Market Power, Technology Shocks, and the Profitability Premium*

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Abstract

This paper studies how market power affects the well-documented positive relation between firms' profitability and future stock returns in the cross-section. We find that this relation is significantly more pronounced among firms with high markup. A long-short portfolio sorted on profitability earns an average monthly return of 0.57% among firms with high markup, and only 0.05% among firms with low markup. Firms' differential exposure to investment-specific technology shocks explains this gap. To understand these results, we introduce market power into a standard investment-based asset pricing model to study its impact on firms' endogenous investment and risk exposures. Market power exacerbates the displacement risk faced by highly profitable firms.

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1 Introduction

Profitable firms earn significantly higher average stock returns than unprofitable firms. This return spread – often referred to as the profitability premium – has attracted a lot of attention among both academics and practitioners. Moreover, a profitability-based factor model can help to explain a large set of asset pricing anomalies. Given the extraordinary empirical explanatory power of the profitability factor, understanding the economic forces behind it is important. Existing studies explaining the firm-level profitability premium abstract from imperfect competition. In this paper, we fill this gap to provide an empirical and theoretical analysis of the effect of market power on the profitability premium.

Market power captures the ability of a firm to charge output prices that deviate from marginal costs and is therefore a natural source of profitability. At the same time, firms' optimal investment decisions are distorted in the absence of perfect competition. Therefore, based on the neoclassical investment-based asset pricing literature, one should expect that market power, which jointly accounts for profitability and optimal investment, could provide further insights that shed light on the economic mechanisms for the profitability premium.

Empirically, we investigate how the profitability premium varies across firms that differ in market power. We measure market power using price markup. We double sort portfolios based on firms' markup and firms' gross profitability independently using US data on publicly traded firms. We find that the profitability return spread and alpha are significantly higher among high markup firms than among low markup firms. Among firms with high markup, the profitability return spread is about 0.57% per month. Among firms with low markup, the profitability return spread is only 0.05% per month. Thus, the difference of the profitability return spread between high and low markup firms is economically large, about 0.52% per month with a t-statistic of 2.32.

Consistent with the results from the portfolio approach, in the firm-level Fama and MacBeth cross-sectional regressions with firms' lagged profitability as a return predictor, the positive relation between profitability and future returns is significantly steeper across firms with high markup than across firms with low markup. The difference in the slope coefficient associated with firms' lagged profitability between high and low markup firms is both economically and statistically significant: a one standard deviation (about 25%) increase in firms' profitability is associated with an increase of 0.24% in firms' monthly expected stock returns among high markup firms, while only with an increase of 0.11% in firms' monthly expected stock returns among low markup firms, after controlling for other return predictors.

The main finding that the profitability premium is prominent among high markup firms and negligible among low markup firms is robust across many specifications: it holds for using industry-level markup as the sorting variable, different markup measures, different sorting methods, and different asset-pricing factor models.

Our novel empirical findings shed light upon the source of the profitability premium and imply that market power plays a significant role in the risk and return of firms with different profitability. However, existing studies of the firm-level profitability premium abstract from imperfect competition.[1] One notable explanation of the average profitability premium is the displacement risk channel proposed by Kogan and Papanikolaou (2013). In their model with perfect competition, when the economy is hit by positive investment-specific technology (IST) shocks, more profitable firms tend to be displaced by less profitable firms, because more profitable firms benefit less from IST shocks than less profitable firms. Thus, more profitable firms are less exposed to IST shocks. With a negative price of risk for IST shocks, more profitable firms are riskier and thus have higher expected returns.

We show that market power amplifies the displacement risk channel and is the key to understand the source of the risk to the profitability strategy. Empirically, we find that a long-short portfolio sorted on profitability among high markup firms is more exposed to IST shocks than it is among low markup firms. A standard linear stochastic discount factor

[1] One exception is Dou, Ji, and Wu (2021) which build an asset-pricing model with dynamic strategic competition to explain the cross-industry gross profitability premium, instead of the within-industry gross profitability premium which is the focus of this paper.

(SDF) test shows a significantly negative price of risk for the IST shocks, consistent with the previous literature. Together with the total factor productivity (TFP) shocks, the two-factor model can explain a sizable portion of the observed profitability premium across firms with different levels of markup. The mean absolute pricing error of the two-factor model decreases significantly relative to that of the model with only the TFP risk factor. These findings suggest that the heterogeneity in firms' IST risk exposures provides an explanation for the different profitability premium among firms with high and low markups.

An alternative way to demonstrate that market power exacerbates the displacement risk faced by the profitable firms is to inspect the future profitability dynamics. We show that in the years following portfolio formation, the profitability of the most profitable firms with low markup is quite persistent. In contrast, the profitability of the most profitable firms with high markup declines much faster, about 9% over the next 5 years.

To understand the economic mechanisms behind the empirical findings, we introduce market power into a simple investment-based asset pricing model to study its implications on firms' optimal corporate decisions and endogenous risk exposures. Firms produce with physical capital and make optimal investment and product pricing decisions to maximize the present value of cash flows. Investment-specific technology affects the efficiency of transforming new investment into capital. Firms face a downward-sloping demand curve in the product market, and the price elasticity of the demand parameter in the demand function governs the degree of market power. Our model is highly tractable, and we obtain closed-form solutions to analytically characterize firms' optimal policies and endogenous risk exposures.

The model delivers important economic mechanisms that link optimal investment, market power, profitability, and IST risk exposures. We find that profitable firms with high market power benefit less from positive technology shocks than profitable firms with low market power. The economic intuition is as follows. First, for high profitability firms, irrespective of their market power, their existing assets already generate strong cash-flows, so they have lower incentives to expand production capacity, compared with low profitability firms. More importantly, profitable firms with significant market power find it sub-optimal to largely expand production capacity because doing so reduces output prices which eventually lowers their profits. Thus, market power exacerbates the displacement risk faced by profitable firms with high market power.

To further test the model's mechanisms, we derive the model's predictions on firms' investment responses to IST shocks and test them in the data. The predictions are that (1) profitable firms, which have less valuable growth opportunities, should invest less in response to a positive IST shock than unprofitable firms, which have more valuable growth opportunities; and (2) this pattern is more pronounced among high markup firms. We find strong empirical support for both predictions. Profitable firms with high market power have less incentive to invest upon positive IST shocks than unprofitable firms. This relation is much weaker when firms do not have market power. Taken together, these findings further support the explanation of heterogeneous IST risk exposure through the investment channel documented in both the empirical and the theoretical parts of the paper.

