrelations of up to 12 lags. Panel B reports for each of the 40 deciles and the high-minus-low decile, the time series contemporaneous correlations between the stock and fundamental returns. The  $p$ -values are those of the slopes from regressing the stock returns on the contemporaneous fundamental returns, adjusted for autocorrelations of up to 12 lags. The correlations that are significant at the 1%, 5%, and 10% levels are denoted with three stars, two stars, and one star, respectively. The results are based on the parameter values from estimating the benchmark model on all the 40 equal-weighted testing deciles jointly.

Panel A: Correlations with the fundamental returns, $r_{it}^F$											
	$r_{it-60}^S$	$r_{it-36}^S$	$r_{it-24}^S$	$r_{it-12}^S$	$r_{it-3}^S$	$r_{it}^S$	$r_{it+3}^S$	$r_{it+12}^S$	$r_{it+24}^S$	$r_{it+36}^S$	$r_{it+60}^S$
Firms	-0.01	-0.02***	-0.02**	0.04***	0.11***	0.12***	0.10***	0.03***	-0.01**	-0.01	0.00
Portfolios	0.21***	0.24***	0.19***	0.21***	0.31***	0.33***	0.33***	0.25***	0.18***	0.23***	0.21***
Panel B: Contemporaneous correlations between the stock and fundamental returns across the testing deciles											
	L	2	3	4	5	6	7	8	9	H	H-L
Bm	0.39***	0.27**	0.25*	0.15	0.17	0.16*	0.18**	0.11	0.14	0.18**	0.40***
$R^{11}$	0.24**	0.14	0.10	0.03	0.09	0.03	0.14	0.18**	0.26***	0.37***	0.22***
I/A	0.23**	0.13*	-0.04	0.14	0.11	0.09	0.13	0.10	0.08	0.31***	0.34***
Roe	0.31**	0.17	0.14*	0.05	0.01	0.11	0.14	0.08	0.08	0.21**	0.31**



**Table A.7 : Market States and Factor Premiums, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

For each month  $t$ , we categorize the market state as Up (Down) if the value-weighted market returns from month  $t - N$  to  $t - 1$ , with  $N = 12, 24$ , or  $36$ , are nonnegative (negative). The table reports the high-minus-low decile returns averaged across Up (Down) states.  $r^S$  denotes the stock return, and  $r^F$  the fundamental returns. Both are in percent per annum. The  $t$ -values are adjusted for heteroscedasticity and autocorrelations of up to 12 lags. The results are based on the parameter values from estimating the benchmark model on the 40 equal-weighted testing deciles jointly.

$N$	MKT	$r^S$	$t_S$	$r^F$	$t_F$	$r^S$	$t_S$	$r^F$	$t_F$
		Panel A: Book-to-market, Bm				Panel B: Momentum, $R^{11}$			
12	Down	12.29	4.53	7.25	2.62	2.45	0.22	19.09	5.81
12	Up	7.87	2.69	5.00	2.82	20.22	6.98	14.67	11.37
24	Down	12.31	2.72	6.51	3.42	-7.63	-0.61	17.14	4.04
24	Up	8.28	3.00	5.34	2.87	20.35	6.87	15.43	11.38
36	Down	11.77	2.51	7.25	3.89	-9.98	-1.06	13.16	6.46
36	Up	8.37	2.99	5.21	2.79	20.83	6.84	16.14	10.60
		Panel C: Asset growth, I/A				Panel D: Return on equity, Roe			
12	Down	-13.87	-5.34	-8.36	-2.27	5.46	0.88	8.20	2.91
12	Up	-5.51	-3.18	-9.51	-6.76	13.96	5.65	9.62	7.31
24	Down	-16.00	-5.12	-5.10	-1.49	2.75	0.34	9.20	2.63
24	Up	-5.91	-3.40	-9.98	-6.26	13.64	5.82	9.31	6.95
36	Down	-11.04	-4.28	-3.17	-1.03	0.04	0.01	8.64	3.25
36	Up	-6.79	-3.69	-10.34	-6.39	14.15	5.75	9.41	6.87

**Table A.8 : Higher Moments of Stock Returns and Fundamental Returns, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

For each decile, we report volatility,  $\sigma$ , skewness,  $S_k$ , and kurtosis,  $K_u$ , of its stock returns,  $r^S$ , and fundamental returns,  $r^F$ . For each high-minus-low decile, the volatility and skewness significantly different from zero and the kurtosis significantly different from three at the 1%, 5%, and 10% levels are denoted with three, two stars, and one star, respectively. The significance is based on 5,000 block bootstrapped samples (each with 60 months). The results are based on parameters from estimating the benchmark model on the 40 equal-weighted deciles jointly.

		L	2	3	4	5	6	7	8	9	H	H-L
Panel A: Book-to-market, Bm												
$\sigma$	$r^S$	0.26	0.23	0.22	0.21	0.21	0.20	0.19	0.19	0.19	0.22	0.21***
	$r^F$	0.07	0.07	0.07	0.05	0.06	0.05	0.06	0.06	0.08	0.13	0.13***
$S_k$	$r^S$	0.06	0.05	0.10	0.04	0.10	0.20	0.21	0.17	0.11	0.54	0.39
	$r^F$	-1.51	-2.22	-1.69	-0.27	-0.28	-0.54	0.30	0.54	0.56	0.13	0.30
$K_u$	$r^S$	3.19	3.02	3.43	3.24	3.70	3.81	4.00	4.47	3.98	6.51	4.91***
	$r^F$	6.15	9.72	7.77	2.64	2.56	2.88	3.13	2.78	3.73	3.66	3.64
Panel B: Momentum, $R^{11}$												
$\sigma$	$r^S$	0.30	0.23	0.21	0.19	0.18	0.18	0.18	0.20	0.24	0.33	0.30***
	$r^F$	0.12	0.08	0.06	0.06	0.06	0.06	0.05	0.06	0.06	0.07	0.13***
$S_k$	$r^S$	1.48	0.31	0.30	0.06	0.08	0.05	0.18	0.06	0.45	1.05	-0.67
	$r^F$	-0.71	-0.29	0.13	0.05	0.05	0.10	0.21	0.07	-0.19	-0.49	0.57
$K_u$	$r^S$	9.27	4.69	4.15	3.74	3.81	3.69	3.96	3.42	4.46	6.78	11.09***
	$r^F$	5.00	3.42	3.63	3.37	3.43	3.99	3.55	2.76	3.66	3.88	4.56**
Panel C: Asset growth, I/A												
$\sigma$	$r^S$	0.24	0.19	0.18	0.17	0.18	0.18	0.20	0.21	0.23	0.26	0.13***
	$r^F$	0.10	0.06	0.06	0.06	0.06	0.05	0.06	0.06	0.07	0.10	0.12***
$S_k$	$r^S$	0.61	0.35	0.28	0.10	0.00	0.07	-0.02	0.07	0.14	0.09	0.03
	$r^F$	-0.74	0.07	0.33	0.40	1.18	0.26	-0.31	-0.14	-0.23	-0.79	-0.26
$K_u$	$r^S$	4.81	4.24	4.01	4.09	3.95	3.71	3.92	3.52	3.50	3.25	3.28
	$r^F$	5.70	2.77	3.01	3.42	6.08	2.39	2.78	3.36	3.33	3.22	2.87
Panel D: Return on equity, Roe												
$\sigma$	$r^S$	0.31	0.25	0.20	0.18	0.18	0.19	0.19	0.20	0.20	0.24	0.21***
	$r^F$	0.12	0.09	0.07	0.06	0.05	0.06	0.06	0.05	0.06	0.06	0.12***
$S_k$	$r^S$	1.17	0.60	0.32	-0.02	-0.06	-0.20	-0.17	0.02	0.00	0.04	-1.91*
	$r^F$	-0.10	-0.64	-0.36	0.34	0.17	0.01	-0.10	-0.01	-0.33	-0.41	0.17
$K_u$	$r^S$	8.18	5.22	4.07	3.55	3.53	3.45	3.51	3.72	3.44	3.51	16.84**
	$r^F$	4.65	5.62	3.89	3.53	3.05	2.91	3.20	3.07	3.18	3.01	4.38***

**Table A.9 : Empirical Distribution of the Absolute Residual from the Capital Accumulation Equation As a Percentage of Physical Capital, June 1967–December 2016**

The residual from the capital accumulation equation is measured as  $K_{it+1} - (1 - \delta_{it})K_{it}$ .  $K_{it}$  is net property, plant, and equipment (Compustat annual item PPENT), and  $\delta_{it}$  the capital depreciation rate (item DP minus item AM, zero if missing, scaled by item PPENT) minus capital expenditures (item CAPX) plus sales of property, plant, and equipment (item SPPE, zero if missing). We report the empirical distribution (different percentiles) of the absolute value of the residual as a percentage of net property, plant, and equipment for six different samples: (i) the full sample; (ii) the subsample without mergers and acquisitions (No M&A); (iii) the subsample with only M&A (Only M&A); (iv) the subsample with only M&A and its transaction value greater than or equal to 5% of the acquiring firm's total book assets (item AT); (v) the subsample with only M&A and its transaction value greater than or equal to 10% of the acquiring firm's assets; and (vi) the subsample with only M&A and its transaction value greater than or equal to 15% of the acquiring firm's assets. We identify M&A transactions from the Securities Data Company (SDC) dataset, supplemented with Compustat (item AQC, acquisitions). SDC and Compustat are merged on an acquiring firm's CUSIP number.

