# Glamour vs. Value:
# The Real Story

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**Abstract:** Does stock market misvaluation finance investment? We use cross-sectional variation between glamour (high stock price) and value (low stock price) portfolios to test whether stock market misvaluation create a financing channel for fixed investment. In a large sample of U.S. firms over the period 1980-2004, glamour firms invest substantially more than value firms (even controlling for fundamentals), and they use substantially more equity finance. If glamour firms are responding to misvaluation rather than fundamentals, then they may be investing too much. We describe and implement four new tests that are designed to determine whether the high investment of glamour firms is exclusively the result of fundamental shocks or whether misvaluation shocks also play a role by lowering the cost of finance. In addition, parametric estimates of the effect of misvaluation on investment suggest that a one-standard-deviation increase in misvaluation raises investment by more than 30%. These results suggest that, as in the theoretical model of Jermann and Quadrini (2003), misvaluation lowers the cost of finance for some firms and may lead to more investment and the reallocation of capital and labor to financially-constrained firms.

Keywords: investment, stock market misvaluation, bubbles, financing, real effects of financial markets. JEL codes: E44, E22, E32, G3

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"Perhaps the crucial, and relatively neglected, issues have to do with real consequences of financial markets. How do firms issue securities, which ones do they issue, and when? How aggressively do they take advantage of favorable sentiment? How do firms use the funds they raise? ... 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

"If the only macroeconomic consequence of booms and busts in asset prices were via conventional wealth effects on aggregate demand, then they would constitute little more than a nuisance to monetary policymakers."

Charles Bean, *American Economic Review,* May 2004, p. 14

## 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 is an ongoing, 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 provide empirical evidence on the links between stock market misvaluation and business fixed investment.

Even if a firm's shares are overvalued, will managers necessarily increase investment? The firm could issue overvalued 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 implies 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 link between overvaluation and investment has been discussed by Keynes (1936), Bosworth

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

(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. 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. Baker, Stein, and Wurgler (2003), Gilchrist, Himmelberg, and Huberman (2005) and Polk and Sapienza (2003) all provide models in which rational managers increase investment in response to overvaluation of their firm's shares. Thus economic theory does not provide a definitive answer on whether overvalued firms will overinvest; empirical evidence is required.

We use cross-sectional variation between glamour and value portfolios to test whether there is a relationship between misvaluation and fixed investment. Glamour firms 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.[2]

We begin our analysis by comparing the investment behavior of glamour and value firms. Using a large, unbalanced panel data set of almost 100,000 observations of U.S. firms over the period 1980-2001, we find that glamour firms invest more than twice as much as value firms and rely more heavily on equity financing.

The fact that glamour firms invest more than value firms could be entirely due to fundamental shocks. In a world without misvaluation, a favourable fundamental shock raises Q (both average and marginal) and leads to higher investment. This must surely be an accurate description for some glamour firms. The question is whether there are a

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[2] An alternative explanation is that the risk characteristics of glamour and value portfolios differ. See, for example, Campbell and Vuolteenaho (2004) and Cohen, Polk, and Vuolteenaho (2002).

statistically – and economically – significant group of glamour firms that are overvalued and invest too much.

We begin by looking at whether economic fundamentals can account for the difference in investment between glamour and value firms. We examine three different benchmarks for investment. The first, the comparable firms benchmark, is based on the idea that firms in the same industry will face similar fundamental shocks. The second, the fundamental Q benchmark, is based on standard investment theory and a technique for measuring marginal Q due to Abel and Blanchard (1986) and Gilchrist and Himmelberg (1995). The third, the market-information-augmented fundamental Q benchmark, uses an insight from Campbell and Shiller (1987) designed to incorporate information that is available to market participants but that may not be incorporated into the econometrician's information set. Each benchmark accounts for part of the difference in investment between glamour and value firms but leaves a significant portion of the difference unexplained.

Is the high investment of glamour firms economically inefficient -- or does the lower cost of finance help to overcome other distortions? Jermann and Quadrini (2003), for example, provide a model in which small firms are finance constrained. 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. See also Caballero and Hammour (2002). 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."

On the other hand, overvaluation may induce at least some glamour firms to invest in negative NPV projects.[3] If overvaluation leads to overinvestment, there may eventually be a day of reckoning. As Shleifer (2000, p. 189) points out, historically many stock market booms "have been followed by prolonged depressions and severe cuts in real investment." The experiences of the U.S. in the Great Depression and Japan in

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[3] The *Economist* (October 4, 2003, p. 60), for example, reports that, "One reason for the current doldrums [in IT spending] is that many firms still regret binge-buying during the bubble."

1990s are cautionary.[4] A precipitous drop in security prices can lead to a collapse in the collateral value of assets and lead to highly inefficient liquidation, as illustrated in the Asian crisis of the late 1990s.

Do overvalued firms invest too much? We address this question using four tests for overinvestment.

First, we study investment reversals. A firm that experiences a favorable fundamental shock today will have higher investment in the future than it had before the shock. In contrast, a firm that overinvests today as a result of overvaluation will have lower investment than it did before the shock at some point in the future. For glamour firms, we find evidence of investment reversals.

Second, we analyze the time path of the marginal product of capital. 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, a favorable 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 falls around the time of portfolio formation for glamour firms and then gradually rises back to its pre-shock level.

Third, we examine stock market returns. Suppose a firm enters the glamour portfolio as a result of a misvaluation shock. If misvaluation influences investment decisions, the firm will tend to overinvest. Eventually, this excess investment may 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

[4] See Kindleberger (1978) for a more extensive survey of historical examples.

increase in measured overinvestment reduces cumulative excess returns over the next two years by 460 basis points.

Fourth, 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 as a possible explanation for the returns of value firms. If some investors have extrapolative expectations and if the financing mechanism is active, then glamour and value firm will respond differently to a sales shock. By estimating VARs and plotting the associated impulse response functions, we find that the investment of glamour firms responds more than twice as much as that of value firms to a one-standard-deviation sales shock.

While the above qualitative evidence is strongly suggestive of a role for misvaluation, it does not address the question of how large an effect misvaluation has 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. In addition, it discusses the mechanics of the active financing mechanism and presents data on new share issues by portfolio. Section 3 examines whether glamour firms' investment can be readily explained by fundamentals. Section 4 presents evidence on investment reversals. Section 5 discusses the time path of the marginal product of capital. Section 6 presents Fama-MacBeth tests of the effect of a measure of overinvestment on returns. Section 7 explains the idea of extrapolative expectations and the distinctive implications for glamour and value firms, as well as presenting the associated empirical evidence. Section 8 presents parametric estimates of the effect of misvaluation on investment. Section 9 concludes and discusses the implications.

## 2 Data description

### 2a Data sources, variable construction, and summary statistics

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 several 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.

Size is frequently measured by the equity value of the firm (especially in finance research), but that would be clearly inappropriate when we are investigating misvaluation. Instead, when we analyze investment, we use the replacement value of the capital stock to control for size. The capital stock is calculated using a standard perpetual inventory algorithm. The primary variable we analyze is the ratio of investment (I) to the capital stock (K).

