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Economics Series

Fundamentals, Misvaluation, and Investment:
The Real Story

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Abstract

Is real investment fully determined by fundamentals or is it sometimes affected by stock market misvaluation? We introduce three new tests that: measure the reaction of investment to sales shocks for firms that may be overvalued; use Fama-MacBeth regressions to determine whether "overinvestment" affects subsequent returns; and analyze the time path of the marginal product of capital in reaction to fundamental and misvaluation shocks. Besides these qualitative tests, we introduce a measure of misvaluation into standard investment equations to estimate the quantitative effect of misvaluation on investment. Overall, the evidence suggests that both fundamental and misvaluation shocks affect investment.

Keywords

investment, stock market, fundamentals, misvaluation, bubbles, real effects of financial markets

JEL Classification

E44, E22, E32, G3

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Contents

> "Perhaps the crucial, and relatively neglected, issues have to do with real consequences of financial markets. ... Does market inefficiency have real consequences, or does it just lead to the redistribution of wealth from noise traders to arbitragers and firms?"
>
> Andrei Shleifer, *Inefficient Markets*, p. 178

1 Introduction

Some observers believe that the 2001 U.S. recession was the culmination of a stock market bubble that led to unusually high levels of business fixed investment in the late 1990s (especially in the sectors of the economy that were most affected by the bubble) and the collapse of investment as some firms attempted to reverse bubble-induced excesses. If correct, this account has important implications for macroeconomic theory and policy. In fact, there has been a lively debate about the appropriate monetary policy response to a possible bubble and, more generally, the role of asset prices in policy formulation.[1] In this paper, we examine whether business fixed investment is determined solely by fundamentals or whether stock market misvaluation sometimes affects investment.

For most economists, some skepticism seems appropriate about the idea that misvaluation led first to overinvestment and then a recession. Before the late 1990s, many economists doubted that stock prices deviated much from fundamentals. Even if one is now prepared to concede that the shares of firms may sometimes be misvalued, it is far from obvious that this will have any meaningful effect on real investment.

Our prior – probably shared by most economists – is that fundamentals play a large role in determining investment. The role of misvaluation is less clearly established. At the level of basic economic theory, even if managers believe that their firms' shares are overvalued, they could issue shares and invest the proceeds in cash or fairly priced securities (such as T-bills) without increasing real investment. We refer to this as the "passive financing mechanism." On the other hand, overvaluation may suggest a low cost of equity finance. If managers perceive the cost of capital as low, they may proceed with investment projects that would have negative net present value in the absence of overvaluation. We refer to this as the "active financing mechanism." The passive financing mechanism implies that misvaluation does not affect investment, while the active financing mechanism implies that misvaluation does affect investment.[2]

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[1] For example, see Bean (2004), Bernanke (2003), Bernanke and Gertler (1999), Borio and White (2003), Cecchetti (2006), Dupor (2002, 2005), Gilchrist and Leahy (2002), Hunter, Kaufman, and Pomerleano (2003), and references cited therein for a discussion of these monetary policy issues.

[2] The [0] link between overvaluation and investment has been discussed by Keynes (1936), Bosworth (1975), Fischer and Merton (1984), Galeotti and Schiantarelli (1994), Chirinko and Schaller (1996, 2001), and Stein (1996), among others.

The debate concerning the relevance of passive vs. active financing remains unsettled in theoretical models. Blanchard, Rhee, and Summers (1993) and Morck, Shleifer, and Vishny (1990) argue for the passive financing mechanism, suggesting that firms should engage in financial arbitrage without letting misvaluation affect investment. In contrast, in the De Long, Shleifer, Summers, and Waldmann (1989) model, firms must precommit to their investment plans, and it is rational for managers to let misvaluation influence investment. Stein (1996), Baker, Stein, and Wurgler (2003), Gilchrist, Himmelberg, and Huberman (2005) and Polk and Sapienza (2006) all provide models in which rational managers increase investment in response to overvaluation of their firm's shares. Panageas (2005a, 2005b) develops a model in which the response of investment to overvaluation depends on investors' horizons and ownership stakes. Given this diversity of views, even if one is prepared to concede that firms are sometimes misvalued, economic theory does not provide a definitive answer on whether overvalued firms will overinvest. Empirical evidence is required.

The existing empirical evidence is also mixed. Some papers have found evidence that misvaluation affects investment, while others have not.[3] This suggests that power may be an important issue. Through much of the paper, we therefore focus on the set of firms that are the most likely to be misvalued. If we fail to find evidence of the effect of misvaluation on investment among these firms, we are unlikely to find it anywhere.

The set of firms we focus on are glamour firms, which have been defined as firms with high stock market prices relative to an accounting-based measure of firm worth. In contrast, value firms have been defined as firms with relatively low stock market prices. Value firms substantially outperform glamour firms, with 8-10 % higher annual returns averaged over the five years subsequent to portfolio formation. A leading interpretation is that investor sentiment affects stock market prices and glamour portfolios include many temporarily overvalued firms. An alternative explanation is that the risk characteristics of glamour and value portfolios differ.[4] The possibility that risk explains differences in returns between glamour firms and other portfolios will feature in our tests.

According to both the active financing and passive financing stories, overvalued firms should issue equity. Do glamour firms issue shares? Using a large, unbalanced panel data set of almost 100,000 observations of U.S. firms over the period 1980-2001, we find that the median glamour firm issues enough new shares to finance 75 % of its annual investment spending. In contrast, the median value firm issues no shares.

If the active financing story applies to at least some firms, the investment of glamour firms should be relatively high. Based on the same panel data, we find that glamour firms invest more than twice as much as value firms. Using two other basic benchmarks – one based on the corporate finance literature, the other on the macroeconomic investment literature – we again find that the investment of glamour firms is relatively high.

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[3] We review the empirical evidence in more detail in Section 7.

[4] See, for example, Campbell and Vuolteenaho (2004) and Cohen, Polk, and Vuolteenaho (2003).

While the data on equity issuance and investment do not directly contradict the idea that misvaluation exists and affects real investment, we do not believe that they provide compelling evidence. Glamour firms might simply be firms that have received favorable fundamental shocks. These shocks would raise the firms' marginal Q, increase their investment, and perhaps induce them to issue new shares to finance their increased investment spending.

The first main contribution of this paper is to introduce three new tests that are designed to determine whether investment is fully determined by fundamentals or whether misvaluation sometimes affects investment.

First, some models suggest agents have extrapolative expectations. In these models, agents may overreact to a sequence of positive or negative shocks. Barberis, Shleifer, and Vishny (1998) propose this mechanism as a possible explanation for the difference in returns between glamour and value firms. If some investors have extrapolative expectations and if the financing mechanism is active, then glamour firms will tend to overreact to a sales shock. By estimating VARs and plotting the associated impulse response functions, we find that the investment of glamour firms responds strongly to sales shocks. We use a bootstrapping procedure to test whether the magnitude of the glamour firms' reaction can be accounted for by fundamentals.

Second, we examine stock market returns. Under the efficient markets hypothesis, information available last year should have no affect on stock market returns in future years. Even if there is misvaluation and returns are predictable to some extent, as long as misvaluation does not affect investment, a measure of "overinvestment" should have no significant predictive power for future returns. On the other hand, suppose a firm enters the glamour portfolio as the result of a misvaluation shock. If misvaluation influences investment decisions, the firm will tend to overinvest. Eventually, this excess investment will become apparent to investors, leading to lower stock market returns for overinvesting glamour firms. We test for the possible effect of "overinvestment" on the returns of glamour firms using Fama-MacBeth regressions. We find that a measure of overinvestment at the time of portfolio formation has significant predictive power for future excess returns. The economic magnitude is substantial: a one-standard-deviation increase in measured overinvestment reduces cumulative excess returns over the next five years by about 560 basis points per year.

Third, we analyze how the time path of the marginal product of capital reacts to fundamental shocks and misvaluation shocks. A favorable fundamental shock increases a firm's stock price and shifts up its demand for capital (i.e., its marginal product of capital schedule). At the original capital stock, the marginal product of capital is higher. As the firm increases its capital stock in response to the shock, the marginal product of capital gradually declines. In contrast, if the active financing mechanism is operative, a misvaluation shock shifts down the capital supply curve (due to cheaper equity financing). The marginal product of capital declines around the time of portfolio formation (as firms increase their capital stock to equate the marginal product of capital to the lower cost of capital) and later rises as the misvaluation gradually dissipates. In the data, the marginal product of capital for glamour firms follows such an "elongated U" pattern, falling around the time of portfolio formation and then gradually rising back to its pre-shock level. We use two additional approaches in an effort to draw out the respective roles of fundamental and misvaluation shocks.

While the above qualitative evidence is suggestive of some role for misvaluation, it does not address the question of how large an effect misvaluation has on investment. An additional contribution of the paper is to directly estimate the effect of misvaluation on investment. We present parametric estimates based on four standard investment specifications – a generic investment specification, the neoclassical model, the flexible accelerator model, and the Q model. Coefficient estimates imply that a one-standard-deviation increase in misvaluation raises investment by more than 30 %.

The paper is organized as follows. Section 2 describes the data and provides summary statistics for the full sample. Section 3 discusses the mechanics of the passive and active financing mechanisms and presents data on new share issues by portfolio. In addition, Section 3 examines whether glamour firms' investment is high or low relative to some basic benchmarks. Section 4 explains the idea of extrapolative expectations and presents the "overreaction test," the test based on the response of the glamour portfolio to a sales shock. Section 5 presents Fama-MacBeth tests of the effect of a measure of "overinvestment" on future returns. Section 6 tests the time path of the marginal product of capital. Section 7 presents quantitative estimates of the effect of misvaluation on investment. Section 8 concludes and discusses the implications of the results.

2 Data description

The data is primarily drawn from CompuStat and CRSP. The sample period is 1980-2004. To minimize survivorship biases, we use unbalanced panel data.

We measure whether a firm is a glamour or value firm in a given year using the price/sales ratio (i.e., the ratio of market value of equity to sales). The price/sales ratio has two key advantages: sales is a relatively straightforward accounting concept and is never negative.[5] Portfolios are formed by sorting all the firms for which the necessary data is available in a given year by the price/sales ratio. The two deciles with the highest stock market value (relative to sales) in a given year are classified as glamour firms. The next six deciles are classified as "typical" firms. The two deciles with the lowest stock market value (again, relative to sales) are classified as value firms. The portfolio formation procedure allows a firm to be a glamour firm this year, a typical firm next year, and a value firm the year after. In fact, it is common for firms to move from one portfolio to another.

[5] Other valuation measures are problematic. Market/book (equity value/book value) is used in the literature, but it has many disadvantages noted by Lakonishok, Shleifer, and Vishny (1994, p. 1547). The equity value/cash flow ratio suffers from the frequent occurrence of negative values for cash flow and the resulting ambiguity. For example, negative cash flow might characterize a very young firm with excellent growth prospects but substantial current expenses or a mature firm whose current and future profitability is in doubt.

The primary variable we analyze is the ratio of investment (I) to the capital stock (K). The capital stock is calculated using a standard perpetual inventory algorithm.

There are a few extreme outliers in the data. This is a common issue in panel data studies, resulting from mergers and other accounting changes. We use standard techniques to address the issue, specifically trimming the sample by deleting the 1 % tails of I/K, Sales/K, Cost/K, and real sales growth.

Further details of data construction are provided in the Appendix. Summary statistics for several of the main variables are presented in Panel A of Table 1.

3 Are glamour firms different?

3a Equity Finance

If overvaluation exists, overvaluation may give the firm the impression that equity finance is cheap. In fact, some economists believe that firms time the market to take advantage of overvaluation.[6] If this affects the firm's discount rate, some formerly negative NPV projects will become worthwhile. We refer to this as the active financing mechanism.[7]

Under both the active and passive financing mechanisms, firms issue new shares to take advantage of overvaluation. Our next step is to check a necessary condition for both of these mechanisms – that glamour firms issue new shares.

We normalize new share issues by investment spending. This allows us to readily address the following question: what percentage of capital expenditures in the current year is financed by new share issues? As shown in Panel B of Table 1, the median glamour firm raises about three-quarters of its investment standing from new share issues. In contrast, the median value firm does not raise any funds from equity markets.

In the aggregate, glamour firms raise about 56 percent of their investment spending from new share issues. Value firms raise only 12 percent from new share issues. The difference is highly statistically significant; the t-statistic (based on 25 annual observations) is 6.23.