Percentile	1st	5th	10th	25th	50th	75th	90th	95th	99th
All	0.00	0.00	0.00	0.38	2.52	10.28	31.50	57.45	201.74
No M&A	0.00	0.00	0.00	0.17	1.57	7.09	23.08	43.23	133.65
Only M&A	0.00	0.15	0.48	1.86	6.36	19.85	53.35	94.59	322.62
M&A, target/Acquirer assets $\geq 5\%$	0.00	0.53	1.51	5.45	16.12	41.46	96.59	165.92	597.64
M&A, target/Acquirer assets $\geq 10\%$	0.00	0.79	2.15	8.42	24.56	59.91	131.69	223.22	877.06
M&A, target/Acquirer assets $\geq 15\%$	0.01	0.98	2.84	11.47	32.68	75.81	163.25	281.91	1075.64

**Table A.10 : GMM Estimation and Tests, the Benchmark 2-capital Model Estimated at the Firm Level in the No-large-M&A Sample, June 1967–December 2016**

This table uses the no-large-M&A sample, excluding firms with sizeable M&As with the target assets at least 15% of the acquirer assets. We identify M&As via the SDC dataset and Compustat (item AQC). The testing deciles are formed on book-to-market (Bm), prior 11-month returns ( $R^{11}$ ), asset growth (I/A), and return on equity (Roe), separately and jointly (Bm and  $R^{11}$ , I/A and Roe, and all 40 deciles together). d.f. is the degrees of freedom in the overidentification test.  $\gamma$  is the technological parameter on the marginal product of total capital as a fraction of sales-to-total capital,  $Y_{it+1}/(K_{it+1} + W_{it+1})$ .  $a$  is the adjustment costs parameter of physical capital.  $[\gamma]$  and  $[a]$  are the standard errors of the point estimates.  $|\overline{\alpha}|$  is the mean absolute alpha across a given set of testing portfolios,  $|\overline{\alpha_{H-L}}|$  is the average absolute high-minus-low alpha, and  $p$  is the  $p$ -value of the overidentification test.  $\gamma$ ,  $[\gamma]$ , and  $p$  are in percent, and  $|\overline{\alpha}|$  and  $|\overline{\alpha_{H-L}}|$  are in percent per annum.

Panel A: NYSE breakpoints and value-weighted returns								
	d.f.	$\gamma$	$[\gamma]$	$a$	$[a]$	$ \overline{\alpha} $	$ \overline{\alpha_{H-L}} $	$p$
Bm	8	18.48	2.01	3.89	0.73	1.48	0.81	0.75
$R^{11}$	8	16.75	2.47	5.94	0.00	0.71	0.51	60.19
I/A	8	17.42	1.74	1.54	0.70	0.75	0.50	57.64
Roe	8	17.55	2.44	6.56	0.01	0.82	1.71	1.91
Bm- $R^{11}$	18	18.39	2.02	3.74	0.61	1.28	1.16	0.05
I/A-Roe	18	17.30	1.76	1.56	0.66	1.04	1.33	0.00
Bm- $R^{11}$ -I/A-Roe	38	18.09	1.90	2.89	0.52	1.32	2.81	0.00
Panel B: All-but-micro breakpoints and equal-weighted returns								
	d.f.	$\gamma$	$[\gamma]$	$a$	$[a]$	$ \overline{\alpha} $	$ \overline{\alpha_{H-L}} $	$p$
Bm	8	17.18	2.23	5.88	0.00	0.58	0.12	96.00
$R^{11}$	8	16.98	2.02	3.71	1.77	0.44	0.40	23.18
I/A	8	17.47	1.74	2.28	0.61	0.79	0.53	0.17
Roe	8	16.79	2.16	5.61	0.01	0.62	1.51	21.69
Bm- $R^{11}$	18	17.19	2.09	4.11	0.48	0.66	0.63	0.00
I/A-Roe	18	17.14	1.79	2.25	0.59	0.83	1.81	0.00
Bm- $R^{11}$ -I/A-Roe	38	17.31	1.97	3.43	0.43	0.90	2.41	0.00

**Table A.11 : GMM Estimation and Tests, the Benchmark 2-capital Model Estimated at the Firm Level with Imputed Costs of Debt, June 1967–December 2016**

This table uses the 40 testing deciles formed on book-to-market (Bm), prior 11-month returns ( $R^{11}$ ), asset growth (I/A), and return on equity (Roe), separately and jointly (Bm and  $R^{11}$ , I/A and Roe, and all 40 deciles together). d.f. is the degrees of freedom in the GMM test of overidentification.  $\gamma$  is the technological parameter on the marginal product of total capital as a fraction of sales-to-total capital,  $Y_{it+1}/(K_{it+1} + W_{it+1})$ .  $a$  is the adjustment costs parameter of physical capital.  $[\gamma]$  and  $[a]$  are the standard errors of the point estimates.  $|\bar{\alpha}|$  is the mean absolute alpha across a given set of testing portfolios,  $|\bar{\alpha}_{H-L}|$  is the average absolute high-minus-low alpha, and  $p$  is the  $p$ -value of the overidentification test.  $\gamma$ ,  $[\gamma]$ , and  $p$  are in percent, and  $|\bar{\alpha}|$  and  $|\bar{\alpha}_{H-L}|$  in percent per annum.

Panel A: NYSE breakpoints and value-weighted returns								
	d.f.	$\gamma$	$[\gamma]$	$a$	$[a]$	$ \bar{\alpha} $	$ \bar{\alpha}_{H-L} $	$p$
Bm	8	17.21	2.15	3.58	0.74	1.16	0.12	0.16
$R^{11}$	8	15.31	2.46	5.83	0.01	0.83	0.03	48.43
I/A	8	17.01	1.95	1.79	0.73	0.87	2.85	0.59
Roe	8	16.10	2.46	5.63	0.00	0.86	0.54	7.64
Bm- $R^{11}$	18	17.44	2.19	3.26	0.55	1.18	0.68	0.00
I/A-Roe	18	16.87	1.98	1.72	0.66	1.10	2.62	0.00
Bm- $R^{11}$ -I/A-Roe	38	17.28	2.10	2.73	0.47	1.23	1.92	0.00
Panel B: All-but-micro breakpoints and equal-weighted returns								
	d.f.	$\gamma$	$[\gamma]$	$a$	$[a]$	$ \bar{\alpha} $	$ \bar{\alpha}_{H-L} $	$p$
Bm	8	16.41	2.25	3.58	0.64	0.53	0.52	47.92
$R^{11}$	8	15.90	2.29	3.23	1.37	0.76	0.23	6.07
I/A	8	16.53	2.04	2.19	0.53	0.50	1.01	15.56
Roe	8	15.94	1.95	2.91	2.88	0.65	2.86	0.36
Bm- $R^{11}$	18	16.13	2.27	3.50	0.42	0.72	0.67	0.00
I/A-Roe	18	16.28	2.06	2.22	0.48	0.65	1.84	0.00
Bm- $R^{11}$ -I/A-Roe	38	16.25	2.17	3.01	0.34	0.81	1.74	0.00

**Table A.12 : GMM Estimation and Tests, the Extended 2-capital Model with Working Capital Adjustment Costs Estimated at the Firm Level, June 1967–December 2016**

This table reports GMM estimation and tests for the 40 testing deciles formed on book-to-market (Bm), prior 11-month returns ( $R^{11}$ ), asset growth (I/A), and return on equity (Roe), separately and jointly (Bm and  $R^{11}$ , I/A and Roe, and all 40 deciles together). d.f. is the degrees of freedom in the GMM test of overidentification.  $\gamma$  is the technological parameter on the joint marginal product of total capital as a fraction of sales-to-total capital,  $Y_{it+1}/(K_{it+1} + W_{it+1})$ .  $a$  is the adjustment costs parameter of physical capital, and  $b$  is that of working capital.  $[\gamma]$ ,  $[a]$ , and  $[b]$  are the standard errors of the point estimates of these parameters.  $|\overline{\alpha}|$  is the mean absolute alpha across a given set of testing portfolios,  $|\overline{\alpha_{H-L}}|$  is the average absolute high-minus-low alpha, and  $p$  is the  $p$ -value of the overidentification test.  $\gamma$ ,  $[\gamma]$ , and  $p$  are in percent, and  $|\overline{\alpha}|$  and  $|\overline{\alpha_{H-L}}|$  in percent per annum.

Panel A: NYSE breakpoints and value-weighted returns										
	d.f.	$\gamma$	$[\gamma]$	$a$	$[a]$	$b$	$[b]$	$ \overline{\alpha} $	$ \overline{\alpha_{H-L}} $	$p$
Bm	8	14.05	2.38	2.86	0.00	3.07	0.00	0.52	0.03	92.76
$R^{11}$	8	12.08	2.78	8.14	0.00	0.01	0.01	0.66	0.02	72.98
I/A	8	17.58	1.78	1.53	0.71	0.50	0.82	0.81	2.23	0.19
Roe	8	14.33	2.67	5.76	0.00	2.61	0.02	0.85	0.29	17.78
Bm- $R^{11}$	18	16.22	2.91	3.32	0.60	2.16	0.90	1.08	2.13	0.10
I/A-Roe	18	17.46	1.80	1.61	0.65	0.33	0.82	1.08	2.43	0.00
Bm- $R^{11}$ -I/A-Roe	38	17.89	1.95	2.79	0.49	0.48	0.91	1.28	2.11	0.00
Panel B: All-but-micro breakpoints and equal-weighted returns										
	d.f.	$\gamma$	$[\gamma]$	$a$	$[a]$	$b$	$[b]$	$ \overline{\alpha} $	$ \overline{\alpha_{H-L}} $	$p$
Bm	8	17.03	2.21	3.53	0.68	0.92	1.36	0.53	0.22	32.21
$R^{11}$	8	12.76	2.89	3.20	1.39	2.58	0.55	0.30	0.47	54.58
I/A	8	17.24	1.73	1.83	0.77	0.34	0.84	0.63	0.36	2.44
Roe	8	15.29	2.18	5.53	0.05	1.02	0.18	0.57	1.93	21.74
Bm- $R^{11}$	18	15.77	2.31	3.49	0.44	1.62	1.02	0.68	0.72	0.00
I/A-Roe	18	16.80	1.86	2.04	0.57	0.05	0.57	0.75	1.64	0.00
Bm- $R^{11}$ -I/A-Roe	38	16.81	1.89	3.03	0.45	0.09	0.59	0.93	2.27	0.00

