A Unified Economic Explanation for Profitability Premium and Value Premium *

Leonid Kogan Jun Li Harold H. Zhang

February 2018

Preliminary Version

Abstract

We jointly explain the gross profitability premium and the value premium in a dynamic structural model. Co-existence and negative correlation between profitability and value factors in the data challenge existing asset pricing models because high (low) gross profitability firms resemble growth (value) firms. We demonstrate that the profitability premium is driven by more productive firms having higher exposures to aggregate demand shocks, whereas the value premium is created by high book-to-market firms having more assets in place relative to growth options in their asset composition. Our model replicates co-existence of negatively correlated profitability premium and value premium. We also uncover a novel profitability decomposition and the stronger return predictive power of transitory profitability as evidenced in the data.

JEL Classifications: G12, E44

Keywords: Gross profitability premium, Value premium, Aggregate demand shocks, Investment shocks, Persistent and transitory profitability

*We thank Amir Yaron for helpful discussions. Leonid Kogan is at the Sloan School of Management, Massachusetts Institute of Technology. Jun Li and Harold H. Zhang are at the Jindal School of Management, University of Texas at Dallas. All remaining errors are our own.

1 Introduction

Firms with high gross profitability have higher future stock returns than firms with low gross profitability. Novy-Marx (2013) documents that the most profitable firms earning 0.31% per month (3.78% annually) higher average returns than the least profitable firms. This empirical finding in the cross-section of stock returns has attracted increasing interests and motivated the inclusion of the profitability premium into the recent asset pricing factor models (see Fama and French (2015) and Hou, Xue, and Zhang (2015)). It also created debates on the underlying sources of this large premium. On the rational expectations side, it has been argued that the gross profitability premium is related to the investment-specific technology shocks (Kogan and Papanikolaou (2013)) or credit risk (Ma and Yan (2015)). On the behavioral explanations side, it has been linked to investors' under-reaction to news on firm fundamentals (see Wang and Yu (2015), Lam, Wang, and Wei (2014)). One particularly puzzling observation is that high gross profitability firms look a lot like growth firms while low gross profitability firms look like value firms, whereas value firms are well known to earn higher average returns than growth firms (see Fama and French (1992)). This creates a challenge for an economic model to generate co-existence of negatively correlated profitability factor and the value factor simultaneously, as well as the positive profitability and value premia. It is therefore imperative to explain these empirical regularities in a unified economic framework.

In this paper, we develop a structural asset pricing model with production to jointly explain the gross profitability premium and the value premium. Our model features both aggregate demand and investment-specific technology (IST) shocks that affect all firms in the economy.[1] The extent to which firms are affected by aggregate shocks differs, leading to differential exposure to demand and IST shocks. Existing studies (Kogan and Papanikolaou (2013), Kogan and Papanikolaou

[1]Because our model is partial equilibrium in nature, we do not spell out the exact origins of the systematic demand shock affecting the entire population of firms. These shocks may reflect the effects of the production network, with productivity shocks to downstream firms translating into demand shocks from the perspective of upstream firms. Alternatively, these shocks may originate in the household sector as shocks to beliefs or tastes, or be driven by monetary policy shocks, in which case they would fit the more common interpretation of the "aggregate demand" shocks. What is important for our purposes is that such shocks create correlated movements in firm profits relative to their output.

(2014)) provided empirical evidence that firms with different compositions of asset-in-place and growth options have different stock return and investment responses to the IST shock. Firms with high growth options have higher exposure to the IST shock, leading to a lower return due to a negative price of risk for investment-specific shocks. In the same spirit, the heterogeneity in asset composition between assets in place and growth options drives the value premium in our model.

To capture the empirical finding that more profitable firms earn higher return than less profitable firms, we introduce a production function with constant elasticity of substitution between capital and other inputs into a standard asset pricing model with firm production. Firms own capital and rent other inputs, and firms with high productivity (more profitable firms) utilize more non-capital inputs relative to capital and incur higher production costs than firms with low productivity (less profitable firms). We show that at a moderate level of the elasticity of substitution between capital and other inputs, the increase in revenue due to a positive productivity shock is greater than the increase in input costs. When the price of inputs is highly procyclical with respect to the aggregate demand shock, a negative demand shock reduces the percentage of input costs more than the percentage change in revenus. The change in the input costs thus serves as a hedge against the demand shock. This hedging effect is stronger for low profitability firms than for high profitability firms because the input costs is larger relative to their revenue than high profitability firms. This leads to a high exposure to demand shocks for high profitability firms than for low profitability firms. The price of risk for the systematic demand shock is positive, so higher exposure to demand shocks merits a higher expected return for more profitable firms than less profitable firms. This is the channel for the gross profitability premium. On the other hand, as in Kogan and Papanikolaou (2013) and Kogan and Papanikolaou (2014), the value premium is due to the heterogeneity in the asset composition between assets in place and growth options. In our model, firms are also subject to heterogenous firm-specific investment shocks (random arrival of projects). Firms that have experienced positive (negative) firm-specific investment shocks have larger (smaller) exposures to the aggregate investment shock and are growth (value) firms.

When calibrated to match empirical moments, our model generates large profitability premium, value premium, and, importantly, the negative correlation between the profitability factor and the value factor. The annualized profitability premium based on the quintile sorts on gross profitability is 3.1 percent from the model relative to 3.69 percent in the data for the value-weighted returns. The value premium implied in the model is 3.25 percent annually relative to 5.43 percent for the value-weighted returns in the data. The correlation between the profitability factor and the value factor is -0.19 in the model versus -0.5 in the data. Consistent with the empirical findings, the model also replicates the failure of the CAPM. Further, it generates a higher abnormal return of the profitability premium with the inclusion of the value premium factor than without in the asset pricing tests, which offers suggestive evidence that the profitability premium is the other side of the value as described by Novy-Marx (2013).

Our study also proposes a novel perspective of decomposing firm gross profitability to sharpen the construction of the profitability premium. In the empirical data, we find that the gross profitability is persistent but its predictive power for future stock returns is short-lived. As a result, one can decompose the gross profitability into a persistent component and a transitory component, with only the latter being able to predict returns. Indeed, when we construct the persistent component using the predicted value from a cross-sectional regression of firms' gross profitability on the lagged gross profitability five years ago, we find this component, with a very high annual autocorrelation of 0.928, is unable to predict future returns. However, it has a strong negative correlation with the book-to-market ratio.

The transitory component of firm gross profitability is constructed as the deviation of the gross profitability from its persistent component. In contrast to the persistent component, the transient component has a much lower autocorrelation of 0.626 and contains more relevant information about future stock returns. Indeed, Figure 1 shows that even though the ROA portfolios display an increasing pattern in Sharpe ratio (the top panel), the pattern is however not monotone. In the meantime, the Sharpe ratio remains flat for portfolios sorted by the persistent ROA (the middle panel). In sharp contrast, the Sharpe ratio increases monotonically from low to high transitory ROA portfolios with a much steeper trend (the bottom panel). Furthermore, a horse race test on stock returns between the gross profitability and its transitory component generates an insignificant loading on the former, whereas the t-statistic for the latter is highly significant with or without controlling for other firm characteristics. In our model, since firm's gross profitability is informative about both firm-specific productivity and growth opportunities, the return predictive power of gross profitability is weakened by the firm-specific investment opportunities, which are highly persistent. Our investment-based model qualitatively replicates the above-mentioned interesting empirical results.

[Insert Figure 1 Here]

Our paper is related to but distinct from the recent literature on the effect of labor rigidity on asset prices. For instance, Danthine and Donaldson (2002) show that wage rigidity can induce a strong labor leverage and improve the performance of production-based asset pricing model to better match aggregate market volatility and equity premium. Favilukis and Lin (2015) examine the quantitative effect of wage rigidity and labor leverage on both the equity premium and value premium. Donangelo, Gourio, Kehrig, and Palacios (2017) document that firms with high labor shares have higher expected returns than firms with low labor shares. Favilukis, Lin, and Zhao (2017) examine the effect of labor leverage on the credit market. An important distinction of our paper from this line of literature is that the production inputs we consider here are much broader than labor, which is the focus of those other papers. Instead, production inputs also include other intermediate goods such as materials and energy. As a result, the properties of the overall inputs can be quite different from the properties of labor and human capital. In particular, while the wage is sticky with respect to the business cycles, we find that the overall inputs for firms' production are highly procyclical in the empirical data, which affects cross-sectional asset prices differently from the labor leverage channel.

Our paper is related to the growing literature that investigates the relation between firm stock returns and accounting measures such as firm profitability and book-to-market ratio. Studies on the value premium include Lakonishok, Shleifer, and Vishny (1994), Berk, Green, and Naik (1999), Zhang (2005), Carlson, Fisher, and Giammarino (2004), Cooper (2006), Lettau and Wachter (2007), Kogan and Papanikolaou (2014), and Choi (2013), among many others. The literature on the explanation of the profitability premium is relatively new. Ma and Yan (2015) extend the idea of Garlappi and Yan (2011) and find that the performance of the value and gross profitability strategies varies with credit conditions. Wang and Yu (2015) and Lam, Wang, and Wei (2014) compare the risk-based and behavioral explanations of gross profitability premium. They argue that the empirical evidence is more consistent with investors' underreaction to news on firm fundamentals. Akbas, Jiang, and Koch (2017) find the recent trajectory of a firm's profits predicts future profitability and stock returns. Bouchaud, Krueger, Landier, and Thesmar (2016) propose a theoretical explanation for the profitability premium based on sticky expectations. Hou, Xue, and Zhang (2015) include a profitability factor in their investment-based four-factor model and show that the profitability factor is associated with several anomalies in the cross-sectional stock returns, including momentum profits. The literature on the value and profitability premiums tends to focus on one phenomenon while being silent on the other. One exception is Kogan and Papanikolaou (2013), which we discuss in more detail in Section 4.

2 Empirical Benchmark and Motivating Evidence

Our data for the empirical analysis are from several sources. The stock return data is from CRSP, the accounting data is from Compustat. Following Novy-Marx (2013), we define the gross profitability, which we refer to as ROA, as revenue (Compustat item REVT) minus cost of goods sold (Compustat item COGS) divided by total asset (Compustat item AT). We define book-to-market equity ratio following Fama and French (1992). We remove firms in the financial industries and only keep in our sample firms with a share code 10 or 11, and exchange code of 1, 2, or 3. Our final sample is monthly from July 1963 to December 2014. In this section, we first replicate the profitability premium and value premium documented in the literature. We then provide empirical evidence that help motivate our proposed mechanism for generating the profitability premium.

2.1 Gross profitability premium and value premium

We examine the standard gross profitability strategy and the value strategy by constructing quintile portfolios sorted by ROA and book-to-market ratio, respectively, and report their respective portfolio characteristics, returns, and asset pricing test results. Panel A of Table 1 reports the ROA portfolio characteristics. Consistent with Novy-Marx (2013), we find that high ROA firms have low book-to-market ratio and high Tobin's Q. They have lower leverage, higher investment rate; they also have better stock performance in the past one year (Mom). These patterns suggest that the high ROA firms look a lot like growth firms.

[Insert Table 1 Here]

Panel B of Table 1 reports the value-weighted portfolio returns and the asset pricing test results, including the CAPM and Fama-French three factor model test, for these quintile portfolios sorted by ROA.[2] High profitability firms have higher average returns than low profitability firms. The annualized return spread is 3.69% per year with a Sharpe ratio of 0.35. CAPM fails to capture the ROA premium, as the difference in market beta between high and low ROA portfolios is only 0.01 (t-statistic = 0.35). Controlling for Fama-French three factors further improves the return spread, due to the similarity of high (low) ROA and growth (value) firms. Indeed, the coefficient of the ROA spread portfolio on the HML factor is -0.48 (t-statistic = -6.71), giving rise to an abnormal return of 6.37% per year (t-statistic = 4.56). In an untabulated analysis, we find the correlation between the gross profitability factor and the value factor is -0.5. These results replicate the finding in Novy-Marx (2013) that the gross profitability is the other side of value.

Table 2 reports the main characteristics, returns, and the asset pricing test results for quintile portfolios sorted by book-to-market ratio. Once again, we observe that high book-to-market (value) firms have lower profitability and low book-to-market (growth) firms have higher profitability. Value firms have higher leverage than growth firms, lower Tobin's Q, lower research and development expenditure, and in particular lower investment rate (I/K) relative to growth firms.