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 Data Appendix. Summary statistics for several of the main variables are presented in Panel A of Table 1.

### 2b The active financing mechanism

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[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 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.

Overvaluation implies that a firm faces a low cost of equity finance. In fact, there is evidence 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.

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 many alternative sources of finance but have an unusually good opportunity to use equity finance because of its low cost.

A natural first step in determining whether an active financing mechanism exists is to look at differences in the sources of financing for glamour and value firms. In particular, do glamour firms rely more heavily on equity financing?

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? Normalizing by investment spending does have an important disadvantage, however. Observations with very low values of investment spending have a disproportionate impact on the mean. Instead of reporting the means, we therefore report the median and an additional "aggregated" statistic. Aggregated new share issues (normalized by investment spending) equal the sum of new share issues divided by the sum of investment spending, where the sums are taken over a given portfolio in a particular year. Test statistics for the aggregated variables are based on 25 annual observations for each portfolio (1980-2004).

As shown in Panel B of Table 1, for glamour firms, the median ratio of new share issues to investment spending is about 0.75. For value firms, the median ratio is exactly 0. Thus 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.

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

The aggregated statistics show a similar pattern. 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.

## 3 Can glamour firms' investment be readily explained by fundamentals?

The use of new share issues by glamour firms documented in Table 1.B is one of the two key elements of the misvaluation story investigated in this paper. If misvaluation is to have real effects, then, at a minimum, investment spending by glamour forms must exceed that of value firms. Table 2 compares the investment of glamour and value firms. The mean investment/capital (I/K) ratio for glamour firms is 0.285. This is more than twice as large as the mean for value firms of 0.120, and the difference is highly significant.

Can this difference in investment between glamour and value firms be readily explained by differences in fundamentals? In the finance literature, one explanation for the difference in returns between glamour and value firms involves differences in the industries which comprise the two portfolios. We therefore begin by controlling for industry- and time-specific shocks to fundamentals by defining the comparable firms benchmark for investment 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.

The first row of Table 3 controls for fundamentals with the comparable firms benchmark. To construct these entries, we begin by subtracting the mean of I/K for the corresponding industry and year from each observation of I/K. The mean of I/K after subtracting this comparable firms benchmark is presented for glamour and value portfolios in the first row. Fundamentals, as measured by the comparable firms benchmark, account for some of the difference in investment between glamour and value firms. In Table 2, the difference in investment between glamour and value firms is 0.165.

After accounting for fundamentals (using the comparable firms benchmark), the difference is 0.149. Based on the comparable firms benchmark, fundamentals account for about 10% of the difference in investment between glamour and value firms [(0.165 - 0.149)/0.165].

The comparable firms benchmark has the great virtue of simplicity and controls for industry- and time-specific shocks, but it does not control for idiosyncratic shocks. Standard economic theory says that investment depends on Q, the expected present value of future marginal products of capital. In empirical work, a common measure of Q is stock market Q (also known as Tobin's Q or average Q), defined as the market value of the firm divided by the replacement cost of its capital stock. In a study of the potential effect of stock market misvaluation on investment, stock market Q cannot be used as a measure of fundamentals, since the numerator might be affected by misvaluation. Another measure of Q used in empirical work is based on Abel and Blanchard (1986), who present a method of constructing a forward-looking measure of investment opportunities that does not depend on the stock market. 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 stock market misvaluations. We refer to the Abel and Blanchard measure of Q as fundamental Q.

Originally applied to aggregate data, the Abel and Blanchard technique was extended to panel data by Gilchrist and Himmelberg (1995), a crucial point, since we want to account for idiosyncratic shocks. In their implementation, Gilchrist and Himmelberg (1995) assume a constant discount rate. This is a potential source of concern, because variation in discount rates, either over time or across industries, might account for differences in investment between glamour and value portfolios. In the finance literature, risk is a leading explanation for the difference in returns between firms in 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. The discount rate is carefully constructed, incorporating risk adjustment and tax variables.

The forecasting variables used to construct fundamental Q are lagged values of the discount factor, Sales/K, Cost/K, $p^I / p^Y$, and I/K, where $p^I$ is the price of investment goods and $p^Y$ is the price of output. The discount factor is a natural candidate. Since investment is determined, at least in part, by fundamentals, then I/K is a useful forecasting variable reflecting the expected present value of future marginal products of capital. 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 profitability. We follow Abel and Blanchard in including them as separate variables. Finally, the relative price ratio $p^I / p^Y$ is a component of Q but is not affected by misvaluation. The fundamental Q benchmark for investment is constructed as follows (see the Appendix for details). For all observations where the required data are available, we regress I/K on fundamental Q. The predicted value of I/K from this regression is the fundamental Q benchmark. The entries for glamour and value firms in the second row of Table 3 are the mean of the difference between actual I/K and the predicted I/K computed from the fundamental Q benchmark.

As we would expect, fundamental Q accounts for some of the difference in investment between glamour and value firms. In Table 2, the difference in investment between glamour and value firms is 0.165. After accounting for fundamental Q, the difference is 0.155. Based on the fundamental Q benchmark, fundamentals account for about 6% of the difference in investment between glamour and value firms [(0.165 - 0.155)/0.165], and the t-test indicates that this difference is statistically significant at conventional levels.

Fundamental Q is constructed with an information set that may be less extensive than the information set used by investors and firms. Facing a similar issue, Campbell and Shiller (1987) pointed out that using the stock price could be very helpful. To the extent that the stock market rationally reflects available information, adding it to the set of forecasting variables should reduce any gap between stock market Q and fundamental Q that arises because the forecasting variables fail to capture information available to market participants. We therefore add lagged stock market Q as a forecasting variable and calculate a market-information-augmented fundamental Q.

Of the three benchmarks, market-information-augmented fundamental Q explains the largest proportion of the difference in investment between glamour and value firms. After accounting for this measure of Q, the difference is 0.137. Thus, market-information-augmented fundamental Q accounts for about 17% of the difference in investment between glamour and value firms [(0.165 -0.137)/0.165].

Regardless of the benchmark, the difference in investment between glamour and value firms is highly significant, both economically and statistically, even after we control for fundamentals.

## 4 Investment reversals

Suppose a firm is overvalued and invests too much. Eventually, this will become apparent, and the firm will need to reduce investment below the rate that existed before the spurt of overinvestment. Analyzing investment reversals can be thought of as the real counterpart to studies of long-run stock market returns in financial economics. Both are based on the idea that mistakes are eventually reversed. In financial economics, long-run returns studies have been used to provide evidence of temporary overvaluation. We use the analysis of possible investment reversals to provide evidence on whether firms temporarily overinvest.