**Table A.13 : Cross-sectional Forecasting Regressions, June 1967–December 2017**

Panel A shows monthly cross-sectional regressions of 1-year-ahead investment-to-physical capital,  $I_{it+1}/K_{it+1}$ , on current log Tobin's  $Q$ ,  $\log(Q_{it})$ , sales-to-total capital,  $Y_{it}/(K_{it} + W_{it})$ , and investment-to-physical capital,  $I_{it}/K_{it}$ . Panel B shows monthly cross-sectional regressions of 1-year-ahead annual sales growth on the year-to-year quarterly sales growth of the prior four quarters, denoted by  $g_{iq-1}^Y$ ,  $g_{iq-2}^Y$ ,  $g_{iq-3}^Y$ , and  $g_{iq-4}^Y$ , respectively. Tobin's  $Q$  is the market equity (price per share times the number of shares outstanding from CRSP) plus long-term debt (Compustat annual item DLTT) and short-term debt (item DLC) scaled by book assets (item AT), all from the most recent fiscal year ending at least four months ago. The Fama-MacBeth  $t$ -values, denoted  $[t]$ , are adjusted for heteroscedasticity and autocorrelations. The goodness-of-fit,  $R^2$ , is in percent. We estimate the cross-sectional regressions in two ways. In "Full-WLS" we use weighted least squares on the full sample with a firm's relative market equity (the firm's market equity divided by the aggregate market equity in the same month) as its weight. In "ABM-OLS" we use ordinary least squares on the all-but-micro sample.

	Panel A: Investment-to-capital, $I_{it+1}/K_{it+1}$						Panel B: Annual sales growth, $Y_{it+1}/Y_{it}$						
	Full-WLS			ABM-OLS			Full-WLS			ABM-OLS			
	Slope	$[t]$	$R^2$	Slope	$[t]$	$R^2$	Slope	$[t]$	$R^2$	Slope	$[t]$	$R^2$	
$\log(Q_{it})$	0.11	30.08	28.34	0.16	36.67	25.50	$g_{iq-1}^Y$	0.43	54.09	67.45	0.43	80.64	64.96
$Y_{it}/(K_{it} + W_{it})$	0.02	9.29		0.03	17.08		$g_{iq-2}^Y$	0.14	19.96		0.15	30.82	
$I_{it}/K_{it}$	0.34	34.07		0.28	44.70		$g_{iq-3}^Y$	0.08	10.77		0.07	13.27	
							$g_{iq-4}^Y$	0.10	14.54		0.07	14.91	

**Table A.14 : Deciles Formed on the Expected Return Estimates, All-but-Micro Sample and Equal-weighted Returns, July 1980–December 2017**

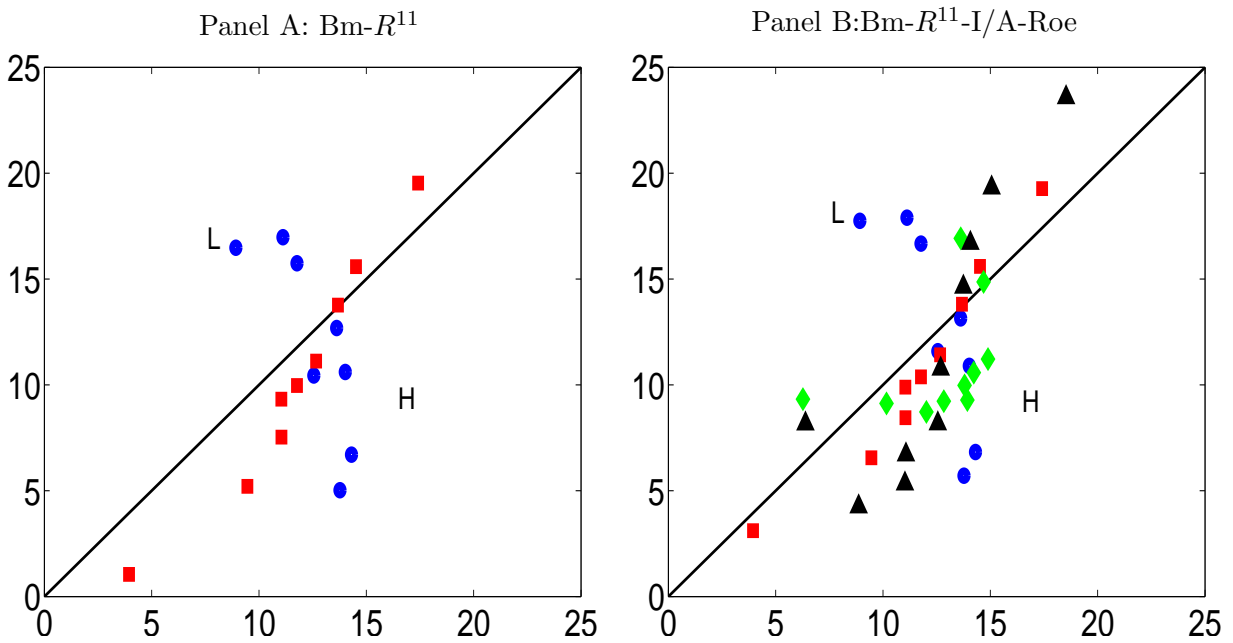
This table reports the average excess return of a given expected return decile for the  $h$ -month holding period, in which  $h = 1, 6,$  and  $12$ . The  $t$ -values adjusted for heteroscedasticity and autocorrelations are reported in the rows beneath the corresponding estimates. The deciles are formed on the expected return estimates with all-but-micro breakpoints and equal-weighted returns.

$h$	L	2	3	4	5	6	7	8	9	H	H–L
Panel A: The 2-capital model estimated at the firm level											
1	0.44	0.68	0.82	0.86	0.87	0.87	0.87	0.91	0.96	1.03	0.60
	1.31	2.25	2.87	3.11	3.38	3.63	3.58	3.96	3.99	4.09	3.38
6	0.47	0.77	0.81	0.87	0.87	0.88	0.87	0.93	0.94	0.99	0.52
	1.39	2.56	2.87	3.21	3.40	3.68	3.60	4.00	3.93	3.89	3.01
12	0.50	0.80	0.79	0.87	0.87	0.88	0.90	0.90	0.90	0.98	0.47
	1.50	2.66	2.83	3.27	3.38	3.64	3.76	3.85	3.73	3.79	2.80
Panel B: The physical capital model estimated at the portfolio level											
1	0.40	0.77	0.81	0.77	0.89	0.86	0.94	0.94	0.94	0.97	0.57
	1.15	2.66	3.27	3.23	3.74	3.67	3.75	3.74	3.67	3.50	3.51
6	0.47	0.83	0.81	0.77	0.87	0.87	0.95	0.94	0.95	0.95	0.48
	1.35	2.84	3.31	3.28	3.64	3.65	3.83	3.72	3.69	3.39	2.99
12	0.53	0.83	0.80	0.79	0.88	0.87	0.92	0.94	0.92	0.91	0.38
	1.52	2.86	3.28	3.38	3.66	3.64	3.70	3.73	3.59	3.24	2.41
Panel C: The Hou-Xue-Zhang $q$ -factor model											
1	0.67	0.87	0.90	0.84	0.88	0.79	0.89	0.83	0.88	0.85	0.18
	1.88	3.01	3.68	3.67	3.82	3.61	3.73	3.34	3.21	2.69	0.89
6	0.69	0.90	0.87	0.83	0.89	0.83	0.85	0.89	0.87	0.84	0.15
	1.96	3.22	3.58	3.61	3.92	3.68	3.59	3.57	3.19	2.68	0.81
12	0.67	0.84	0.86	0.83	0.87	0.85	0.85	0.90	0.90	0.85	0.18
	1.91	3.02	3.56	3.58	3.86	3.75	3.56	3.60	3.31	2.69	0.96
Panel D: The Fama-French 5-factor model											
1	0.73	0.79	0.75	0.87	0.87	0.86	0.89	0.89	0.88	0.87	0.14
	2.09	3.09	3.32	3.94	3.86	3.68	3.68	3.44	3.13	2.56	0.67
6	0.71	0.76	0.80	0.90	0.85	0.90	0.89	0.87	0.92	0.86	0.16
	2.05	2.94	3.53	4.09	3.84	3.89	3.69	3.33	3.20	2.60	0.76
12	0.70	0.77	0.80	0.88	0.84	0.89	0.89	0.87	0.91	0.88	0.17
	2.05	2.99	3.56	4.00	3.79	3.82	3.62	3.29	3.15	2.65	0.87