The rest of this paper is organized as follows. Section 2 discusses the related literature. Section 3 presents the empirical results. Section 4 describes the model to assess the proposed explanation. Section 5 derives and tests the model predictions in the data. Section 6 concludes.

2 Related Literature

This paper contributes to the literature on the relation between firms' profitability and future stock returns (Novy-Marx 2013, Hou, Xue, and Zhang 2014, Fama and French 2015). Existing literature offers several explanations for the profitability premium. Kogan and Papanikolaou (2013) highlight the role of investment-specific technology shocks as a systematic risk factor in the cross section and show that more profitable firms tend to be displaced by less profitable firms upon positive technology shocks. Kogan, Li, and Zhang (2023) highlight an operating hedge effect which is weaker for more profitable firms, giving rise to the profitability premium. Ai, Li, and Tong (2021) argue that high profitability firms are more sensitive to shocks to the marginal cost of capital utilization and therefore riskier. However, all of the above frameworks abstract from imperfect competition. We differ from existing explanations by introducing market power as a natural source of profitability and study its risk and return implications.[2]

One notable exception is Dou, Ji, and Wu (2021) which build an asset-pricing model with dynamic strategic competition to explain the cross-industry gross profitability premium. More profitable industries are more exposed to discount rate shocks, generating the industry profitability premium. Our paper focuses on the firm-level profitability premium and the interplay between market power, endogenous investment decisions, and IST shocks, highlighting different channels in explaining the within- and cross-industry profitability premium, thus complementing their paper.

Our paper also contributes to the growing literature that links imperfect competition to firm risk and asset returns. See, for example, Hou and Robinson (2006), Aguerrevere (2009), Giroud and Mueller (2011), Loualiche (2016), Bustamante and Donangelo (2017), Garlappi and Song (2017), Corhay, Kung, and Schmid (2020), Dou, Ji, and Wu (2022), and Corhay, Li, and Tong (2022). We document and explain a novel empirical fact that the profitability premium is prominent among firms with market power, shedding light upon the source and the risk of the profitability premium.

This paper is also related to the strand of production-based asset pricing literature that links firm characteristics to asset returns. See, for example, Cochrane (1991), Zhang (2005), Belo, Lin, and Bazdresch (2014), İmrohoroğlu and Tüzel (2014), Croce (2014), Kung and Schmid (2015), Li (2017), and Deng (2021), among many others.

[2]On the behavioral side, Wang and Yu (2013) find that the profitability premium exists primarily among firms with high arbitrage costs or high information uncertainty. Inattention-induced underreaction can partially explain this puzzle. Bouchaud et al. (2019) propose a behavioral theory for the profitability premium with sticky expectation.

3 Empirical Findings

In this section, we explore the empirical relationships between market power, technology shocks, and the profitability premium. We first describe the data, then conduct the portfolio analysis and Fama and MacBeth regressions, followed by the asset pricing tests.

3.1 Sample construction

We take monthly stock returns from CRSP and annual accounting data from Compustat. To be included in the sample, a firm must have matching data in both datasets. Following Fama and French (1992), only NYSE-, AMEX-, and Nasdaq-listed securities with share codes 10 and 11 are included in the sample. Thus, only firms with ordinary common equity are included (American depositary receipts, real estate investment trusts, and units of beneficial interest are excluded). Finally, the sample excludes financial firms (SICs 6000 to 6999) and regulated utilities (SICs 4900 to 4999). To be consistent with our model in Section 4, we omit firms in the investment sector. We follow Gomes, Kogan, and Yogo (2009) for the classification of investment sector. Doing so does not materially affect our analysis and results. The benchmark tradable sample is from July 1963 to December 2020. The data for the Fama French three factors are from Kenneth French's website.

Measuring firms' market power, the ability of a firm to influence and control aspects of a market, is known to be challenging. We follow the literature to analyze firms' markups, the most common measure of whether firms are able to price their goods above marginal cost. Grullon, Larkin, and Michaely (2019) and De Loecker, Eeckhout, and Unger (2020) show that firm-level markup captures firms' market power. To measure markup, we follow the literature (for example, Bustamante and Donangelo 2017 and Crouzet and Eberly 2019) and use profit margin (also known as price-cost margin) which is defined as total revenue (REVT) minus cost of goods sold (COGS) divided by total revenue. We focus on measuring markup at the firm level for at least the following two reasons. First, as documented in De Loecker, Eeckhout, and Unger (2020), there is a large amount of heterogeneity in firms' markups even within an industry. This type of heterogeneity is useful for our purpose. Second, it is challenging to accurately identify firms' product market space and their competitors. Firm-level markup does not rely on the definition of a market nevertheless captures the market power the firm possesses in its market. However, we show that our main findings are robust with industry-level markup measure. To compute industry-level markup, we classify industries by four-digit SIC codes from CRSP and calculate both the mean and median of firm-level markup.

To measure profitability, we follow Novy-Marx (2013) and use the gross profitability over assets (GPA) as the profitability measure. GPA is defined as total revenue (REVT) minus cost of goods sold (COGS) scaled by book assets (AT). Note that this profitability measure contains expensed investments, such as research and development (R&D), advertising, and human capital development. Expensed investments directly reduce earnings without increasing book equity but are nevertheless associated with higher future profitability.

We also retain the following accounting variables. Market equity (size) is price times shares outstanding in June of year t from CRSP. Asset is total assets. The firm-level investment rate (IK) is given by $IK_t = I_t/K_{t-1}$, in which the physical capital stock (K_{t-1}) is given by data item PPENT (net property plant and equipment), and the physical capital investment I_t is given by data item CAPX (capital expenditure) minus SPPE (sales of property, plant, and equipment). Missing values of SPPE are set to zero. The book-to-market ratio (BM) is the ratio of the firm's book equity to market equity, following Fama and French (1993).

3.2 Portfolio analysis

In this section, we use the portfolio approach to study how the profitability premium varies with the extent of markup. Compared to the Fama and MacBeth regressions approach, the portfolio approach weights each observation based on its market cap and does not impose a specific relationship between the variables. Each June of year t, we construct fifteen portfolios by sorting NYSE, AMEX, and Nasdaq stocks into three groups based on the tercile of the ranked values of markup for each firm. Independently, we sort stocks into five groups based on the quintile of the ranked values of gross profitability. Monthly value-weighted excess returns on the fifteen portfolios are calculated for the period from July of year t to June of year $t+1$, and the portfolios are rebalanced in June of each year.