Investment reversals are not a prediction of a permanent fundamental shock. The effect of a fundamental shock can be analyz ed in a standard Q theory phase diagram. In Figure 1, let K be interpreted as the ratio of the capital stock to efficiency units of labour and assume that the depreciation rate is $\delta$ and labour-embodied technological progress is growing at rate $\gamma$. The purpose of these assumptions is to allow for the realistic possibility of non-zero steady-state growth. (The specific assumption of labour-embodied technological progress is not crucial; it is merely a simple way of allowing for growth.) At point E, before the favourable fundamental shock arrives, the capital stock is growing at rate $\gamma$ and the steady-state I/K ratio is $\delta+\gamma$. A favourable fundamental shock shifts the $\dot{Q}=0$ schedule to the right. The stock market price (which is reflected in Q) rises and the investment/capital ratio is greater than $\delta+\gamma$ (i.e., greater than it was before the shock) along the saddle path to the new steady state. Thus, a permanent fundamental shock leads to a rate of investment at every point on the adjustment path that is higher than the rate of investment before the shock. This provides a clear contrast to overinvestment that is induced by misvaluation.

Table 4 reports the difference between I/K in years subsequent to portfolio formation and I/K in the year immediately before portfolio formation. Two years after portfolio formation, investment is lower for glamour firms than it was before portfolio formation. The rate of investment continues to decline. By five years after portfolio formation, I/K is 0.086 lower than it was in the year before portfolio formation. The difference is highly significant, with a t-statistic of 23.5.

What about value firms? In the absence of misvaluation, value firms would be the mirror image of glamour firms in the wake of a fundamental shock. An unfavorable fundamental shock shifts the $\dot{q} = 0$ schedule to the left, leading to an immediately lower stock market price and an extended period of lower investment. An important difference between glamour and value firms is that equity financing is not the marginal source of finance for most value firms; hence, an unfavorable misvaluation shock will have a relatively small effect on investment. In Table 4, the mean investment of value firms is virtually unchanged in the five years subsequent to portfolio formation. This evidence is hard to reconcile with fundamental shocks, since fundamental shocks imply that the investment of value firms should fall over a horizon of several years from the time of portfolio formation.

The evidence on investment reversals is intuitively appealing, but there is a caveat. As illustrated in Figure 2, a *transitory* fundamental shock also leads to an initial increase in the rate of investment as the firm moves towards (but never quite to) the new steady state. When the effect of the transitory shock disappears, the firm begins moving back towards the initial steady state and the rate of investment falls below the initial pre-shock level. Thus, the path of investment displayed in Figure 2 for an overvaluation shock may apply equally well to a transitory fundamental shock. The evidence in Table 4 is therefore inconsistent with a world in which permanent fundamental shocks are the only source of investment fluctuations, but the evidence could be consistent with either transitory fundamental shocks or misvaluation shocks that lead to overinvestment.

## 5 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 3, 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 3. A favorable fundamental shock leads to an increasing marginal product of capital around the time of portfolio formation and a declining marginal product 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 4. 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 capital -- exactly the opposite implication from favorable 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 5 plots the marginal product of capital for glamour firms. The time path of the marginal product of capital corresponds better with misvaluation shocks than fundamental shocks. The marginal product of capital falls around the time of portfolio formation and rises in subsequent years.[7]

Again, 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 5 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 5. 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. Thus, from the evidence on the time path of marginal products of capital, we are left to conclude that the behavior of glamour firms is substantially affected by misvaluation shocks or by fundamental shocks realized at least five years in the future.

It may be useful to consider how the evidence on investment reversals (in the previous section) fits together with the evidence on the time path of the marginal product

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[7] The effect of fundamental shocks is symmetric for glamour and for value forms. Unfavorable fundamental shocks (which will tend to push firms into the value portfolio) will lead to a decreasing marginal product of capital around the time of portfolio formation and an increasing marginal product of capital in subsequent years. In contrast, misvaluation shocks have asymmetric effects on glamour and value firms. Glamour firms are heavy issuers of new shares, while equity is unlikely to be the marginal source of finance for value firms (cf. Table 1.B). Misvaluation shocks will therefore tend to have a small effect on the marginal product of capital for value firms. Although it is of lesser interest (and not shown in a figure), the time path of the mean marginal product of capital for value firms is roughly flat, fluctuating less than 0.005 above and below its central value from the year before entry into the portfolio until five years after.

of capital. The investment reversals evidence is consistent with two possibilities, either: 1) transitory fundamental shocks (with the investment reversal starting two years after portfolio formation); or 2) misvaluation shocks that lead to overinvestment. The marginal product of capital evidence is also consistent with two possibilities, either: 1) anticipated fundamental shocks (which, based on the mean marginal product of capital for glamour firms, tend not to be realized for at least five years after portfolio formation); or 2) misvaluation shocks that lead to overinvestment.

## 6 Returns

A firm could enter the glamour portfolio either because of a fundamental shock or a misvaluation shock. As illustrated in Figure 1, good news about fundamentals will boost a firm's share price (i.e., q) and lead to unusually high returns in the period when the news arrives. In subsequent periods, the firm will earn normal returns. Because good news about fundamentals raises marginal q, the firm's rate of investment will also be higher in the wake of a fundamental shock. On the other hand, suppose a firm enters the glamour portfolio as a result of a misvaluation shock. If misvaluation influences investment decisions, the firm will tend to overinvest. Eventually, this excess investment may become apparent to investors, leading to lower stock market returns for glamour firms that have overinvested.

We can test the effect of "overinvestment" on the returns of glamour firms using a variant of Fama-MacBeth (1973) regressions:

$$ret_t^h = \gamma_{ot} + \gamma_{1t}\beta + \gamma_{2t}O_tG_t + \eta_t$$ $ret_t^h = \gamma_{ot} + \gamma_{1t}\beta + \gamma_{2t}O_tG_t + \eta_t$

where $ret_t^h$ is the cumulative excess return for horizon h, $\beta$ is the CAPM $\beta$, $O_t$ is the amount of "overinvestment" in the period of portfolio formation, $G_t$ is a dummy variable taking the value 1 for each of the five glamour portfolios and 0 for the 20 remaining portfolios, and $\eta_t$ is the error term in the regression. "Overinvestment" is defined so as to correspond to the second row of Table 3 (i.e., based on the residuals in the year of portfolio formation in a regression of I/K on fundamental Q). 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. With no misvaluation, "overinvestment" should play no role in explaining the cross-section of returns, once we control for risk, and $\gamma_2$ should be zero. If misvaluation affects investment, $\gamma_2$ should be negative.[8]

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 $\beta$ for each of the 25 portfolios. A cross-sectional regression is run for each year. The Fama-Macbeth procedure tests whether the mean of the estimated values of $\gamma_2$ (over the years in the sample) is significantly different from 0.

Table 5 presents the results of the Fama-MacBeth tests. The values of $\gamma_2$ 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 460 basis points. The effect is about the same at the three-year horizon and larger at the four- and five-year horizons.

## 7 Overreaction

As noted above, Barberis, Shleifer, and Vishny (1998) suggest that misvaluation is driven by extrapolative errors on the part of investors. In particular, they argue that investors 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.

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[8] Polk and Sapienza (2003) also use a returns test in this context, but the details are different. They focus on current returns, they use lagged values of six control variables (investment/assests ratio, Brainard-Tobin's Q, cash flow/assests ratio, market capitalization, book equity/market equity ratio, and firm momentum) and two misvaluation variables (discretionary accruals and equity issues), and they sort the sample by R&D intensity, share turnover, and the Kaplan-Zingales measure of finance constraints.