For our sample period, the value-weighted return spread between the high book-to-market and the low book-to-market portfolios (the value premium) has an average of 5.43 percent per year with a Sharpe ratio of 0.40. The unconditional CAPM fails to capture the value premium, and

[2] For the rest of the paper, we only report the result for the value-weighted strategy, but the equal weighted strategy generates a very similar conclusion.

not surprisingly, including the HML factor reduces the estimated alpha and makes it statistically insignificant. The ROA premium, value premium, and the negative correlation between the profitability and the value factors serve as target moments for our economic model in the next section.

[Insert Table 2 Here]

2.2 Profitability and risk exposures

To motivate our explanation for the profitability premium, we provide empirical evidence on the exposure of the cash flow and excess return to demand shocks across profitability portfolios. We use two types of aggregate shocks that are likely positively correlated with demand shocks, as defined in the model. The first is the government spending growth, corresponding to the fiscal policy shocks. The second one is the Romer and Romer (2004) monetary policy shocks.[3]

Table 3 Panel A shows that the estimated cash flow betas of the profitability portfolios at one-, two-, and three-year lags. Our results demonstrate that the exposure of gross profit growth to both measures of the aggregate demand shocks increases from the low to high ROA portfolios, with their difference in demand exposures being statistically significant in the subsequent years. For example, a 1% increase in government spending growth is associated with a 0.73% (t-stat = 2.13), 0.7% (t-stat = 2.67), and 0.73% (t-stat = 3.3) increase in the difference in the growth rate of gross profits between the two extreme portfolios in one, two, and three years, respectively. The pattern is similar when we use Romer and Romer shocks as the demand shock proxy.

Reinforcing our findings on the cash flow exposure, the excess return of the Hi-Lo profitability portfolio also has a positive exposure to the aggregate demand shock measures. Table 3 Panel B reports the return betas of the ROA portfolios from the time series regressions on the market factor and one of the demand shock measures as the other factor (denoted as Dshock). Consistent with the pattern of the cash flow exposure, we find the return beta also displays an increasing

[3]The original sample of Romer and Romer (2004) shocks is 1966-1996. We use the updated Romer and Romer (2004) measure in an extended sample (1966-2007) from the website of Basil Halperin (http://www.basilhalperin.com/blog/2013/12/updated-romer-and-romer-2004-measure-of-monetary-policy-shocks/). Our results are quantitatively similar when we use the original Romer and Romer (2004) measure.

pattern from low to high ROA portfolios. The difference in the demand shock exposure of the H-L portfolio is 1.45 (t-stat = 2.58) when we use government spending shocks and 1.78 (t-stat = 3.28) when use Romer and Romer shocks.

The empirical evidence on both the cash flow and return betas indicates that the profitability premium is positively related to the aggregate demand shock. These empirical evidence in conjunction with the empirical findings in Kogan and Papanikolaou (2013, 2014) provide the motivation for introducing both the aggregate demand shock and the aggregate investment shock to jointly explain the profitability premium and the value premium as elaborated in our next section.

[Insert Table 3 Here]

3 A Unified Economic Model

In this section, we propose a unified investment-based asset pricing model that is aimed at replicating the empirical regularities: 1) the coexistence of the positive gross profitability premium and value premium; 2) the negative correlation between gross profitability premium and the value premium. Our model features an aggregate demand shock and an aggregate disembodied productivity shock (referred to as aggregate investment shock thereafter) that affect all firms in the economy. As we see below, while the value premium is driven by firms with different asset composition and consequently different exposure to the aggregate investment shocks, the profitability premium is driven by firms with differential exposures to the aggregate demand shock.

3.1 An illustrative static model

To elucidate the intuition of the full dynamic model to generate the gross profitability premium that will be introduced in Section 3.2, we first consider a simple static model. Suppose there are two types of inputs, capital K and other production inputs L, including labor. The production function takes a form with constant elasticity of substitution between capital and other inputs.

The firm's profit π is the difference between revenue and total input costs:[4]

$$\pi = \max_{L} \left\{ X \left[(ZL)^{\frac{\eta-1}{\eta}} + K^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} - WL \right\} \tag{1}$$

where X represents the aggregate demand, Z is idiosyncratic input-augmenting productivity, W is the rental rate of input L, and $\eta > 0$ measures the elasticity of substitution between capital and the other inputs. Firms take the rental rate process for other inputs as given and choose these inputs to maximize total profits.

The share of the other inputs can be calculated from the first order condition:

$$LS = \frac{(ZL)^{\frac{\eta-1}{\eta}}}{(ZL)^{\frac{\eta-1}{\eta}} + K^{\frac{\eta-1}{\eta}}} \tag{2}$$

Plugging this first order condition back to the profit function, we have

$$\pi = X \left[(ZL)^{\frac{\eta-1}{\eta}} + K^{\frac{\eta-1}{\eta}} \right]^{\frac{1}{\eta-1}} K^{\frac{\eta-1}{\eta}} \tag{3}$$

Taking the partial derivative of log profit with respect to $\log Z$, we can show that:

$$\frac{\partial \log L}{\partial \log Z} = \eta \left(\frac{ZL}{K} \right)^{\frac{\eta-1}{\eta}} + (\eta - 1). \tag{4}$$

The exposure of the gross profit with respect to X, β_X, is defined as:

$$\beta_X = \frac{\partial \log \pi}{\partial \log X} \tag{5}$$

Taking the partial derivative of log profit with respect to $\log X$, we can immediately show that:

$$\begin{aligned} \beta_X &= \frac{\partial \log W}{\partial \log X} + \frac{1}{\eta} \frac{\partial \log L}{\partial \log X} \\ &= \frac{\partial \log W}{\partial \log X} + \left(1 - \frac{\partial \log W}{\partial \log X} \right) \left[\left(\frac{ZL}{K} \right)^{\frac{\eta-1}{\eta}} + 1 \right]. \end{aligned} \tag{6}$$

[4]We assume that the firm is entirely equity financed. The accounting profit accrued to shareholders is thus the difference between the revenue and the costs of inputs other than capital.

Taking the partial derivative of β_X with respect to $\log Z$:

$$\begin{aligned}\frac{\partial \beta_X}{\partial \log Z} &= \left(\frac{\eta-1}{\eta}\right)\left(1-\frac{\partial \log W}{\partial \log X}\right)\left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}\left(1+\frac{\partial \log L}{\partial \log Z}\right) \\ &= (\eta-1)\left(1-\frac{\partial \log W}{\partial \log X}\right)\left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}\left[1+\left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}\right].\end{aligned} \tag{7}$$

The last two terms in Eq. (7) are always positive, so for $\frac{\partial \beta_X}{\partial \log Z} > 0$, we require:

1. $\eta > 1$ and $\frac{\partial \log W}{\partial \log X} < 1$; or

2. $\eta < 1$ and $\frac{\partial \log W}{\partial \log X} > 1$.

In Section 3.4, we find the second condition ($\eta < 1$ and $\frac{\partial \log W}{\partial \log X} > 1$) holds strongly in the data. Intuitively, condition (2) implies that the elasticity of substitution between capital and the other imputs is inelastic and the rental rate of the other inputs is procyclical.

Firm's gross profitability is equal to the ratio between π and K, which can be written as

$$\text{ROA} = X\left[\left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}} + 1\right]^{\frac{1}{\eta-1}}. \tag{8}$$

Equation (8) suggests that ROA is directly related to the aggregate demand X and increases with idiosyncratic productivity Z. Therefore, under the aforementioned condition (2) ($\eta < 1$ and $\frac{\partial \log W}{\partial \log X} > 1$), firms with higher Z have higher profitability and higher exposure to aggregate demand shocks. The intuition goes as follows. In this static model, firms take a long position in the revenue and short position in the input costs. When $\frac{\partial \log W}{\partial \log X} > 1$, the input costs provide a hedge on the aggregate demand shocks. In the event of a negative aggregate demand shock, a highly procyclical input rental rate leads to a larger percentage input cost reduction than its percentage impact on revenue. In addition, if the elasticity of substitution between capital and other inputs is low ($\eta < 1$), a positive firm-specific productivity shock (z shock) induces greater increase in revenue than in input costs, which raises the aggregate demand shock exposure (β_X). This is the mechanism for the profitability premium in our full dynamic model in the next section.

3.2 The full dynamic model

The full dynamic model is a partial equilibrium model. There are a continuum of firms in the cross section. The basic unit of production is projects. Each project uses capital, which is normalized to be 1, and L_{jt} units of other inputs, including labor for production. Projects are identical within a firm, and firms differ in their firm-specific input efficiency in producing outputs. They also differ in their firm-specific investment shocks, capturing arrival rates of incoming projects.

The production function of a project takes a form with constant elasticity of substitution. For each project of firm j, the operating profit π_{jt} is the difference between revenue and input costs:

$$\begin{aligned}\pi_{jt} &= \max_{L_{jt}} \left\{ X_t \left[(Z_{jt} L_{jt} Y_t)^{\frac{\eta-1}{\eta}} + Y_t^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} - W_t Y_t L_{jt} \right\} \\ &= Y_t \max_{L_{jt}} \left\{ X_t \left[(Z_{jt} L_{jt})^{\frac{\eta-1}{\eta}} + 1 \right]^{\frac{\eta}{\eta-1}} - W_t L_{jt} \right\}\end{aligned} \tag{9}$$

where Z_{jt} is idiosyncratic productivity, X_t is the aggregate demand, Y_t is the aggregate productivity, W_t is the rental rate of input, L_{jt}, normalized by the aggregate productivity, η measures the elasticity of substitution between capital and the other inputs. Firms take the process for W_t as given and choose inputs to maximize profits within each period. Based on our definitions, π_{jt} is the ROA for firm j at time t.

It can be shown from the first order condition that:

$$\pi_{jt} = \left[(Z_{jt} L_{jt})^{\frac{\eta-1}{\eta}} + 1 \right]^{\frac{1}{\eta-1}} X_t Y_t, \tag{10}$$

Defining the number of projects (or capital stock) operated by firm j as K_{jt}, the total operating profit is $K_{jt}\pi_{jt}$.

Firms accumulate capital with arrivals of new projects. The law of motion for capital stock is:

$$K_{jt+1} = (1-\delta)K_{jt} + \delta S_t A_{jt} K_{jt}, \tag{11}$$

where S_t and A_{jt} measure the aggregate and firm-specific investment shocks, respectively, which jointly capture the intensity of new project arrivals, and δ is the depreciation rate. We allow A shocks and Z shocks to be positively correlated, consistent with the empirical observation that more profitable firms also have greater investment opportunities. As we see below, the cross-sectional variation in book-to-market ratio is mainly driven by A_{jt}. In addition, firms with higher A_{jt} have higher exposures to S_t than firms with lower A_{jt}. This is the channel for a positive value premium in the model.

For given processes governing the pricing kernel, the input rental rate, the aggregate demand, productivity, and investment shocks, and idiosyncratic productivity and investment shocks, which we specify below, a firm's value can be written recursively as:

$$\begin{aligned} V_{jt} &= K_{jt}\pi_{jt} + E_t[M_{t+1}V_{jt+1}] \\ &\text{s.t. } (9) - (10) \end{aligned} \tag{12}$$

Using the lower case variables to represent the logarithmic transformation of the corresponding level variables, we assume the exogenous variables x, s, z, and a follow AR(1) processes, respectively:

$$x_{t+1} = \rho_x x_t + (1-\rho_x)\bar{x} + \sigma_x \epsilon^x_{t+1} \tag{13}$$

$$s_{t+1} = \rho_s s_t + (1-\rho_s)\bar{s} + \sigma_s \epsilon^s_{t+1} \tag{14}$$

$$z_{jt+1} = \rho_z z_{jt} + (1-\rho_z)\bar{z} + \sigma_z \epsilon^z_{jt+1} + \mu_z \tag{15}$$

$$a_{jt+1} = \rho_a a_{jt} + \sigma_a \epsilon^a_{jt+1} \tag{16}$$

and y follows a random walk

$$\Delta y_{t+1} = \sigma_y \epsilon^y_{t+1} \tag{17}$$

We assume the rental rate W_t is a function of the aggregate demand as follows:

$$\log W_t = \log w_0 + w_1 \log X_t, \tag{18}$$

where $w_0 > 0$ and $w_1 > 0$ capture the level and the cyclicality of the input rental rate.