Before we examine the return properties of the profitability portfolios with different markup, it is informative to examine the characteristics of the firms in these portfolios. Table 1 reports the typical stock characteristics within each portfolio. Note that, given the independent sorting, the range for the profitability is very similar across the different levels of markup. More specifically, a firm with low markup can be as profitable as a firm with high markup, making sure a fair comparison of their riskiness given different market power. Not surprisingly, profitable firms with low markup have higher asset turnover, indicating that they are profitable by being more efficient in generating sales from assets. Profitable firms tend to have lower book-to-market ratios than unprofitable firms, regardless of their levels of markup, and market equity do not vary monotonically across the portfolios.

[Table 1 here]

Table 2 reports our main empirical findings. The table reports the monthly profitability quintile portfolios and the high-minus-low portfolio value-weighted excess returns across each markup tercile and the corresponding t-statistics which are heteroskedasticity and autocorrelation consistent (Newey-West). Besides examining the raw excess portfolio returns, we also investigate whether the spreads can be explained by the traditional CAPM and Fama and French (1993) three-factor model. Thus, the table also reports the intercepts and factor loadings and their t-statistics.

[Table 2 here]

Based on Table 2, we find that the profitability premium is monotonically increasing with markup. There is an insignificant (t-statistic = 0.29) monthly profitability premium of 0.05% among firms with the lowest markup. In the medium markup tercile, the profitability premium is 0.30% per month with t-statistic of 1.60. Most of the profitability premium is among firms with the highest markup with a monthly return spread of 0.57% with a t-statistic of 3.02. The last column of Table 2 reports the difference in the profitability premium across firms of high and low markup. The difference is economically large, about 0.52% per month with a t-statistic of 2.32.

The asset pricing tests of the CAPM and Fama-French three factor model reported in Table 2 show that both factor models perform poorly. In particular, the CAPM alpha of the profitability premium among high markup firms is economically large, 0.73% with a t-statistic of 3.87, is significantly higher than the alpha of the profitability premium among low markup firms (difference of 0.55% with a t-statistic of 2.46). Fama-French three factor model alpha is even bigger and more significant partly due to the negative loadings on the HML factor.

To show robustness, we also report the results based on industry-level markup as the sorting variable. Specifically, each June of year t, we construct fifteen portfolios by first sorting stocks into three groups based on the tercile of the ranked values of the industry-level markup. Then we sort stocks within each markup tercile into five groups based on the quintile of the ranked values of gross profitability. The pattern remains largely the same for both industry-level mean and median markup. Table 3 reports the results based on industry-level mean markup. The profitability premium increases from -0.06% per month in the lowest markup industries to 0.48% in the highest markup industries. The difference between these two groups is 0.54% per month with t-statistic of 2.18.

[Table 3 here]

3.3 Fama and MacBeth regressions

The simple double-sorting approach in the previous section delivers the main empirical finding that profitability predicts returns, but only among firms with high markup. However, this finding could possibly be driven by other forces not being controlled for in the portfolio analysis. Besides, sorting on three or more variables is impractical. Thus, to investigate other possible mechanisms, we perform Fama and MacBeth (1973) cross-sectional regressions, which allow us to conveniently control for additional variables.

The multivariate regressions are specified as follows:

$$R_{i,t+1} = \beta_0 + \beta_1 GPA_{i,t} + \beta_2 MK_{i,t} + \beta_3 GPA_{i,t} * MK_{i,t} + Controls_{i,t} + \epsilon_{i,t+1}, \qquad (1)$$

where $R_{i,t+1}$ is the month $t+1$ raw returns on stock i, $GPA_{i,t}$ is the gross profitability of firm i at month t, and $MK_{i,t}$ is the proxy for markup for firm i at month t. To mitigate the potential measurement problems of markup, we identify high markup firms by using dummy variables. We define the dummy variable MK, which equals one if markup is in the highest tercile of the yearly sample distribution, and equals zero otherwise. This dummy variable also allows for an intuitive economic interpretation of coefficient estimates. The variables $Controls_{i,j,t}$ include book-to-market ($log(B/M)$), size ($log(ME)$), and past performance measured at horizons of one month ($r_{1,0}$) and twelve to two months ($r_{12,2}$). Independent variables are trimmed at the 1% and 99% levels. The t-statistics are calculated using Newey and West (1987) standard errors.

Table 4 reports all parameter estimates. The coefficient of interest is the coefficient on the interaction term of profitability and markup (i.e., the column labeled Interaction). For both cases with and without controls, the coefficient on the interaction term is significantly positive, suggesting that the power of profitability in predicting returns is more significant among high markup firms. The difference in the profitability slope coefficient among high and low markup firms is economically large. In the specification with controls (row 3), the slope coefficient on the interaction of profitability and markup is 0.53, whereas the slope coefficient on the profitability alone is 0.42. This difference is large in economic terms: a one standard deviation (about 25%) increase in the firm's profitability is associated with an increase of 0.24% in firm's monthly expected stock return among high markup firms, while only with an increase of 0.11% in firm's monthly expected stock return among low markup firms, after controlling for other return predictors.

[Table 4 here]

Taken together, both the portfolio approach and regression tests show that the profitability premium is much stronger among firms with high markup. This implies that market power plays an important role in the risk and return of firms with different profitability.

3.4 Asset pricing tests

Firms' market power, profitability, and their equity risks are intrinsically connected. However, previous literature explaining the firm-level profitability premium abstract from imperfect competition. One prominent explanation of the average profitability premium is the displacement risk channel proposed by Kogan and Papanikolaou (2013). In their model with perfect competition, when the economy is hit by positive investment-specific technology (IST) shocks, more profitable firms tend to be displaced by less profitable firms, thus are riskier. The key economic mechanism is that more profitable firms benefit less from IST shocks than less profitable firms because their market firm value is contributed mostly by the value of existing assets rather than the present value of growth opportunities, thus are less exposed to IST shocks. IST shock features a negative price of risk (documented in previous literature and also confirmed in Section 3.4.2), thus firms with less exposure to IST shocks are riskier and thus have higher expected returns.

In this section, we show that market power amplifies the displacement risk channel and thus is the key to understand the source of the risk to the profitability strategy. This analysis is important because it provides information about the class of models that can potentially explain the data. Specifically, we evaluate the performance of a two macro-risk factor model, including the productivity shock risk factor and the investment shock risk factor, in explaining the above empirical findings. We find that firms' heterogeneous IST shock exposure largely accounts for the above empirical findings.