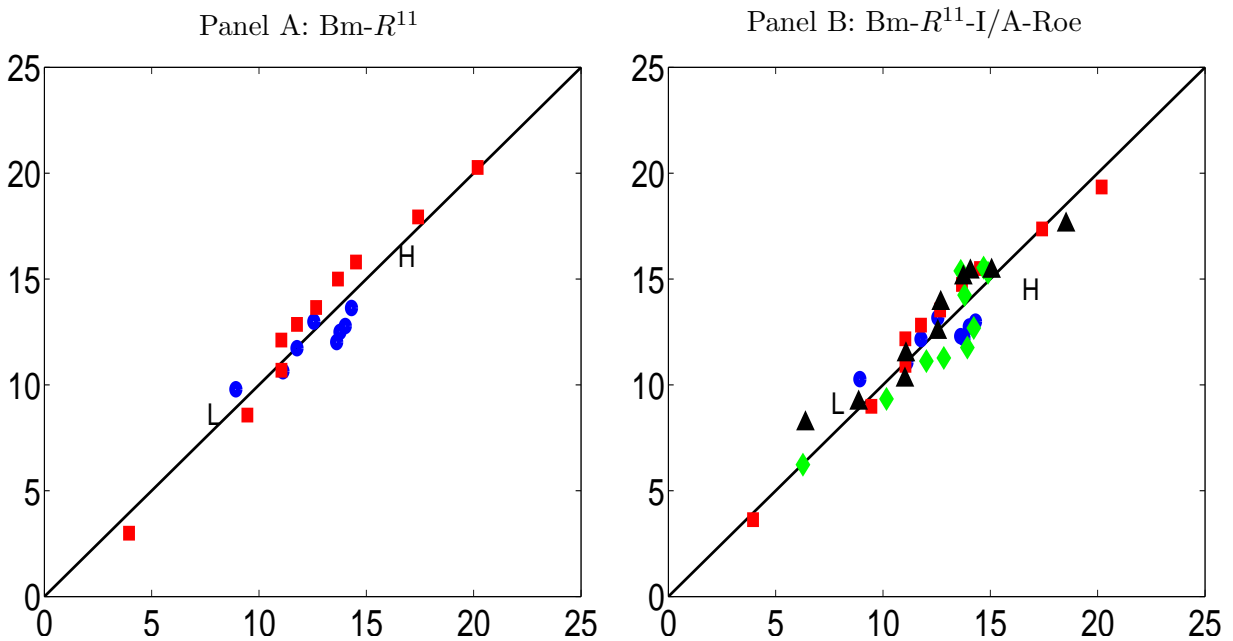
**Figure A.1 : Average Predicted Stock Returns versus Average Realized Stock Returns, The Physical Capital Model Estimated at the Portfolio Level, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

Both average predicted and realized stock returns are in percent per annum. The book-to-market (Bm) deciles (except for the two extreme deciles) are in blue circles, the momentum ( $R^{11}$ ) deciles in red squares, the asset growth (I/A) deciles in green diamonds, and the return on equity (Roe) deciles in black triangles. The low Bm decile is denoted “L,” and the high Bm decile “H.” Panel A fits the Bm and  $R^{11}$  deciles jointly, and Panel B fits all the 40 equal-weighted deciles together.



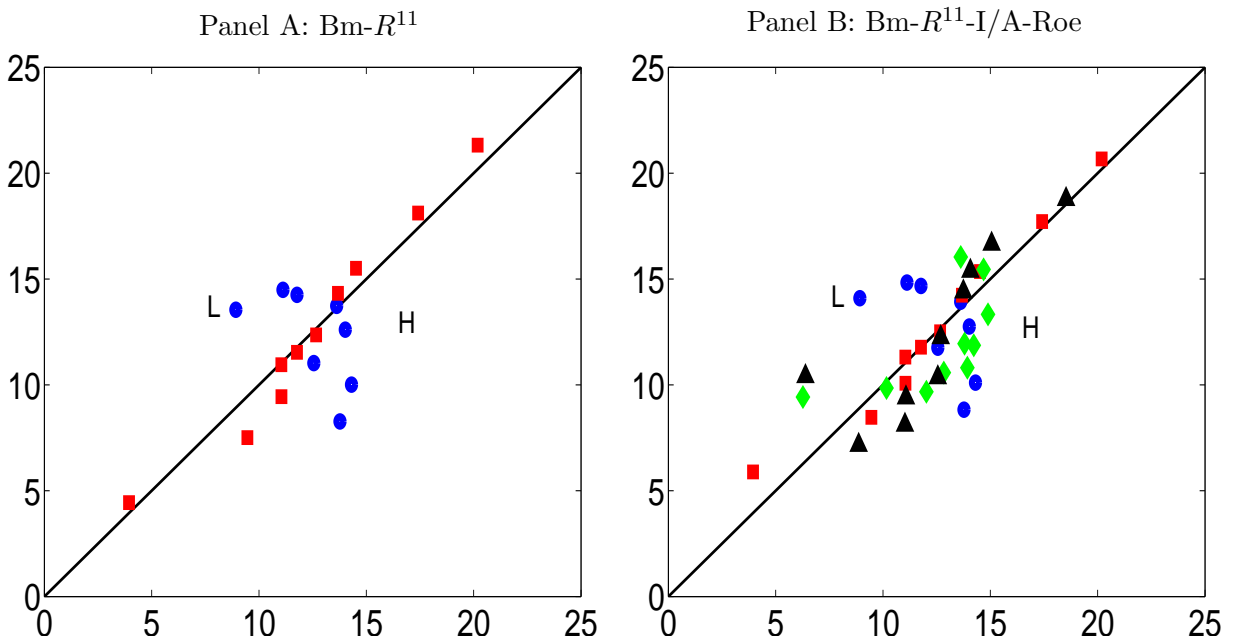
**Figure A.2 : Average Predicted Stock Returns versus Average Realized Stock Returns, The Benchmark 2-capital Model Estimated at the Firm Level, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

Both average predicted and realized stock returns are in percent per annum. The book-to-market (Bm) deciles (except for the two extreme deciles) are in blue circles, the momentum ( $R^{11}$ ) deciles in red squares, the asset growth (I/A) deciles in green diamonds, and the return on equity (Roe) deciles in black triangles. The low Bm decile is denoted “L,” and the high Bm decile “H.” Panel A fits the Bm and  $R^{11}$  deciles jointly, and Panel B fits all the 40 equal-weighted deciles together.



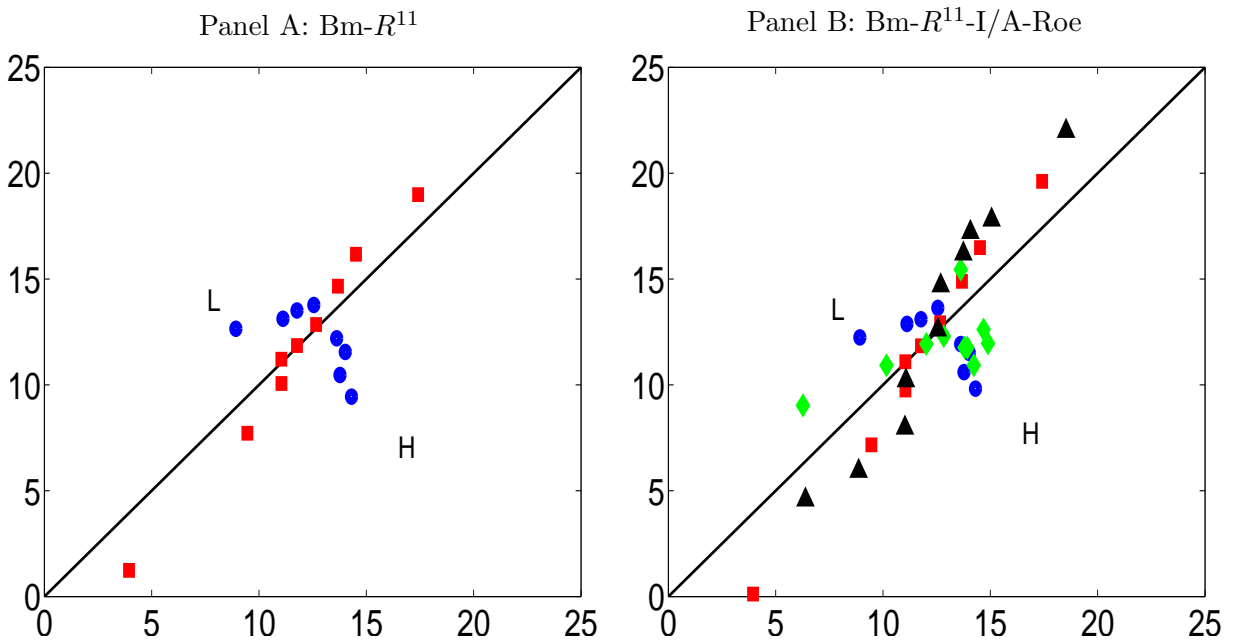
**Figure A.3 : Average Predicted Stock Returns versus Average Realized Stock Returns, The 2-capital Model Estimated at the Portfolio Level, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

Both average predicted and realized stock returns are in percent per annum. The book-to-market (Bm) deciles (except for the two extreme deciles) are in blue circles, the momentum ( $R^{11}$ ) deciles in red squares, the asset growth (I/A) deciles in green diamonds, and the return on equity (Roe) deciles in black triangles. The low Bm decile is denoted “L,” and the high Bm decile “H.” Panel A fits the Bm and  $R^{11}$  deciles jointly, and Panel B fits all the 40 equal-weighted deciles together.



**Figure A.4 : Average Predicted Stock Returns versus Average Realized Stock Returns, The Physical Capital Model Estimated at the Firm Level, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

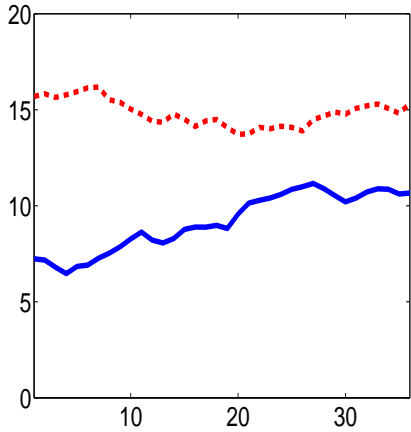
Both average predicted and realized stock returns are in percent per annum. The book-to-market (Bm) deciles (except for the two extreme deciles) are in blue circles, the momentum ( $R^{11}$ ) deciles in red squares, the asset growth (I/A) deciles in green diamonds, and the return on equity (Roe) deciles in black triangles. The low Bm decile is denoted “L,” and the high Bm decile “H.” Panel A fits the Bm and  $R^{11}$  deciles jointly, and Panel B fits all the 40 equal-weighted deciles together.