3b Real Investment

The use of new share issues by glamour firms (documented in Table 1.B) is one of the two key elements of the active financing mechanism. The second element is investment

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[6] See, for example, Baker and Wurgler (2000) and the references cited therein.

[7] Baker, Stein, and Wurgler (2003) investigate a related issue. Like us, they are interested in whether stock market misvaluation might affect real investment, but their focus is somewhat different. They look at firms that are dependent on equity because they do not have an alternative source of external finance. They find that the investment of equity-dependent firms is more responsive to stock market Q. In contrast, our focus is on glamour firms; i.e., firms that may have alternative sources of finance but may perceive equity finance as cheap.

spending. If misvaluation has real effects, then, at a minimum, investment spending by glamour firms must be relatively high. This subsection presents three basic benchmarks for evaluating whether glamour firms' investment is relatively high.

Value firms provide one basic benchmark, since it is unlikely that value firms are overvalued. The first row of Table 2 compares the investment of glamour and value firms. The mean investment/capital (I/K) ratio for glamour firms is 0.299. This is more than twice as large as the mean for value firms of 0.121, and the difference is highly significant.

The corporate finance literature provides a second benchmark. One explanation for the difference in returns between glamour and value firms in that literature involves differences in the industries which comprise the two portfolios. We therefore define the comparable firms benchmark for a given firm as the mean of I/K for firms in the same industry in the same year. The comparable firms benchmark is forward-looking to the extent that the investment of comparable firms is based on expectations of future discount rates and the expected future stream of marginal products of capital.

For each firm in the glamour portfolio in a given year, we calculate the mean of I/K for firms in the same industry in the same year. The comparable firms portfolio substitutes this mean for the value of I/K for each firm in the glamour portfolio in each year, so the comparable firms benchmark reflects the industrial composition of the glamour portfolio as it evolves over time. The mean I/K ratio for the comparable firms benchmark is 0.205, which is about one-third lower than the mean for the glamour portfolio.

Our third benchmark is based on the macroeconomic investment literature. Abel and Blanchard (1986) present a method of constructing marginal Q that does not depend on the stock market.[8] The Abel and Blanchard technique is well suited to our situation because we require a measure of investment opportunities that takes into account rational expectations of the future but is not contaminated by potential stock market misvaluations.

Originally applied to aggregate data, the Abel and Blanchard technique was extended to panel data by Gilchrist and Himmelberg (1995). In their implementation, Gilchrist and Himmelberg (1995) assume a constant discount rate. Risk is a leading explanation for the difference in returns between glamour and value portfolios, so this is a potential problem because variation in risk-adjusted interest rates might account for differences in investment between glamour and value portfolios. We therefore extend the work of Abel and Blanchard (1986) and Gilchrist and Himmelberg (1995) so that it applies to panel data and allows for variation in discount rates, both over time and across industries. In particular, we account for systematic risk in constructing marginal Q.[9]

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[8] Marginal Q is the expected present value of future marginal products of capital.

[9] The appendix provides details of how we construct marginal Q and the marginal Q benchmark.

The marginal Q benchmark for investment is constructed as follows. For all observations where the required data are available, we regress I/K on marginal Q. The marginal Q portfolio substitutes the predicted value of I/K from this regression for the value of I/K for each firm in the glamour portfolio (where the necessary data is available) in each year. The mean I/K ratio for the marginal Q benchmark is 0.166, which is about 40 % lower than the mean for the glamour portfolio.[10]

4 Overreaction?

Barberis, Shleifer, and Vishny (1998) suggest that misvaluation is driven by extrapolative errors on the part of investors. In particular, based on evidence from the psychology literature, they argue that agents tend to see patterns where none exist. For example, a series of positive shocks to sales may give investors the illusion that a firm has moved into a new, higher sales growth regime that will persist for some time.

The possibility of extrapolative errors leads to a test of the real effects of misvaluation. If firms enter the glamour portfolio because investors make extrapolative errors and if there is an active financing mechanism at work, then the response of investment to sales will be stronger for glamour firms than it would be if only fundamentals determined investment. Why? If investors make extrapolative errors, a positive sales shock will have two effects. First, since sales shocks are likely to contain some information about future marginal products of capital, a positive sales shock will increase Q (and thus investment). This is the conventional effect. Second, a positive sales shock will cause those with extrapolative expectations to unduly increase their estimate of the firm's value. If there is an active financing mechanism at work, the sales shock will thus lead to a larger increase in investment than if investment were fully determined by fundamentals. The "overreaction test" is especially appealing because it is closely linked to the Barberis, Shleifer, and Vishny (1998) model.

We implement the overreaction tests by estimating a bivariate VAR of Sales/K and I/K using two lags. Sales is ordered first in the VAR. Under the assumption that the only shocks are to fundamentals, firms base their investment on fundamental shocks that are reflected in sales shocks. Value firms provide a natural point of reference in evaluating the response of glamour firms to a sales shock, since value firms are unlikely to be overvalued. We estimate the VAR for glamour and value firms separately and examine the difference in the impulse response functions.[11] In estimating the VAR, we are careful to include the necessary lagged values of

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[10] The number of observations is smaller for the marginal Q benchmark because the data are not available to calculate marginal Q for all glamour observations. As a result, the mean of I/K for the glamour portfolio is slightly different in the row with the marginal Q benchmark than for the two previous rows of the table.

[11] Gilchrist, Himmelburg, and Hubermann (2005) also estimate firm-level VARs to evaluate the effect of misvaluation on investment. Their empirical work is aimed at finding a link between a measure of misvaluation (dispersion in analysts' forecasts) and investment in a single VAR. By contrast, our test, which offers complementary evidence, is based on two separate VARs estimated for sets of firms that differ in the likelihood of misvaluation and the differential response to a sales shock.

variables for a firm that is in the glamour portfolio in period t even though that firm may not have been in the glamour portfolio in t-1 or t-2.

Figure 1 presents the impulse response functions for glamour and value firms. The investment of glamour firms responds more than twice as much as that of value firms to a one-standard-deviation sales shock. For glamour firms, the peak increase in I/K is about 0.07. For value firms, the peak increase in I/K is less than 0.03.

The overreaction test is suggestive but not, in our view, fully persuasive. Glamour and value portfolios might differ in a variety of dimensions that could lead to different reactions to shocks, even if the only shocks are to fundamentals. Glamour firms might use different production technologies. Value firms might be riskier and face higher discount rates.

To examine whether fundamentals can explain the magnitude of the glamour portfolio response to a sales shock, we adapt a technique from financial economics that is designed to control for risk but is also useful in controlling for production technology. The matching portfolios technique matches each firm in the portfolio of interest – in our case, the glamour portfolio – to a firm with similar characteristics (industry and size) and then forms a portfolio of matching firms.[12] The difference between the matched portfolios and the glamour portfolio is that we strip potential misvaluation out of the matched portfolios. Our objective is that the matched portfolios will have the same fundamentals (i.e., industry and size) but little, if any, misvaluation. We use a bootstrapping procedure for inference, the details of which are provided in the appendix. Figure 1 confirms our skepticism that the magnitude of the glamour response to a sales shock (relative to the value response) is fully attributable to misvaluation and overreaction. The dashed line, labeled "bootstrapped fundamental," shows the median impulse response function of the bootstrapped matching portfolios. The peak of the bootstrapped fundamental response is about 50 % greater than the peak response of the value portfolio. This is consistent with the idea that part of the glamour response is accounted for fundamentals, such as production technology and risk. The dotted lines in Figure 1 provide the 95 % confidence interval for the bootstrapped fundamental impulse response function. The confidence intervals are sufficiently tight to allow us to reject the hypothesis that the difference between the peak response of the value and bootstrapped fundamental portfolios is due to sampling error.

Fundamentals explain part of the response of the glamour portfolio to a sales shock, but they do not appear to explain all of the response. The peak response of the glamour portfolio is an increase of about 0.07 in I/K. The peak bootstrapped fundamental response is about one-third smaller. The confidence intervals are sufficiently tight to reject the null hypothesis that the peak response is the same for the glamour and bootstrapped fundamental portfolios.

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[12] Industry and size are both good measures of differences in production technology. The traditional measure of risk (CAPM beta) is often calculated by industry. Size is one of the factors in the Fama-French three-factor model of risk.

5 Returns

Suppose, for the moment, that misvaluation exists and that a particular firm enters the glamour portfolio as the result of a misvaluation shock. If the active financing mechanism is operative for this firm (i.e., if misvaluation affects investment), the firm will tend to overinvest. Eventually, this excess investment will become apparent to investors, leading to low stock market returns in the future.

In contrast, suppose there is no significant misvaluation. Under the efficient markets hypothesis, it is not possible to forecast future stock market returns based on current information.

Now consider a third possibility. Suppose that misvaluation exists but has no significant effect on investment. If firms in the glamour portfolio tend to be overvalued, their returns may be predictably lower than those of other portfolios (such as the value portfolio).[13] But, if misvaluation has no effect on investment, a purported measure of "overinvestment" should have no predictive power for future returns.

We use a variant of Fama-MacBeth (1973) regressions to distinguish between the first scenario and the latter two scenarios. Specifically, we estimate regressions of the form:

$$ret_{pt}^{h} = \gamma_t + \gamma_{\beta,t}\beta_p + \gamma_{O,G,t}O_{pt}G_{pt} + \eta_{pt}$$

where ret_{pt}^{h} is the cumulative excess return for horizon h, β_p is the CAPM β for portfolio p, O_{pt} is the amount of "overinvestment" in the period of portfolio formation, G_{pt} is a dummy variable taking the value 1 for glamour portfolios and 0 for the remaining portfolios, η_{pt} is the error term in the regression, and t and p index time and portfolio, respectively. "Overinvestment" is defined as the investment that is not accounted for by marginal Q. The horizon is defined such that, e.g., the two-year horizon refers to returns from the beginning of the first year after portfolio formation to the end of the second year after portfolio formation. Under the latter two scenarios described above, "overinvestment" should have no predictive power for returns, and $\gamma_{O,G}$ should be zero. If misvaluation affects investment, $\gamma_{O,G}$ should be negative.[14]

In each year, we divide the firms into 25 portfolios based on quintiles of the price/sales ratio and "overinvestment." We then calculate mean "overinvestment" for each portfolio in the year of portfolio formation and the CAPM β for each of the 25 portfolios. A cross-sectional

[13] This is the behavioral finance interpretation of the difference in returns between glamour and value firms.

[14] Polk and Sapienza (2006) also use a returns test in this context, but the details are different. They focus on one period ahead returns, use six control variables (investment/assets ratio, Brainard-Tobin's Q, cash flow/assets ratio, market capitalization, book equity/market equity ratio, and firm momentum) and two misvaluation variables (discretionary accruals and equity issues), and sort the sample by R&D intensity, share turnover, and the Kaplan-Zingales measure of finance constraints.

regression is run for each year. The Fama-Macbeth procedure tests whether the mean of the estimated values of $\gamma_{O,G}$ (over the years in the sample) is significantly different from 0.

Table 3 presents the results of the Fama-MacBeth tests. The values of $\gamma_{O,G}$ are negative and statistically significant at each horizon indicating that “overinvestment” has a significant effect on returns. To gauge economic importance, the final column of the table reports the effect on returns of a one-standard-deviation increase in “overinvestment.” The effect is substantial. At the two-year horizon, for example, a one-standard-deviation increase in “overinvestment” for glamour firms decreases returns by about 470 basis points per year. The effect is about the same at the three-year horizon and larger at the four-year horizon (about 600 basis points) and five-year horizon (about 610 basis points).

The results in Table 3 are consistent with evidence from the corporate finance literature. Loughran and Ritter (1995) find that returns are substantially lower for the five years following a seasoned equity offering. Since the active financing mechanism involves equity issuance (and since glamour firms are heavy issuers of new shares, as shown in Table 1, Panel B), part of the explanation for the low returns Loughran and Ritter document could be that some overvalued firms overinvest.

Titman, Wei, and Xie (2004) find that substantial increases in investment are associated with low returns over the next five years. They suggest corporate governance problems, specifically empire building by managers, as an explanation for these low returns. The corporate governance explanation is consistent with some other evidence. For example, Blanchard, Lopez-de-Silanes and Shleifer (1994) find that firms that receive cash windfalls tend to increase investment more than can be justified by either their investment opportunities or the relaxation of finance constraints. Using a revealed preference approach, Chirinko and Schaller (2004) find that the firms that are the most likely to suffer from managerial agency problems (firms with high free cash flow and poor investment opportunities) use risk-adjusted discount rates that are 300-400 basis points lower than other firms in discounting the cash flows from investment projects.