3.4.1 IST risk exposure

Here we examine the role played by the IST risk factor. In particular, we regress the profitability portfolio returns across different markups directly on IST shocks and TFP shocks. Following Papanikolaou (2011), we consider two empirical proxies for IST shocks (Δz). The first measure is constructed from the change in the detrended quality-adjusted relative price of new capital goods ($\triangle z_t^I$). Data on the relative price of equipment are from DiCecio (2009). The second measure is the changes in the log aggregate investment-to-consumption ratio ($\triangle ic$). We construct the investment-consumption ratio as the ratio of nonresidential fixed investment expenditures (row 9 of NIPA table 1.1.5) divided by the sum of consumption expenditures in nondurables (row 5) plus services (row 6). We measure the disembodied shock (Δx) using the total factor productivity series in the consumption sector from Basu, Fernald, and Kimball (2006). The time-series regressions are conducted as follows. We use annual portfolio excess returns to estimate risk exposure:

$$R_{i,t} = \alpha_{i,t} + \beta_i^{TFP} \Delta x_t + \beta_i^{IST} \Delta z_t + \epsilon_{i,t}. \tag{2}$$

Table 5 reports the risk exposure estimates and the corresponding t-statistics for the profitability and markup double-sorted portfolios. To save space, we only report the beta estimates for the profitability quintile portfolios with low and high levels of markup. From Table 5, we first find consistent results with Kogan and Papanikolaou (2013) that profitable firms are significantly less exposed to IST shocks (smaller β^{IST}) than unprofitable firms, for both IST shocks proxies. Because of the negative price of IST risk, this is the main driver for the profitability premium on average. Second, we find that these different levels of IST risk exposure vary across markup levels. The profitability long-short portfolio among firms with high markup is more exposed to IST shocks in absolute terms than it is among firm with low markup. In the relative price specification (Panel A), the profitability long-short portfolio among high markup firms has an IST shock beta of -2.86, compared to an IST shock beta of -1.71 for the profitability long-short portfolio among low markup firms. That is close to 70% higher in the IST risk exposure. In the aggregate investment consumption ratio specification, the profitability premium among high markup firms has an IST shock beta of -1.37, compared to an IST shock beta of -0.93 for the profitability premium among low markup firms. That is close to 50% higher in the IST risk exposure.

[Table 5 here]

In sum, firms with similar levels of profitability, but which possess different levels of markup, have quite different exposures to certain systematic risk factors, here the IST risk factor. In particular, the profitability premium is riskier among high markup firms than among low markup firms. Profitable firms with high market power benefit even less from positive technology shocks than profitable firms with low market power, and thus they are more likely to be displaced.

An alternative way to show that market power exacerbates the displacement risk faced by the profitable firms is to inspect the future profitability dynamics. Figure 1 visualizes the average 5-year post-formation profitability dynamics of the highly profitable firms (top GPA quintile) with high and low markup. In the years following portfolio formation, the profitability of the highly profitable firms with low markup is quite persistent. In contrast, the profitability of the highly profitable firms with high markup declines much faster, about 9% over the next 5 years.

[Figure 1 here]

Next, we estimate the market price of the IST and the total productivity shocks. Moreover, we evaluate the extent to which the differences in the levels of IST risk exposure contribute to the differences in the risk premium.

3.4.2 Linear SDF test

One key assumption explaining the empirical findings is the negative price of the IST risk factor. This section formally estimates the market prices of the risk factors. In particular, we specify the stochastic discount factor (SDF) as

$$m = a - \gamma_x \Delta x - \gamma_z \Delta z, \tag{3}$$

where Δx refers to disembodied technology shocks and Δz refers to investment-specific technological shocks. We normalize Δx and Δz to unit standard deviation so that γ_x and γ_z can be interpreted as the Sharpe ratio of a test asset perfectly correlated with Δx and Δz, respectively. We estimate the parameters using the generalized method of moments (GMM). The moment condition is

$$E[R_i^e] = -cov(m, R_i^e), \tag{4}$$

where R_i^e denotes the excess return of portfolio i over the risk-free rate. As test assets, we use five profitability-sorted portfolios across markup terciles, resulting in fifteen test portfolios. We use annual portfolio returns. We report both first-stage and second-stage GMM estimates using the identity matrix and the optimal weighting matrix respectively to weight moment conditions, and adjust standard errors using the Newey-West procedure. As a measure of fit, we report the mean squared errors (MSE) and the mean absolute pricing error (MAPE) from the Euler equations. In particular, we use two-factor specifications with the TFP shocks and the IST shocks for the SDF. We use relative price of investment goods and changes in aggregate investment-to-consumption ratio to proxy for IST shocks.

The results are reported in Table 6. The point estimates of the market price of IST shocks are negative and statistically significant, implying a negative relation between average returns and the IST shock exposures. The estimated price of risk for the TFP shocks is positive, although it is less statistically significant in the first stage but more significant in the second stage estimates. The estimated signs of the risk factors are also consistent with previous studies (Kogan and Papanikolaou 2014). In addition, the pricing errors are substantially reduced by the addition of the IST shock to the SDF. The TFP risk factor only model results in a mean squared pricing error of 2.85% based on the first-stage GMM (Column 1), while the combination of the TFP risk factor with the IST risk factor (measured by relative price of investment goods) produces an MSE value of 1.35% (Column 2).

[Table 6 here]

In sum, this section confirms that cross-sectional differences in IST risk exposures among the test portfolios account for a sizable portion of the differences in their average returns.

4 An Investment-Based Model with Market Power

In this section, we develop a simple model that illustrates a potential economic mechanism to understand the empirical results that IST risk plays a key role in the interconnection between market power and the profitability premium. Our model is analytically tractable since we obtain closed-form solutions under certain parameter values. We show that the mechanism in the simple model can quantitatively account for the profitability premium in high markup industries once extended to a dynamic industrial equilibrium model.

The model has two periods dated as $t = 0, 1$, with a firm choosing optimal investment and product pricing decisions to maximize present value of cash-flows. At the first period, the firm is endowed with some initial capital K_0 with current profitability X_0. The optimal investment I and pricing decision P_1 also takes place at period 0. Investment incurs quadratic adjustment cost with parameter η that controls the penalty of changing investment. Investment-specific technology Z affects the efficiency of transforming new investment I into capital K_1 and production at period 1. Further, the firm faces an inverse demand function at date 1. The optimization problem from the firm's perspective at period 0 is

$$
\begin{aligned}
V(X_0, K_0) = & \max_{I,P_1} \left\{ X_0 K_0 - \frac{1}{Z} \left[I + \frac{\eta}{2} \left(\frac{I}{K_0} - \delta \right)^2 K_0 \right] + P_1 Y_1 \right\} \\
s.t. \quad & Y_1 \leq K_1 \\
& K_1 \leq (1-\delta) K_0 + I \\
& Y_1 \leq P_1^{-\nu}
\end{aligned}
\tag{5}
$$

We assume a linear production technology and the amount of output that the firm supplies at period 1 is $Y_1 = K_1$. Undepreciated capital $(1-\delta)K_0$, combined with new investment I, becomes productive capital in period 1. The firm faces an inverse demand curve with the demand elasticity parameter ν, which pins down price markup μ as $\mu = \frac{\nu}{\nu - 1}$. Note that we abstract away from industry competition and assumes that the firm is a pure monopoly in its product. We break this assumption in the fully dynamic model and assume realistic industry competition structure instead.