The pricing kernel is a function of the three aggregate shocks, ϵ_t^x, ϵ_t^y, and ϵ_t^s:

$$M_{t+1} = \exp\left(-r_f - \gamma_x\sigma_x\epsilon_{t+1}^x - \gamma_y\sigma_y\epsilon_{t+1}^y - \gamma_s\sigma_s\epsilon_{t+1}^s - \frac{1}{2}\gamma_x^2\sigma_x^2 - \frac{1}{2}\gamma_y^2\sigma_y^2 - \frac{1}{2}\gamma_s^2\sigma_s^2\right), \tag{19}$$

where $\gamma_x > 0$, $\gamma_y > 0$, and $\gamma_s < 0$ are the prices of risks for the aggregate demand and supply shocks and aggregate investment shock, respectively, and r_f is the risk-free rate.

Since the economy is homogenous of degree one with respect to capital stock, it can be shown that $V_{jt}(X_t, Y_t, S_t, Z_{jt}, A_{it}, K_{it}) = K_{jt}v_{jt}(X_t, Y_t, S_t, Z_{jt}, A_{it})$. The firm value can be re-written as:

$$v_{jt} = \pi_{jt} + E_t[M_{t+1}v_{jt+1}][(1-\delta) + \delta A_{jt}S_t] \tag{20}$$

The normalized value function v_{jt} is also the market-to-book for firm j at time t. Since y follows a random walk, we can further simplify this problem as:

$$\hat{v}_{jt} = \hat{\pi}_{jt} + E_t[M_{t+1}\hat{v}_{jt+1}\exp(\mu_y + \sigma_y\epsilon_{t+1}^y)][(1-\delta) + \delta A_{jt}S_t] \tag{21}$$

where $\hat{\pi} = \pi/Y$ and $\hat{v} = v/Y$. Since the firm value is linear in Y, the aggregate productivity contributes to the equity premium, but not to the risk premium in the cross section. The normalized firm value $\hat{v}$ is a function of four state variables: X_t, S_t, Z_{jt}, and A_{jt}.

3.3 Implications for profitability premium and value premium

We solve the problem numerically using value function iterations at a monthly frequency. We simulate the model 100 times with each sample representing 1,000 firms and 600 months. Table 4 reports the parameter values for our numerical analysis and use the simulated data to compute various moments. The depreciation rate is 1% per month (or 12% per year), and risk-free rate is 0.25% per month (or 3% per year), consistent with the literature on the real business cycles (e.g., Kydland and Prescott (1982), Cooper and Haltiwanger (2006)). We set the elasticity of substitution between capital and other input η to 0.3, which is in line with our empirical estimates based on a model implied relation between the demand elasticity of revenues and demand elasticity of profits (Section 3.4.2). We normalize $\bar{x} = 0$, and set $\rho_x = 0.98$, $\sigma_x = 0.035$, $\sigma_y = 0.025$ to approximately match the volatility of the aggregate market returns and aggregate gross profit growth, and the autocorrelation of the aggregate profitability. We choose $\bar{s} = 0.046$, $\rho_s = 0.985$, $\sigma_s = 0.02$ to match the mean, standard deviation, and autocorrelation of the aggregate investment rate of 11.4%, 1%, and 0.725, respectively. We set $\rho_z = 0.97$, $\sigma_z = 0.4$, $\rho_a = 0.99$, $\sigma_a = 0.052$, and $\rho_{az} = 0.25$ to match the cross-sectional distribution between ROA and book-to-market ratios. w_1 is set to 1.16 from our estimates in Section 3.4.1. We choose $w_0 = 2.1$ to match the level of aggregate ROA. Finally, we set $\gamma_x = 12$, $\gamma_y = 7$, and $\gamma_s = -10$ to match the equity premium and aggregate book-to-market ratio. These values are also in line with Kogan and Papanikolaou (2013, 2014).

[Insert Table 4 Here]

Figure 2 plots the value functions. The top row of Figure 2 plots the total firm value (or the total market-to-book), the value of assets-in-place, the value of growth options, and profitability against the two aggregate state variables (x and s), while the bottom row plots these value functions against the two idiosyncratic state variables (z and a). We calculate the value of assets-in-place by eliminating future project arrivals using value function iterations. The value of growth options is the difference between the total firm value and the value of assets-in-place. Consistent with our intuition, total firm value increases with all four state variables, so both aggregate demand shocks (positively) and aggregate IST shocks (negatively) contribute to the equity premium, given the signs of the prices of risk for these two aggregate risk factors. The value of assets-in-place increases with aggregate demand and idiosyncratic productivity, but its exposures to the aggregate and idiosyncratic IST shocks are much lower. On the other hand, the value of growth options is more sensitive to the aggregate and idiosyncratic investment shocks. Taken together, while the firm value (the market-to-book ratio) increases with both the idiosyncratic productivity and investment shocks, its sensitivity to the latter is higher, indicating that book-to-market differentials are mainly driven by cross-sectional dispersion in A. The difference in the exposure to the aggregate investment shocks between assets-in-place and growth options gives rise to a composition effect as in Kogan and Papanikolaou (2013, 2014). The right two panels show the profitability (ROA) against these state variables. The profitability is a function of aggregate demand and idiosyncratic productivity only. The positive relation between ROA and z indicates that sorts on ROA create cross-sectional dispersions in Z and exposure to X.

[Insert Figure 2 Here]

Tables 5 and 6 provide quantitative results on the portfolio analysis. Panel A of these two tables reports the portfolio characteristics of the ROA and BM quintile portfolios. In our model, high (low) ROA firms look like growth (value) firms. For instance, Table 5 Panel A shows that high ROA firms have a logBM of -1.09, as compared to -0.64 for low ROA firms. Similarly, Table 6 Panel A shows that value firms have a ROA of 0.06, as compared to 0.38 for growth firms. Therefore, the model reproduces the empirical fact that gross profitability behaves like the other side of value. Panel A also confirms that the cross-sectional variation in ROA is mainly driven by the idiosyncratic productivity shock Z (ROA increases in Z) in both Tables 5 and 6 Panel A, whereas the variation in BM is driven by both A and Z. Compared with value firms, growth firms have higher A and Z because positive shocks to these two firm-specific variables increase the firm value. Panel A in both Tables 5 and 6 also shows that high ROA firms have higher input-capital ratio than low ROA firms.

[Insert Table 5 Here]

[Insert Table 6 Here]

Panel B of Tables 5 and 6 examines the value-weighted returns and asset pricing tests of the ROA portfolios and BM portfolios.[5] For the asset pricing models, we consider the CAPM and a two-factor model with the market and the value premium factor (HML) as the risk factors.[6] The

[5]To save space, we only report the value-weighted portfolio returns. The results for the equal-weighted returns are very similar.

[6]We use the two-factor model in the simulation to draw parallel to the Fama and French three-factor model in the empirical analysis. We do not include a separate size premium factor as we did in the empirical analysis (Tables 1 and 2) because our theoretical model is a three-factor model and we lack one additional risk factor compared to the data. In the empirical analysis, the ROA premium is unable to be captured by the Fama and French three-factor model, so a total of four factors are needed to capture the size, value, and gross profitability premiums in the data.

model generates a positive ROA premium of 3.10% per year and value premium of 3.25% per year. Thus, we are able to reconcile the coexistence of profitability premium and value premium in one unified rational economic framework. CAPM fails to capture both premiums. For the profitability premium, even though the market beta increases slightly from low to high ROA firms, the CAPM alpha remains 2.84% per year, which is 3.65 standard errors from zero. For the value premium, the CAPM beta goes in the wrong direction (a negative market beta), so that the abnormal return spread (4.08%) is even greater than the return spread (3.25%). Adding the value premium factor eliminates the abnormal return of the value premium as shown in Table 6 Panel B, but increases the abnormal return of the ROA premium even further as shown in Table 5 Panel B. The two-factor model alpha controlling for HML becomes 3.49% per year, which is greater than both the average return and CAPM alpha of the Hi-Lo ROA portfolio. Therefore, while the model reproduces a coexistence of the profitability premium and the value premium, these two premiums are negatively correlated with each other, with a correlation coefficient of -0.194 (untabulated).

To understand the drivers of the profitability premium and the value premium in our investment-based model, Panel C of Tables 5 and 6 reports the exposures of the ROA and BM portfolios to the aggregate demand (X), aggregate productivity (Y), and aggregate investment (S) shocks. High ROA firms have higher exposures to aggregate demand shocks (X) than low ROA firms, with a difference in β(X) of 0.15 (t-statistic = 8.54). So consistent with our earlier discussion, the aggregate demand shock is the main underlying risk factor for the positive ROA premium. For the value premium, value firms have an exposure to S shocks of 0.39, much lower than that of growth firms (0.85), and their difference is more than 20 standard errors from zero. On the other hand, the exposure to X shocks is hump-shaped, with a slightly higher β(X) for value firms than growth firms. Therefore, asset composition and the exposure to the aggregate demand shocks are the major sources of the positive value premium in our model.

The prediction of our model on the negative correlation between the gross profitability premium and the value premium is novel and stands out from the existing studies on these cross-sectional phenomena. Most analyses focus on one phenomena while ignoring the other (e.g., Wang and Yu (2015), Lam, Wang, and Wei (2014), Zhang (2005), Carlson, Fisher, and Giammarino (2004)). One exception is Kogan and Papanikolaou (2013). In their model, both the value premium and gross profitability are driven by the asset composition and heterogeneous exposures to the aggregate investment shocks. Specifically, more profitable firms derive much of their values from assets-in-place than growth options, and hence their exposure to the aggregate investment shocks is lower than less profitable firms. Since the aggregate investment shock is also driving the different risk premiums between value and growth firms, the value premium and the gross profitability premium in their model are positively, instead of negatively, correlated.

Different from their model, high ROA firms in our model have low BM, instead of high BM, than low ROA firms, so profitable firms look like growth firms, not value firms. In addition, the sources of the ROA and value premiums are different in our model. While the value premium is due to the heterogeneous exposure to the aggregate investment shock, the ROA premium is driven by different exposures to the aggregate demand shock. Thus, our model breaks the positive correlation between the profitability premium and the value premium.

3.4 Additional evidence

In this section, we provide additional empirical evidence for our proposed explanation. Specifically, we empirically estimate the two key parameters in our model that are responsible for a positive ROA premium: the cyclicality of inputs prices (w_1) and the elasticity of substitution between capital and other inputs (η).

3.4.1 The cyclicality of inputs prices

One important parameter in the model is w_1, the cyclicality of inputs prices with respect to the aggregate demand shock. When $w_1 > 1$, the cost of goods sold provides a hedge to the decrease in aggregate demand. That is, when the aggregate demand is low, the percentage reduction in total cost of goods sold is larger than the percentage reduction in revenue. Combined with an inelastic substitution between capital and other inputs is inelastic ($\eta < 1$), our model implies a positive ROA premium. Since Compustat do not separate the total cost of goods sold into inputs prices and inputs quantities, we cannot empirically estimate w_1 from Compustat.

In this section, we explore the NBER-CES Manufacturing Industry Database, which contains annual industry-level data from 1958-2011 on output, employment, payroll and other input costs, investment, capital stocks, TFP, and various industry-specific price indexes. Particularly relevant for us, this data provide detailed information on the inputs prices of materials, labor (wage), and energy, as well as the output prices of the shipped goods for the 459 four-digit SIC industries.

Table 7 reports our estimated results. In Panel A, we report the means and standard deviations of the growth rate of the price of shipped goods, labor, energy, and materials. In order to capture the overall inputs, we also create an input index (Input) which is the weighted average of labor, material, and energy, and report its properties in the last column. Panel A shows that the average volatility of shipped goods prices is 4.1% per year, which is about twice more volatile as the wage bill (2.15%). This finding is consistent with the empirical findings on wage rigidity in the labor economics literature. In contrast, the materials price and energy price are much more volatile; their annual standard deviations are 5.85% and 8.21%, respectively. Since on average, the wage bill, material costs, and energy consumptions represent about 20.8%, 76.4%, and 2.8% of the total inputs, the volatility of the input index price is 4.91% per year, about 20% more volatile than the output prices. It is noteworthy that labor cost only accounts for a small percentage of total input costs, and the largest component of input costs is materials.

[Insert Table 7 Here]

In Panel B, we use the shipped goods price growth as a measure of aggregate demand shocks, and regress the growth rate of labor wages, materials prices, energy prices, and the input index prices on this demand shock measure. The result shows that while labor wage is less procyclical with respect to the aggregate demand, the materials and energy prices are much more procylical, with the estimated coefficients of 1.38 and 1.59, respectively. Furthermore, the input index price has an elasticity of 1.16 with respect to the aggregate demand shock. This value is used in our model calibration.