We do additional work in an effort to determine whether the results in Table 3 reflect corporate governance problems, misvaluation that leads to overinvestment by some firms, or both. We begin by estimating the following specification:

$$ret_{pt}^{h} = \gamma_t + \gamma_{\beta,t}\beta_p + \gamma_{IRP,t} IRP_{pt} + \eta_{pt}$$

where IRP_{pt} is “investment relative to the past” (the key variable in the Titman, Wei, and Xie study). “Investment relative to the past” is defined as I/K in the year of portfolio formation divided by the sum of I/K over the three years before portfolio formation. The results are presented in the first and second columns of Table 4 and are consistent with the findings of Titman, Wei, and Xie. For firms in general, unusually high investment (relative to the past) leads to low returns.

Next, we estimate a similar specification in which we differentiate between glamour and non-glamour firms. To be precise, we estimate the following two regressions:

$$ret_{pt}^{h} = \gamma_t + \gamma_{\beta,t}\beta_p + \gamma_{IRP,G,t} IRP_{pt}\, G_{pt} + \eta_{pt}$$

$$ret_{pt}^{h} = \gamma_t + \gamma_{\beta,t}\beta_p + \gamma_{IRP,NG,t} IRP_{pt}\, NG_{pt} + \eta_{pt}$$

where NG_{pt} is a dummy variable taking the value 1 for non-glamour portfolios and 0 for glamour portfolios. The results are reported in columns three through six of Table 4. For non-glamour firms, the results are similar to those for firms in general. However, for glamour firms, high IRP is associated with high subsequent returns. This is a surprising result and one that seems inconsistent with a corporate governance interpretation. Instead, we suspect that some firms enter the glamour portfolio because they have been hit by favourable fundamental shocks that improve their investment opportunities. These firms are acting in the interests of their shareholders when they increase their investment relative to the past. If a manager has no way of credibly communicating the full improvement in investment opportunities, the firm's stock market price will not fully respond at the time of the shock. Instead, subsequent returns will be high as the favourable fundamental shock gradually translates into strong performance and the firm's high investment proves to be justified.

The regression results in Tables 3 and 4 suggest that "overinvestment" captures very different economic behaviour for glamour firms than investment relative to the past. Conceptually, overinvestment is not the same as high investment relative to the past. In situations where there has been no favourable fundamental shock to the firm, the two measures may both capture excessive investment. But in situations where some firms have received favourable fundamental shocks, the two variables will diverge. In the data, the correlation between the IRP_{pt} and O_{pt} is positive but much less than 1 (about 0.35).

As a further check, we enter $O_{pt}G_{pt}$ and $IRP_{pt}\, G_{pt}$ in the same regression:

$$ret_{pt}^{h} = \gamma_t + \gamma_{\beta,t}\beta_p + \gamma_{O,G,t} O_{pt} G_{pt} + \gamma_{IRP,G,t} IRP_{pt}\, G_{pt} + \eta_{pt}$$

As shown in Table 5, both variables are highly significant. As in the previous regressions, "overinvestment" has a strongly negative effect on the returns of glamour firms, while IRP has a strongly positive effect. The economic significance of IRP is about the same when both "overinvestment" and IRP are included in the regression as when only IRP is included. (In both specifications, a one-standard-deviation increase in IRP increases returns by about 800-1000 basis points per year for glamour firms.) In contrast, when both variables are included in the regression, the estimated effect of "overinvestment" roughly doubles. When only "overinvestment" is included, the estimated effect of a one-standard-deviation increase in "overinvestment" is a decrease of about 500-600 basis points per year for glamour firms. When both "overinvestment" and IRP are included, the estimated effect of "overinvestment" is a decrease in returns of about 1000-1100 basis points per year for glamour firms.

The Fama-MacBeth tests provide evidence that both fundamental shocks and misvaluation shocks play a role in explaining the investment and returns behaviour of glamour firms. Some firms seem to enter the glamour portfolio as a result of favorable fundamental shocks. Some of these firms increase their investment relative to the past and enjoy high subsequent returns as the favorable fundamental shock and increased investment translate into better performance that is eventually perceived by investors. In contrast, other firms seem to enter the glamour portfolio because of misvaluation shocks. Some of these firms overinvest. When they overinvest, they act against the interests of their shareholders, and this is eventually reflected in low subsequent stock market returns.

6 The time path of the marginal product of capital

Misvaluation shocks and fundamental shocks have different implications for the time path of the marginal product of capital. As illustrated on the left-hand side of Figure 2, a favorable fundamental shock shifts out the firm's demand for capital as measured by the marginal product of capital schedule. At the existing capital stock (K_0), the marginal product of capital (MPK) rises. In the steady state, the marginal product of capital equals the user cost of capital (r in the figure). In order to restore this equality, the firm increases its capital stock, causing the marginal product of capital to decline. In the presence of adjustment costs, this process will take several years, leading to a time path of gradually declining marginal products of capital in the wake of a favorable fundamental shock. Thus, fundamental shocks have a clear implication for the time path of the marginal product of capital, as illustrated in the graph on the right hand side of Figure 2. A favorable fundamental shock leads to an increasing marginal product of capital around the time of portfolio formation and a declining marginal product of capital in subsequent years.

If a positive misvaluation shock affects the cost of equity financing, it will shift down the capital supply curve, as illustrated in Figure 3. If the user cost of capital (at least as perceived by managers) decreases, the firm will tend to increase its capital stock in an effort to equate the marginal product of capital to the new, lower cost of capital (r_1). Such increases in the capital stock cause the marginal product of capital to decline around the time of portfolio formation. As the misvaluation dissipates, the perceived cost of capital rises and the desired capital stock falls. As firms adjust their capital stock downward, the marginal product of capital rises. Thus misvaluation shocks also have a clear empirical implication for the time path of the marginal product of capital – exactly the opposite implication from fundamental shocks. A positive misvaluation shock leads to a decrease in the marginal product of capital around the time of portfolio formation and an increase in the marginal product of capital in subsequent years.

Figure 4 plots the marginal product of capital for the glamour portfolio. The time path of the marginal product of capital corresponds more closely with misvaluation shocks than fundamental shocks. The marginal product of capital falls around the time of entry into the glamour portfolio and rises in subsequent years.

A caveat is in order. The discussion above focuses on realized fundamental shocks. If a firm anticipates a fundamental shock at some point in the future, it begins increasing its capital stock at the time the news of the future fundamental shock arrives. This increase in the capital stock reduces the firm's marginal product of capital. When the fundamental shock is realized, it increases the marginal product of capital. As the firm continues to increase its capital stock, the marginal product of capital again declines. Thus, an anticipated fundamental shock would lead the marginal product of capital to fall, then rise above its initial level, then fall again. (The second fall would be avoided if the firm fully adjusted its capital stock before the anticipated shock was realized, but this seems implausible in view of the widespread evidence on the sluggishness of the capital stock in adjusting to shocks.)

The fall and subsequent rise of the marginal product of capital illustrated in Figure 4 bears some resemblance to an anticipated fundamental shock, but two features of the time path are at odds with an anticipated fundamental shock. First, the marginal product of capital should rise above its original level. There is no sign of this in Figure 4. Second, the marginal product of capital should decline when the shock is realized. Five years after entry into the portfolio, there is still no sign of this decline.

The time path of the marginal product of capital for the glamour portfolio supports the idea that misvaluation exists and affects investment. But we have strong priors that fundamental shocks must play an important role. We use two additional approaches in an effort to draw out the respective roles of fundamental and misvaluation shocks.

First, we note that there may be heterogeneity: some firms could be affected solely by fundamental shocks while other firms are substantially affected by misvaluation shocks. To assess the role of heterogeneity, we move to the individual firm level and classify the path of the marginal product of capital as corresponding to either a fundamental shock or a misvaluation shock. If the marginal product of capital rises from period -1 to period 0 and is less than or equal to the period 0 level in period +3, we classify the shock as fundamental. (Time "0" here refers to the year of portfolio formation. In Figure 4, this corresponds to the year the firm first enters the glamour portfolio.) If the marginal product of capital falls from -1 to 0 and is greater than the 0 level at +3, we classify the shock as a misvaluation shock. All other time paths are counted as "not classifiable." We then tabulate the number of fundamental and misvaluation shocks as a percentage of all the classifiable shocks. The classifiable shocks are split nearly evenly between fundamental shocks (51 %) and misvaluation shocks (49 %). This suggests that both fundamental shocks and misvaluation shocks play a role in determining the investment of glamour firms.

Second, we make use of bootstrapped matching portfolios, as we did earlier (in Section 4). The dashed line in Figure 4 shows the marginal product of capital for the bootstrapped fundamental portfolio. At time 0 (the year of portfolio formation), the marginal product of capital of the bootstrapped fundamental portfolio rises, the response to a favorable fundamental shock predicted by economic theory. Again, as economic theory predicts in the case of a realized fundamental shock, the marginal product of capital declines after the shock, gradually returning to its pre-shock level. This provides empirical evidence that confirms the predictions of economic theory regarding the effects of a fundamental shock and suggests that realized fundamental shocks play an important role for firms that are similar to those in the glamour portfolio (except for the fact that they do not have such high stock market prices). As shown by the dark line in Figure 4, the marginal product of capital for the glamour portfolio behaves in the opposite way, dropping relatively sharply at time 0 and then gradually rising back to its pre-shock level. The dotted lines in Figure 4 show the 95 % confidence interval for the bootstrapped fundamental path. At time 0, the marginal product of capital for the glamour portfolio moves well outside the confidence interval and it remains outside the confidence interval until three years after the shock. Together with the evidence on the proportion of fundamental and misvaluation shocks, the results in Figure 4 suggest that firms enter the glamour portfolio due to both fundamental and misvaluation shocks and that this is reflected in the investment behavior of the firms and resulting path of their marginal products of capital. Neither fundamental shocks nor misvaluation shocks can be ignored if we want to understand the economic behavior of these firms.

7 How large an effect does misvaluation have on investment?

The evidence in preceding sections is qualitative in nature. In this section, we provide quantitative estimates of the effect of misvaluation on investment. In order to do this, we must construct a measure of misvaluation. The measure of misvaluation is stock market Q minus marginal Q (both measured at the beginning of the period). Stock market Q is the market value of the firm's shares divided by the replacement cost of the firm's capital stock. Details are provided in the Appendix.

A number of earlier empirical studies have examined the relationship between stock market misvaluation and investment. Using aggregate US data, Blanchard, Rhee, and Summers (1993) find that stock market Q has a significant effect on investment after using a simple control for fundamentals, but they conclude that non-fundamentals have little effect on investment. Also using US aggregate data, Chirinko and Schaller (1996) find no evidence that misvaluation affects investment. In contrast, Galeotti and Schiantarelli (1994) find that non-fundamentals have a significant effect on investment, and Chirinko and Schaller (2001) obtain qualitatively similar results using aggregate Japanese data. Using firm-level US data, Morck, Shleifer, and Vishny (1990) find that movements in relative share prices are associated with statistically significant investment changes, but they conclude that misvaluation has a minor impact on investment because of low incremental R^2 s. Baker, Stein, and Wurgler (2003) find that the investment of equity-dependent firms is relatively more sensitive to stock market Q. Gilchrist, Himmelberg, and Huberman (2005) find that shocks to dispersion in analysts' forecasts (a proxy for misvaluation) affect investment. Polk and Sapienza (2006) find that various proxies for misvaluation affect investment after controlling for, among other variables, stock market Q (their proxy for fundamentals). On the other hand, Bond and Cummins (2001), after controlling for fundamentals using analysts' forecasts, find a statistically weak effect of stock market Q, and Bakke and Whited (2006), using a measurement-error-consistent estimator to separate fundamentals and non-fundamentals, find that the non-fundamental information in stock prices only influences small firms that have low levels of market mispricing and rely on equity finance.

In standard models of investment, key variables in the determination of investment are the interest rate, the relative price of investment goods, and output. In Table 6, we present a generic investment specification in which I/K is regressed on misvaluation and the lagged percentage changes in real sales, the relative price of investment goods, and the interest rate for the full sample of observations for which all the necessary data are available.[15]

The coefficient on misvaluation in the generic investment specification is positive and highly significant (with a t-statistic of 46). The coefficient estimate of 0.0032 implies that a one-standard-deviation increase in misvaluation increases I/K by 0.039 (about 37 % of the median I/K of 0.104).