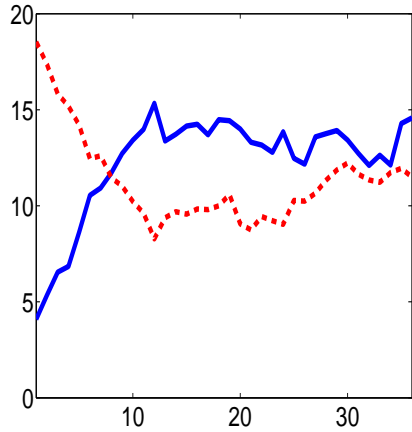
**Figure A.5 : Event-time Dynamics of the Stock and Fundamental Returns of the High and Low Deciles, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

For 36 months after the portfolio formation, we plot the stock returns,  $r_{it+1}^S$ , and the fundamental returns,  $r_{it+1}^F$ , for the high and low deciles formed on book-to-market, prior 11-month returns, asset growth, and return on equity. Both stock and fundamental returns are in percent per annum. The blue solid lines represent the low deciles, and the red broken lines the high deciles. The fundamental returns are based on the parameters from estimating the 2-capital model at the firm level on the 40 equal-weighted deciles jointly.

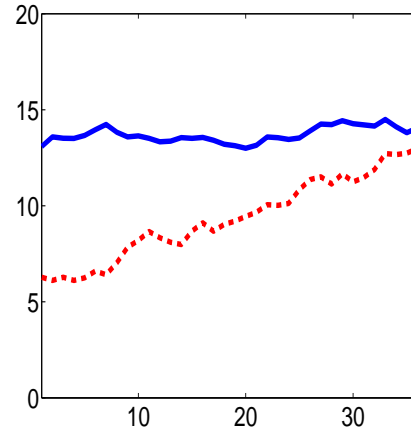
Panel A: Book-to-market,  $r_{it+1}^S$



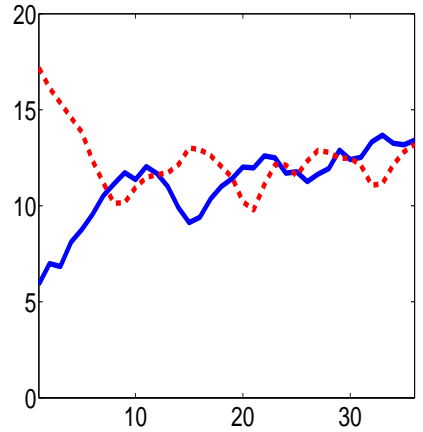
Panel B: Momentum,  $r_{it+1}^S$



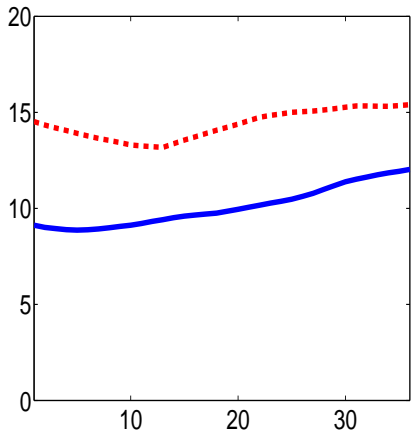
Panel C: Asset growth,  $r_{it+1}^S$



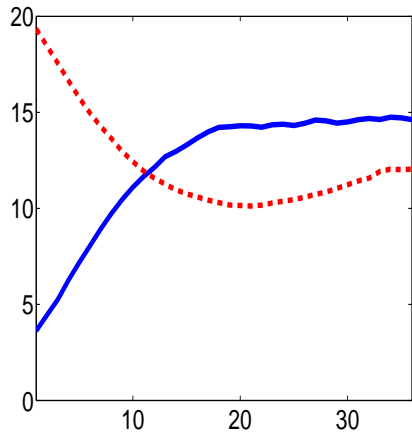
Panel D: Return on equity,  $r_{it+1}^S$