3.4.2 The elasticity of substitution between capital and other inputs

Another key parameter in the model is the elasticity of substitution between capital and other inputs (i.e., η). In the appendix, we show that

$$\frac{\partial \log R}{\partial \log X} - 1 = \eta \left(\frac{\partial \log \pi}{\partial \log X} - 1 \right) \tag{22}$$

where R is firm's revenue. In words, η can be estimated by regressing firm's exposures of revenues to the aggregate demand shock onto firm's exposures of profits to the aggregate demand shock. Therefore, we estimate this parameter in two steps. In the first step, for each firm, we run time series regressions of the growth rate of revenues (and growth rate of gross profits) onto the aggregate demand shock, which is measured by the government spending growth and Romer and Romer shocks. As robustness checks, we also consider two other aggregate demand measures – GDP growth and nondurable consumption growth, although these growth variables can also capture other aggregate shocks such as shocks to the total factor productivity. The estimated exposures β(Rev) and β(Prof) are reported in Panel A. The growth rates of revenues and profits tend to be procyclical with respect to GDP growth and nondurable consumption growth, but their exposures to the government spending growth is negative on average. However, there is a large dispersion for these exposures across firms. More importantly, in terms of the magnitude, the exposure to the aggregate demand shock is typically larger for profits than revenues. For instance, when we use the government spending growth as the demand shock proxy, we find the average exposure is -0.39 for revenues and -0.71 for profits. The difference is even greater when we use nondurable consumption growth and GDP growth as the demand shock proxy.

[Insert Table 8 Here]

In the second step, we run a cross-sectional regression of β(Rev) on β(Prof), both of which are estimated from the first step. From Equation (22), the coefficient on β(Prof) is our estimates for the elasticity of substitution between capital and other inputs (η in the model). As reported in Panel B of Table 8, the coefficient on β(Prof) ranges well between 0.3 and 0.4 for all three demand shock measures, indicating that the substitutability between capital and other inputs is rather inelastic. Our model calibrated value for η is consistent with these estimates.

4 ROA Decomposition

Our model has additional testable implications in the empirical data. For instance, Panel A of Table 5 shows that sorting on ROA is not a "clean" construction of the profitability strategy, in the sense that it creates dispersions in both Z and A. While a higher Z increases the exposure to the aggregate demand (X) shock, an increase in A raises the exposure to the aggregate investment (S) shock. Since the price of risk for X shocks (S) is positive (negative), these two exposures tend to offset each other, weakening the overall profitability premium. This also implies that there are ways to enhance the performance of the profitability strategy by controlling the effect of A. Neither Z nor A is directly observable. However, as we discussed earlier, BM contains better information about A, so that double-sorting on BM and ROA improves the profitability of ROA premium, as already shown in Novy-Marx (2013). In this section, we discuss an alternative way of improving its performance that is based on the ROA decomposition.

4.1 Decomposition of gross profitability

To elucidate our idea, in Figure 3, we plot the empirical dynamics of gross profitability spread (the top left panel) and the average value-weighted return spread of quintile portfolios sorted by firm gross profitability (the bottom left panel), up to five years following the portfolio formation. One prominent observation from this figure is that gross profitability is highly persistent. Even five years after portfolio formation, the gross profitability differential between high and low ROA portfolios remains 85% of the initial gross profitability differential. In sharp contrast, the portfolio return spread decays very quickly. In particular, the profitability premium remains positive but becomes statistically insignificant one year after the portfolio formation.

[Insert Figure 3 Here]

Our investment-based asset pricing model can help understand these patterns. In our calibration, the AR(1) coefficient of Z is 0.975, much smaller than 0.99 for A. The difference in persistence between these firm-specific exogenous variables implies that compared to the current ROA, the ROA a few years back contains more information about A and less information about Z. As a result, the existence of the persistent offsetting force from A makes the decaying speed of the buy-and-hold ROA premium to be faster than the mean-reverting speed of ROA. Since both ROA and ROA a few years back contain similar amount of information about A (due to the high AR(1) of A), the recent change in ROA in the past years should contain “cleaner” information about Z that is less “contaminated” by A, and we should expect a stronger ROA premium.

Therefore, we decompose firm-level ROA into a persistent component and a transitory component. The result from the left panels of Figure 3 indicates that the return predictive power of ROA only exists for the first few years following the portfolio formation, so we use a simple decomposition based on the information that prevails four years back and new incoming information afterwards.[7] Specifically, at each year t, we run a cross-sectional regression of ROAs in year t on the lagged ROAs in year $t-4$. The predicted value is referred to as the persistent ROA (or PROA thereafter), and the residual is referred to as the transitory ROA (or TROA thereafter).

4.2 Persistent ROA portfolios and risk premium

Table 9 Panel A presents the characteristics of portfolios sorted by the persistent component of ROA. Overall, PROA portfolios look very similar to the ROA portfolios reported above. High PROA firms have higher Tobin’s Q, more cash holdings, lower leverage ratio, higher investment rate than firms with low PROA. In addition, the ROA spread between high and low PROA portfolios is 0.55, which is about 87% of the spread for the ROA quintile portfolios. Panel B of Table 9 reports the portfolio returns and the asset pricing test result. Even though ROA strongly and positively predicts future returns, its persistent component does not. The PROA portfolio return is almost flat across portfolios, and the high-minus-low PROA portfolio has an annualized return of only 0.78% (t-statistic = 0.47). The Fama-French three-factor model test indicates that

[7] Our results remain similar if we use lagged ROA in year $t-3$ or $t-5$.

the PROA premium has a strong negative exposure to the value premium factor (HML). The t-statistic for the loading of the high-minus-low PROA portfolio on the HML factor is more than 9 in absolute value, and the magnitude of -0.59 is even stronger than that of the Hi-Lo ROA portfolio (-0.48 in Table 2). This result is intuitive from our theoretical model because PROA contains better information about A than ROA, as we discussed above. In the language of Novy-Marx (2013), PROA looks more like the other side of value than ROA.

[Insert Table 9 Here]

The top middle panel of Figure 3 shows the dynamics of PROA spread up to five years, and the bottom middle panel shows that of the average value-weighted return spread of quintile portfolios sorted by firm PROA. While we observe a strong upward trend of the PROA, the return spread of the PROA remains flat and insignificantly different from zero for all horizons up to five years.

4.3 Transitory ROA portfolios and risk premium

We now turn to the portfolios formed by sorting firms' transitory profitability. Table 10 reports the result for the transitory ROA (referred to as TROA) portfolios. The difference in ROA between the high and low TROA portfolios is 0.36, which is 57% of the spread in the ROA sorted portfolios. Unlike the ROA portfolios or PROA portfolios, most other firm characteristics of TROA portfolios display a non-monotonic pattern. For example, the high and low TROA firms have smaller firm size, higher Tobin's Q, more cash holdings and more R&D expenditures than medium TROA firms. However, high TROA firms have better stock performance in the past one year (Mom) than low TROA firms.[8] Panel B reports the TROA portfolio returns and asset pricing test result. The transitory ROA has a strong predictive power for future stock returns. The average quintile portfolio return increases monotonically from 4.56% for the low TROA firms to 9.21% for the

[8] One may wonder if the return predictability of TROA in the subsequent discussion is due to the way we construct TROA so that this transitory component simply reflects momentum. The answer is no. First, the momentum spread between the high and low TROA portfolios is only 6%, which is way smaller than the momentum spread in a typical momentum strategy. Second, in untabulated analysis with the Cahart four-factor model and Fama-MacBeth regressions (Table 11) controlling for momentum, we find the return predictability of TROA remains highly significant.

high TROA firms, generating a spread of 4.64% per year with a t-statistic of 3.67. The Hi-Lo TROA portfolio has a standard deviation of only 9.68%, so the annual Sharpe ratio is now 0.48, a 37% increase from the ROA spread portfolio. In addition, the Fama-French three-factor model cannot explain the TROA premium. When we control for the market, HML, and SMB factors, the abnormal return of the TROA spread portfolio becomes 5.96% per year. Interestingly, the HML factor exposure displays a hump-shape for the TROA quintile portfolios, with an insignificant difference between high and low TROA portfolios.

[Insert Table 10 Here]

The right two panels of Figure 3 show the dynamics of the buy-and-hold TROA portfolios. As the TROA spread declines over time, the average value-weighted return spread of the quintile portfolios sorted by firm TROA also decreases with a similar speed. The similarity in the dynamics of sorting variable and return spread for TROA portfolios is consistent with the stronger TROA premium than the raw ROA premium, because this transitory component mitigates the potential noise associated with PROA which has no predictive power for future stock returns.

4.4 Robustness checks

The difference in return predictive power of firm's ROA and its components can also be due to their correlation with other firm characteristics in the data. In Table 11, we report the result of the Fama-MacBeth cross-sectional regressions of monthly returns on ROA, PROA, and TROA, controlling for firm-level variables including size, book-to-market, short-term and intermediate-term return. Specifications 1-3 report the univariate regressions on ROA and its two components. Consistent with the portfolio approach, we find the coefficient of ROA is statistically significant, but much weaker than the TROA. The t-statistic, which is closely related to the Sharpe ratio of the related long-short investment strategy, is 48% higher when we use TROA (Specification 3) as the regressor than we use ROA (Specification 1). On the other hand, the coefficient of PROA is very small and statistically insignificant from zero.

When we control for other firm characteristics in Specifications 4 to 6, the results are similar. Including variables such as the log book-to-market ratio (logBM) adds the predictive power of ROA on stock returns, and its coefficient increases from 0.42 to 0.48 with a t-statistic of 2.80. On the other hand, PROA still does not predict future returns, whereas the TROA remains a significant predictor, with a coefficient barely changed from the specification without control variables. Specifications 7-8 perform the horse race between ROA and TROA. Without any controls (Specification 7), ROA loses its predictive power in the presence of TROA, and its coefficient reduces by more than half from Specification 1 and becomes statistically insignificant. Even when we add other control variables including the book-to-market ratio, the coefficient of ROA remains statistically insignificant, whereas the t-statistic of the coefficient of TROA is significant at 2.83.

[Insert Table 11 Here]

Table 12 confirms the result from the above horse race analysis using double sorts. In Panel A, we double sort firms sequentially first by TROA and then by ROA into 5-by-5 portfolios, and the result shows that conditional on TROA, 3 out of 5 ROA spread portfolios have a negative average return, and the average conditional ROA premium is only 0.96% per year and statistically insignificant (with a t-statisitc of 0.68). On the other hand, when we reverse the order and double sort firms sequentially first by ROA and then TROA in Panel B, the average conditional TROA premium is 3.12% and highly significant with a t-statistic of 2.48.

[Insert Table 12 Here]

Overall, we find the two components of ROA have very different characteristics and relations with the risk premium of portfolios sorted by these profitability components. The persistent ROA has a strong negative correlation with the book-to-market ratio, but it does not strongly predict future stock returns. The transitory ROA strongly predicts future stock returns, but its premium does not really look like the other side of value, as highlighted in the title of Novy-Marx (2013).

4.5 ROA decomposition in the model

We repeat the same ROA decomposition and portfolio analysis using the simulated data from our investment-based asset pricing model. Our analyses for the Hi-Lo PROA and TROA portfolios from our model show qualitatively similar findings to their empirical counterpart. The results are summarized in Table 13.

[Insert Table 13 Here]

In Panel A, similar to the empirical finding on the PROA portfolio return spread, we find that the counterpart implied in the model is small (0.54% per year) and statistically insignificant. When we regress the time series of PROA portfolio returns on the market factor, the market beta of the Hi-Lo PROA portfolio is 0.02 and statistically insignificant, and the average abnormal return of the Hi-Lo PROA portfolio is only 0.4% per year. On the other hand, the TROA quintile sorts using the simulated data show a large average return spread of 3.51 percent per year, which is larger than the simulated ROA premium of 3.1 percent per year. It is lower but comparable to the TROA return spread of 4.64 percent per year in the data. When we control the market return factor in the asset pricing test, we find that the abnormal return remains highly significant at 3.31% per year.

Overall, our investment-based model offers clear intuition for the decomposition of ROA into PROA and TROA as we performed in the empirical data. On the one hand, TROA has a stronger return predictive power than ROA, as it contains cleaner information about Z and the risk exposure to the aggregate demand shock. On the other hand, PROA contains better information about A, which is more persistent than Z in our model. These additional analyses provide further support for our parsimonious investment-based asset pricing model.