The possibility of extrapolative errors leads to a further simple 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 is likely to be stronger for glamour firms than for value firms. Why? If investors make extrapolative errors, a positive sales shock will have two effects. First, since sales are likely to contain some information about future marginal products of capital, a positive sales shock will increase Q. This is the conventional effect, and it applies to both glamour and value firms. Second, a positive sales shock will cause those with extrapolative expectations to unduly increase their estimate of the firm's value (i.e., increase overvaluation). If there is an active financing mechanism at work, the sales shocks will thus increase overinvestment. This is the overreaction effect that affects glamour firms but not value firms. By comparing the response of glamour and value firms to a sales shock, we can get a measure of the second effect.

We implement the overreaction tests by estimating a bivariate VAR of Sales/K and I/K using two lags.[9] This VAR approach is especially appealing because it is closely linked to the Barberis, Shleifer, and Vishny (1998) model. Sales is ordered first in the VAR since, under the assumption that the only shocks are to fundamentals, firms base their investment on fundamental shocks that are reflected in sales. We estimate the VAR for glamour and value firms separately and examine the difference in the impulse response functions.[10] In estimating the VAR, we are careful to include the necessary lagged values of variables for a firm that is in the glamour portfolio in period t even though that firm was not in the glamour portfolio in t-1 or t-2.

Figure 6 presents the impulse response functions for glamour and value firms. The investment of glamour firms responds about three times 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 0.075. For value firms, the peak increase in I/K is about 0.025.

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[9] The tests based on the impulse response function of investment to sales differ from the investment reversals tests because the investment reversals tests do not condition on sales.

[10] 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. Our test differs, although it also uses VAR techniques.

## 8 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 fundamental 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 Data Appendix.

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.[11]

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 mean 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.[12] 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

[11] The regression includes both fixed 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%.

[12] A leading interpretation is that cash flow enters due to finance constraints [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.

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 mean 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 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 fundamental Q in the regression. Like stock market Q, fundamental 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 mean 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 results in this section are consistent with a number of earlier studies that have found significant evidence that stock market misvaluation affects 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 and Galeotti and Schiantarelli (1994) find that non-fundamentals have a significant effect on investment. 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 using a simple procedure intended to hold fundamentals constant (although they downplay the impact of misvaluation 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; and Polk and Sapienza (2003) find that various proxies for misvaluation affect investment after controlling for stock market Q (their proxy for fundamentals). One exception to this general finding is Bond and Cummins (2001), who find a statistically weak effect of stock market Q after controlling for fundamentals using analysts' forecasts, but it is far from clear that analysts are impervious to the forces that drive investor sentiment. In fact, as widely reported, analysts at least occasionally appear to foment investor sentiment by touting stocks connected with their financial institution.

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 two potential explanations. First, the measures of fundamentals (fundamental Q) and misvaluation (which is based on fundamental 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. Second, 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.

## 9 Conclusion

This paper begins with a quote from Shleifer (2000) in which he poses the question, "Does market inefficiency have real consequences?" A variety of evidence in this paper suggests that the answer is "yes." Firms sometimes appear to become overvalued. At least for some firms, overvaluation leads to overinvestment. As market participants gradually become aware of the overvaluation and overinvestment, the stock market punishes overinvesting glamour firms and the firms themselves retrench, investing less than they did in the period before the misvaluation shock arrived. There is clear evidence that the possibility of obtaining cheap financing by issuing overvalued stock plays a significant role.

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) for a formal model.) 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.[13]

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

[13] 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.

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 induce financial intermediaries to misleadingly promote securities.

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. 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, alluded to in the introduction, is whether overvaluation can sometimes play a positive role in fostering economic growth. The primary argument for the beneficial effects of overvaluation involves the relaxation of finance constraints. 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.

## References


Abel, Andrew B., and Blanchard, Olivier J., "The Present Value of Profits and Cyclical Movements in Investment," *Econometrica* 54 (March 1986), 249-274.

Abel, Andrew B., and, Eberly, Janice E., “A Unified Model Of Investment Under Uncertainty,” *American Economic Review* 84 (December 1994), 1369-1384.

Abel, Andrew B., and Eberly, Janice C., "Q Theory without Adjustment Costs & Cash Flow Effects without Financing Constraints," Wharton and Northwestern (October 2003).

Baker, Malcolm, Stein, Jeremy C., and Wurgler, Jeffrey, "When Does The Market Matter? Stock Prices and the Investment of Equity-Dependent Firms," *Quarterly Journal of Economics* 118 (August 2003), 969-1005.

Baker, Malcolm, and Wurgler, Jeffrey, “The Equity Share In New Issues And Aggregate Stock Returns,” *Journal Of Finance* 55 (October 2000), 2219-2257.

Barbaris, Nicholas, Shleifer, Andrei, and Vishny, Robert, “A Model Of Investor Sentiment,” *Journal Of Financial Economics* 49 (1998), 307-343.

Bean, Charles R., “Asset Prices, Financial Instability, and Monetary Policy,” *American Economic Review* 94 (May 2004), 14-18.

Bernanke, Ben S., “Monetary Policy and the Stock Market: Some Empirical Results,” Banking and Finance Lecture, Widener University (October 2, 2003).

Blanchard, Olivier J., Rhee, Changyong, and Summers, Lawrence H., "The Stock Market, Profit and Investment," *Quarterly Journal of Economics* 108 (February 1993), 115-136.

Blanchard, Olivier J., and Watson, Mark, "Bubbles, Rational Expectations and Financial Markets," in Paul Wachtel (ed.), *Crises in the Economic and Financial Structure* (Lexington, MA: Lexington Books, 1982), 295-315.

Bond, Stephen R., and Cummins, Jason G., "Noisy Share Prices and the Q Model of Investment," Oxford University (2001).

Bosworth, Barry, "The Stock Market and the Economy," *Brookings Papers on Economic Activity* 1, 257-290 (1975).

Caballero, Ricardo J., and Hammour, Mohamad L., “Speculative Growth,” MIT (November 2002).

Campbell, John Y. and Shiller, Robert J. “Cointegration and Tests of Present Value Models,” *Journal of Political Economy*, 95(3) (October 1987), pages 1062-1088.

Campbell, John Y., and Vuolteenaho, Tuomo, “Bad Beta, Good Beta,” *American Economic Review*, vol. 94(5) (December 2004), pages 1249-1275.

Chirinko, Robert S., Fazzari, Steven M., and Meyer, Andrew P., "How Responsive Is Business Capital Formation To Its User Cost?: An Exploration With Micro Data," *Journal of Public Economics* 74 (October 1999), 53-80.

Chirinko, Robert S., and Schaller, Huntley. “Bubbles, Fundamentals, and Investment: A Mutiple Equation Testing Strategy,” *Journal of Monetary Economics 38* (August 1996), 47-76.

Chirinko, Robert S., and Schaller, Huntley. "Business Fixed Investment and 'Bubbles': The Japanese Case," *American Economic Review* 91 (June 2001), 663-680.