Much recent research has suggested that investment is sensitive to cash flow, so in the second column of Table 6 we estimate a similar specification, this time including the ratio of cash flow to the capital stock.[16] Including cash flow in the specification has little effect on the misvaluation coefficient.

The neoclassical investment model [(Jorgenson (1963), Hall and Jorgenson (1971), Eisner and Nadiri (1968)] suggests a specification in which investment is regressed on distributed lags of the percentage change in output and the user cost of capital. In Table 7, we add misvaluation to a neoclassical investment specification. The coefficient on misvaluation is smaller than the coefficient in the generic investment specification. The coefficient estimate of 0.0027 implies that a one-standard-deviation increase in misvaluation increases I/K by 0.033 (about 32 percent of the median I/K of 0.104). The effect of misvaluation is again highly significant, with a t-statistic of 37. Including cash flow in the specification has little effect on the misvaluation coefficient.

The flexible accelerator model is similar to the neoclassical model except that the user cost of capital terms are omitted. As columns 3 and 4 of Table 7 show, misvaluation also has an economically and statistically significant effect on investment in the flexible accelerator model.

Finally, in Table 8, we estimate a Q model of investment. A conceptual advantage of the Q model is that Q, unlike the variables that appear in the generic, neoclassical, or flexible

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[15] The regression includes both fixed firm effects and time effects. The inclusion of fixed effects raises an econometric issue. Sufficiently high serial correlation of the errors may lead to biased estimates of the coefficient on the misvaluation term with fixed effects estimation. Since the residual serial correlation coefficient (about 0.25 in Tables 6-8) is approximately equal to the coefficient on the lagged dependent variable, we can use the simulation results of Judson and Owen (1999, Table 1) to evaluate coefficient bias. For T equal to five (about the average number of observations per firm in our sample), the bias in the coefficient on the regressor is less than 1 %.

[16] A leading interpretation is that cash flow enters due to finance constraints, as suggested by Fazzari, Hubbard, and Petersen (1988). This interpretation has been contested by Abel and Eberly (2003), Gomes (2001), and Kaplan and Zingales (1997, 2000). See Fazzari, Hubbard, and Petersen (2000) for a reply to the Kaplan and Zingales critique and Hubbard (1998) and Schiantarelli (1995) for surveys.

accelerator specifications, is explicitly forward-looking. A potential problem with the Q model is that stock market Q will be affected by any misvaluation in the stock market. To avoid this problem, we use marginal Q in the regression. Like stock market Q, marginal Q reflects expectations of future discount rates and the future stream of marginal products of capital.

The coefficient on misvaluation in the Q specification is close to the estimated coefficient in the generic investment specification. The estimated coefficient on misvaluation is 0.0031. This implies that a one-standard-deviation increase in misvaluation raises I/K by 0.038 – slightly more than 35 %, relative to the sample median of I/K. Again, the estimated effect of misvaluation is highly significant, with a t-statistic of 45. Specifications including and excluding cash flow are presented in the table; the coefficient estimates and t-statistics for misvaluation are similar, irrespective of whether or not cash flow is included in the specification.

The parametric estimates in Tables 6 to 8 indicate misvaluation has a quantitatively large effect on investment, with a one standard deviation increase in misvaluation leading to a 30 % or so increase in investment. The effects in Tables 6 to 8 are more striking – both statistically and economically – then those found in many previous studies. There are at least three potential explanations. First, we directly estimate the effect of misvaluation. Some previous studies have used indirect approaches such as orthogonality tests (e.g., Chirinko and Schaller (1996)) or plausible proxies for misvaluation. (See the studies discussed earlier in this section.) Second, the measures of fundamentals (marginal Q) and misvaluation (which is based on marginal Q) have strong foundations in investment theory and are constructed with careful attention to issues like discount rate variation, risk, and information sets. Sharper measures of fundamentals and misvaluation should lead to sharper empirical estimates. Third, the coverage of firms in this paper is considerably more extensive than in previous studies, including many newer (and more short-lived) firms for which misvaluation (and its effect on investment) may be relatively important.

8 Conclusion and Implications

In this paper, we introduce three new tests designed to evaluate whether investment is fully determined by fundamentals or whether stock market misvaluation plays some role. We look carefully for the effect of both fundamental and misvaluation shocks and find considerable evidence that fundamental shocks play an important role in determining the investment of glamour firms. However, none of the three new tests – overreaction, returns, and marginal product of capital – yields evidence that is consistent with the null hypothesis that investment is fully determined by fundamentals.

In Section 7, we estimate the quantitative effect of misvaluation on investment using standard investment equations. We estimate four types of investment equations – neoclassical, accelerator, Q, and a generic specification (which includes the key variables that are believed to determine investment). Consistent with the evidence in Sections 4-6, the fundamental variables (such as user cost and marginal Q) have a highly significant effect on investment. The effect of misvaluation on investment is also statistically significant. As a measure of economic significance, the estimated coefficients imply that a one-standard-deviation increase in misvaluation increases investment by about 30 % relative to the median level of investment in the sample. The estimated effect of misvaluation is robust across the four types of investment equations.

There are important policy implications of evidence that misvaluation has real consequences. Central banks may need to pay some attention to possible stock market misvaluation. Misvaluation shocks affect asset prices but may have relatively little impact on broad measures of inflation. If misvaluation shocks can lead to overinvestment and subsequent, possibly dramatic, retrenchment, central banks may need to move beyond Taylor rules (which treat inflation and unemployment as the only legitimate inputs for monetary policy rules).

Tax policy may also have a role to play if misvaluation distorts the efficient allocation of capital. Both informal accounts and the most sophisticated recent asset pricing models suggest that the prospect of capital gains plays a key role in driving misvaluation. Agents buy assets not for their intrinsic value but because they believe that they will be able to resell the asset at a still higher price to some other agent. (See, e.g., Scheinkman and Xiong (2003).) Stiglitz (2003) argues that a relatively simple way to defuse this sort of misvaluation is by increasing the capital gains tax rate and thus reducing the speculative motive for asset acquisition.[17]

Simply recognizing the possibility of misvaluation – and that misvaluation can have real consequences – might conceivably lead to more prudent fiscal decisions. Projections of tax revenues based on periods of significant misvaluation (and the associated increase in real activity) may be misleading, resulting in subsequent fiscal imbalances.

Recognizing the possibility that overvaluation may lead to overinvestment also opens up interesting research questions. How much distortion in capital allocation results from misvaluation? Are there institutional changes that would make misvaluation less likely? Are there institutional or policy changes that could decrease the misallocation of capital induced by misvaluation? One example of such an institutional change would be greater transparency, perhaps through reform of accounting procedures. Blanchard and Watson (1982) argue that misvaluation is more likely when agents do not know economic fundamentals. Another example flows from the evidence in this paper that the active financing mechanism plays an important role. This suggests that it might be helpful to reduce the conflicts of interest that tempt financial intermediaries to misleadingly promote securities.

There are also implications for how we understand the economics of growth, financial markets, and economic fluctuations. Cochrane (1994) argues that is hard to account for macroeconomic fluctuations with conventional demand and technology shocks. The evidence presented in this paper suggests that misvaluation shocks have an effect on real variables.

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[17] Schaller and Zhang (2005) analyze this more formally by introducing capital gains taxation into the Scheinkman and Xiong (2003) model and assessing the effect of changes in the capital gains tax rate on the magnitude of misvaluation.

Can misvaluation shocks help to account for aggregate fluctuations? Are there other channels through which misvaluation shocks significantly affect real variables (e.g., stock price or housing price misvaluations affecting consumption, commercial property misvaluations affecting investment)? Have misvaluation shocks played a significant role in noteworthy macroeconomic episodes, such as the late 1980s boom in Japan and the subsequent decade of stagnation or the Great Depression?

A very large question is whether overvaluation can sometimes play a positive role in fostering economic growth. Jermann and Quadrini (2003), for example, provide a model in which small firms are finance constrained.[18] Overvaluation lowers the cost of finance and relaxes finance constraints for these firms, leading to more investment and the reallocation of capital and labor to constrained firms. The result is an increase in productivity. Much earlier, in a discussion of the 1920s, Keynes (1931) expressed similar sentiments: "While some part of the investment which was going on ... was doubtless ill judged and unfruitful, there can, I think, be no doubt that the world was enormously enriched by the constructions of the quinquennium from 1925 to 1929." Can we measure the extent to which overvaluation reduces finance constraints? If we could, it might be possible to more carefully investigate possible trade-offs between the advantages of misvaluation (fostering growth) and the disadvantages (misallocation of capital, potential for a subsequent crash and resulting recession or depression).

The evidence presented in this paper suggests that these questions are relevant for developed economies with strong capital markets (such as the US). Arguably, they are even more important for developing economies with relatively weak capital markets.

[18] See also Caballero, Farhi, and Hammour (2006).

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10 Appendix

This appendix details the construction of and data sources for several of the variables, stock portfolios, and statistics analyzed in the paper: glamour and value portfolios; capital stock and investment; the user cost of capital; the real risk-adjusted market discount rate; the marginal product of capital; misvaluation, stock market Q, and marginal Q; and the empirical bootstrap procedures for the overreaction and marginal product of capital tests.

A. Glamour and Value Portfolios

We construct the glamour and value portfolios using the price/sales ratio. The price/sales ratio is Common Shares Outstanding (CompuStat item 25) times Price – Fiscal Year – Close (CompuStat item 199) divided by Net Sales (CompuStat item 12). Observations with missing or non-positive values for the price/sales ratio are dropped. Additionally, firms with a value of GPLANT less than $1 million are dropped, where GPLANT is gross property, plant, and equipment (CompuStat item 7), and the first observation for each firm is excluded. We then trim the sample, eliminating the 1 % most extreme observations in each tail for the following four variables: I/K, Sales/K, Cost/K, and real sales growth. Cost is equal to Cost of Goods Sold (CompuStat item 41) plus Selling, General, and Administrative Expense (CompuStat item 189). After trimming, the remaining observations for a given year are sorted into deciles by the price/sales ratio. The top two deciles are classified as glamour firms (i.e., firms with high stock market prices relative to sales). The bottom two deciles are classified as value firms (i.e., firms with low stock market prices relative to sales), and the remaining deciles are classified as typical firms.

B. Capital Stock and Investment

For the first observation for firm f, the capital stock is based on the net plant (NPLANT), the nominal book value of net property, plant, and equipment (CompuStat item 8). To convert this to real terms, we divide by the sector-specific price index for investment (p^I). Since book value is not adjusted for changes in the value of capital goods purchased in the past, we adjust the initial capital stock using the sector-specific ratio of nominal replacement cost to historical cost:

$$K_{f,t_0^f} = \frac{NPLANT_{f,t_0^f}}{p^I_{s,t_0^f}} \frac{K\$_{s,t_0^f}}{KHIST_{s,t_0^f}} \qquad \text{(B1)}$$

where K$ is the current-cost net stock of private fixed assets by sector (BEA, Table 3.1ES), KHIST is historical-cost net stock of private fixed assets by sector (BEA, Table 3.3ES), s is a sector index (for firm f's sector), and t_0^f is the year of the first observation for firm f.

For subsequent observations, a standard perpetual inventory method is used to construct the capital stock,

$$K_{f,t+1} = (1-\delta_{s,t})K_{f,t} + \frac{I_{f,t+1}}{p^I_{s,t+1}} \qquad \text{(B2)}$$

where δ is the depreciation rate (defined below) and I is gross investment, which is capital expenditures in the firm's financial statements (CompuStat item 128). The firm reports capital expenditures in nominal terms, so we divide by p^I to convert to real terms.[19]

In some cases, there is a data gap for a particular firm. In this case, we treat the first new observation for that firm in the same way as we would if it were the initial observation. This avoids any potential sample selection bias that would result from dropping firms with gaps in their data.

We construct sector-specific, time-varying depreciation rates using data from the BEA. Specifically,

$$\delta_{s,t} = \frac{D\$_{s,1996} DQUANT_{s,t}}{K\$_{s,1996} KQUANT_{s,t}} \qquad \text{(B3)}$$

where D$ is current-cost depreciation of private fixed assets by sector (BEA, Table 3.4ES), DQUANT is the chain-type quantity index of depreciation of private fixed assets by sector (BEA, Table 3.5ES), K$ is the current cost net stock of private fixed assets by sector (as defined above), and KQUANT is the chain-type quantity index of the net stock of private fixed assets by sector (BEA, Table 3.2ES).