5 Conclusion

In this paper, we propose a unified economic model to jointly explain the co-existence and the dynamics of negatively correlated profitability premium and value premium. Our model features aggregate demand and investment shocks. We demonstrate that the profitability premium is driven by firms with different exposures to the aggregate demand shock after they experience idiosyncratic productivity shocks. Firms with positive idiosyncratic productivity shocks are more profitable and also have higher exposure to the aggregate demand shock than firms with negative productivity shocks, due to a weaker hedging effect that is associated with firm's production inputs. These firms thus earn higher expected returns leading to the profitability premium. In the meantime, firm's value relative to its capital stock (market-to-book) increases in its firm-specific investment shock. Firms that experienced positive firm-specific investment shocks (growth firms) derive more value from growth options and hence have greater exposure to aggregate investment shocks. With a negative price of risk associated with the aggregate investment shock, these growth firms earn lower expected returns than value firms, leading to a positive value premium.

In contrast to the existing models on the profitability premium and value premium with a single aggregate shock, our model with both aggregate demand and investment shocks made it possible to generate the co-existence of negatively correlated profitability premium and value premium. Although the underlying risk factor for the gross profitability premium is the aggregate demand shock, because firm's profitability is positively associated with its future growth options, more profitable firms also have a higher exposure to the aggregate investment shock than less profitable firms, giving rise to the negative correlation between the profitability premium and value premium.

Our empirical investigation also uncovers novel findings on the gross profitability premium. Motivated by the empirical observations of persistent portfolio gross profitability and its short-lived return predictability, we decompose gross profitability into a persistent and a transitory component. We find the persistent component is strongly negatively related to the book-to-market ratio and captures "the other side of value", as in the title of Novy-Marx (2013). However, it does not predict future stock returns. On the other hand, the transitory component has a strong predictive power for stock returns. The result is found in both portfolio analysis and Fama-MacBeth regressions. Our model also supports such a ROA decomposition. The relative information contents of gross profitability (and its components) and the book-to-market ratio about the underlying state variables are important to understand these interesting empirical findings.

References

Akbas, Ferhat, Chao Jiang, and Paul D. Koch, 2017, The trend in firm profitability and the cross-section of stock returns, *The Accounting Review* 92, 1–32.

Berk, Jonathan B., Richard C. Green, and Vasant Naik, 1999, Optimal investment, growth options, and security returns, *Journal of Finance* 54, 1553–1607.

Bouchaud, Jean-Philippe, Philipp Krueger, Augustin Landier, and David Thesmar, 2016, Sticky expectations and the profitability anomaly, working paper.

Carlson, Murray, Adlai Fisher, and Ron Giammarino, 2004, Corporate investment and asset price dynamics: Implications for the cross-section of returns, *Journal of Finance* 59, 2577–2603.

Choi, Jaewon, 2013, What drives the value premium?: The role of asset risk and leverage, *The Review of Financial Studies* 26, 2845–2875.

Cooper, Ilan, 2006, Asset pricing implications of nonconvex adjustment costs and irreversibility of investment, *Journal of Finance* 61, 139–170.

Cooper, Russell W., and John C. Haltiwanger, 2006, On the nature of capital adjustment costs, *The Review of Economic Studies* 73, 611–633.

Danthine, Jean-Pierre, and John B. Donaldson, 2002, Labour relations and asset returns, *The Review of Economic Studies* 69, 41–64.

Donangelo, Andres, Francois Gourio, Matthias Kehrig, and Miguel Palacios, 2017, The cross-section of labor leverage and equity returns, Discussion paper.

Fama, Eugene F., and Kenneth R. French, 1992, The cross-section of expected stock returns, *Journal of Finance* 47, 427–65.

——— , 2015, A five-factor asset pricing model, *Journal of Financial Economics* 116, 1 – 22.

Favilukis, Jack, and Xiaoji Lin, 2015, Wage rigidity: A quantitative solution to several asset pricing puzzles, *The Review of Financial Studies* 29, 148–192.

——— , and Xiaofei Zhao, 2017, The elephant in the room: The impact of labor obligations on credit markets, Discussion paper.

Garlappi, Lorenzo, and Hong Yan, 2011, Financial distress and the section of equity returns, *Journal of Finance* 66, 789–822.

Hou, Kewei, Chen Xue, and Lu Zhang, 2015, Digesting anomalies: An investment approach, *Review of Financial Studies* 28, 650–705.

Kogan, Leonid, and Dimitris Papanikolaou, 2013, Firm characteristics and stock returns: The role of investment-specific shocks, *Review of Financial Studies*.

——— , 2014, Growth opportunities, technology shocks, and asset prices, *The Journal of Finance* 69, 675–718.

Kydland, Finn E., and Edward C. Prescott, 1982, Time to build and aggregate fluctuations, *Econometrica* 50, 1345–70.

Lakonishok, Josef, Andrei Shleifer, and Robert W Vishny, 1994, Contrarian investment, extrapolation, and risk, *The Journal of Finance* 49, 1541–1578.

Lam, F.Y. Eric C., Shujing Wang, and John Wei, 2014, The profitability premium: Macroeconomic risks or expectation errors?, working paper.

Lettau, Martin, and Jessica A. Wachter, 2007, Why is long-horizon equity less risky? a duration-based explanation of the value premium, *Journal of Finance* 62, 55–92.

Ma, Liang, and Hong Yan, 2015, The value and profitability premiums, working paper.

Novy-Marx, Robert, 2013, The other side of value: The gross profitability premium, *Journal of Financial Economics* 108, 1–28.

Romer, Christina D., and David H. Romer, 2004, A new measure of monetary shocks: Derivation and implications, *American Economic Review* 94, 1055–1084.

Wang, Huijun, and Jianfeng Yu, 2015, Dissecting the profitability premium, working paper.

Zhang, Lu, 2005, The value premium, *Journal of Finance* 60, 67–103.

Appendix

Firm's problem chooses other inputs to maximize firm operating profits:

$$\begin{aligned}\pi &= \max_L \{O - WL\} \\ &= \max_L \{X[(ZL)^{\frac{\eta-1}{\eta}} + K^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} - WL\}.\end{aligned} \tag{A.1}$$

where O is firm's revenues. The first-order condition implies that:

$$W = XZ^{\frac{\eta-1}{\eta}} L^{\frac{-1}{\eta}} \times [(ZL)^{\frac{\eta-1}{\eta}} + K^{\frac{\eta-1}{\eta}}]^{\frac{1}{\eta-1}}, \tag{A.2}$$

so the other inputs share is:

$$LS \equiv \frac{WL}{O} = \frac{(ZL)^{\frac{\eta-1}{\eta}}}{(ZL)^{\frac{\eta-1}{\eta}} + K^{\frac{\eta-1}{\eta}}}. \tag{A.3}$$

Taking the partial derivative of the logarithm of both sides of equation A.2 with respect to $\log X$, we have:

$$\frac{\partial \log L}{\partial \log X} = \eta \left(1 - \frac{\partial \log W}{\partial \log X}\right) \left[1 + \left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}\right]. \tag{A.4}$$

Taking the partial derivative of the logarithm of both sides of equation A.2 with respect to $\log Z$, we have:

$$\frac{\partial \log L}{\partial \log Z} = \eta \left[1 + \left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}\right] - 1. \tag{A.5}$$

Therefore, the exposure of firm's operating profit with respect to X, or β_X, is:

$$\begin{aligned}\beta_X \equiv \frac{\partial \log \pi}{\partial \log X} &= 1 + \frac{1}{\eta} \frac{(ZL)^{\frac{\eta-1}{\eta}}}{(ZL)^{\frac{\eta-1}{\eta}} + K^{\frac{\eta-1}{\eta}}} \times \frac{\partial \log L}{\partial \log X} \\ &= 1 + \left(1 - \frac{\partial \log W}{\partial \log X}\right) \left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}.\end{aligned} \tag{A.6}$$

Taking the partial derivative of β_X with respect to $\log Z$:

$$\begin{aligned}\frac{\partial \beta_X}{\partial \log Z} &= \left(\frac{\eta-1}{\eta}\right)\left(1-\frac{\partial \log W}{\partial \log X}\right)\left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}\left(1+\frac{\partial \log L}{\partial \log Z}\right) \\ &= (\eta-1)\left(1-\frac{\partial \log W}{\partial \log X}\right)\left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}\left[1+\left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}\right].\end{aligned} \tag{A.7}$$

The last two terms are always positive, so a positive ROA premium requires:

1. $\eta > 1$ and $\frac{\partial \log W}{\partial \log X} < 1$; or

2. $\eta < 1$ and $\frac{\partial \log W}{\partial \log X} > 1$.

Now we show that the pattern that the elasticity of profits with respect to revenues increases with ROA implies $\frac{\partial \log W}{\partial \log X} > 1$. It can be quickly shown that:

$$\frac{\partial \log O}{\partial \log Z} = \eta\left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}, \tag{A.8}$$

and

$$\frac{\partial \log O}{\partial \log X} = 1+\eta\left(\frac{ZL}{K}\right)^{\frac{\eta-1}{\eta}}\left(1-\frac{\partial \log W}{\partial \log X}\right). \tag{A.9}$$

Comparing equation (9) with equation (6), we have the following identity:

$$\frac{\partial \log O}{\partial \log X} - 1 = \eta\left(\frac{\partial \log \pi}{\partial \log X} - 1\right) \tag{A.10}$$

Table 1: ROA portfolios

This table reports the characteristics and returns of quintile value-weighted portfolios sorted by ROA. Panel A reports the average characteristics of ROA portfolios, including gross profitability (ROA), log book-to-market (logBM), log market cap (logSize), momentum (Mom), leverage ratio (Lev), Tobin's Q (Q), cash holdings (CH), R&D intensity (R&D), and investment rate (IK). Panel B reports the mean, standard deviation, CAPM test result, and Fama-French three-factor model test result of the quintile ROA portfolios. The sample is 196307-201412. Newey-West t-stats given in parentheses control for heteroscedasticity and autocorrelation.

Panel A: Portfolio characteristics

Portfolio	ROA	logBM	logSize	Mom	Lev	Q	CH	RD	IK
Lo	0.09	-0.28	4.58	0.02	0.32	1.68	0.21	0.42	0.09
2	0.22	-0.19	4.71	0.05	0.28	1.08	0.10	0.03	0.11
3	0.34	-0.31	4.51	0.06	0.23	1.55	0.15	0.05	0.11
4	0.47	-0.49	4.46	0.07	0.18	2.09	0.20	0.09	0.12
Hi	0.72	-0.71	4.38	0.08	0.12	2.60	0.25	0.11	0.14

Panel B: Portfolio returns and Fama-French 3-factor model test

	Lo	2	3	4	Hi	Hi-Lo
Mean	4.83	5.34	6.89	6.03	8.51	3.69
Std	15.38	16.01	16.39	17.02	15.88	10.52
α	-0.79	-0.55	0.71	-0.33	2.81	3.60
	(-0.91)	(-0.58)	(1.07)	(-0.40)	(2.81)	(2.21)
MKT	0.92	0.97	1.01	1.04	0.94	0.01
	(46.36)	(36.92)	(51.62)	(50.88)	(36.22)	(0.35)
$R^2(\%)$	85.68	86.81	91.37	89.63	82.93	0.04
α	-1.96	-1.56	0.64	1.11	4.41	6.37
	(-2.46)	(-1.82)	(0.90)	(1.55)	(4.98)	(4.56)
MKT	0.96	1.03	1.00	1.00	0.89	-0.06
	(52.81)	(45.96)	(47.28)	(59.50)	(35.89)	(-1.67)
HML	0.21	0.21	-0.01	-0.25	-0.28	-0.48
	(5.89)	(5.69)	(-0.25)	(-6.66)	(-5.56)	(-6.71)
SMB	0.02	-0.09	0.07	-0.03	-0.05	-0.07
	(0.75)	(-2.65)	(2.73)	(-1.11)	(-1.50)	(-1.32)
$R^2(\%)$	87.26	88.95	91.59	91.54	85.58	18.45

Table 2: Book-to-market portfolios

This table reports the characteristics and returns of quintile value-weighted portfolios sorted by the book-to-market equity ratio (BM). Panel A reports the average characteristics of BM portfolios, including gross profitability (ROA), log book-to-market (logBM), log market cap (logSize), momentum (Mom), leverage ratio (Lev), Tobin's Q (Q), cash holdings (CH), R&D intensity (R&D), and investment rate (IK). Panel B reports the mean, standard deviation, CAPM test result, and Fama-French three-factor model test result of the quintile BM portfolios. The sample is 196307-201412. Newey-West t-stats given in parentheses control for heteroscedasticity and autocorrelation.