It turns out that we can characterize the solutions analytically when the adjustment cost parameter η is set to 1. With this parameter restriction, we proceed and solve the optimal investment and pricing decision analytically, and provide three propositions that link optimal investment, market power, profitability, and exposure of firm's value of assets in place to IST risk.

Proposition 1. *Assume that $\eta = 1$, the optimal investment I is analytical and given by*

$$
I = Z^{\frac{\nu}{\nu+1}} K_0^{\frac{\nu}{\nu+1}} \mu^{-\frac{\nu}{\nu+1}} - (1-\delta) K_0. \tag{6}
$$

The sensitivity of investment to IST shock Z is therefore

$$
\frac{\partial I}{\partial Z} = \frac{\nu}{\nu+1} Z^{-\frac{1}{\nu+1}} K_0^{\frac{\nu}{\nu+1}} \mu^{-\frac{\nu}{\nu+1}} \tag{7}
$$

where μ is the price markup $\mu = \frac{\nu}{\nu-1}$. Clearly, as ν rises, markup goes up, investment becomes less responsive to IST shock.

Proposition 1 analyzes how investment responds to IST shock in the presence of imperfect competition. Consistent with the asset pricing literature such as Papanikolaou (2011), positive IST shock improves the efficiency in the transformation of new investment into capital stock and therefore firm should invest more when a positive IST shock is realized. The novelty of proposition 1 is to investigate how market power distorts this well-known effect of IST shock.

Under imperfect competition in which the firm has pricing power, firm's investment becomes less responsive to IST shock. The presence of market power introduces a counteracting effect to dampen the rise in demand of new investment as technology efficiency improves. Since firms are encountered with an inverse demand curve, as technology improvement increases the number of units produced, the firm has to lower its output price. This effect has larger impact on firms with higher market power because such firms face a more inelastic demand curve.

The investment expenditure at date 0 generates cash-flow at date 1 which depends on the firm's market power. Therefore, investment, upon the impact of IST shock, creates an intertemporal redistribution of cash-flows that has non-trivial implications for firm's valuation. The next two propositions investigate asset pricing implications of proposition 1.

Proposition 2. *Define Value of Assets in Place (VAP) as*

$$VAP = X_0 K_0 + P_1(1-\delta)K_0 \tag{8}$$

which is the value of cash-flow determined by current asset K_0. $\frac{\partial VAP}{\partial X_0} > 0$. Further, $\frac{\partial \frac{VAP}{K_0}}{\partial X_0} > 0$. That is, there is a positive association between current profitability X_0 and VAP.

Proposition 2 shows that firms with higher profitability ratios, which is the ratio between current profits to total assets ($\frac{X_0 K_0}{K_0}$), also carry higher VAP proportionally. We replicate the well-known positive association between VAP and profitability in the investment-based asset pricing literature such as Kogan and Papanikolaou (2013). With the positive relation between profitability ratio and VAP, we analyze the exposures to IST risk for profitable firms by examining the risk profiles of their VAPs.

Proposition 3. *VAP is negatively impacted by IST Z, that is*

$$\frac{\partial VAP}{\partial Z} < 0. \tag{9}$$

Higher market power and markup further amplify the risk of VAP with respect to IST shock, that is,

$$\frac{\frac{\partial VAP}{\partial Z}}{\partial \mu} < 0. \tag{10}$$

Proposition 3 is the key to understand the heterogeneous profitability premium across firms with different markups. VAP of firms with higher market power has even lower (negative) exposures to IST risk. If IST carries a negative risk premium as identified in earlier literature, VAP of such firms earn higher expected stock returns. Since high profitability firms are richer in VAP, profitable firms who also has strong market power should be riskier and earn higher risk premium, than profitable firms with lower markups.

Intuitively, technology progress reduces the cost of capital input which improves production efficiency. Profitable firms with strong market power benefit less from this type of technology improvement. First, for high profitability firms, irrespective of their market power, their existing assets already generate strong cash-flows, so they have lower incentives to expand production capacity, compared with low profitability firms. More importantly, profitable firms with significant market power find it sub-optimal to largely expand production capacity because doing so reduces output prices which eventually lowers their profits.

Figure 2 visualizes the key model mechanisms based on the Propositions given a set of parameter values.

[Figure 2 here]

We extend the simple model to a dynamic model in a later section. We show that the channel we highlight here can quantitatively account for the heterogeneous profitability premium across firms with different market power.

5 Testing Model Predictions

Our simple model is consistent with the risk and return dynamics for profitability-sorted portfolios with different levels of markup. In addition, it offers novel predictions regarding investment, firm value, and exposures to IST risks, which we test and provide empirical support for the model's economic mechanisms. In this section, we focus on testing the model's novel prediction on investment, as we already present supportive evidence on the tests of IST risk exposure in Section 3.4.1.

Firms must invest to realize their growth opportunities. Thus, given the readily available empirical proxies for investment shocks, we compare firms' investment responses to IST shocks in the real data to further test the model's mechanisms. The model has two key predictions for firms' investment responses to IST shocks:

1. Profitable firms, which have less valuable growth opportunities, should invest less in response to a positive IST shock than unprofitable firms, which have more valuable growth opportunities.

2. This pattern is more pronounced among high markup firms. That is, profitable firms with high markup have even less incentive to invest upon a positive IST shock.

In order to empirically test these predictions, we estimate the following specification using a panel OLS regression:

$$i_{ft} = b_1 \triangle z_{t-1} + \sum_{d=2}^{5} b_d D(G_{ft-1})_d \triangle z_{t-1} + \rho i_{ft-1} + \gamma X_{ft-1} + u_{ft}, \tag{11}$$

where i_{ft} is the firm's investment rate and $\triangle z = \triangle z^I$ is the measure of the IST shock proxied by the relative price of investment goods. The dummy variable $D(G_{ft-1})_d$ takes the value of one if the firm's gross profitability ranking belongs to quintile d in year $t-1$. We standardize all right-hand-side variables to a zero mean and unit standard deviation. We cluster standard errors by firm and year. The vector X includes the dummy variables $D(G_f)$ and firm fixed effects. The coefficient of interest is b_5, which captures the differential response of investment to the IST shock across firms in the top and bottom quintiles.