We construct the sector-specific price index for investment using BEA data:

$$p^I_{s,t} = \frac{100(I\$_{s,t} / I\$_{s,1996})}{IQUANT_{s,t}} \qquad \text{(B4)}$$

where I$ is historical-cost investment in private fixed assets by sector (BEA, Table 3.7ES) and IQUANT is the chain-type quantity index of investment in private fixed assets by sector (BEA, Table 3.8ES).

The variables obtained from the BEA for constructing depreciation rates and price indices for investment are calculated for 2002, 2003, and 2004 by extending the corresponding 1950 to 2001 data series, which are reported with a somewhat different classification scheme. (The data for 1950 to 2001 are on a SIC basis, while the data for 2002 to 2004 are on a NAICS basis.) This extension uses BEA data for 2002 through 2004 to calculate the percentage

[19] The BEA tables beginning with a 3 cited in this Appendix contain data for private fixed assets, equal to the sum of nonresidential fixed assets (relevant for this study) and residential fixed assets. Residential fixed assets only enter the Real Estate and Farm industries. Since we exclude firms in the Real Estate industry and the number of firms in the Farm industry is tiny, data drawn from the BEA private fixed asset tables (those beginning with a 3) for this study pertain to nonresidential fixed assets.

change in a given variable between two years and then multiplies by the previous observation in the existing series to get the new value. For example, for 2002, the variable K$ is calculated for each industry as:

$$K\$_{s,2002} = K\$_{s,2001} \left(\frac{K\$^{MR}_{s,2002}}{K\$^{MR}_{s,2001}} \right) \quad \text{(B5)}$$

where the superscript MR denotes the more recent version of the variable. The validity of this procedure was evaluated by comparing values estimated by the procedure represented in equation (B5) for 2001 with data on the prior classification for 2001. The relations among the SIC codes, BEA SIC industries, and BEA NAICS industries are detailed in the following correspondence table,

SIC Codes	BEA SIC Industries Agriculture, forestry, & fishing	BEA NAICS Industries Agriculture, forestry, fishing, & hunting
0100-0799	Farms	Farms
0800-0999	Ag. services, forestry, & fishing	Forestry, fishing, & related activities
	Mining	**Mining**
1000-1199	Metal mining	Mining (except oil & gas) + Support activities for mining[1]
1200-1299	Coal mining	Mining (except oil & gas) + Support activities for mining[1]
1300-1399	Oil & gas extraction	Oil & gas extraction
1400-1499	Nonmetallic minerals, except Fuels	Mining (except oil & gas) + Support activities for mining[1]
1500-1799	**Construction**	**Construction**
1800-1999	No Match To BEA SIC Industries	
	Manufacturing	
	Durable goods	
2400-2499	Lumber & wood products	Wood products
2500-2599	Furniture & fixtures	Furniture & related products
3200-3299	Stone, clay, & glass products	Nonmetallic mineral products
3300-3399	Primary metals industries	Primary metals
3400-3499	Fabricated metal products	Fabricated metal products
3500-3599	Industrial mach. & equipment	Machinery
3600-3699	Electronic & other electrical Equipment	Electrical equipment, appliances, & Components
3711, 3714	Motor vehicles and equipment	Motor vehicles, bodies & trailers, & Parts
3700-3799[2]	Other transportation equipment	Other transportation equipment

3800-3899	Instruments & related products	Computer & electronic products
3900-3999	Miscellaneous mfg. industries	Miscellaneous manufacturing
	Nondurable goods	
2000-2099	Food & kindered products	Food & beverage & tobacco prods.
2100-2199	Tobacco products	Food & beverage & tobacco prods.
2200-2299	Textile mill products	Textile mills & textile prod. mills
2300-2399	Apparel & other textile prods.	Apparel & leather & allied prods.
2600-2699	Paper & allied products	Paper products
2700-2799	Printing & publishing	Printing & related support activities
2800-2899	Chemicals & allied products	Chemical products
2900-2999	Petroleum & coal products	Petroleum & coal products
3000-3099	Rubber & misc. plastic prods.	Plastics & rubber products
3100-3199	Leather & leather products	Apparel & leather & allied prods.
	Transportation & public utils.	
4300-4399	No Match To BEA SIC Industries	
	Transportation	
4000-4099	Railroad transportation	Railroad transportation
4100-4199	Local & interurban passenger Transit	Transit & ground passenger Transportation
4200-4299	Trucking & warehousing	Truck transportation + Warehousing & storage[3]
4400-4499	Water transportation	Water transportation
4500-4599	Transportation by air	Air transportation
4600-4699	Pipelines, except natural gas	Pipeline transportation
4700-4799	Transportation services	Other transportation & support Activities
4800-4899	**Communications**	Publishing industries (including software) + Broadcasting & telecommunications + Information & data processing services
4900-4999	**Electric, gas & sanitary services**	**Utilities**
5000-5199	**Wholesale trade**	**Wholesale trade**
5200-5999	**Retail trade**	**Retail trade**
6000-6799	**Finance, insurance, & real estate**	**Finance & insurance + Real estate & rental & leasing**
6800-6999	No Match To BEA SIC Industries	
	Services	
7000-7099	Hotels & other lodgings	Accommodation
7100-7199	No Match To BEA SIC Industries	

7200-7299	Personal services	**Other services, except government**
7300-7399	Business services	Computer systems design & related services and Miscellaneous professional, scientific, & technical services, + **Management of companies & enterprises + Administrative & waste management services**[4]
7400-7499	No Match To BEA SIC Industries	
7500-7599	Auto repair, services & parking	**Other services, except government**
7600-7699	Miscellaneous repair services	**Other services, except government**
7700-7799	No Match To BEA SIC Industries	
7800-7899	Motion pictures	Motion picture & sound recording Industries
7900-7999	Amusement & recreational svcs.	**Arts, entertainment, & recreation**
	Other services	
8000-8099	Health services	**Health care & social assistance**
8100-8199	Legal services	Legal services
8200-8299	Educational services	Educational services
8300-8999	Other	**Other services, except government**

Notes to the correspondence table:

1. The indexes for KQUANT (BEA, Table 3.2ES), DQUANT (BEA, Table 3.5ES), and IQUANT (BEA, Table 3.8ES) can not be added together across NAICS categories. The components are combined by taking a weighted-average of the growth rates of the NAICS indexes. The weights used to allocate Mining (except oil & gas) + Support activities for mining are (66 %, 34 %) for KQUANT, (59 %, 41 %) for DQUANT, and (57 %, 43 %) for IQUANT.
2. Excludes industries 3711 and 3714.
3. See note 1. The weights used to allocate Truck transportation + Warehousing & storage are (73 %, 27 %) for KQUANT, (87 %, 13 %) for DQUANT, and (82 %, 18 %) for IQUANT.
4. See note 1. The weights used to allocate Computer systems design & related services and Miscellaneous professional, scientific, & technical services (the indexes for Professional, scientific, and technical services are used for these computations), + Management of companies & enterprises + Administrative & waste management services are (34 %, 42 %, 24 %) for KQUANT, (54 %, 25 %, 21 %) for DQUANT, and (55 %, 24 %, 21 %) for IQUANT.

C. The User Cost of Capital

The user cost of capital is calculated as follows

$$C_{f,t} = (r_{f,t} + \delta_{s,t})\left(\frac{1 - z_t - u_t}{1 - \tau_t}\right)\frac{p^I_{s,t}}{p^Y_{s,t}} \qquad \text{(C1)}$$

where r is the real, risk-adjusted interest rate, z is the present value of depreciation allowances, u is the investment tax credit rate, τ is the corporate tax rate, p^I is the price of investment goods, and p^Y is the price of output. *C* is expressed as an annual rate, so *r* and δ are both expressed as annual rates. Where variables are available at a monthly or quarterly frequency, we take the average for the calendar year. The corporate tax rate is the U.S. federal tax rate on corporate income. The present values of depreciation allowances for non-residential equipment and structures were provided by Dale Jorgenson. (The data provided by Dale Jorgenson end in 2001; for 2002-04, we use 2001 values.) To calculate z, we took the weighted sum of Jorgenson's z's for equipment and structures, where the weights are the share of equipment investment and the share of structures investment (for a given year) in nominal gross private nonresidential investment in fixed assets from the Bureau of Economic Analysis (from table 1IHI, where equipment investment is referred to as equipment and software). Because the investment tax credit applies only to equipment, *u*=0 for structures, we multiply the statutory ITC rate for each year by the ratio of equipment investment to the sum of structures and equipment investment for that year. The corporate tax rates were provided directly by the Treasury Department, and investment tax credit rates are drawn from Pechman (1987, p.160-161). For the years 1980 to 2001, the sector-specific price index for output, p^Y, is the implicit price deflator for Gross Domestic Product by industry produced by the BEA, normalized to 1 in 1996. For 2002 through 2004, the sector-specific price index is recursively extended forward by:

$$p^Y_{s,t+1} = p^Y_{s,t}\left(\frac{p^A_{t+1}}{p^A_t}\right) \quad \text{(C2)}$$

where p^A is the aggregate non-farm business price index for gross value added (BEA Table 1.3.4).

In Table 9, the cost of capital is divided into two components – the relative price of investment goods (including tax adjustments), defined as

$$(1 - z_t - u_t)\frac{p^I_{s,t}}{p^Y_{s,t}} \quad \text{(C3)}$$

and the real, risk-adjusted interest rate (including depreciation and the adjustment for the corporate income tax rate),

$$\left(\frac{r_{f,t} + \delta_{s,t}}{1 - \tau_t}\right) \quad \text{(C4)}$$

D. The Real Risk-Adjusted Market Discount Rate

The real, risk-adjusted market discount rate is defined as follows,

$$r_{f,t} = ((1 + r^{NOM}_{f,t}) / (1 + \pi^e_t)) - 1.0. \quad \text{(D1)}$$

The equity risk premium is calculated using CAPM. The components of $r_{f,t}$ are defined and constructed as follows,

$r_{f,t}^{NOM}$ = Nominal, short-term, risk-adjusted cost of capital

= $\lambda_s (1-\tau_t)\ r_t^{NOM,DEBT} + (1-\lambda_s)\ r_{s,t}^{NOM,EQUITY}$.

$r_t^{NOM,DEBT}$ = Nominal corporate bond rate (Moody's Seasoned Baa Corporate Bond Yield)

$r_{s,t}^{NOM,EQUITY}$ = Nominal, short-term, risk-adjusted cost of equity capital for firmsin sector s.

= $r_t^{NOM,F} + \sigma_s$.

$r_t^{NOM,F}$ = Nominal, one-year, risk-free rate (One-Year Treasury Constant Maturity Rate)

$\pi_{s,t}^{e}$ = Sector-specific capital goods price inflation rate from t to t+1. Sector-specific data was not yet available for 2005 at the time of data construction, so $\pi_{s,t}^{e}$ for 2003 was also used for 2004.

σ_s = Equity risk premium.

τ_t = Marginal rate of corporate income taxation.

λ_s = Sector-specific leverage ratio calculated as the mean of book debt for the sector divided by the mean of (book debt + book equity) for the sector.

Under the CAPM,

$$\sigma_s = \beta_s (\mu^{EQUITY} - \mu^{F}), \qquad \text{(D2)}$$

where

β_s = CAPM β for sector s

μ^{EQUITY} = Total return on equities from 1950-2004. The source is the value-weighted CRSP index (including dividends).

μ^{F} = Total return on risk-free Treasury bills from 1950-2004. The source is the FRED database, specifically the series for 1-Year Treasury Constant Maturity Rate.