Panel A: Portfolio characteristics

Portfolio	ROA	logBM	logSize	Mom	Lev	Q	CH	RD	IK
Lo	0.43	-1.52	5.20	0.04	0.16	7.30	0.43	0.22	0.18
2	0.37	-0.80	5.20	0.05	0.20	2.79	0.22	0.09	0.14
3	0.34	-0.39	4.90	0.06	0.22	1.56	0.15	0.06	0.12
4	0.30	-0.02	4.37	0.07	0.23	0.95	0.11	0.05	0.10
Hi	0.27	0.49	3.42	0.07	0.25	0.48	0.09	0.03	0.08

Panel B: Portfolio returns and Fama-French 3-factor model test

	Lo	2	3	4	Hi	Hi-Lo
Mean	5.20	6.01	7.03	8.73	10.64	5.43
Std	17.14	15.63	15.19	15.43	17.82	13.58
α	-1.18	0.07	1.50	3.31	4.73	5.91
	(-1.26)	(0.10)	(1.78)	(2.95)	(3.23)	(2.74)
MKT	1.05	0.98	0.91	0.89	0.97	-0.08
	(48.34)	(53.66)	(37.16)	(26.27)	(22.28)	(-1.31)
R^2(%)	89.01	92.96	85.22	79.13	70.55	0.79
α	1.48	0.13	0.29	0.23	0.27	-1.20
	(2.61)	(0.20)	(0.37)	(0.31)	(0.27)	(-1.05)
MKT	1.00	0.97	0.94	0.95	1.02	0.03
	(72.73)	(56.93)	(44.36)	(47.51)	(39.39)	(0.90)
HML	-0.45	-0.02	0.22	0.53	0.72	1.17
	(-16.37)	(-0.48)	(4.29)	(11.05)	(14.44)	(20.95)
SMB	-0.13	0.02	0.01	0.13	0.33	0.46
	(-5.56)	(0.83)	(0.17)	(5.32)	(9.70)	(12.61)
R^2(%)	95.11	92.99	87.07	89.36	86.56	70.32

Table 3: Aggregate demand exposure of ROA premium

This table reports the exposures of the quintile ROA portfolios to the aggregate demand shock (Dshock). We consider two types of demand shocks: government spending shocks and the Romer and Romer (2004) shocks. Panel A reports the cash flow betas, which are estimated in the following annual regressions:

$$\Delta \text{GP}^i_{t+k} = a^i_k + b^i_k \times \text{Dshock}_t + \epsilon^i_{t+k},$$

where ΔGP^i_{t+k} is the growth rate of gross profits (revenue minus costs of goods sold) of the ROA quintile i k year following the Dshock. Panel B reports the stock return exposure of the ROA quintiles to the market and Dshock from the time-series asset pricing tests. The sample is from 1964 to 2014 for government spending shocks, and is from 1966 to 2007 for Romer and Romer shocks. Newey-West t-statistics given in parentheses control for heteroscedasticity and autocorrelation.

Panel A: Cash flow betas

	Panel A1: Government spending shocks						Panel A1: Romer and Romer shocks					
Horizon	Lo	2	3	4	Hi	H-L	Lo	2	3	4	Hi	H-L
k=1	-0.32	-0.25	-0.02	0.18	0.40	0.73	-0.83	-0.04	-1.05	-0.51	0.18	1.01
	(-0.87)	(-0.56)	(-0.06)	(0.55)	(1.30)	(2.13)	(-0.75)	(-0.04)	(-0.75)	(-0.42)	(0.24)	(0.97)
k=2	-0.37	0.20	-0.03	0.29	0.32	0.70	-2.45	-2.31	-2.81	-1.51	-1.20	1.24
	(-0.85)	(0.45)	(-0.07)	(0.92)	(1.01)	(2.67)	(-3.74)	(-4.74)	(-5.44)	(-2.02)	(-5.00)	(1.98)
k=3	-0.80	-0.04	-0.59	0.22	-0.07	0.73	-3.32	-2.60	-2.44	-1.31	-1.18	2.15
	(-2.38)	(-0.08)	(-1.05)	(1.07)	(-0.24)	(3.30)	(-4.94)	(-3.98)	(-3.88)	(-2.09)	(-3.94)	(2.66)

Panel B: Stock return betas

	Panel B1: Government spending shocks						Panel B2: Romer and Romer shocks					
Est.	Lo	2	3	4	Hi	H-L	Lo	2	3	4	Hi	H-L
Cons.	0.42	0.68	1.02	-0.49	1.65	1.22	5.07	5.38	6.02	4.81	8.21	3.13
	(0.49)	(0.67)	(1.19)	(-0.55)	(1.24)	(0.61)	(4.89)	(5.56)	(8.00)	(5.12)	(7.18)	(1.76)
MKT	0.98	0.91	0.98	1.02	0.95	-0.03	0.89	0.92	1.04	1.07	0.96	0.07
	(18.97)	(12.30)	(20.67)	(17.94)	(15.95)	(-0.34)	(45.04)	(38.45)	(54.72)	(52.31)	(32.71)	(1.61)
Dshock	-0.74	-0.56	-0.10	0.11	0.70	1.45	-1.08	-0.09	0.13	0.11	0.71	1.78
	(-2.72)	(-3.40)	(-0.73)	(0.32)	(1.92)	(2.58)	(-3.41)	(-0.17)	(0.47)	(0.30)	(1.59)	(3.28)

Table 4: Parameter values

This table reports the parameter values used for the numerical analysis. The model is solved and simulated at a monthly frequency.

Parameter	Description	Value
γ_x	Price of risk for aggregate demand shocks	12
γ_y	Price of risk for aggregate productivity shocks	7
γ_s	Price of risk for aggregate investment shocks	-10
η	Elasticity of substitution between capital and inputs	0.3
δ	Depreciation rate	0.01
r_f	Risk-free rate	0.0025
$\bar{x}$	Unconditional aggregate demand	0
ρ_x	Persistence of aggregate demand shocks	0.98
σ_x	Conditional volatility of aggregate demand shocks	0.035
σ_y	Conditional volatility of aggregate productivity shocks	0.025
$\bar{s}$	Unconditional aggregate investment opportunity	-0.0394
ρ_s	Persistence of aggregate investment shocks	0.9685
σ_s	Conditional volatility of aggregate investment shocks	0.026
$\bar{z}$	Unconditional idiosyncratic productivity	1
ρ_z	Persistence of idiosyncratic productivity shocks	0.97
σ_z	Conditional volatility of idiosyncratic productivity shocks	0.4
ρ_a	Persistence of idiosyncratic investment shocks	0.99
σ_a	Conditional volatility of idiosyncratic investment shocks	0.052
ρ_{az}	Correlation between idiosyncratic productivity and investment shocks	0.25
w_0	Level of input rental rates	2.1
w_1	Cyclicality of input rental rates with respect to aggregate demand	1.16

Table 5: ROA portfolios: Model

Panel A of this table reports the characteristics, including the log book-to-market ratio (logBM), gross profitability (ROA), idiosyncratic productivity (Z), idiosyncratic investment opportunity (A), and input-capital ratio (LK) of the ROA quintile portfolios. Panel B reports the mean and standard deviation the value-weighted returns, and the asset pricing test results based on CAPM and a two-factor model with market (MKT) and the value premium factor (HML) as the risk factors. Panel C reports the risk factor exposures of the ROA portfolios to the aggregate demand shocks β(X), aggregate productivity shocks β(Y), and aggregate investment shocks β(S). The portfolio returns, standard deviations, and the abnormal returns are annualized. The model is simulated for 100 samples, with each sample representing 1,000 firms and 600 months. The Newey-West t-statistics control heteroscedasticity and autocorrelation.

Panel A: Portfolio characteristics

	logBM	ROA	Z	A	LK
Lo	-0.64	-0.01	-0.21	-0.19	0.07
2	-0.59	0.01	-0.63	-0.21	0.13
3	-0.80	0.12	0.98	-0.12	0.56
4	-0.91	0.36	1.77	-0.08	1.01
Hi	-1.09	0.66	3.07	-0.01	1.94

Panel B: Portfolio returns and asset pricing tests

	Lo	2	3	4	Hi	Hi-Lo
Mean	6.15	6.38	7.31	8.32	9.25	3.10
Std	16.02	15.98	16.16	16.26	16.48	5.55
α	-1.41	-1.16	-0.33	0.63	1.44	2.84
	(-2.84)	(-2.31)	(-0.70)	(1.33)	(3.10)	(3.65)
MKT	0.99	0.98	1.00	1.00	1.02	0.03
	(107.93)	(106.82)	(113.04)	(113.95)	(121.34)	(2.28)
R^2(%)	95.17	95.05	95.51	95.57	96.02	1.05
α	-1.71	-1.50	-0.39	0.73	1.78	3.49
	(-3.38)	(-2.95)	(-0.79)	(1.48)	(3.78)	(4.43)
MKT	0.99	0.99	1.00	1.00	1.01	0.02
	(105.51)	(104.99)	(108.90)	(109.63)	(116.99)	(1.04)
HML	0.07	0.08	0.01	-0.02	-0.08	-0.16
	(2.97)	(3.27)	(0.56)	(-0.94)	(-3.48)	(-3.95)
R^2(%)	95.27	95.17	95.52	95.59	96.14	4.44

Panel C: Risk exposures

	Lo	2	3	4	Hi	Hi-Lo
β(X)	0.16	0.16	0.22	0.26	0.31	0.15
	(13.40)	(12.91)	(16.88)	(19.79)	(24.63)	(8.54)
β(Y)	1.68	1.68	1.68	1.68	1.68	0.00
	(97.24)	(96.83)	(94.08)	(91.75)	(95.01)	(0.10)
β(S)	0.62	0.61	0.63	0.63	0.65	0.03
	(37.80)	(37.47)	(36.56)	(36.06)	(38.24)	(1.20)

Table 6: Book-to-market portfolios: Model

Panel A of this table reports the characteristics, including the log book-to-market ratio (logBM), gross profitability (ROA), idiosyncratic productivity (Z), idiosyncratic investment opportunity (A), and input-capital ratio (LK) of the book-to-market (BM) quintile portfolios. Panel B reports the mean and standard deviation the value-weighted returns, and the asset pricing test results based on CAPM and a two-factor model with market (MKT) and the value premium factor (HML) as the risk factors. Panel C reports the risk factor exposures of the BM portfolios to the aggregate demand shocks β(X), aggregate productivity shocks β(Y), and aggregate investment shocks β(S). The portfolio returns, standard deviations, and the abnormal returns are annualized. The model is simulated for 100 samples, with each sample representing 1,000 firms and 600 months. The Newey-West t-statistics control heteroscedasticity and autocorrelation.

Panel A: Portfolio characteristics

	logBM	ROA	Z	A	LK
Lo	-1.47	0.38	1.98	0.38	1.27
2	-1.06	0.31	1.59	0.05	1.01
3	-0.84	0.24	1.15	-0.14	0.76
4	-0.63	0.15	0.60	-0.32	0.49
Hi	-0.32	0.06	-0.33	-0.59	0.17

Panel B: Portfolio returns and asset pricing tests

	Lo	2	3	4	Hi	Hi-Lo
Mean	5.69	8.25	8.87	8.98	8.95	3.25
Std	17.00	16.00	15.74	15.58	15.34	6.36
α	-2.36	0.64	1.40	1.61	1.72	4.08
	(-4.99)	(1.60)	(3.31)	(3.54)	(3.51)	(4.74)
MKT	1.05	0.99	0.98	0.96	0.94	-0.11
	(121.48)	(135.58)	(125.47)	(115.38)	(105.65)	(-6.88)
R^2(%)	96.07	96.83	96.34	95.70	94.83	7.46
α	-0.36	0.02	0.50	0.50	-0.36	0.00
	(-1.64)	(0.06)	(1.29)	(1.26)	(-1.64)	
MKT	1.00	1.01	1.00	0.99	1.00	0.00
	(243.85)	(139.79)	(138.56)	(133.24)	(243.85)	
HML	-0.49	0.15	0.22	0.27	0.51	1.00
	(-43.74)	(7.66)	(11.61)	(13.63)	(45.71)	
R^2(%)	99.18	97.18	97.09	96.85	98.99	100

Panel C: Risk exposures

	Lo	2	3	4	Hi	Hi-Lo
β(X)	0.20	0.25	0.26	0.25	0.23	0.03
	(14.49)	(24.71)	(27.21)	(26.83)	(25.92)	(1.61)
β(Y)	1.68	1.68	1.68	1.68	1.68	0.00
	(86.67)	(117.97)	(125.88)	(128.47)	(136.81)	(0.10)
β(S)	0.85	0.61	0.52	0.46	0.39	-0.46
	(45.72)	(45.15)	(41.58)	(37.65)	(33.67)	(-20.95)

Table 7: Cyclicality of input prices

This table estimates the cyclicality of the input prices. We use the price change (ΔP) of shipped goods as the proxy for the aggregate demand shock, and estimate the elasticity of the inputs prices with respect to the price of shipped goods as a measure of the input price elasticity with respect to the aggregate demand shock (w_1 in the model). We consider four measures of inputs: labor, materials, energy, and an input index, which is constructed as the weighted average of these three inputs. Panel A reports the mean and standard deviation of these price changes. Panel B reports the result from the univariate regression of the input price change on the output price change, where β(ΔP(Shipped)) measures the elasticity of inputs price with respect to the aggregate demand. The Newey-West t-statistics control heteroscedasticity and autocorrelation. The data is annual from 1958 to 2011 from NBER-CES Manufacturing Industry Database.