First, as shown in Table 7, we find that on average, unprofitable firms exhibit investment behavior that is more sensitive to the IST shock, compared with the most profitable firms. A single-standard-deviation positive IST shock leads to an increase in the investment-to-capital ratio of unprofitable firms of 0.4%, relative to profitable firms. This dispersion in investment responses suggests that unprofitable firms are positioned with more investment opportunities than profitable firms.

We then use profitability quintile portfolios among low and high markup terciles, respectively, to test if there is any differential response. Table 7 shows the coefficient estimates of bs and the corresponding t-statistics. Among high markup firms, the differential response of investment across unprofitable and profitable firms is as large as 1.1% and statistically significant. There is no such pattern among low markup firms. Profitable firms with high market power have less incentive to invest upon positive IST shocks than unprofitable firms. This relation is much weaker when firms do not possess market power. Thus, we confirm in the data both predictions of the model and show that firms with similar profitability, but which have different levels of markup, are very different in their investment behaviors as well.

[Table 7 here]

Taken together, the results from this analysis support that firms' differential exposures to IST shocks is a plausible driver for heterogeneous performance of the profitability premium across high and low levels of markup.

6 Conclusion

The profitability premium is significantly higher among high markup firms than among low markup firms. The profitability long-short strategy earns an average monthly return of 0.57% among high markup firms, and only 0.05% among low markup firms. We find that this strategy is more exposed to the investment-specific technology (IST) shocks among firms with high market power, making this strategy riskier and thus capable of earning a higher risk premium.

Theoretically, we introduce market power into a standard neoclassical investment-based model to understand the empirical findings. The economic intuition is that profitable firms with high market power benefit even less from positive technology shocks than profitable firms with low market power. Thus, market power exacerbates the displacement risk faced by the profitable firms. The model's novel empirical predictions for the investment responses to IST shocks are further supported in the data. Overall, these findings suggest that market power has a significant impact on profitable firms' risk and return and potentially drives the profitability premium.

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Table 1. Portfolio characteristics

This table reports the average portfolio characteristics of markup and gross profitability double-sorted portfolios. Markup is measured by revenue minus cost of goods sold divided by revenue. Gross profitability (GPA) is defined as revenue minus cost of goods sold scaled by total assets. Turnover is asset turnover, defined as revenue divided by total assets. Size is market equity (in millions). BM is the book-to-market ratio. The portfolio-level characteristic is the time-series average of the median characteristic across firms in the portfolio in each year. The sample is from 1963 to 2020.

Markup	Profitability	GPA	Markup	Turnover	Size	BM
Five profitability portfolios with low markup						
Low	Low	0.04	-0.10	0.67	99.55	0.81
Low	2	0.23	0.17	1.36	256.33	0.92
Low	3	0.33	0.19	1.80	180.96	0.81
Low	4	0.46	0.19	2.49	149.85	0.72
Low	High	0.75	0.20	4.14	139.25	0.75
Five profitability portfolios with high markup						
High	Low	0.12	0.58	0.20	215.79	0.64
High	2	0.23	0.54	0.44	411.88	0.63
High	3	0.35	0.52	0.70	419.03	0.54
High	4	0.49	0.52	0.97	438.32	0.47
High	High	0.77	0.56	1.43	217.05	0.41

Table 2. Markup and the profitability premium: firm-level results

This table reports the average excess value-weighted returns and CAPM and Fama-French three-factor model alphas and factor loadings on portfolios independently sorted on firm-level markup and gross profitability. In June of each year t, stocks are sorted into three groups based on the tercile of the ranked values of markup in year $t-1$. Independently, stocks are sorted into five groups based on the quintile of the ranked values of gross profitability in year $t-1$. Monthly returns on the resulting fifteen portfolios are then calculated from July of year t to June of year $t+1$. Monthly portfolio abnormal returns and factor loadings are computed by running time-series regressions of portfolio excess returns on CAPM and Fama-French three-factor model. The excess returns and alphas are in percentages, and the t-statistics are heteroskedasticity and autocorrelation consistent (Newey-West). L and H stands for the low and high profitability portfolio, respectively. $H-L$ stands for the high-minus-low profitability portfolio. Diff $H-L$ stands for the difference in the $H-L$ between high and low markup firms. The sample is from 1963 to 2020.

	Low markup				Medium markup				High markup				Diff
	L	3	H	$H-L$	L	3	H	$H-L$	L	3	H	$H-L$	$H-L$
R^{ex}	0.63	0.59	0.68	0.05	0.59	0.56	0.89	0.30	0.19	0.56	0.77	0.57	0.52
[t]	2.90	3.04	3.32	0.29	2.55	2.83	4.12	1.60	0.76	2.90	4.32	3.02	2.32
CAPM													
α	0.02	0.06	0.21	0.19	-0.05	-0.03	0.32	0.37	-0.48	-0.01	0.26	0.73	0.55
[t]	0.16	0.55	1.48	1.08	-0.43	-0.32	2.65	2.00	-3.07	-0.07	2.98	3.87	2.46
β^{mkt}	1.08	0.94	0.84	-0.24	1.13	1.03	1.00	-0.12	1.18	1.00	0.89	-0.29	-0.05
[t]	37.45	23.70	22.85	-5.01	28.04	50.62	29.27	-2.05	24.60	37.94	36.33	-4.75	-0.70
Fama-French three-factor model													
α	-0.04	-0.03	0.16	0.20	-0.11	-0.09	0.32	0.43	-0.49	0.07	0.36	0.85	0.65
[t]	-0.47	-0.30	1.14	1.16	-0.98	-1.19	2.66	2.37	-3.17	0.90	4.47	4.75	3.03
β^{mkt}	1.03	0.92	0.82	-0.21	1.18	1.04	0.99	-0.18	1.19	0.96	0.88	-0.32	-0.11
[t]	35.80	23.55	18.32	-3.59	28.06	55.59	26.44	-3.01	24.37	40.78	36.94	-5.58	-1.63
β^{smb}	0.33	0.21	0.16	-0.16	-0.10	0.10	0.04	0.14	-0.02	0.00	-0.09	-0.08	0.09
[t]	8.57	3.50	1.73	-1.37	-1.91	3.23	0.57	1.69	-0.32	-0.13	-2.92	-1.24	0.73
β^{hml}	0.09	0.23	0.11	0.01	0.21	0.17	-0.02	-0.23	0.05	-0.25	-0.28	-0.32	-0.34
[t]	2.29	3.67	1.38	0.13	3.31	4.40	-0.32	-2.19	0.50	-6.40	-5.89	-2.96	-2.75