E. The Marginal Product of Capital

We assume that production possibilities are described by the following CES technology that depends on capital ($K_{i,t}$), labor ($L_{i,t}$), and labor-augmenting technical progress ($A_{i,t}$) for firm i at time t,

$$Y_{i,t} = Y[K_{i,t}, L_{i,t}, A_{i,t}] = \left\{ \omega K_{i,t}^{[(\sigma-1)/\sigma]} + (1-\omega)(A_{i,t}L_{i,t})^{[(\sigma-1)/\sigma]} \right\}^{[((1+\eta)\sigma)/(\sigma-1)]} \quad \text{(E1)}$$

where ω is the share parameter, σ is the elasticity of substitution between labor and capital (this σ differs from the one defined in Section D as the equity risk premium), and η represents deviations from constant returns to scale. In order to allow for the effects of imperfect competition in the product market, we embed equation (E1) into the following revenue function,

$$REV[K_{i,t}, A_{i,t}L_{i,t}] = p[Y[K_{i,t}, A_{i,t}L_{i,t}]]\ Y[K_{i,t}, A_{i,t}L_{i,t}], \quad \text{(E2)}$$

and assume that the inverse demand schedule, p[.], has a constant elasticity,

$$\mu \equiv -(p'[Y_{i,t}]Y_{i,t} / p[Y_{i,t}] \qquad 1 > \mu \geq 0, \quad \text{(E3)}$$

Differentiating equation (E3) with respect to capital, we obtain the following expression for the value marginal product of capital, which, with some violation of convention, we simply refer to as the marginal product of capital (MPK),

$$MPK[Y_{i,t}, K_{i,t} : \sigma, \omega, \eta, \mu] \equiv (\partial REV / \partial K) / p, \quad \text{(E4)}$$

$$= \Gamma\ [Y_{i,t} / K_{i,t}]^{[1/\sigma]}\ Y_{i,t}^{\zeta}, \quad \text{(E5)}$$

$$\Gamma \equiv (1-\mu)(1+\eta)\,\omega, \quad \text{(E6)}$$

$$\zeta \equiv [(\eta(\sigma-1))/(1+\eta)\sigma]. \quad \text{(E7)}$$

As shown in equation (E5), the MPK depends on three separate elements:

i) three parameters combined in Γ representing product market competition (μ), returns to scale (1+η), and the factor share of capital (ω);

ii) the output/capital ratio raised to the inverse of the elasticity of substitution (σ);

iii) output raised to a power determined by a parameter (ζ) that reflects non-constant returns to scale and the substitution elasticity. Note that ζ = 0 if returns to scale are constant or the substitution elasticity is unity.

The frequently used Cobb-Douglas production function is a special case of equation (E5). The Cobb-Douglas is defined by an elasticity of substitution of unity (*σ* = 1) and constant returns to scale (η = 0). With either of these restrictions, the output term (elements iii)) disappears, and the output/capital ratio is no longer raised to a power. If we further assume that market power is absent in the product market (μ = 0), then the MPK for the Cobb-Douglas production function is written as follows,

$$MPK[Y_{i,t}, K_{i,t} : \sigma = 1, \omega, \eta = 0, \mu = 0] = \omega \, [Y_{i,t} / K_{i,t}] . \tag{E8}$$

In this case, the MPK is proportional to the output/capital ratio with the constant of proportionality equal to the capital share parameter.

Equation (E5) assumes that three parameters – μ, η, and ω – are constant across all firms. This assumption seems restrictive. We allow these parameters to vary by sector and represent their product by Γ_j, where *j* denotes the sector in which firm *i* operates. Equation (E5) can be rewritten in terms of Γ_j, the output/capital ratio raised to [1/σ], and an additional output term that differs from unity whenever returns to scale are not constant ($\eta_j \neq 0$) or the elasticity of substitution differs from unity ($\sigma \neq 1$),

$$MPK[Y_{i,t}, K_{i,t} : \sigma, \omega_j, \eta_j, \mu_j] = \Gamma_j \, [Y_{i,t} / K_{i,t}]^{[1/\sigma]} \, Y_{i,t}^{\zeta_j} , \tag{E9a}$$

$$\Gamma_j \equiv (1 - \mu_j)(1 + \eta_j) \omega_j , \tag{E9b}$$

$$\zeta_j \equiv [(\eta_j (\sigma - 1)) / ((1 + \eta_j) \sigma)] . \tag{E9c}$$

In order to make equation (E9a) operational, two decisions need to be made concerning the unknown parameters. First, we will assume that σ equals 1.0. Second, following Gilchrist and Himmelberg (1998, Section 2.1), we estimate Γ_j by utilizing the long-run relation between MPK and the user cost of capital ($UC_{i,t}$) for all firms in sector *j*. Specifically, we compute Γ_j for all firms in sector *j* (*i ε I(j)*) for all available time periods *t* (*t ε T(j)*) as follows,

$$\sum_{i \in I(j)} \sum_{t \in T(j)} MPK_{i,t} = \sum_{i \in I(j)} \sum_{t \in T(j)} UC_{i,t} , \tag{E10a}$$

$$\sum_{i \in I(j)} \sum_{t \in T(j)} \Gamma_j[\sigma, \eta_j] \, [Y_{i,t} / K_{i,t}]^{[1/\sigma]} = \sum_{i \in I(j)} \sum_{t \in T(j)} UC_{i,t} , \tag{E10b}$$

$$\Gamma_j[\sigma, \eta_j] = \left\{ \frac{1}{N_{UC}} \sum_{i \in I(j)} \sum_{t \in T(j)} UC_{i,t} \right\} \Big/ \left\{ \frac{1}{N_{YK}} \sum_{i \in I(j)} \sum_{t \in T(j)} [Y_{i,t} / K_{i,t}]^{[1/\sigma]} \right\} \tag{E10c}$$

where N_{UC} is the number of nonmissing observations over which the sum in the numerator of the right hand side of (E10c) is taken and N_{YK} is the number of nonmissing observations over which the sum in the denominator of the right hand side of (E10c) is taken. The MPK for firm i at time t equals equation (E9a) with the estimate of Γ_j given in equation (E10c).

F. Misvaluation, Stock Market Q, and Marginal Q

Misvaluation (MV) is defined as the difference between stock market Q (Q^{SM}) and marginal Q (Q^{M}).

Stock market Q is defined as the market value of common equity divided by the replacement cost of the capital stock. Common equity is defined as Common Shares Outstanding (CompuStat item 25) times Price – Fiscal Year – Close (CompuStat item 199). The replacement cost of capital is K, as described above. The nominal value of common equity is converted to real terms by dividing by p^{Y}.

Define λ_t as the expected present value of future marginal products of capital,

$$\lambda_t = E_{t-1} \ \Sigma_{j=0}^{\infty} \ \Pi_{s=0}^{j-1} \ R_{t+s} \ \left(F_{K,t+j} - C_{K,t+j}\right) \quad \text{(F1)}$$

where E_{t-1} is the expectations operator, conditional on the information set in period t-1, R is the discount factor, F_K is the marginal product of capital, narrowly defined, and C_K is the derivative of the adjustment cost function with respect to the capital stock. Marginal Q is defined in the empirical work as $Q_t^M = \lambda_t - p_t^I / p_t^Y$, where p^I is the price of investment goods and p^Y is the price of output. (For expositional simplicity, we focus on λ in the equations below.) Define the marginal product of capital (broadly defined to include the marginal reduction in adjustment costs from an additional unit of capital) as,

$$M_t \equiv \left(F_{K,t} - C_{K,t}\right) \quad \text{(F2)}$$

We can then define the ex post present value of future marginal products of capital as:

$$\tilde{\lambda}_t \equiv \Sigma_{j=0}^{\infty} \left(\ \Pi_{s=0}^{j-1} R_{t+s} \right) \ M_{t+j} \quad \text{(F3)}$$

and the *ex ante* present value of future marginal products of capital as:

$$\lambda_t = E_{t-1}\left[\tilde{\lambda}_t\right] \quad \text{(F4)}$$

Note that λ is the sum of products of random variables, but we can simplify by linearizing $\tilde{\lambda}$ around $R_{t+s} = \overline{R}$ and $M_{t+s} = \overline{M}$, where $\overline{R}$ and $\overline{M}$ are the respective sample means.

$$\tilde{\lambda}_t \approx \overline{M}(1 - \overline{R})^{-1} + \overline{M}(1 - \overline{R})^{-1} \sum_{j=0}^{\infty} \overline{R}^{j}(R_{t+j} - \overline{R}) + \sum_{j=0}^{\infty} \overline{R}^{j}(M_{t+j} - \overline{M}) \quad \text{(F5)}$$

We can then find observable counterparts to R and M by using linear combinations of economic variables.

$$M_t = a' Z_t \quad \text{(F6)}$$

$$R_t = b' Z_t \quad \text{(F7)}$$

Suppose Z has an auto-regressive structure. For specificity, consider the example where there are two variables in Z and where all the variables in Z are measured as deviations from their sample means,

$$\begin{bmatrix} Z_{1,t} \\ Z_{2,t} \end{bmatrix} = \begin{bmatrix} a(L) & b(L) \\ c(L) & d(L) \end{bmatrix} \begin{bmatrix} Z_{1,t-1} \\ Z_{2,t-1} \end{bmatrix} + \begin{bmatrix} v_{1,t} \\ v_{2,t} \end{bmatrix}. \quad \text{(F8)}$$

Stacking the vectors defined in (F8),

$$\begin{bmatrix} Z_{1,t} \\ . \\ . \\ Z_{1,t-\ell+1} \\ Z_{2,t} \\ . \\ . \\ Z_{2,t-\ell+1} \end{bmatrix} = \begin{bmatrix} a_1 & . & . & . & a_\ell & b_1 & . & . & . & b_\ell \\ 1 & 0 & . & . & 0 & 0 & . & . & . & 0 \\ : & & & & & : & & & & \\ 0 & . & 0 & 1 & 0 & 0 & . & . & . & 0 \\ c_1 & . & . & . & c_\ell & d_1 & . & . & . & d_\ell \\ 0 & . & . & . & 0 & 1 & . & . & . & 0 \\ : & & & & & : & & & & \\ 0 & . & . & . & 0 & 0 & . & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} Z_{1,t-1} \\ . \\ . \\ Z_{1,t-\ell} \\ Z_{2,t-1} \\ . \\ . \\ Z_{2,t-\ell} \end{bmatrix} + \begin{bmatrix} v_{1t} \\ 0 \\ . \\ 0 \\ v_{2t} \\ 0 \\ . \\ 0 \end{bmatrix} \quad \text{(F9)}$$

In the empirical work, we set ℓ =2. Equation (F9) can be re-written in companion matrix form,

$$\tilde{Z}_t = A\tilde{Z}_{t-1} + \tilde{v}_t . \quad \text{(F10)}$$

Under the assumption of rational expectations, the expectations can be represented as linear projections on variables in the information set,

$$E_{t-1}\left[M_{t+j}\right] = aA^{j+1}\tilde{Z}_{t-1} , \quad \text{(F11)}$$

$$E_{t-1}\left[R_{t+j}\right] = bA^{j+1}\tilde{Z}_{t-1} . \quad \text{(F12)}$$

The infinite sums that constitute marginal Q can be calculated as follows, using the last term in the expression for marginal Q (equation (F5)) as an example:

$$E_{t-1}\,\Sigma_{j=0}^{\infty}\,\overline{R}^{j}\,M_{t+j} = \Sigma_{j=0}^{\infty}\,\overline{R}^{j}\,aA^{j+1}\,\tilde{Z}_{t-1} = a(I - \overline{R}A)^{-1}A\,\tilde{Z}_{t-1} \qquad \text{(F13)}$$

Evaluating all of the terms in (F5), we obtain the following equation for λ_t :

$$\lambda_t = \overline{M}(1-\overline{R})^{-1} + \overline{M}(1-\overline{R})^{-1}\overline{R}\; b\left(I-\overline{R}A\right)^{-1} A\tilde{Z}_{t-1} + \overline{R}a\left(I-\overline{R}A\right)^{-1} A\tilde{Z}_{t-1} \qquad \text{(F14)}$$

In our empirical work, the variables that enter Z are R, Sales/K, Cost/K, p^I / p^Y, and I/K. R is a natural candidate. Under a variety of assumptions (including constant and non-constant returns to scale, fully competitive markets, and imperfect competition, Sales/K and Cost/K are components of the marginal product of capital. We follow Abel and Blanchard in including them as separate variables. The relative price ratio p^I / p^Y is a component of Q. Finally, under some assumptions, I/K is a useful forecasting variable; if investment is determined by fundamentals, then I/K reflects the expected present value of future marginal products of capital.[20] With the variables in Z in the order listed above, we can define the vectors a and b as follows,

$$a = [0 \;\; 1 \;\; -1 \;\; 0 \;\; 0], \qquad \text{(F15)}$$

$$b = [1 \;\; 0 \;\; 0 \;\; 0 \;\; 0]. \qquad \text{(F16)}$$

G. Empirical Bootstrap for the Overreaction Test

The procedure described in this paragraph is carried out for each year. First, divide all firms into one-digit industries and size quintiles (by industry).[21] Calculate the number of glamour firms in each industry-size cell. Define the complement of the glamour portfolio (i.e., all firms not in the glamour portfolio). From each industry-size cell, draw a random sample of firms from the complement of the glamour portfolio, with replacement, where the sample size is equal to the number of glamour firms in the cell. (We draw from the complement of the glamour portfolio to strip out potential misvaluation.) Denote the resulting portfolio as the simulated glamour portfolio. Calculate the impulse response of investment to a sales shock for the simulated glamour portfolio for horizons 1 through 40. Repeat the entire procedure 1,000 times.