Panel A: Summary statistics

	ΔP(Shipped)	ΔP(Labor)	ΔP(Materials)	ΔP(Energy)	ΔP(Input)
Mean (%)	2.69	4.44	3.08	3.89	3.43
Std (%)	4.10	2.15	5.85	8.21	4.91

Panel B: Elasticity of inputs prices with respect to price of shipped goods

	ΔP(Labor)	ΔP(Materials)	ΔP(Energy)	ΔP(Input)
β(ΔP(Shipped))	0.31	1.38	1.59	1.16
t-stat	(5.29)	(27.80)	(9.38)	(28.50)

Table 8: Elasticity of substitution between capital and other inputs

This table estimates the elasticity of substitution between capital and other inputs in two steps. In the first step, for each firm, we run time series regressions of the growth rate of revenues (and growth rate of gross profits) onto the aggregate demand shock, which is measured by the government spending growth (ΔGov), Romer and Romer shocks (Rshock), GDP growth (ΔGDP), or nondurable consumption growth (ΔNDU). The estimated exposures β(Rev) and β(Prof) are reported in Panel A. In the second step, we run a cross-sectional regression of β(Rev) on β(Prof), and the estimated coefficient for β(Prof) is our estimated elasticity of substitution between capital and other inputs (η in the model) and is reported in Panel B. The Newey-West t-statistics control heteroscedasticity and autocorrelation. The data is annual from 1963 to 2014, except for the analysis using Romer and Romer shocks which has a shorter sample period between 1966 and 2007. We only keep firms with more than 30 years observation.

Panel A: Summary statistics

Factor =	ΔGov		ΔRshock		ΔNDU		ΔGDP	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
β(Rev)	-0.39	1.79	0.00	0.03	0.07	2.01	0.56	1.60
β(Prof)	-0.71	2.99	0.01	0.06	1.64	3.74	1.71	3.44

Panel B: Elasticity of β(Rev) with respect to β(Prof)

Factor =	ΔGov	Rshock	ΔNDU	ΔGDP
β(Prof)	0.31	0.34	0.39	0.35
	(16.14)	(18.42)	(10.37)	(11.32)

Table 9: Persistent ROA portfolios

This table reports the characteristics and returns of quintile value-weighted portfolios sorted by the persistent component of ROA. Panel A reports the average characteristics of persistent ROA portfolios, including the persistent component of ROA (PROA), gross profitability (ROA), log book-to-market (logBM), log market cap (logSize), momentum (Mom), leverage ratio (Lev), Tobin's Q (Q), cash holdings (CH), R&D intensity (R&D), and investment rate (IK). Panel B reports the mean, standard deviation, and Fama-French three-factor model test result of the quintile persistent ROA portfolios. The sample is 196307-201412. Newey-West t-stats given in parentheses control for heteroscedasticity and autocorrelation.

Panel A: Portfolio characteristics

Portfolio	PROA	ROA	logBM	logSize	Mom	Lev	Q	CH	RD	IK
Lo	0.14	0.12	-0.24	5.09	0.07	0.33	1.26	0.13	0.25	0.08
2	0.24	0.24	-0.18	5.05	0.07	0.26	0.97	0.09	0.03	0.10
3	0.34	0.34	-0.27	4.81	0.08	0.23	1.33	0.12	0.05	0.10
4	0.44	0.44	-0.41	4.82	0.07	0.19	1.79	0.16	0.08	0.11
Hi	0.65	0.67	-0.61	4.82	0.08	0.13	2.37	0.23	0.09	0.13

Panel B: Portfolio returns and Fama-French 3-factor model test

	Lo	2	3	4	Hi	Hi-Lo
Mean	5.86	6.62	6.72	7.24	6.64	0.78
Std	15.03	15.42	16.38	16.75	15.86	11.14
α	-0.97	-0.07	0.34	1.87	2.87	3.84
	(-1.22)	(-0.09)	(0.40)	(2.37)	(3.16)	(2.63)
MKT	0.94	0.99	1.02	1.00	0.90	-0.04
	(47.63)	(51.50)	(39.07)	(54.78)	(38.49)	(-1.10)
HML	0.27	0.23	0.06	-0.15	-0.32	-0.59
	(8.34)	(6.43)	(1.50)	(-3.76)	(-8.32)	(-9.66)
SMB	-0.02	-0.12	-0.04	-0.02	-0.11	-0.08
	(-0.73)	(-3.37)	(-1.20)	(-0.55)	(-3.42)	(-1.68)
R^2(%)	85.17	87.77	89.29	90.05	86.60	25.08

Table 10: Transitory ROA portfolios

This table reports the characteristics and returns of quintile value-weighted portfolios sorted by the transitory component of ROA. The transitory component of ROA is defined as the difference between ROA and the persistent component ROA. Panel A reports the average characteristics of transitory ROA portfolios, including the transitory component of ROA (TROA), gross profitability (ROA), log book-to-market (logBM), log market cap (logSize), momentum (Mom), leverage ratio (Lev), Tobin's Q (Q), cash holdings (CH), R&D intensity (R&D), and investment rate (IK). Panel B reports the mean, standard deviation, and Fama-French three-factor model test result of the quintile persistent ROA portfolios. The sample is 196307-201412. Newey-West t-stats given in parentheses control for heteroscedasticity and autocorrelation.

Panel A: Portfolio characteristics

Portfolio	TROA	ROA	logBM	logSize	Mom	Lev	Q	CH	RD	IK
Lo	-0.14	0.22	-0.27	4.41	0.02	0.23	1.94	0.26	0.13	0.11
2	-0.05	0.22	-0.20	5.42	0.07	0.29	1.04	0.09	0.04	0.10
3	0.00	0.30	-0.27	5.42	0.09	0.25	1.15	0.10	0.04	0.10
4	0.05	0.41	-0.40	5.08	0.09	0.20	1.48	0.14	0.05	0.11
Hi	0.17	0.58	-0.56	4.31	0.08	0.15	2.03	0.22	0.12	0.11

Panel B: Portfolio returns and Fama-French 3-factor model test

	Lo	2	3	4	Hi	Hi-Lo
Mean	4.56	5.25	6.18	7.78	9.21	4.64
Std	18.14	15.11	14.76	15.18	16.32	9.68
α	-1.90	-0.72	0.42	2.65	4.06	5.96
	(-2.43)	(-1.16)	(0.78)	(3.96)	(5.07)	(4.68)
MKT	1.06	0.97	0.95	0.94	0.96	-0.10
	(47.37)	(51.47)	(69.96)	(52.60)	(46.09)	(-2.70)
HML	-0.08	0.08	0.07	-0.09	-0.15	-0.06
	(-1.95)	(2.65)	(3.19)	(-3.37)	(-3.04)	(-0.74)
SMB	0.14	-0.10	-0.13	-0.07	-0.02	-0.16
	(3.22)	(-4.53)	(-5.86)	(-3.24)	(-0.59)	(-2.17)
R^2(%)	89.08	91.31	92.31	92.42	87.31	6.50

Table 11: Fama-MacBeth Regressions

This table reports the result from Fama-MacBeth regressions of returns on firm characteristics, including gross profitability (ROA) and its persistent (PROA) and transitory (TROA) components, log book-to-market (logBM), log market cap (logSize), past 1-month return (r_1), and momentum (Mom). The sample is 196307-201412. Newey-West t-stats given in parentheses control for heteroscedasticity and autocorrelation.

Specification	1	2	3	4	5	6	7	8
ROA	0.42			0.48			0.19	0.27
	(2.58)			(2.80)			(1.09)	(1.53)
PROA		0.18			0.26			
		(1.02)			(1.41)			
TROA			0.89			0.91	0.69	0.61
			(3.83)			(3.90)	(3.13)	(2.83)
logBM				0.25	0.23	0.25		0.26
				(3.16)	(2.99)	(3.25)		(3.20)
logSize				-0.10	-0.11	-0.10		-0.10
				(-2.34)	(-2.47)	(-2.35)		(-2.29)
r_1				-5.78	-5.78	-5.72		-5.81
				(-10.63)	(-10.58)	(-10.64)		(-10.68)
Mom				0.45	0.48	0.45		0.44
				(2.11)	(2.20)	(2.09)		(2.06)
Constant	1.14	1.23	1.30	1.59	1.68	1.76	1.22	1.65
	(5.03)	(5.41)	(5.79)	(3.97)	(4.22)	(4.49)	(5.38)	(4.13)
R^2(%)	0.43	0.44	0.28	5.02	5.02	4.87	0.72	5.25

Table 12: Double-sorted portfolios

This table reports the returns from the double sorted portfolios. Panel A reports the average returns of the portfolios sequentially sorted by TROA and then ROA. Panel B reports the average returns of the portfolios sequentially sorted by ROA and then TROA. The sample is 196307-201412. Newey-West t-stats given in parentheses control for heteroscedasticity and autocorrelation.

Panel A: Portfolios sorted by TROA and then ROA

	Lo	2	ROA	4	Hi	Hi-Lo
Lo	5.11	5.83	5.21	5.05	5.06	-0.05
	(1.29)	(1.91)	(1.75)	(1.59)	(1.68)	(-0.02)
2	5.80	5.90	5.77	6.09	5.54	-0.26
	(2.68)	(2.87)	(2.49)	(2.37)	(2.17)	(-0.14)
TROA	5.34	5.54	7.28	7.03	7.99	2.64
	(2.22)	(2.33)	(3.36)	(2.68)	(3.15)	(1.27)
4	8.28	9.85	7.23	6.68	8.17	-0.10
	(3.23)	(4.26)	(2.87)	(2.67)	(3.60)	(-0.05)
Hi	8.16	10.08	9.39	8.22	10.73	2.57
	(2.58)	(3.21)	(3.71)	(3.19)	(4.12)	(1.04)
					Ave.	0.96
					Hi-Lo	(0.68)

Panel B: Portfolios sorted by ROA and then TROA

	Lo	2	TROA	4	Hi	Hi-Lo
Lo	6.36	5.24	4.75	6.13	6.93	0.57
	(1.59)	(1.98)	(2.19)	(3.03)	(2.73)	(0.19)
2	5.14	5.16	6.05	5.30	8.61	3.47
	(1.70)	(1.97)	(2.53)	(2.28)	(3.18)	(1.90)
ROA	5.26	7.78	6.67	9.60	8.55	3.29
	(1.73)	(2.93)	(2.91)	(4.15)	(3.20)	(1.36)
4	4.94	7.34	7.84	7.48	8.81	3.87
	(1.87)	(2.58)	(3.06)	(2.86)	(2.82)	(1.63)
Hi	7.92	8.34	8.14	8.51	12.30	4.38
	(3.00)	(3.76)	(3.45)	(3.41)	(3.92)	(2.19)
					Ave.	3.12
					Hi-Lo	(2.48)

Table 13: ROA decomposition: Model

This table the mean and standard deviation of the value-weighted returns and the CAPM test of the PROA (Panel A) and TROA portfolios (Panel B) from the simulated data. The portfolio returns, standard deviations, and the abnormal returns are annualized. The model is simulated for 100 samples, with each sample representing 1,000 firms and 600 months. The Newey-West t-statistics control heteroscedasticity and autocorrelation.