Table 3. Markup and the profitability premium: industry-level results

This table reports the average excess value-weighted returns and CAPM and Fama-French three-factor model alphas and factor loadings on portfolios conditionally sorted on industry-level markup and gross profitability. Industry-level markup is measured by the average markup of each industry. In June of each year t, stocks are first sorted into three groups based on the tercile of the ranked values of markup in year $t-1$, and then stocks are sorted within each tercile into five groups based on the quintile of the ranked values of gross profitability in year $t-1$. Monthly returns on the resulting fifteen portfolios are then calculated from July of year t to June of year $t+1$. Monthly portfolio abnormal returns and factor loadings are computed by running time-series regressions of portfolio excess returns on CAPM and Fama-French three-factor model. The excess returns and alphas are in percentages, and the t-statistics are heteroskedasticity and autocorrelation consistent (Newey-West). L and H stands for the low and high profitability portfolio, respectively. $H-L$ stands for the high-minus-low profitability portfolio. Diff $H-L$ stands for the difference in the $H-L$ between high and low markup industries. The sample is from 1963 to 2020.

	Low markup				Medium markup				High markup				Diff
	L	3	H	$H-L$	L	3	H	$H-L$	L	3	H	$H-L$	$H-L$
R^{ex}	0.61	0.59	0.56	-0.06	0.57	0.56	0.79	0.22	0.34	0.70	0.82	0.48	0.54
$[t]$	2.13	3.04	3.04	-0.25	2.70	2.78	3.91	1.47	1.60	3.36	3.99	2.83	2.18
CAPM													
α	-0.11	0.05	0.07	0.18	-0.06	-0.04	0.24	0.30	-0.25	0.09	0.26	0.52	0.34
$[t]$	-0.64	0.53	0.63	0.86	-0.62	-0.46	2.31	1.97	-2.25	0.96	2.40	2.91	1.42
β^{mkt}	1.28	0.95	0.87	-0.41	1.11	1.06	0.96	-0.15	1.05	1.07	0.99	-0.06	0.35
$[t]$	30.41	27.35	32.62	-7.68	36.74	42.77	35.05	-3.22	31.25	45.75	29.37	-1.13	5.52
Fama-French three-factor model													
α	-0.12	-0.06	0.11	0.23	-0.11	-0.05	0.27	0.38	-0.27	0.17	0.34	0.61	0.38
$[t]$	-0.70	-0.59	1.13	1.17	-1.16	-0.55	2.52	2.44	-2.43	2.00	3.15	3.61	1.72
β^{mkt}	1.15	0.98	0.86	-0.29	1.15	1.04	0.96	-0.19	1.06	1.01	0.94	-0.12	0.17
$[t]$	26.10	30.72	33.83	-5.34	38.49	40.78	30.04	-4.15	32.02	45.24	26.73	-2.30	2.40
β^{smb}	0.56	0.08	-0.03	-0.58	-0.08	0.10	-0.02	0.07	-0.02	0.09	0.07	0.09	0.68
$[t]$	6.96	1.41	-0.63	-5.51	-1.98	2.50	-0.27	1.08	-0.47	1.61	1.27	1.29	4.98
β^{hml}	-0.14	0.31	-0.14	0.00	0.18	0.01	-0.07	-0.25	0.06	-0.29	-0.26	-0.31	-0.32
$[t]$	-2.16	6.12	-2.55	0.02	3.05	0.10	-1.32	-2.62	1.20	-6.90	-4.06	-3.68	-2.80

Table 4. Fama and MacBeth regressions

This table reports the slope coefficients from Fama and MacBeth regressions of returns (R) on gross profitability (GPA), markup (MK), the interaction term between profitability and markup (Interaction), and controls of the form

$$R_{i,t+1} = \beta_0 + \beta_1 GPA_{i,t} + \beta_2 MK_{i,t} + \beta_3 GPA_{i,t} * MK_{i,t} + Controls_{i,t} + \epsilon_{i,j,t+1}.$$

MK is a dummy variable which equals one if markup is in the highest tercile of the yearly sample distribution, and equals zero otherwise. Controls include book-to-market ($log(B/M)$), size ($log(ME)$), and past performance measured at horizons of one month ($r_{1,0}$) and twelve to two months ($r_{12,2}$). Independent variables are trimmed at the 1% and 99% levels. The slope estimates are reported after multiplied by 100, and the t-statistics are heteroskedasticity and autocorrelation consistent (Newey-West). The sample is from 1963 to 2020.

	GPA	Markup	Interaction	$log(B/M)$	$log(ME)$	$r_{1,0}$	$r_{12,2}$
Coefficient	0.29	-0.18	0.47				
[t]	1.41	-1.47	2.14				
Coefficient	0.42	-0.08	0.53	0.35	-0.05	-4.72	0.72
[t]	2.23	-0.74	2.83	4.99	-1.09	-11.01	4.73

Table 5. Risk exposure

This table presents the levels of IST risk exposure for profitability-sorted portfolios with high and low markup. Portfolio annual excess returns are regressed on TFP shocks and IST shocks. We report results using two empirical proxies for the investment shock: (a) changes in the detrended relative price of investment goods; (b) changes in the log aggregate investment-to-consumption ratio. For the TFP shock, we use the changes in the log total factor productivity in the consumption sector. Factor loadings and Newey-West t-statistics are reported. The sample is from 1963 to 2020.

	Low markup						High markup					
	L	2	3	4	H	$H-L$	L	2	3	4	H	$H-L$
Panel A: relative price												
β^{TFP}	1.76	2.63	1.34	1.98	-0.29	-2.05	1.84	1.96	1.70	1.79	0.86	-0.98
$[t]$	1.07	1.95	1.25	1.05	-0.19	-1.28	0.88	1.30	1.19	1.53	0.67	-0.55
β^{IST}	-2.28	-2.27	-3.61	-2.16	-4.00	-1.71	-0.20	-1.71	-1.73	-3.10	-3.06	-2.86
$[t]$	-1.63	-2.49	-4.24	-1.45	-4.61	-1.45	-0.11	-1.57	-1.43	-3.02	-3.28	-1.78
Panel B: aggregate investment consumption												
β^{TFP}	2.04	3.05	1.97	2.28	0.65	-1.39	1.16	2.25	1.61	2.17	1.15	-0.01
$[t]$	1.10	1.96	1.27	1.10	0.32	-0.87	0.52	1.42	0.98	1.31	0.63	0.00
β^{IST}	-0.43	-0.61	-0.93	-0.45	-1.36	-0.93	0.90	-0.43	0.06	-0.58	-0.47	-1.37
$[t]$	-0.66	-1.20	-1.64	-0.75	-2.41	-2.00	1.31	-0.70	0.11	-0.97	-0.88	-2.84