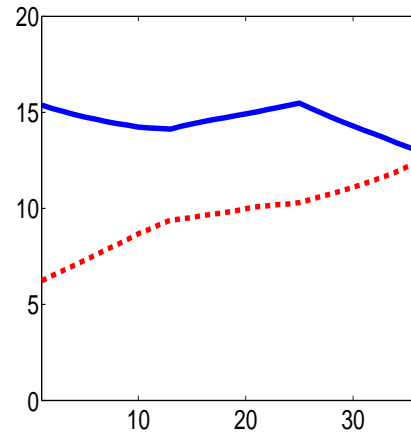
Panel E: Book-to-market,  $r_{it+1}^F$



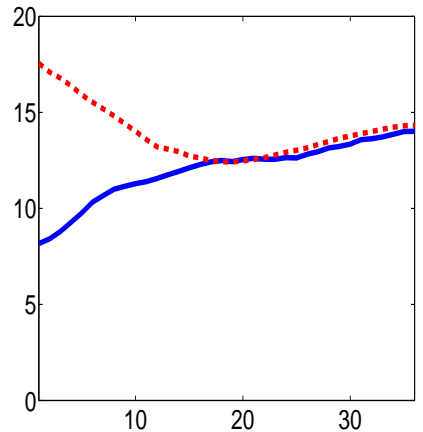
Panel F: Momentum,  $r_{it+1}^F$



Panel G: Asset growth,  $r_{it+1}^F$

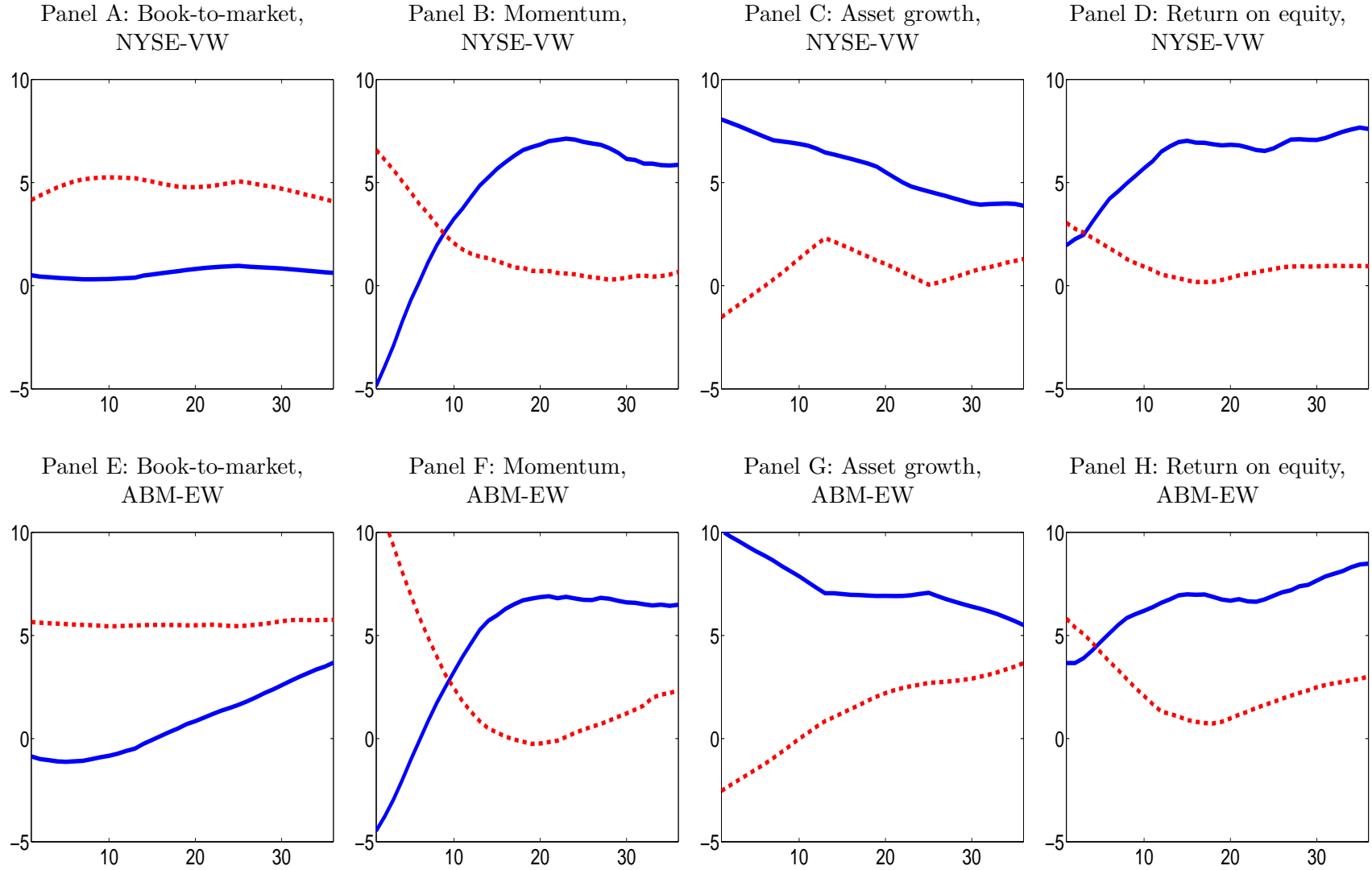


Panel H: Return on equity,  $r_{it+1}^F$



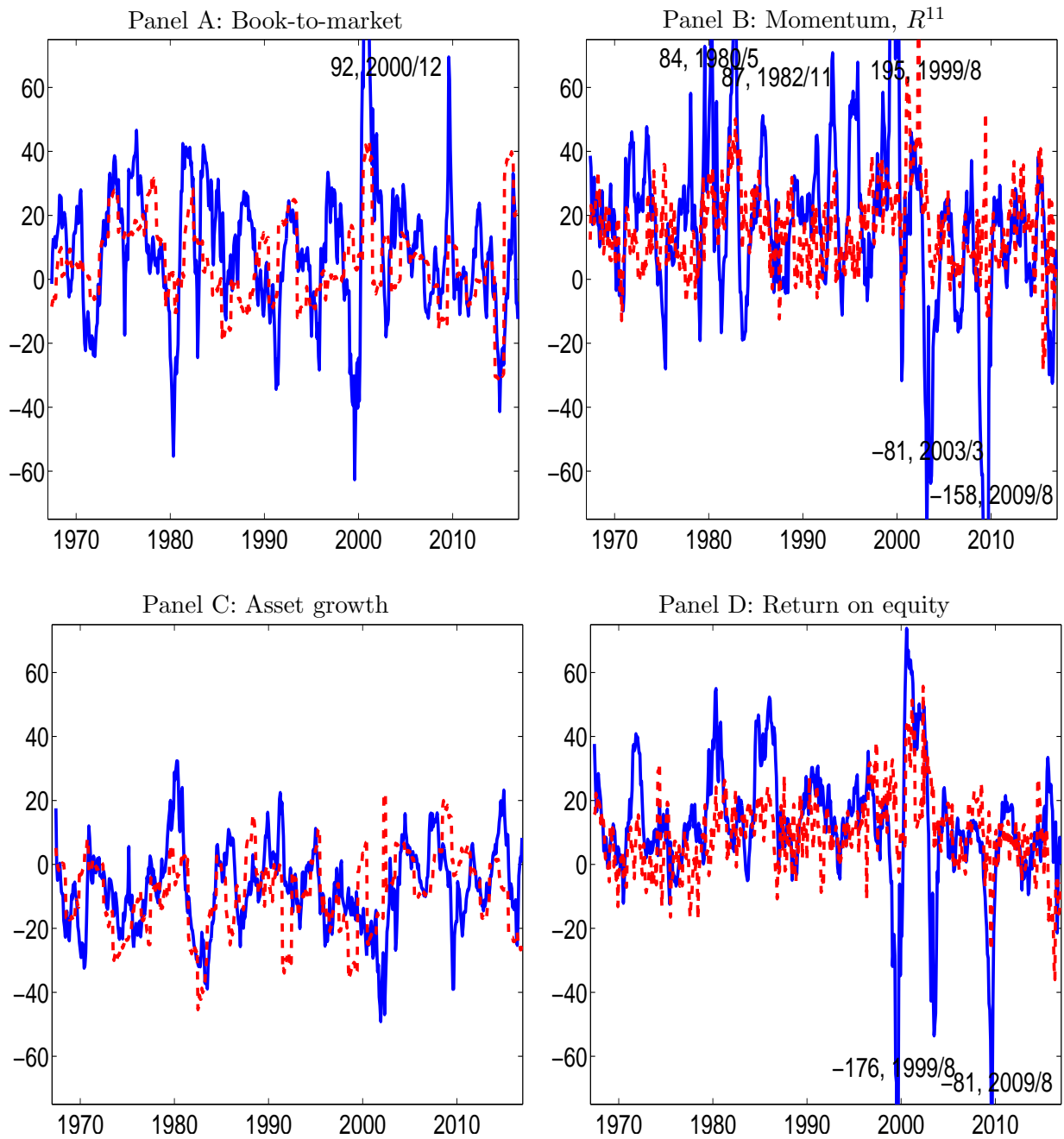
**Figure A.6 : Event-time Dynamics of the Marginal  $Q$  Growth the High and Low Deciles, June 1967–December 2016**

For 36 months after the portfolio formation, we plot the marginal  $q$  growth,  $q_{it+1}/q_{it} - 1$ , for the high and low deciles formed on book-to-market, prior 11-month returns, asset growth, and return on equity. The marginal  $q$  growth is in percent per annum. The blue solid lines represent the low deciles, and the red broken lines the high deciles. Marginal  $q_{it}$  is constructed on the adjustment costs parameter,  $a$ , from estimating the 2-capital model at the firm level on the 40 testing deciles jointly. We report results with NYSE breakpoints and value-weighted returns (NYSE-VW) as well as all-but-micro breakpoints and equal-weighted returns (ABM-EW).



**Figure A.7 : Time Series of the Stock and Fundamental Returns of the Factor Premiums, All-but-micro Breakpoints and Equal-weighted Returns, June 1967–December 2016**

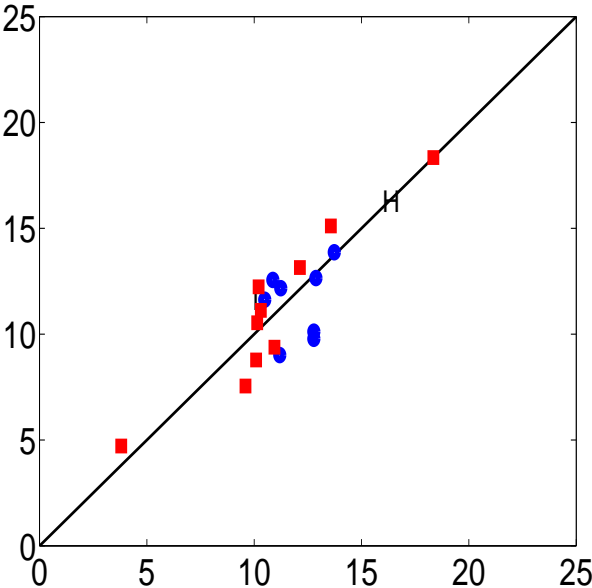
The blue solid lines represent the value-weighted stock returns of the high-minus-low deciles, and the red broken lines the corresponding fundamental returns. Both returns are in percent per annum. Stock returns outliers are indicated with their values and the corresponding months.



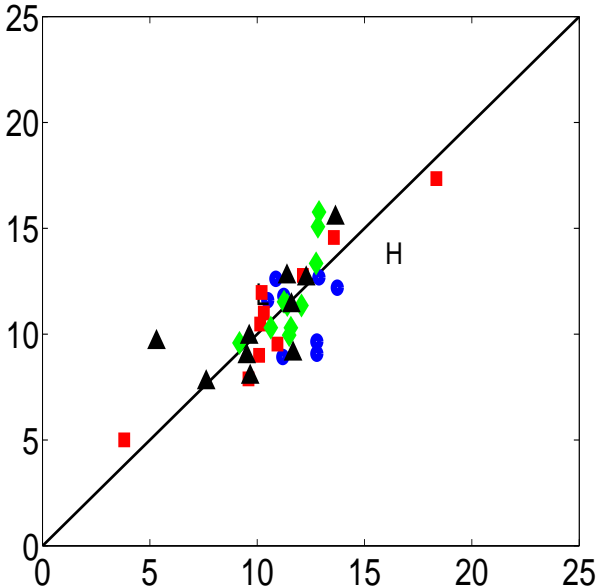
**Figure A.8 : Average Predicted Stock Returns versus Average Realized Stock Returns, The Benchmark 2-capital Model Estimated at the Firm Level in the No-large-M&A Sample, June 1967–December 2016**

This table uses the no-large-M&A sample, in which firms with sizeable M&As with the target assets at least 15% of the acquirer assets are excluded. We identify M&As via the SDC dataset and Compustat (item AQC). Both average predicted and realized stock returns are in percent per annum. The book-to-market (Bm) deciles (except for the two extreme deciles) are in blue circles, the momentum ( $R^{11}$ ) deciles in red squares, the asset growth (I/A) deciles in green diamonds, and the return on equity (Roe) deciles in black triangles. The low Bm decile is denoted “L,” and the high Bm decile “H.” Panels A and C fit the Bm and  $R^{11}$  deciles jointly, and Panel B and D all the 40 deciles jointly.

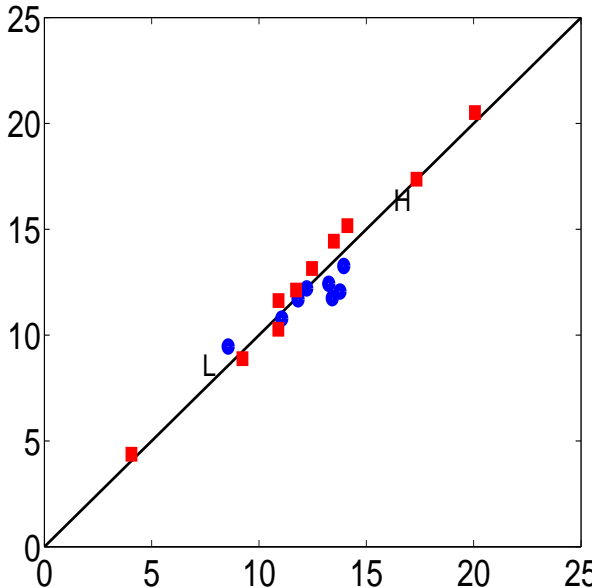
Panel A: Bm- $R^{11}$ , NYSE breakpoints and value-weighted returns



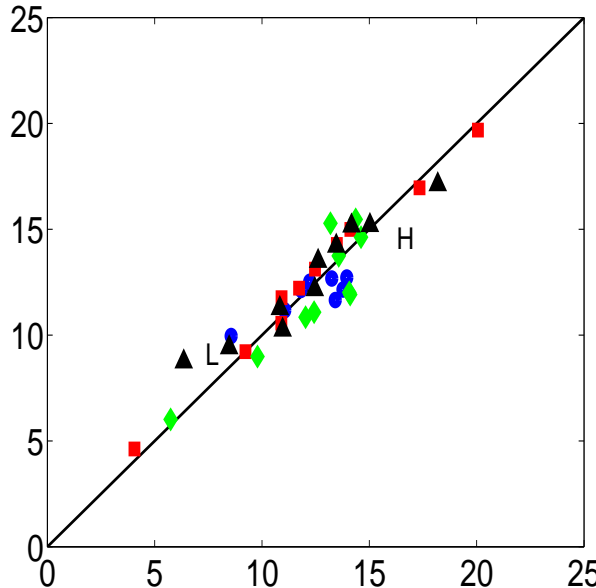
Panel B: Bm- $R^{11}$ -I/A-Roe, NYSE breakpoints and value-weighted returns