The resulting distribution of the impulse response functions is the bootstrapped empirical distribution. The 95 % confidence band that is shown in Figure 1 is formed by plotting the 97.5 % and 2.5 % points of the empirical distribution for each horizon.

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[20] This follows directly in models based on convex adjustment costs. In models with fixed costs, irreversibility, or other nonconvexities, investment will still depend on the expected present value of future marginal products of capital over some range. See Abel and Eberly (1994).

[21] Industry 0 (agriculture and forestry) is quite small, so we combine it with industry 1 (mining and construction), both here and in the empirical bootstrap for the marginal product of capital.

H. Empirical Bootstrap for the Marginal Product of Capital

The procedure described in this paragraph is carried out for each year. First, divide all firms into one-digit industries and size quintiles (by industry). Calculate the number of glamour first entry firms in each industry-size cell. We define the glamour first entry portfolio for each year as the subset of the glamour portfolio that was not a part of the glamour portfolio in the previous year. Define the complement of the glamour portfolio (i.e., all firms not in the glamour portfolio). From each industry-size cell, draw a random sample of firms from the complement of the glamour portfolio, with replacement, where the sample size is equal to the number of glamour first entry firms in the cell. Denote the resulting portfolio as the simulated glamour first entry portfolio. Calculate the mean marginal product of capital for the simulated glamour first entry portfolio for horizons -3 through 5. Repeat the entire procedure 1,000 times.

The resulting median marginal product of capital for horizons -3 through 5 is the basis for the bootstrapped fundamental impulse response function. (In plotting Figure 4, we normalize so that the glamour and bootstrapped fundamental impulse response functions coincide at t-1.) The 95 % confidence band that is shown in Figure 4 is formed by plotting the 97.5 % and 2.5 % points of the resulting empirical distribution for each horizon.

11 Tables and Figures

Table 1
Summary Statistics

Panel A: Statistics for the Full Sample

	N	Mean	25 %	50 %	75 %	Std Deviation	Skew-ness	Kurtosis
I	97713	143.830	1.447	8.442	52.416	736.694	23.091	1196.679
K	97713	5335.914	14.363	76.900	584.853	31250.133	20.146	769.693
I/K	97713	0.161	0.042	0.104	0.203	0.191	2.789	10.583
SG	97713	0.118	-0.048	0.056	0.201	0.348	2.872	15.177
Sales/K	97713	3.903	0.808	2.308	4.868	5.063	2.930	11.363
Cost/K	97713	3.644	0.754	2.155	4.544	4.758	2.972	11.789
MPK	97713	0.167	0.054	0.105	0.198	0.206	5.127	63.312
NSI	95826	20.910	0.000	0.224	4.034	160.839	41.249	2966.890
Returns	63363	0.165	-0.236	0.052	0.365	0.831	9.023	210.090

I is investment in millions of 1996 dollars. K is the replacement value of the capital stock in 1996 dollars. SG is real sales growth. Sales/K is the ratio of real sales to K. Cost/K is the ratio of the real cost of goods sold to K. MPK is the marginal product of capital. NSI is new share issues, measured as the proceeds from equity issues in millions of 1996 dollars. Returns are nominal annual stock market returns. See the Appendix for details of variable definitions.

Panel B: New Share Issues by Portfolio

	Glamour	Value	Difference	Test Statistic [p-value]
Median	0.7534	0.0000	0.7534	91.15 [0.000]
Aggregated (standard deviation)	0.5556 (0.3460)	0.1194 (0.0544)	0.4362 (0.2916)	6.23 [0.000]

Scaled by investment spending. The test statistic for the difference in medians is a nonparametric test based on analysis of variance on ranks. Aggregated new share issues equal (sum of new share issues)/(sum of investment spending), where the sums are taken over a given portfolio in a particular year. The t-test statistics for the aggregated variable is therefore based on 25 annual observations for each portfolio (1980-2004). See the Appendix for details of variable definitions and portfolio construction.

Table 2
Comparing Investment/Capital Ratios

Definition of Benchmark Portfolios	N	Mean of I/K Ratio		Difference (Glamour vs. Benchmark)	Test Statistic [p-value]
		Glamour Portfolio	Benchmark Portfolio		
Value	14961	0.299	0.121	0.178	66.85 [0.000]
Comparable Firms	14961	0.299	0.205	0.094	36.32 [0.000]
Marginal Q	5629	0.272	0.166	0.106	29.01 [0.000]

The table presents mean investment/capital (I/K) ratios. N is the number of glamour observations (smaller for the marginal Q benchmark because the data are not available to calculate marginal Q for all glamour observations). The test statistic is a t-test of the equality of the mean of I/K for the glamour and benchmark portfolios. See the Appendix for details of variable definitions and portfolio construction.

Table 3
Fama-MacBeth Tests with "Overinvestment"

Horizon	$\gamma_{O,G}$ (standard error)	Mean effect on returns of a one std. dev. increase in "overinvestment"
2 year	-0.2908 (0.1067)	-0.0474
3 year	-0.2827 (0.1082)	-0.0475
4 year	-0.3641 (0.1152)	-0.0598
5 year	-0.3722 (0.1316)	-0.0613

The parameter $\gamma_{O,G}$ is the coefficient on "overinvestment" for glamour firms in a Fama-MacBeth regression of cumulative excess returns on the CAPM β and the product of "overinvestment" (in the period of portfolio formation) and a dummy variable taking the value of 1 for glamour portfolios. The horizon is defined such that the two-year horizon, e.g., refers to returns from the beginning of the first year after portfolio formation to the end of the second year after portfolio formation. See the section entitled "Returns" and the Data Appendix for details of the regression specification, variable definitions, and portfolio construction.

Table 4
Fama-MacBeth Tests with IRP

Horizon	γ_{IRP} (std. error)	Mean effect on returns of a one std. dev. increase in IRP	$\gamma_{IRP,NG}$ (std. error)	Mean effect on returns of a one std. dev. increase in IRP	$\gamma_{IRP,G}$ (std. error)	Mean effect on returns of a one std. dev. increase in IRP
2 year	-0.7188 (0.1462)	-0.1032	-0.5000 (0.1195)	-0.0724	0.5005 (0.1333)	0.0760
3 year	-0.6946 (0.1489)	-0.1020	-0.5183 (0.1226)	-0.0750	0.5151 (0.1344)	0.0845
4 year	-0.7245 (0.1555)	-0.1056	-0.5297 (0.1164)	-0.0805	0.5698 (0.1569)	0.0803
5 year	-0.7260 (0.1254)	-0.1143	-0.5154 (0.1044)	-0.0861	0.5449 (0.1593)	0.0845

The parameter γ_{IRP} is the coefficient on IRP (investment relative to the past) in a Fama-MacBeth regression of cumulative excess returns on the CAPM β and IRP. The first column reports this coefficient for the full sample, the third column for glamour portfolios, and the fifth column for non-glamour portfolios. The horizon is defined such that the two-year horizon, e.g., refers to returns from the beginning of the first year after portfolio formation to the end of the second year after portfolio formation. See the section entitled "Returns" and the Data Appendix for details of the regression specification, variable definitions, and portfolio construction.

Table 5
Fama-MacBeth Tests with "Overinvestment" and IRP

Horizon	$\gamma_{O,G}$ (std. error)	Mean effect on returns of a one std. dev. increase in "overinvestment"	$\gamma_{IRP,G}$ (std. error)	Mean effect on returns of a one std. dev. increase in IRP
2 year	-0.6005 (0.1949)	-0.1074	0.5695 (0.1557)	0.0895
3 year	-0.6925 (0.1977)	-0.1270	0.6036 (0.1621)	0.1048
4 year	-0.6643 (0.1779)	-0.1103	0.6108 (0.1648)	0.0876
5 year	-0.8020 (0.2309)	-0.1295	0.6110 (0.1755)	0.1021

The parameter $\gamma_{O,G}$ is the coefficient on "overinvestment" for glamour firms and the parameter $\gamma_{IRP,G}$ is the coefficient on IRP (investment relative to the past) for glamour firms in a Fama-MacBeth regression of cumulative excess returns on the CAPM β and these two variables. The horizon is defined such that the two-year horizon, e.g., refers to returns from the beginning of the first year after portfolio formation to the end of the second year after portfolio formation. See the section entitled "Returns" and the Data Appendix for details of the regression specification, variable definitions, and portfolio construction.

Table 6

Quantitative Estimates of the Effect of Misvaluation on Investment
Generic Investment Specification

	(1)	(2)
Misvaluation	0.0032267 (0.0000696) [46.34]	0.0032630 (0.0000696) [46.89]
Output	0.1057030 (0.0018990) [55.66]	0.1047200 (0.0018967) [55.21]
Relative Price of Investment Goods	-0.1177810 (0.0058704) [-20.06]	-0.1175470 (0.0058573) [-20.07]
Interest rate	-0.0015221 (0.0010937) [-1.39]	-0.0014470 (0.0010912) [-1.33]
Cash Flow		0.0101090 (0.0005758) [17.56]
Number of Observations Number of Firms R^2	67837 9075 0.4964	67756 9070 0.4990

Each cell shows the point estimate, standard error (in parenthesis), and t statistic (in brackets). Output, the relative price of investment goods, and the interest rate enter as lagged percentage changes. Cash flow is the ratio of cash flow to the capital stock. Misvaluation is the difference between stock market Q and marginal Q (both beginning of period), as defined in the text. The regressions include both fixed effects and year effects. See the Appendix for details of variable definitions.

Table 7

Quantitative Estimates of the Effect of Misvaluation on Investment
Neoclassical and Accelerator Specifications

	Neoclassical		Accelerator	
	(1)	**(2)**	**(3)**	**(4)**
Misvaluation	0.0026910 (0.0000734) [36.69]	0.0027009 (0.0000735) [36.77]	0.0027042 (0.0000735) [36.80]	0.0027142 (0.0000736) [36.88]
Output $_t$	0.1119690 (0.0019341) [57.89]	0.1098170 (0.0019518) [56.26]	0.1105660 (0.0019303) [57.28]	0.1083930 (0.0019479) [55.65]
Output $_{t-1}$	0.0906170 (0.0018870) [48.02]	0.0903160 (0.0018878) [47.84]	0.0892470 (0.0018836) [47.38]	0.0889500 (0.0018844) [47.20]
Output $_{t-2}$	0.0552560 (0.0017941) [30.80]	0.0552190 (0.0017958) [30.75]	0.0539810 (0.0017917) [30.13]	0.0539470 (0.0017933) [30.08]
Cost of Capital $_t$	-0.0120950 (0.0011175) [-10.82]	-0.0120150 (0.0011173) [-10.75]		
Cost of Capital $_{t-1}$	-0.0126630 (0.0010992) [-11.52]	-0.0126210 (0.0010994) [-11.48]		
Cost of Capital $_{t-2}$	-0.0093059 (0.0010584) [-8.79]	-0.0092945 (0.0010582) [-8.78]		
Cash Flow		0.0042408 (0.0005727) [7.40]		0.0042984 (0.0005738) [7.49]
Number of Observations Number of Firms R^2	60473 8053 0.5263	60404 8048 0.5264	60473 8053 0.5245	60404 8048 0.5245

Each cell shows the point estimate, standard error (in parenthesis), and t statistic (in brackets). Output and the cost of capital enter as percentage changes. Cash flow is the ratio of cash flow to the capital stock. Misvaluation is the difference between stock market Q and marginal Q (both beginning of period), as defined in the text. The regressions include both fixed effects and year effects. See the Appendix for details of variable definitions.