Panel A: PROA portfolios

	Lo	2	3	4	Hi	Hi-Lo
Mean	7.15	7.34	7.66	7.63	7.69	0.54
Std	16.08	16.06	16.19	16.27	16.36	5.40
α	-0.29	-0.09	0.17	0.10	0.11	0.40
	(-0.62)	(-0.19)	(0.36)	(0.20)	(0.23)	(0.53)
MKT	0.99	0.99	1.00	1.00	1.01	0.02
	(112.23)	(110.35)	(113.00)	(114.70)	(116.30)	(1.32)
$R^2(\%)$	95.45	95.34	95.46	95.63	95.75	0.47

Panel B: TROA portfolios

	Lo	2	3	4	Hi	Hi-Lo
Mean	5.79	6.17	6.91	8.28	9.30	3.51
Std	16.11	15.94	16.14	16.26	16.46	5.66
α	-1.64	-1.18	-0.56	0.75	1.66	3.31
	(-3.24)	(-2.31)	(-1.15)	(1.57)	(3.56)	(4.15)
MKT	0.99	0.98	1.00	1.00	1.02	0.03
	(106.61)	(104.04)	(110.23)	(113.57)	(119.89)	(1.87)
$R^2(\%)$	94.99	94.83	95.36	95.57	95.96	0.78

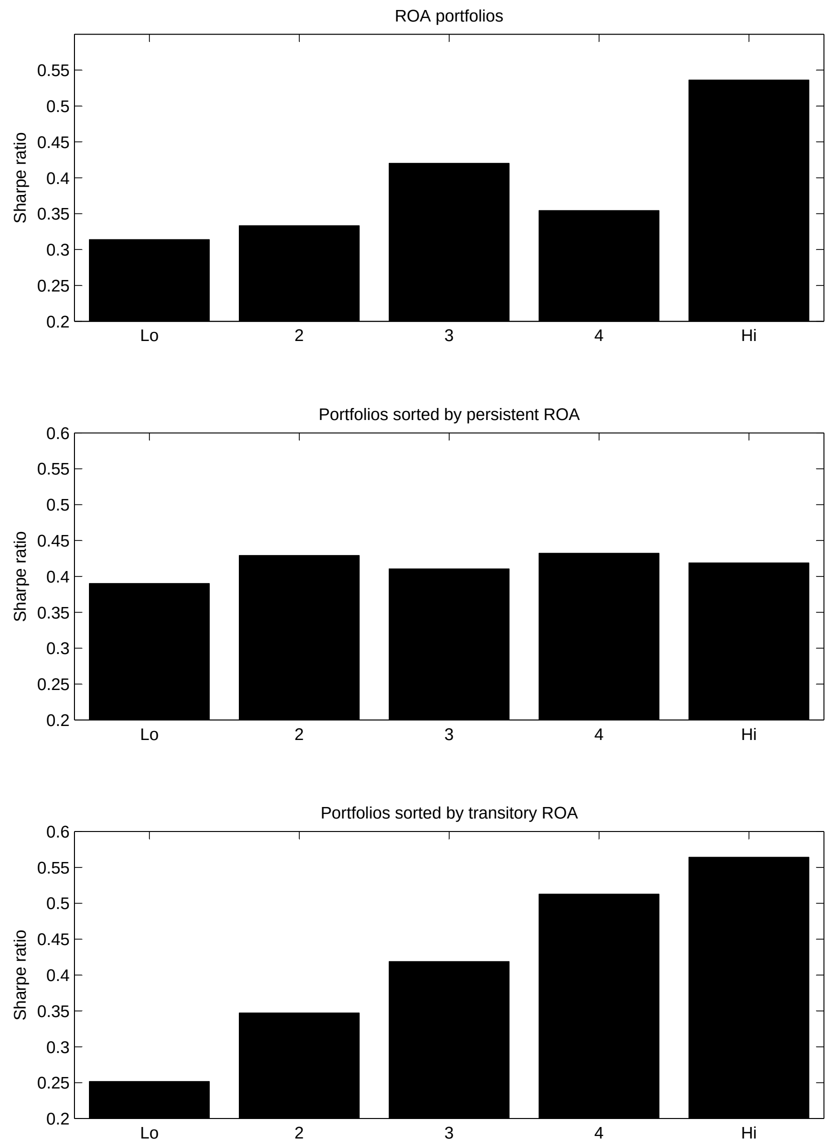
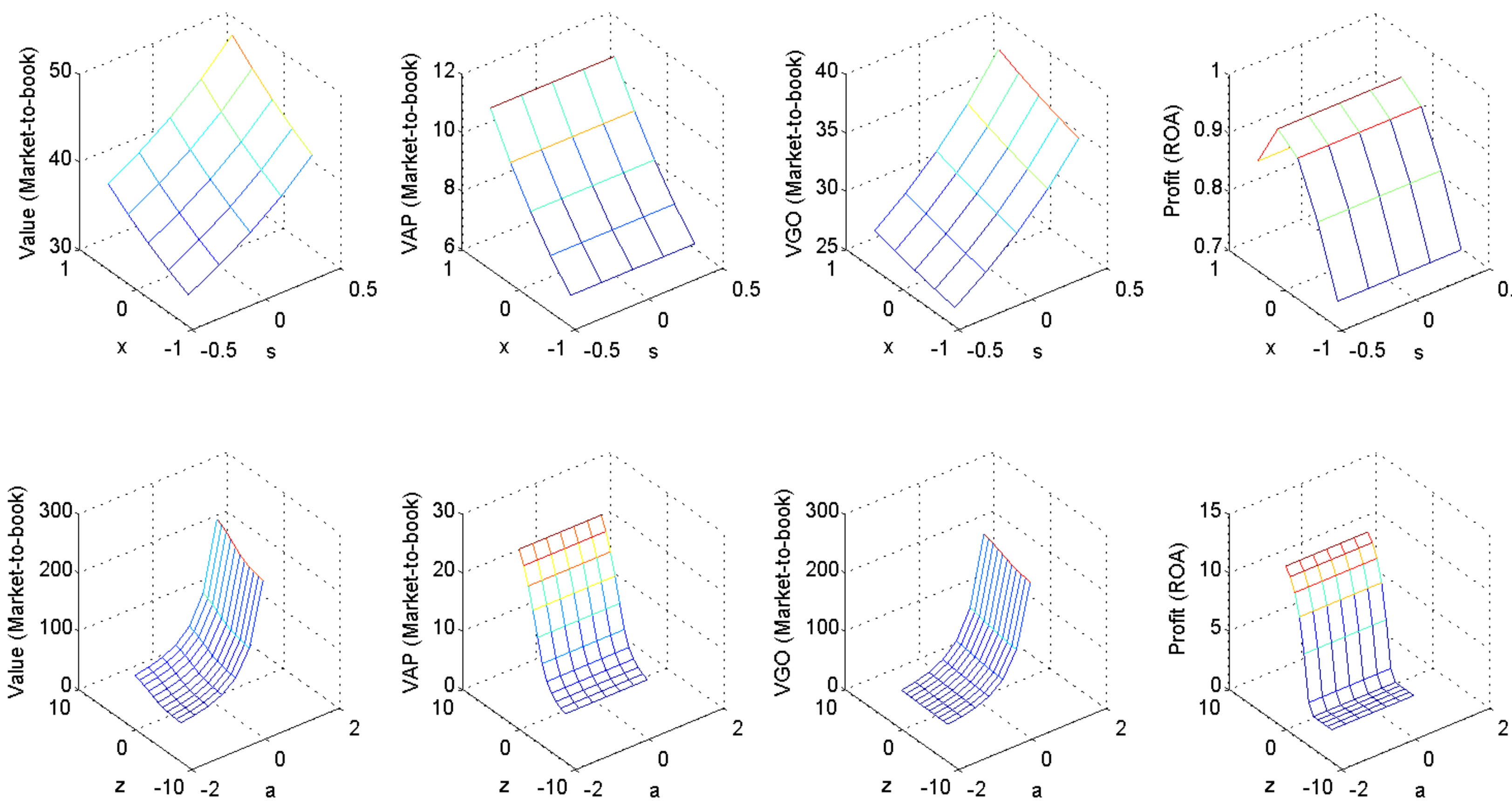


Figure 1: Sharpe ratios of portfolios sorted ROA, PROA, and TROA

This figure plots Sharpe ratios of portfolios sorted by ROA, its persistent component (PROA), and its transitory component (TROA). The sample is 196307-201412.

Figure 2: Value functions

This figure plot the value function of the total firm value (Value), the value of assets-in-place (VAP), the value of growth opportunities (VGO), and profitability against aggregate demand (x), aggregate investment shocks (s), idiosyncratic productivity shocks (z), and idiosyncratic demand shocks (a).



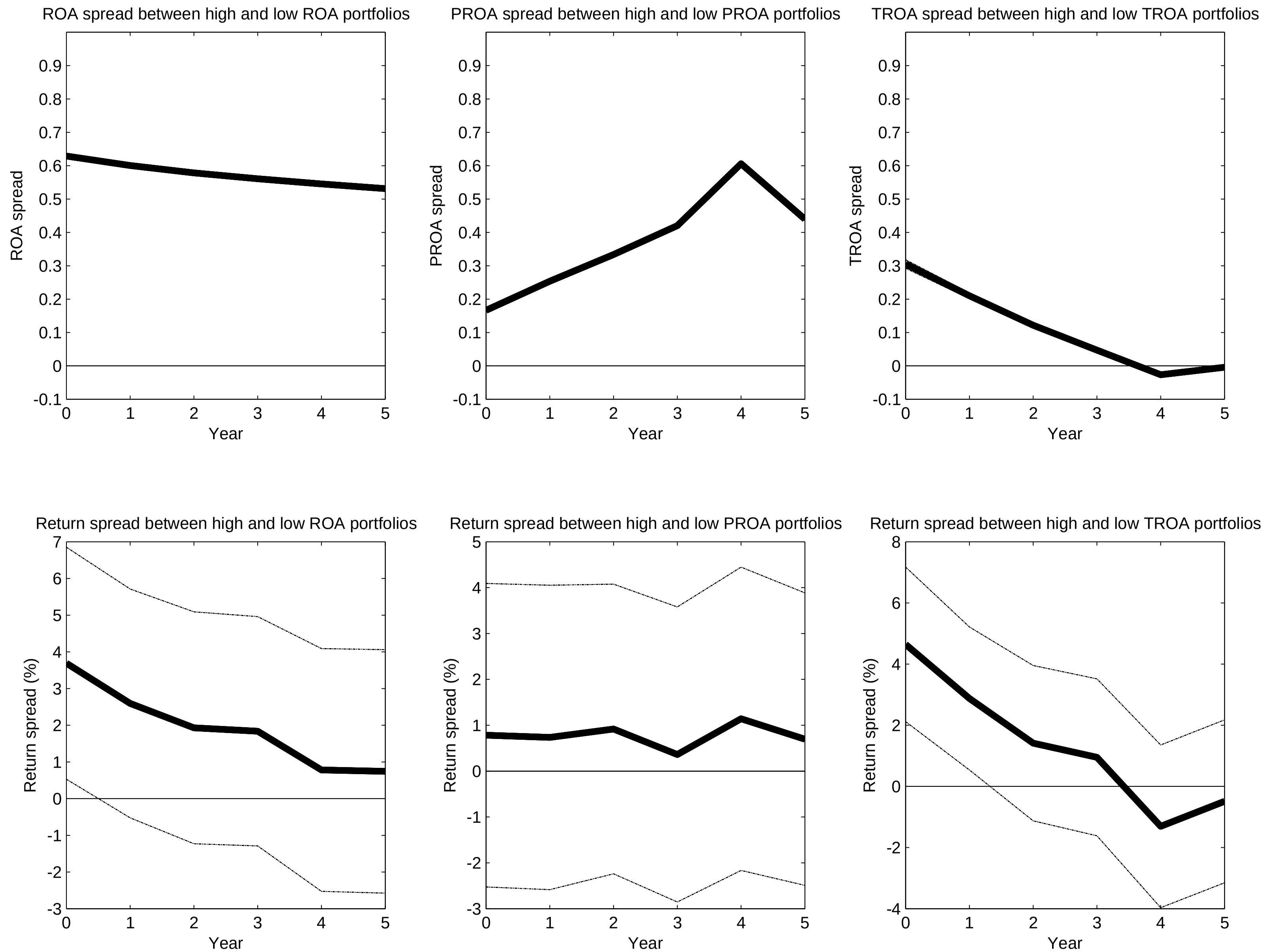


Figure 3: Dynamics of ROA, PROA, and TROA long-short portfolios

This figure plots the dynamics of ROA (PROA, or TROA) spread and value weighted return spread between high and low quintile ROA (PROA, or TROA) portfolios with their 95 percent confidence intervals. The sample is 196307-201412.