Table 6. Stochastic discount factor

This table reports empirical estimates of γ_x and γ_z and pricing errors from the model SDF: $m = a - \gamma_x \Delta x - \gamma_z \Delta z$. We proxy for the IST shocks Δz with the changes in the detrended relative price of investment goods ($\triangle z^I$) and the changes in the log aggregate investment-to-consumption ratio (Δic), for the disembodied shocks Δx with the changes in the log total factor productivity in the consumption sector. We use the fifteen profitability and markup double-sorted portfolios as test portfolios. We report first-stage and second-stage GMM estimates with an identity weighting matrix (I) and an optimal weighting matrix (S^{-1}) respectively, Newey-West t-statistics, the mean squared errors (MSE) and the mean absolute pricing errors (MAPE). The sample is from 1963 to 2020.

		$[I]$			$[S^{-1}]$	
	(1)	(2)	(3)	(4)	(5)	(6)
Δx	1.71	0.74	1.56	0.79	0.74	0.94
$[t]$	1.41	0.75	1.22	1.21	1.87	1.81
$\triangle z^I$		-0.76			-0.62	
$[t]$		-1.66			-2.00	
Δic			-0.73			-0.30
$[t]$			-1.71			-1.22
MSE (%)	2.85	1.35	1.95	4.71	1.61	3.70
MAPE (%)	2.15	1.21	1.69	4.15	1.29	3.22

Table 7. Investment response to IST shock

This table reports the relevant slope coefficients from a panel OLS regression of the form

$$i_{ft} = b_1 \triangle z_{t-1} + \sum_{d=2}^{5} b_d D(G_{ft-1})_d \triangle z_{t-1} + \rho i_{ft-1} + \gamma X_{ft-1} + u_{ft},$$

where i_{ft} is the firm's investment rate, $\triangle z$ is the measure of the IST shock, the dummy variable $D(G_{ft-1})_d$ takes the value of one if the firm's gross profitability belongs to quintile d in year $t-1$, and the vector X includes the dummy variables $D(G_f)$ and firm fixed effects. All right-hand-side variables are normalized to a unit standard deviation. Standard errors are clustered by firm and year. The equation is estimated separately among firms single-sorted by profitability and among firms double-sorted by profitability and markup. The sample is from 1963 to 2020.

	Single sort	Low markup	High markup
$\triangle z_{t-1}$	0.007	0.003	0.014
$[t]$	2.19	0.93	2.49
$D(G_f)_2 \times \triangle z_{t-1}$	-0.001	0.001	-0.001
$[t]$	-0.35	0.30	-0.29
$D(G_f)_3 \times \triangle z_{t-1}$	-0.003	0.000	-0.007
$[t]$	-1.24	0.06	-1.41
$D(G_f)_4 \times \triangle z_{t-1}$	-0.004	-0.001	-0.009
$[t]$	-1.66	-0.32	-2.04
$D(G_f)_5 \times \triangle z_{t-1}$	-0.004	-0.003	-0.011
$[t]$	-1.62	-1.00	-2.16

Figure 1. Post-formation profitability dynamics

This figure plots the average 5-year post-formation profitability dynamics of the highly profitable firms (top GPA quintile) with high and low levels of markup. The sample is from 1963 to 2020.

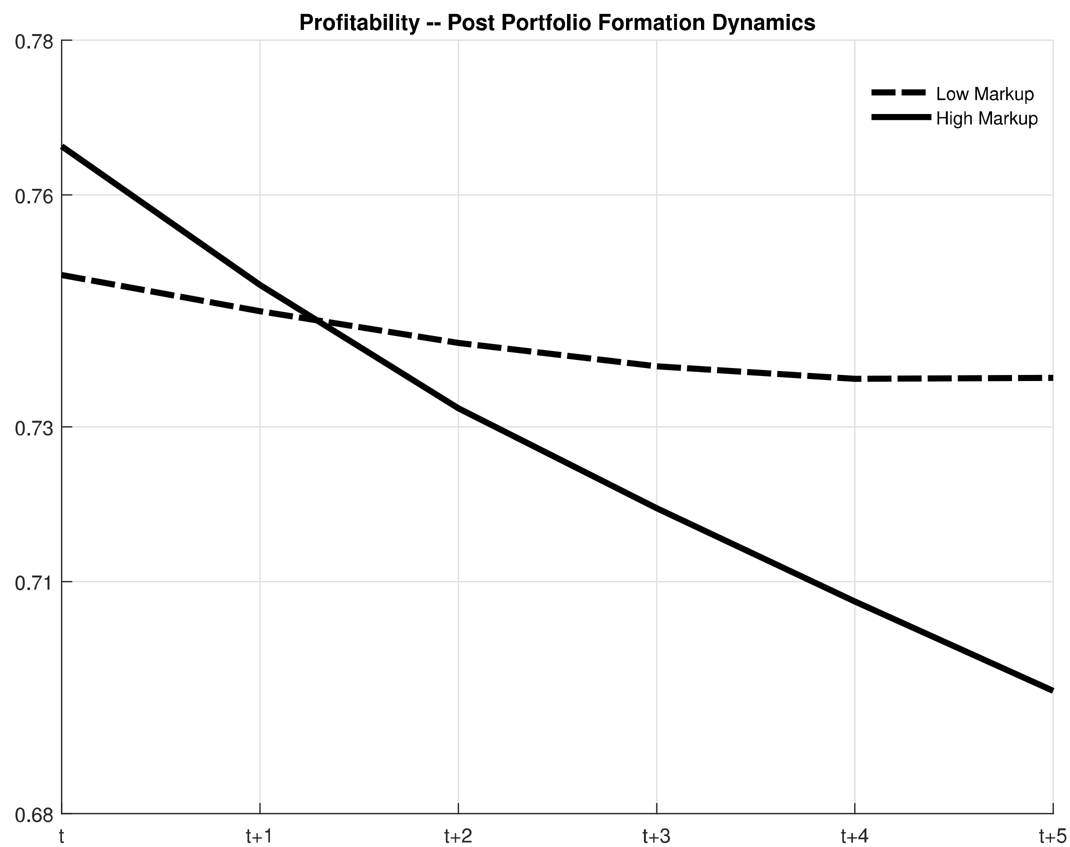

Figure 2. Model mechanisms

This figure plots the key propositions from the model.