Table 8

Quantitative Estimates of the Effect of Misvaluation on Investment
Q Specification

	(1)	(2)
Misvaluation	0.0031106 (0.0000698) [44.56]	0.0031455 (0.0000700) [44.94]
Marginal Q	0.0289500 (0.0005085) [56.94]	0.0280880 (0.0005193) [54.09]
Cash Flow		0.0046464 (0.0005884) [7.90]
Number of Observations	67837	67756
Number of Firms	9075	9070
R^2	0.4972	0.4975

Each cell shows the point estimate, standard error (in parenthesis), and t statistic (in brackets). Cash flow is the ratio of cash flow to the capital stock. Misvaluation is the difference between stock market Q and marginal Q (both beginning of period), as defined in the text. The regressions include both fixed effects and year effects. See the Appendix for details of variable definitions.

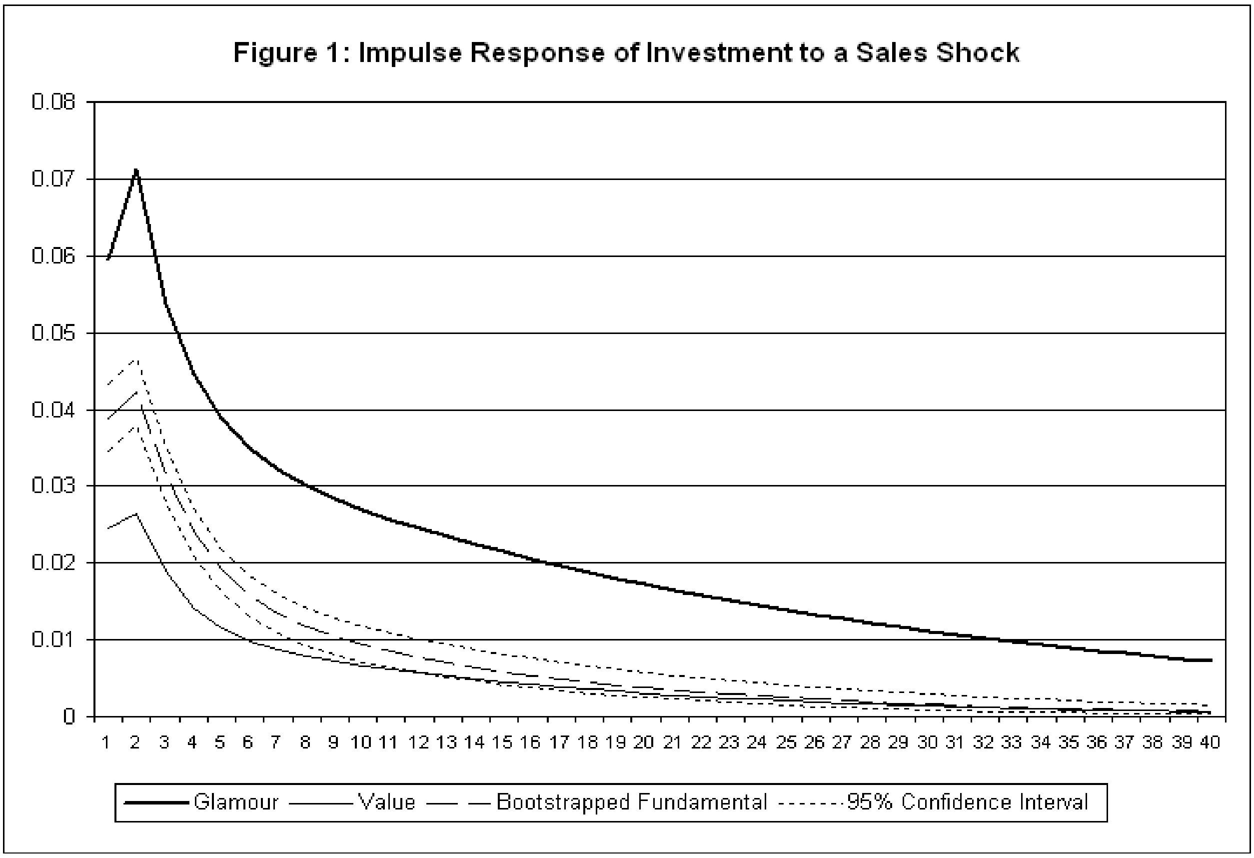
Figure 1: Impulse Response of Investment to a Sales Shock
0.08
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0.03
0.02
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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Glamour
Value
Bootstrapped Fundamental
95% Confidence Interval

Figure 2
Supply and Demand for Capital
Fundamental Shock

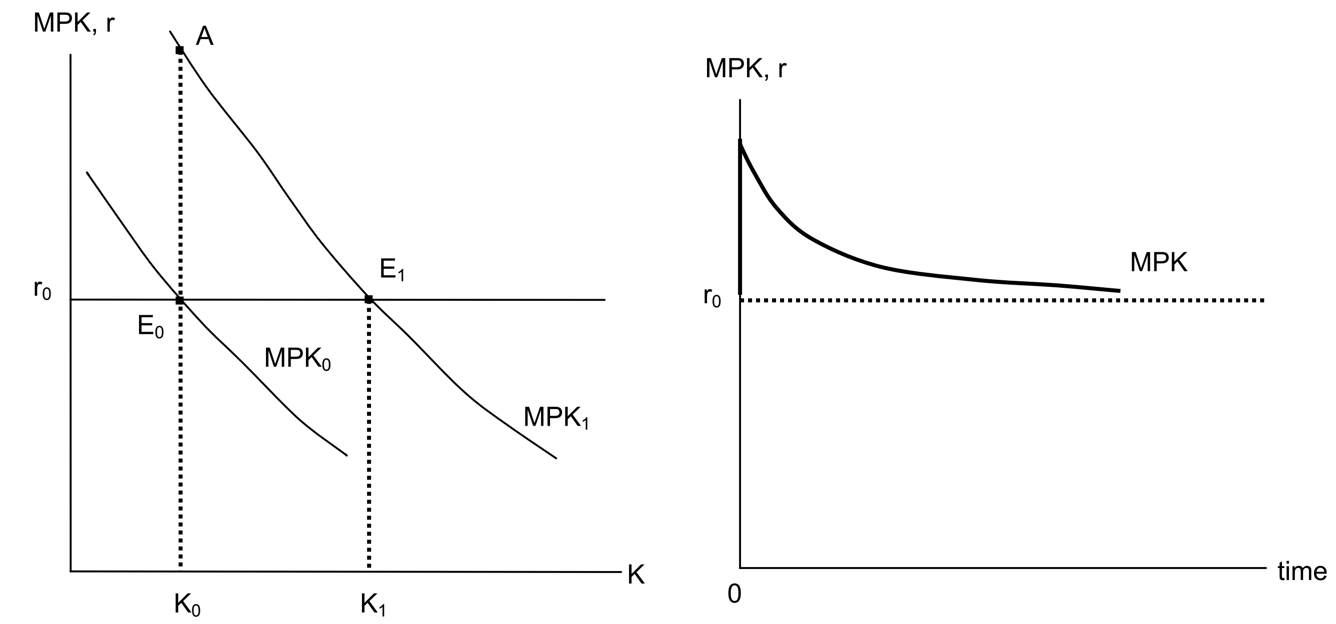


Figure 3
Supply and Demand for Capital
Misvaluation Shock

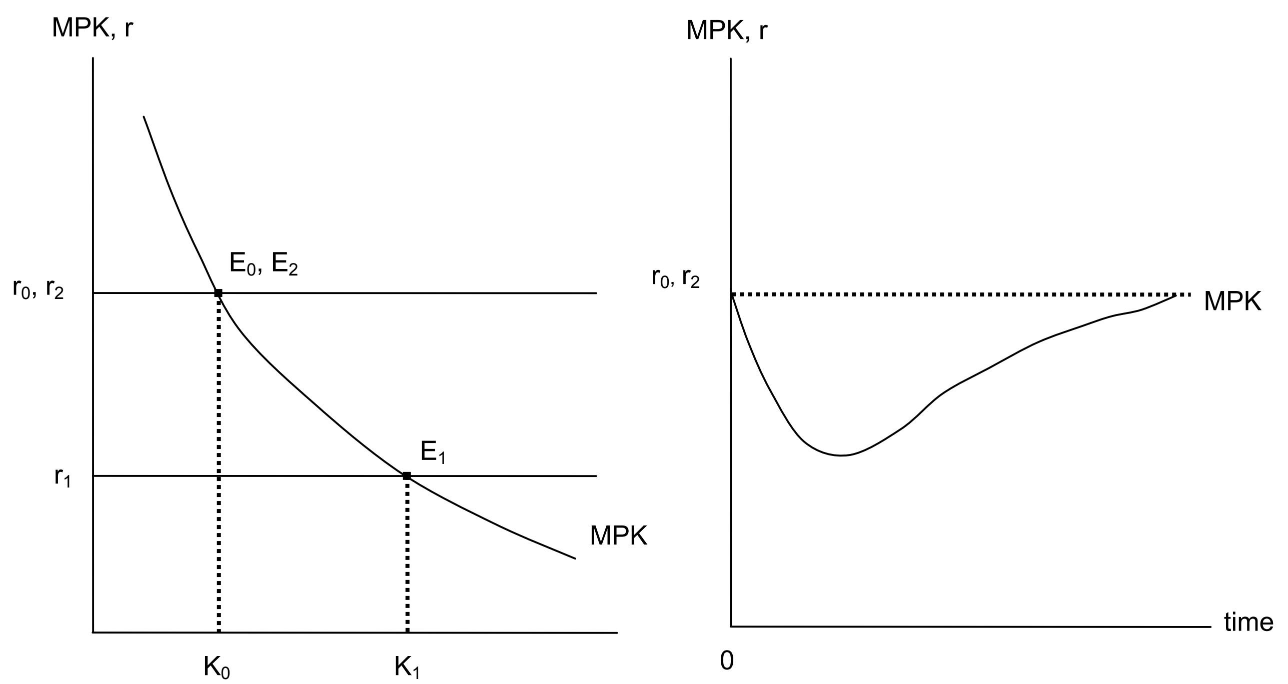
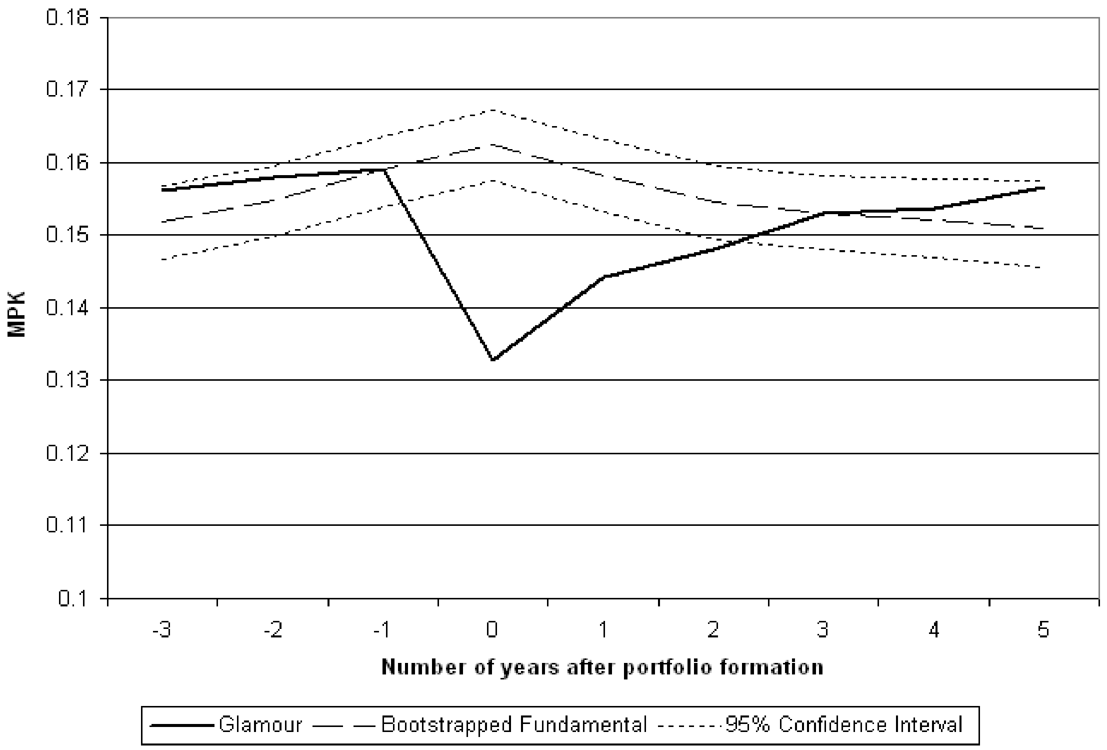


Figure 4: Mean Marginal Product of Capital



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