Panel A: Bm- $R^{11}$ , all-but-micro breakpoints and equal-weighted returns



Panel B: Bm- $R^{11}$ -I/A-Roe, all-but-micro breakpoints and equal-weighted returns

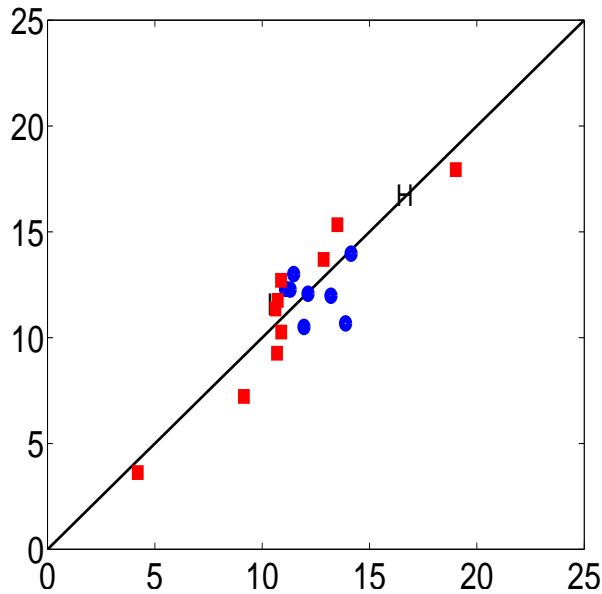




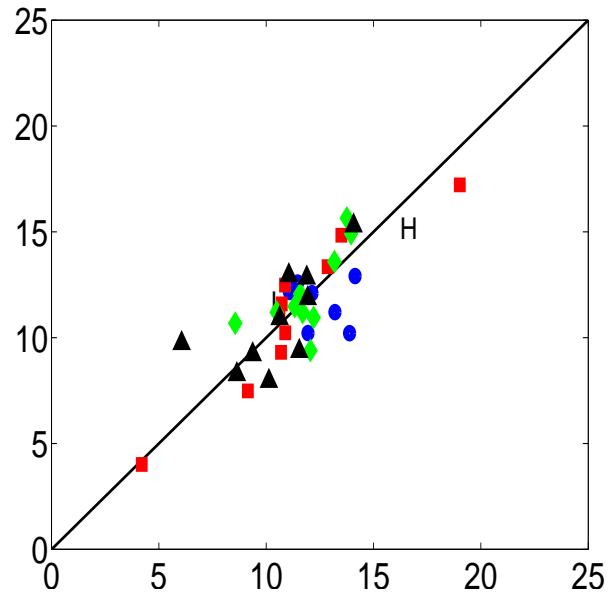
**Figure A.9 : Average Predicted Stock Returns versus Average Realized Stock Returns, The Benchmark 2-capital Model Estimated at the Firm Level with Imputed Costs of Debt, June 1967–December 2016**

Both average predicted and realized stock returns are in percent per annum. The book-to-market (Bm) deciles (except for the two extreme deciles) are in blue circles, the momentum ( $R^{11}$ ) deciles in red squares, the asset growth (I/A) deciles in green diamonds, and the return on equity (Roe) deciles in black triangles. The low Bm decile is denoted “L,” and the high Bm decile “H.” Panels A and C fit the Bm and  $R^{11}$  deciles jointly, and Panel B and D all the 40 deciles together.

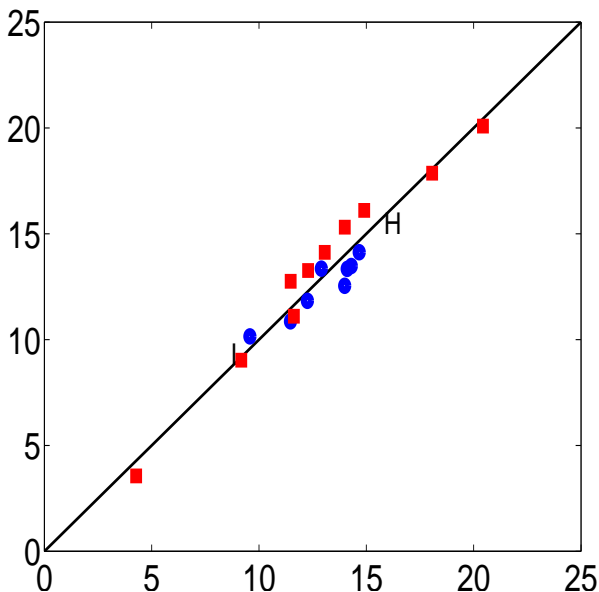
Panel A: Bm- $R^{11}$ , NYSE breakpoints and value-weighted returns



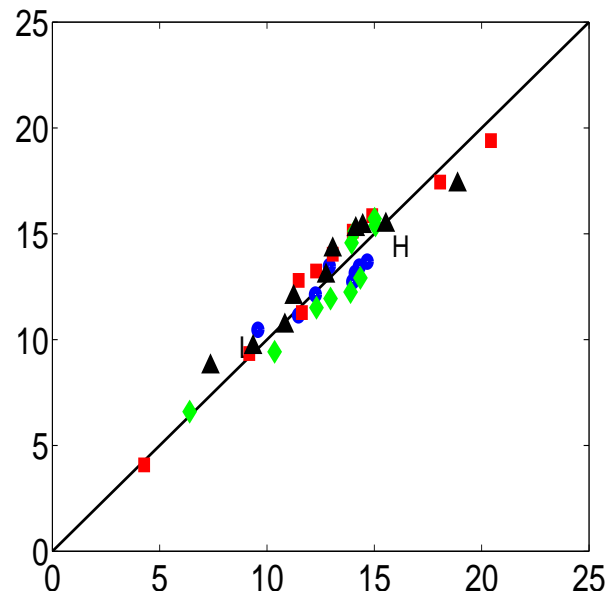
Panel B: Bm- $R^{11}$ -I/A-Roe, NYSE breakpoints and value-weighted returns



Panel A: Bm- $R^{11}$ , all-but-micro breakpoints and equal-weighted returns



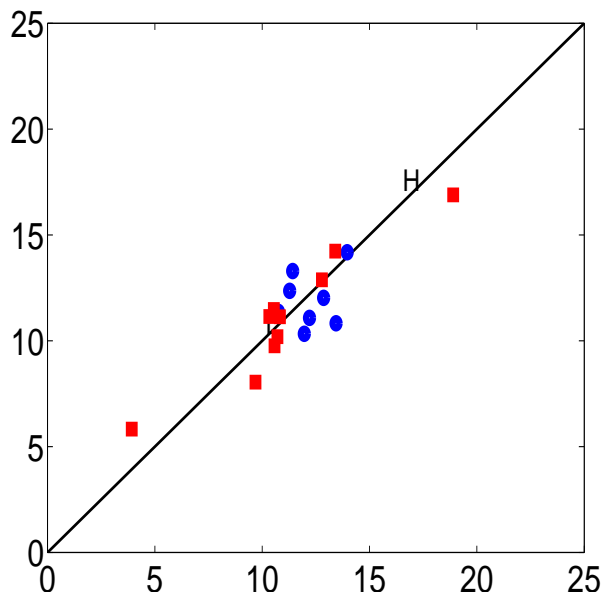
Panel B: Bm- $R^{11}$ -I/A-Roe, all-but-micro breakpoints and equal-weighted returns



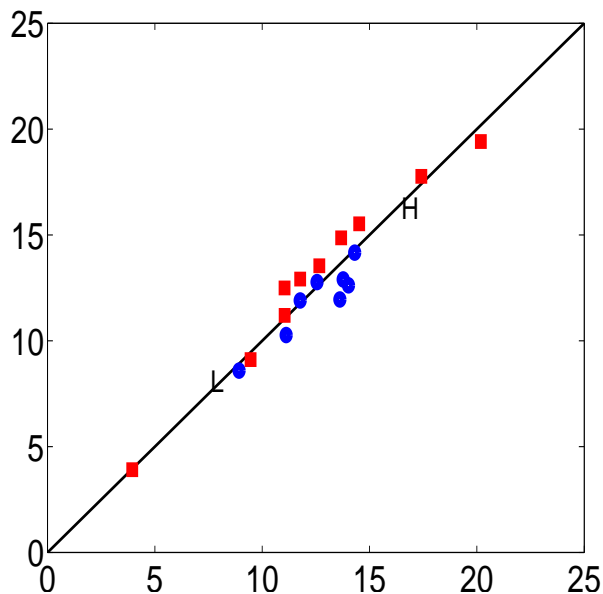
**Figure A.10 : Average Predicted Stock Returns versus Average Realized Stock Returns, The Extended 2-capital Model with Working Capital Adjustment Costs Estimated at the Firm Level, June 1967–December 2016**

Both average predicted and realized stock returns are in percent per annum. The book-to-market (Bm) deciles (except for the two extreme deciles) are in blue circles, the momentum ( $R^{11}$ ) deciles in red squares, the asset growth (I/A) deciles in green diamonds, and the return on equity (Roe) deciles in black triangles. The lowest Bm decile is denoted “L,” and the highest Bm decile “H.” Panels A and B fit the Bm and  $R^{11}$  deciles jointly, and Panels C and D all the 40 deciles together.