Cochrane, John H. "Shocks," Carnegie-Rochester Conference Series on Public Policy, *Elsevier*, vol. 41, (1994), 295-364.

Cohen, Randolph B., Polk, Christopher, and Vuolteenaho, Tuomo, "Does Risk or Mispricing Explain the Cross-Section of Stock Prices?," Harvard (May 2002).

De Long, J. Bradford, Shleifer, Andrei, Summers, Lawrence H., and Waldmann, Robert J., "The Size and Incidence of the Losses from Noise Trading," *Journal of Finance* 44 (July 1989), 681-696.

Dupor, Bill, “The Natural Rate of Q,” *American Economic Review* 92 (May 2002), 96-101

Eisner, Robert, and Nadiri, M. Ishaq, "Investment Behavior and Neo-Classical Theory," *The Review of Economics and Statistics* 50 (August 1968), 369-382.

Fama, Eugene, and MacBeth, James, "Risk, Return, and Equilibrium: Empirical Tests," *Journal of Political Economy* 81 (May/June 1973), 607-636.

Fazzari, Steven M., Hubbard, R. Glenn, and Petersen, Bruce C., "Financing Constraints and Corporate Investment,” *Brookings Papers on Economic Activity* (1988:1), 141-195.

Fazzari, Steven M., Hubbard, R. Glenn, and Petersen, Bruce C., "Investment-Cash Flow Sensitivities Are Useful: A Comment on Kaplan and Zingales," *Quarterly Journal of Economics* 115 (May 2000), 695-705.

Fischer, Stanley, and Robert C. Merton, " Macroeconomics and Finance: The Role of the Stock Market," *Carnegie-Rochester Conference Series on Public Policy* XXI, 57-108 (1984).

Galeotti, Marzio, and Schiantarelli, Fabio, "Stock Market Volatility and Investment: Do Only Fundamentals Matter?," *Economica* 61 (1994), 147-165.

Gilchrist, Simon, and Himmelberg, Charles, "Evidence on the Role of Cash Flow for Investment," *Journal of Monetary Economics* 36 (December 1995), 541-572.

Gilchrist, Simon, Himmelberg, Charles, Huberman, Gur, "Do Stock Price Bubbles Influence Corporate Investment?" *Journal of Monetary Economics*, May 2005.

Gilchrist, Simon, and Leahy, John V., "Monetary Policy and Asset Prices," *Journal of Monetary Economics* 49 (January 2002), 75-97.

Gomes, Joao F., "Financing Investment," *American Economic Review* 91 (December 2001), 1263-1285.

Hall, Robert E., and Jorgenson, Dale W., "Application of the Theory of Optimum Capital Accumulation," in Gary Fromm (ed.), *Tax Incentives and Capital Spending* (Washington: Brookings Institution, 1971), 9-60.

Hubbard, R. Glenn, "Capital-Market Imperfections and Investment," *Journal of Economic Literature* 36 (March 1998), 193-225.

Hunter, William C., Kaufman, George G., and Pomerleano, Michael (eds.), *Asset Price Bubbles: The Implications for Monetary, Regulatory, and International Policies* (Cambridge: MIT Press, 2003).

Jermann, Urban, and Quadrini, Vincenzo, "Stock Market Boom and the Productivity Gains of the 1990's," University of Pennsylvania (March 2003).

Jorgenson, Dale W., "Capital Theory and Investment Behavior," *American Economic Review* 53 (May 1963), 247-259; reprinted in *Investment, Volume 1: Capital Theory and Investment Behavior* (Cambridge: MIT Press, 1996), 1-16.

Judson, Ruth A. and Owen, Ann L., "Estimating Dynamic Panel Data Models: A Guide for Macroeconomists," *Evonomics Letters* 65 (1999), 9-15.

Kaplan, Steven N., and Zingales, Luigi, "Do Investment-Cash Flow Sensitivities Provide Useful Measures of Finance Constraints?," *Quarterly Journal Of Economics* 112 (February 1997), 169-215.

Kaplan, Steven N., and Zingales, Luigi, "Investment-Cash Flow Sensitivities Are Not Valid Measures of Financing Constraints," *Quarterly Journal Of Economics* 115 (May 2000), 707-712.

Keynes, J. M., "An economic analysis of unemployment," In *Collected Writings, Volume XII.* London: Macmillan (1931).

Keynes, J. M., *The General Theory of Employment, Interest, and Money*. London: Macmillan (1936).

Kindleberger, C., *Manias, Panics, and Crashes.* New York: Basic Books (1978).

Lakonishok, Joseph, Shleifer, Andrei, and Vishny, Robert W., "Contrarian Investment, Extrapolation and Risk," *Journal of Finance* 49 (1994), 1541-1578.

Morck, Randall, Andrei Shleifer, and Robert W. Vishny, "The Stock Market and Investment: Is the Market a Sideshow?," *Brookings Papers on Economic Activity* (1990:2), 157-202.

Pechman, Joseph A., *Federal Tax Policy*, Fifth Edition (Washington: Brookings Institution, 1987).

Polk, Christopher, and Sapienza, Paola, "The Real Effects of Investor Sentiment," Northwestern (December 2003).

Schaller, Huntley, and Zhang, Jiankang, "Capital Gains Tax, Overconfidence, and Asset Price Bubbles," (December 2005) mimeo.

Scheinkman, Jose A., and Xiong, Wei, "Overconfidence and Speculative Bubbles," *Journal of Political Economy* 111 (December 2003), 1183-1219.

Schiantarelli, Fabio, "Financial Constraints and Investment: A Critical Review of Methodological Issues and International Evidence," in Joe Peek and Eric S. Rosengren (eds.), *Is Bank Lending Important For The Transmission Of Monetary Policy?* (Boston: Federal Reserve Bank Of Boston, 1995), 177-214.

Shleifer, Andrei, *Inefficient Markets: An Introduction To Behavioral Finance* (Oxford: Oxford University Press, 2000).

Stein, J., "Rational capital budgeting in an irrational world," *Journal of Business* (1996) 69:429-55.

Stiglitz, Joseph E., *The Roaring Nineties: A New History of the World's Most Prosperous Decade* (New York: W.W. Norton, 2003).

## Appendix A: Data

### Construction of Glamour and Value Portfolios

We construct the glamour and value portfolios using the price/sales ratio. The price/sales ratio is Net Sales (CompuStat item 12) divided by Common Shares Outstanding (CompuStat item 25) times Price – Fiscal Year – Close (CompuStat item 199). Observations with missing or non-positive values for the price/sales ratio are dropped. After trimming, the remaining observations for a given year are sorted into deciles. (As noted in the text, we 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.) The top two deciles are classified as glamour firms (i.e., firms with low stock market prices relative to the price/sales ratio). The bottom two deciles are classified as value firms (i.e., firms with high stock market prices), and the remaining deciles are classified as typical firms.

### 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:

$$K_{f,t_0^f} = \frac{NPLANT_{f,t_0^f}}{p^I_{s,t_0^f}} \frac{KQUANT_{s,t_0^f}}{KHIST_{s,t_0^f}} \quad \text{(A1)}$$

where KQUANT is the chain-type quantity index of the net stock of private fixed assets by sector, KHIST is historical-cost net stock of private fixed assets by industry, 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,

$$K_{f,t+1} = (1-\delta_{s,t})K_{f,t} + \frac{KCHG_{f,t+1}}{p^I_{s,t+1}} \quad \text{(A2)}$$

where $\delta$ is the depreciation rate and KCHG is gross additions to the firm's capital stock. The firm reports the additions in nominal terms, so we divide by $p^I$ to convert to real terms.

In the standard case, KCHG is gross investment (I), which is capital expenditures in the firm's financial statements (CompuStat item 128). CompuStat does not always have reliable data for the additions to the capital stock associated with large acquisitions. We use a modified version of the algorithm of Chirinko, Fazzari, and Meyer (1999) to adjust KCHG for acquisitions and divestitures. In the case of a substantial acquisition, we can use accounting identities to derive a more accurate measure of the additions to the capital stock:

$$DGPLANT_{f,t} = I_{f,t} + ACQUIS_{f,t} - RETIRE_{f,t} \qquad \text{(A3)}$$

where $DGPLANT_t$ is the change in GPLANT from the end of year t-1 to the end of year t and $GPLANT_t$ is gross property, plant, and equipment (CompuStat item 7), ACQUIS is acquisitions, and RETIRE is retirements of capital stock (CompuStat item 184). (When data on RETIRE is missing, we assume that the reason is that firms do not report any retirements in their financial statements, and we therefore assign a value of 0 to RETIRE for these observations.) We use the following screen to identify cases where there has been a substantial acquisition. If

$$\frac{DGPLANT_{f,t} - I_{f,t}}{GPLANT_{f,t-1}} > 0.1 \qquad \text{(A4)}$$

then we calculate the gross change in the capital stock as

$$KCHG_t = DGPLANT_t + RETIRE_t \qquad \text{(A5)}$$

We also account for substantial divestitures, using the following screen. If

$$\frac{DGPLANT_{f,t} + RETIRE_{f,t}}{GPLANT_{f,t-1}} < -0.1 \qquad \text{(A6)}$$

we calculate the change in the capital stock as

$$KCHG_{f,t} = DNPLANT_{f,t} + \delta K_{f,t-1} p^I_{s,t} \qquad \text{(A7)}$$

where DNPLANT is the change in NPLANT (as defined above).[14] Because NPLANT in the firm's financial statements will deduct depreciation (as well as accounting for the divestiture), depreciation must be added to KCHG to avoid deducting depreciation twice.

If $GPLANT_{f,t-1}$ is missing (or equal to zero) or $DGPLANT_{f,t}$ is missing, it is not feasible to use these screens, and we set KCHG equal to I.

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.

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[14] To see this result, start with the perpetual inventory equation.

$$K_t = I_t + (1-\delta)K_{t-1}$$

$$K_t - K_{t-1} + \delta K_{t-1} = I_t$$

Now, put the previous equation in nominal terms.

$$[K_t - K_{t-1}]p^I_t + \delta K_{t-1} p^I_t = I_t p^I_t$$

$$DNPLANT_t + \delta K_{t-1} p^I_t = I_t p^I_t = KCHG_t$$

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

$$\delta_{s,t} = \frac{D\$_{s,1996} DQUANT_{s,t}}{K\$_{s,1996} KQUANT_{s,t}} \qquad \text{(A8)}$$

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:

$$p^I_{s,t} = \frac{100(I\$_{s,t} / I\$_{s,1996})}{IQUANT_{s,t}} \qquad \text{(A9)}$$

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).

**Cost of Capital**

The cost of capital is calculated as follows

$$C_{f,t} = (r_{f,t} + \delta_{s,t})\left(\frac{1 - z_t - u_t}{1 - \tau_t}\right)\frac{p^I_{s,t}}{p^Y_{s,t}} \qquad \text{(A10)}$$

where *r* is the real, risk-adjusted interest rate, *z* is the present value of depreciation allowances, *u* is the investment tax credit rate, $\tau$ 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 $\delta$ 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 value of depreciation allowances – for non-residential equipment and structures, respectively – 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 non-residential 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). The sector-specific price index for output is the implicit price deflator for Gross Domestic Product by industry produced by the BEA, normalized to 1 in 1996.

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

$$(1 - z_t - u_t)\frac{p^I_{s,t}}{p^Y_{s,t}} \qquad \text{(A11)}$$

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

$$\left(\frac{r_{f,t} + \delta_{s,t}}{1 - \tau_t}\right) \qquad \text{(A12)}$$

**The Real Risk-Adjusted Market Discount Rate**

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

$$r_{f,t} = ((1 + r^{NOM}_{f,t}) / (1 + \pi^e_t)) - 1.0. \qquad \text{(A13)}$$

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

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

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

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

$r^{NOM,EQUITY}_{s,t}$ = Nominal, short-term, risk-adjusted cost of equity capital for firms in sector s.

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

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

$\pi^e_{s,t}$ = Sector-specific capital goods price inflation rate from t to t+1. Sector-specific data was not yet available for 2002 at the time of data construction, so the inflation rate for nonresidential fixed investment was used for $\pi^e_{s,t}$ for 2001.

$\sigma_s$ = Equity risk premium.

$\tau_t$ = Marginal rate of corporate income taxation.

$\lambda_s$ = 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,

$$\sigma_s = \beta_s (\mu^{EQUITY} - \mu^F), \qquad \text{(A14)}$$

where

$\beta_s$ = CAPM β for sector s

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

$\mu^F$ = 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.

**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,

$$Y_{i,t} = Y[K_{i,t}, L_{i,t}, A_{i,t}] = \left\{\omega K_{i,t}{}^{[(\sigma-1)/\sigma]} + (1-\omega)(A_{i,t}L_{i,t})^{[(\sigma-1)/\sigma]}\right\}^{[((1+\eta)\sigma)/(\sigma-1)]} \qquad \text{(A15)}$$

where ω is the share parameter, σ is the elasticity of substitution between labor and capital, 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 (A15) into the following revenue function,

$$REV[K_{i,t}, A_{i,t}L_{i,t}] = p[Y[K_{i,t}, A_{i,t}L_{i,t}]]\ Y[K_{i,t}, A_{i,t}L_{i,t}], \qquad \text{(A16)}$$

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

$$\mu \equiv -(p'[Y_{i,t}]Y_{i,t} / p[Y_{i,t}] \qquad 1 > \mu \geq 0, \qquad \text{(A17)}$$

Differentiating equation (A16) 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),

$$MPK[Y_{i,t}, K_{i,t} : \sigma, \omega, \eta, \mu] \equiv (\partial REV / \partial K) / p, \tag{A18a}$$

$$= \Gamma \, [Y_{i,t} / K_{i,t}]^{[1/\sigma]} \, Y_{i,t}^{\zeta}, \tag{A18b}$$

$$\Gamma \equiv (1-\mu)(1+\eta)\,\omega, \tag{A18c}$$

$$\zeta \equiv [(\eta(\sigma-1))/(1+\eta)\sigma]. \tag{A18d}$$

As shown in equation (18b), the MPK depends on three separate elements:

i) three parameters combined in $\Gamma$ representing product market competition ($\mu$), returns to scale ($1+\eta$), and the factor share of capital ($\omega$);
ii) the output/capital ratio raised to the inverse of the elasticity of substitution ($\sigma$);
iii) output raised to a power determined by a parameter ($\zeta$) that reflects non-constant returns to scale and the substitution elasticity from unity. Note that $\zeta = 0$ if either of these assumptions are absent.