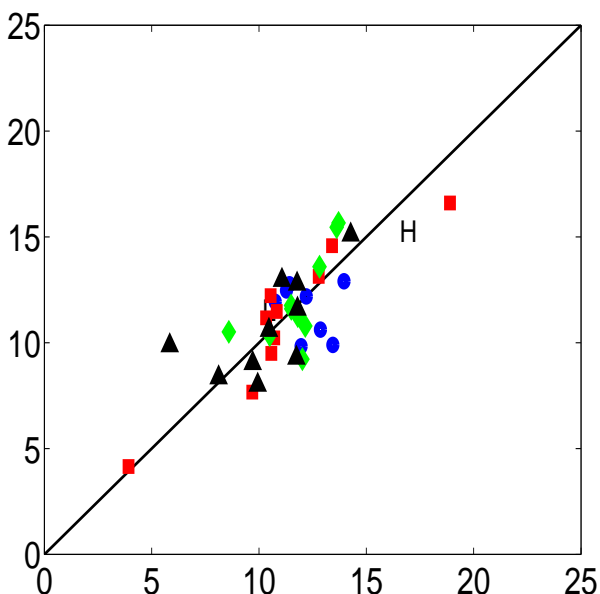
Panel A: Bm- $R^{11}$ , NYSE breakpoints and value-weighted returns



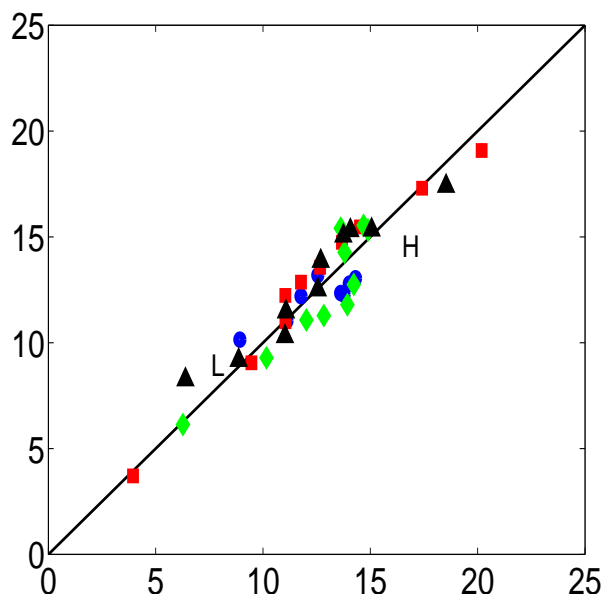
Panel B: Bm- $R^{11}$ , all-but-micro breakpoints and equal-weighted returns



Panel C: Bm- $R^{11}$ -I/A-Roe, NYSE breakpoints and value-weighted returns



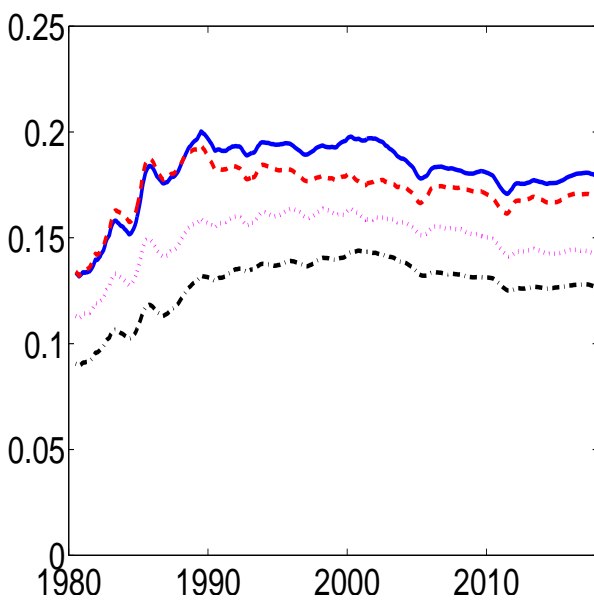
Panel D: Bm- $R^{11}$ -I/A-Roe, all-but-micro breakpoints and equal-weighted returns



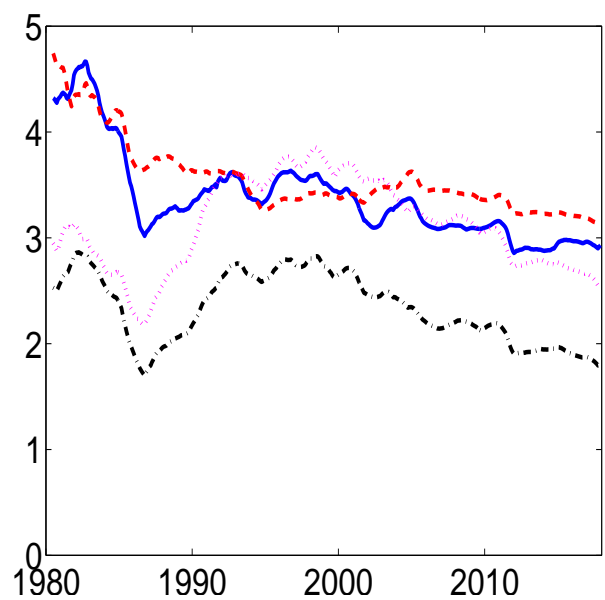
**Figure A.11 : Time Series of Recursively Estimated Parameter Values, July 1980–December 2017**

In the benchmark 2-capital model, the marginal product parameter,  $\gamma$ , is the sum of that for physical capital,  $\gamma_K$ , and that for working capital,  $\gamma_W$ . In the physical capital model, the marginal product parameter is  $\gamma_K$ . In both panels,  $a$  denotes the adjustment costs parameter for physical capital. The blue solid lines are for the 2-capital model estimated at the firm level with value-weighted testing deciles, the red broken lines the 2-capital model estimated at the firm level with equal-weighted deciles, the black dashdot lines the physical capital model estimated at the portfolio level with value-weighted deciles, and the purple dotted lines the physical capital model estimated at the portfolio level with equal-weighted deciles. Recursive estimation means that we add one month to the estimation window at a time to obtain the time series of the parameter estimates.

Panel A: The marginal product parameter,  $\gamma$ , in the 2-capital model, or  $\gamma_K$  in the physical capital model



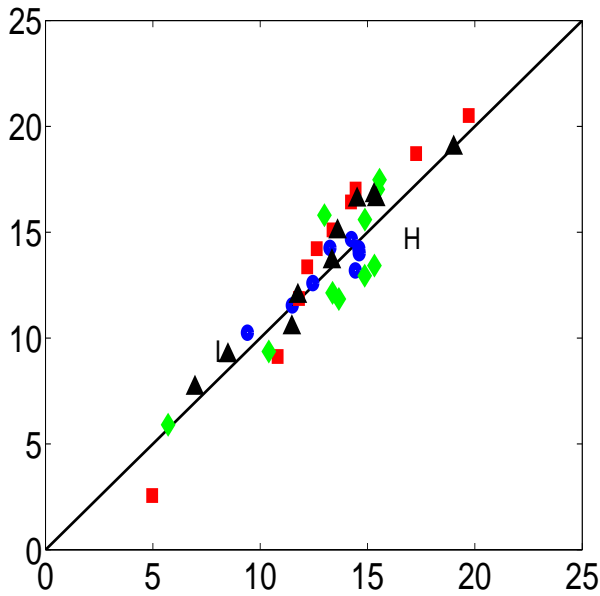
Panel B: The adjustment costs parameter,  $a$



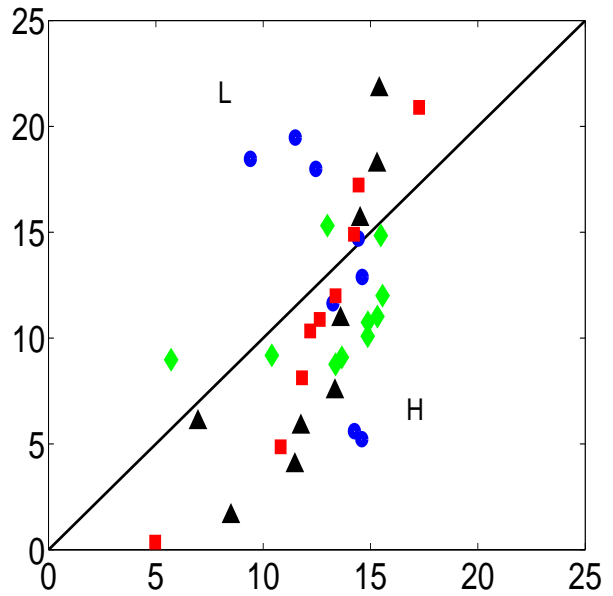
**Figure A.12 : The 1-period-ahead Model Fits via Recursive Estimation, All-but-micro Breakpoints and Equal-weighted Returns, July 1980–December 2016**

Both average predicted ( $y$ -axis) and realized stock returns ( $x$ -axis) are in percent per annum. The book-to-market (Bm) deciles (except for the two extremes) are in blue circles, the momentum ( $R^{11}$ ) deciles in red squares, the asset growth (I/A) deciles in green diamonds, and the return on equity (Roe) deciles in black triangles. The low Bm decile is denoted “L,” and the high Bm decile “H.”

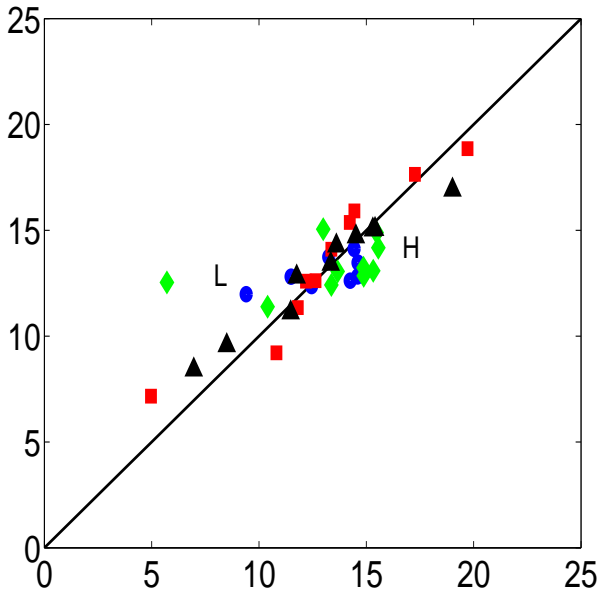
Panel A: The 2-capital model estimated at the firm level



Panel B: The physical capital model estimated at the portfolio level



Panel C: The Hou-Xue-Zhang  $q$ -factor model



Panel D: The Fama-French 5-factor model