The frequently used Cobb-Douglas production function is a special case of equation (18b). The Cobb-Douglas is defined by an elasticity of substitution of unity ($\sigma = 1$) and constant returns to scale ($\eta = 0$). 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 ($\mu = 0$), then the MPK for the Cobb-Douglas production function is written as follows,

$$MPK[Y_{i,t}, K_{i,t} : \sigma = 1, \omega, \eta = 0, \mu = 0] = \omega \, [Y_{i,t} / K_{i,t}]. \tag{19}$$

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

Equation (18b) assumes that three parameters – $\mu$, $\eta$, and $\omega$ – are constant across all firms. This assumption seems restrictive. We allow these parameters to vary by industry and represent their product by $\Gamma_j$, where j denotes the industry in which firm i operates. Equation (18b) can be rewritten in terms of $\Gamma_j$, the output/capital ratio raised to $[1/\sigma]$, 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 ($\sigma \neq 1$),

$$MPK[Y_{i,t}, K_{i,t} : \sigma, \omega_j, \eta_j, \mu_j] = \Gamma_j \, [Y_{i,t} / K_{i,t}]^{[1/\sigma]} \, Y_{i,t}^{\zeta_j}, \tag{20a}$$

$$\Gamma_j \equiv (1-\mu_j)(1+\eta_j)\,\omega_j, \tag{20b}$$

$$\zeta_j \equiv [(\eta_j(\sigma-1))/((1+\eta_j)\sigma)]. \tag{20c}$$

In order to make equation (6a) operational, two decisions need to be made concerning the unknown parameters. First, we will assume that $\sigma$ equals 1.0. Second, following Gilchrist and Himmelberg (1998, Section 2.1), we estimate $\Gamma_j$ by utilizing the long-run relation between MPK and the user cost of capital ($UC_{i,t}$) for all firms in industry j. Specifically, we compute $\Gamma_j$ for all firms in industry j (i ε I(j)) for all available time periods t (t ε T(j)) as follows,

$$\sum_{i \in I(j)} \sum_{t \in T(j)} MPK_{i,t} = \sum_{i \in I(j)} \sum_{t \in T(j)} UC_{i,t} \,, \tag{21a}$$

$$\sum_{i \in I(j)} \sum_{t \in T(j)} \Gamma_j[\sigma, \eta_j]\,[Y_{i,t} / K_{i,t}]^{[1/\sigma]} = \sum_{i \in I(j)} \sum_{t \in T(j)} UC_{i,t} \,, \tag{21b}$$

$$\Gamma_j[\sigma, \eta_j] = \left\{ \sum_{i \in I(j)} \sum_{t \in T(j)} UC_{i,t} \right\} \Big/ \left\{ \sum_{i \in I(j)} \sum_{t \in T(j)} [Y_{i,t} / K_{i,t}]^{[1/\sigma]} \right\}. \tag{21c}$$

The MPK for firm i at time t equals equation (20a) with the estimate of $\Gamma_j$ given in equation (21c).

## Stock Market Q and Misvaluation

We define stock market Q 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 $p^Y$. Misvaluation is defined as the difference between stock market Q and fundamental Q, which is described in detail in the next subsection entitled, "Fundamental Q."

## Appendix B: Constructing Fundamental Q

Fundamental Q is the expected present value of future marginal products of capital:

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

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. (To be precise, fundamental Q is defined in the empirical work as $\lambda_t - p_t^I / p_t^Y$, where $p^I$ is the price of investment goods and $p^Y$ is the price of output. For expositional simplicity, we focus on $\lambda$ 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:

$$M_t \equiv \left( F_{K,t} - C_{K,t} \right) \quad (2)$$

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

$$\tilde{\lambda}_t \equiv \Sigma_{j=0}^{\infty} \left( \Pi_{s=0}^{j-1} R_{t+s} \right) M_{t+j} \quad (3)$$

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

$$\lambda_t = E_{t-1} \left[ \tilde{\lambda}_t \right] \quad (4)$$

Note that $\lambda$ 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.

$$\tilde{\lambda}_t \approx \overline{M}(1 - \overline{R})^{-1} + \overline{M}(1 - \overline{R})^{-1} \; \Sigma_{j=0}^{\infty} \overline{R}^{j} (R_{t+j} - \overline{R}) + \Sigma_{j=0}^{\infty} \overline{R}^{j} (M_{t+j} - \overline{M}) \quad (5)$$

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

$$M_t = a' Z_t \quad (6)$$

$$R_t = b' Z_t \quad (7)$$

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.

$$\begin{bmatrix} Z_{1,t} \\ Z_{2,t} \end{bmatrix} = \begin{bmatrix} a(L) & b(L) \\ c(L) & d(L) \end{bmatrix} \begin{bmatrix} Z_{1,t-1} \\ Z_{2,t-1} \end{bmatrix} + \begin{bmatrix} v_{1,t} \\ v_{2,t} \end{bmatrix} \quad (8)$$

Stacking:

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

(9)

In the empirical work, we set $\ell=2$. Equation (9) can be re-written in companion matrix form:

$$\tilde{Z}_t = A\tilde{Z}_{t-1} + \tilde{v}_t \quad (10)$$

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

$$E_{t-1}\left[M_{t+j}\right] = aA^{j+1}\tilde{Z}_{t-1} \quad (11)$$

$$E_{t-1}\left[R_{t+j}\right] = bA^{j+1}\tilde{Z}_{t-1} \quad (12)$$

The infinite sums that constitute fundamental Q can be calculated as follows, using the last term in the expression for fundamental Q (equation (5)) as an example:

$$E_{t-1}\Sigma_{j=0}^{\infty}\overline{R}^j M_{t+j} = \Sigma_{j=0}^{\infty}\overline{R}^j aA^{j+1}\tilde{Z}_{t-1} = a(I - \overline{R}A)^{-1}A\tilde{Z}_{t-1} \quad (13)$$

Evaluating all of the terms in (5), we obtain the following equation for $\lambda_t$:

$$\lambda_t = \overline{M}(1-\overline{R})^{-1} + \overline{M}(1-\overline{R})^{-1}\overline{R}\ b\left(I-\overline{R}A\right)^{-1} A\tilde{Z}_{t-1}$$
$$+ \overline{R}a\left(I-\overline{R}A\right)^{-1} A\tilde{Z}_{t-1} \qquad (14)$$

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.[15] With the variables in Z in the order listed above, we can define the vectors a and b as follows:

$a = [0 \ \ 1 \ \ -1 \ \ 0 \ \ 0]$

$$b = [1 \ \ 0 \ \ 0 \ \ 0 \ \ 0]$$

[15] 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).

**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 Data 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<br>[0.000] |
| Aggregated<br>(standard deviation) | 0.5556<br>(0.3460) | 0.1194<br>(0.0544) | 0.4362<br>(0.2916) | 6.23<br>[0.000] |

Scaled by investment spending. 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). The test statistic for the difference in medians is a nonparametric test based on analysis of variance on ranks. See the Data Appendix for variable definitions and portfolio construction.

**Table 2**
**Investment of Glamour, Typical, and Value Firms**
**(portfolios based on sp)**

| | Glamour | Value | Difference (Glamour vs Value) | Test Statistic [p-Value] |
|---|---|---|---|---|
| Mean | 0.285 | 0.120 | 0.165 | 67.91 [0.000] |
| Median | 0.182 | 0.080 | 0.102 | 59.70 [0.000] |

The table presents investment/capital (I/K) ratios. Glamour, typical, and value portfolios are based on the price/sales ratio. The test statistic for the difference in means is a t-test and for the difference in medians, a nonparametric test based on analysis of variance on ranks. See the Data Appendix for variable definitions and portfolio construction.

**Table 3**

**Investment of Glamour and Value Firms**
**Controlling for Fundamentals**

| | Glamour | Value | Difference (Glamour vs. Value) | Test Statistic [p-value] |
|---|---|---|---|---|
| Comparable Firms | 0.0935 | -0.0555 | 0.1490 | 58.66 [0.000] |
| Fundamental Q Benchmark | 0.1048 | -0.0503 | 0.1551 | 46.23 [0.000] |
| Market-Information Augmented Fundamental Q | 0.0928 | -0.0442 | 0.1370 | 38.34 [0.000] |

This table presents investment/capital (I/K) ratios relative to three different benchmarks for fundamentals (described more fully in the text). See the Data Appendix for variable definitions and portfolio construction.

**Table 4**
**Investment After Portfolio Formation**

| Years after portfolio formation | Glamour | Value |
|---|---|---|
| 2 | -0.037069 | -0.006496 |
| 3 | -0.057787 | -0.002489 |
| 4 | -0.072696 | -0.002335 |
| 5 | -0.085571 | -0.003141 |
| Test statistics for difference between $(I/K)_{t+5}$ and $(I/K)_{t-1}$ | 23.51 [0.000] | 2.02 [0.044] |

This table presents the mean of $(I/K)_{t+h} - (I/K)_{t-1}$, where h is the number of years after portfolio formation. See the Data Appendix for variable definitions and portfolio construction.

**Table 5**
**Fama-MacBeth Tests**

| Horizon | $\gamma_2$ | t statistic | Mean effect on returns of a one std. dev. increase in “overinvestment” |
|---|---|---|---|
| **2 year** | -0.2840 | -2.7871 | -0.0460 |
| **3 year** | -0.2719 | -2.7095 | -0.0459 |
| **4 year** | -0.3551 | -3.2218 | -0.0584 |
| **5 year** | -0.3430 | -2.9108 | -0.0563 |

The parameter $\gamma_2$ is the coefficient on “overinvestment” for glamour firms in a Fama-MacBeth regression of cumulative excess returns on the CAPM $\beta$ 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 Data Appendix for variable definitions and portfolio construction.

**Table 6**

**Parametric Estimates of The Effect of Misvaluation on Investment**
**Generic Investment Specification**

| | **(1)** | **(2)** |
|---|---|---|
| Misvaluation | 0.0032267<br>(0.0000696)<br>[46.34] | 0.0032630<br>(0.0000696)<br>[46.89] |
| Output | 0.1057030<br>(0.0018990)<br>[55.66] | 0.1047200<br>(0.0018967)<br>[55.21] |
| Relative Price of Investment Goods | -0.1177810<br>(0.0058704)<br>[-20.06] | -0.1175470<br>(0.0058573)<br>[-20.07] |
| Interest rate | -0.0015221<br>(0.0010937)<br>[-1.39] | -0.0014470<br>(0.0010912)<br>[-1.33] |
| Cash Flow | | 0.0101090<br>(0.0005758)<br>[17.56] |
| Number of Obs | 67837 | 67756 |
| Number of Firms | 9075 | 9070 |
| F | 3.8036 | 3.7175 |
| Prob. > F | 0.0000 | 0.0000 |
| $R^2$ | 0.4964 | 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. See the Data appendix for additional details of variable definitions. Misvaluation is the difference between stock market Q and fundamental Q (both beginning of period), as defined in the text. The regressions include both fixed effects and year effects.

## Table 7

**Parametric Estimates of The Effect of Misvaluation on Investment**
**Neoclassical and Accelerator Specifications**

| | Neoclassical | | Accelerator | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Misvaluation | 0.0026910<br>(0.0000734)<br>[36.69] | 0.0027009<br>(0.0000735)<br>[36.77] | 0.0027042<br>(0.0000735)<br>[36.80] | 0.0027142<br>(0.0000736)<br>[36.88] |
| Output $_t$ | 0.1119690<br>(0.0019341)<br>[57.89] | 0.1098170<br>(0.0019518)<br>[56.26] | 0.1105660<br>(0.0019303)<br>[57.28] | 0.1083930<br>(0.0019479)<br>[55.65] |
| Output $_{t-1}$ | 0.0906170<br>(0.0018870)<br>[48.02] | 0.0903160<br>(0.0018878)<br>[47.84] | 0.0892470<br>(0.0018836)<br>[47.38] | 0.0889500<br>(0.0018844)<br>[47.20] |
| Output $_{t-2}$ | 0.0552560<br>(0.0017941)<br>[30.80] | 0.0552190<br>(0.0017958)<br>[30.75] | 0.0539810<br>(0.0017917)<br>[30.13] | 0.0539470<br>(0.0017933)<br>[30.08] |
| Cost of Capital $_t$ | -0.0120950<br>(0.0011175)<br>[-10.82] | -0.0120150<br>(0.0011173)<br>[-10.75] | | |
| Cost of Capital $_{t-1}$ | -0.0126630<br>(0.0010992)<br>[-11.52] | -0.0126210<br>(0.0010994)<br>[-11.48] | | |
| Cost of Capital $_{t-2}$ | -0.0093059<br>(0.0010584)<br>[-8.79] | -0.0092945<br>(0.0010582)<br>[-8.78] | | |
| Cash Flow | | 0.0042408<br>(0.0005727)<br>[7.40] | | 0.0042984<br>(0.0005738)<br>[7.49] |
| Number of Obs | 60473 | 60404 | 60473 | 60404 |
| Number of Firms | 8053 | 8048 | 8053 | 8048 |
| F | 3.5458 | 3.4842 | 3.5636 | 3.5009 |
| Prob. > F | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| $R^2$ | 0.5263 | 0.5264 | 0.5245 | 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 fundamental Q (both beginning of period), as defined in the text. The regressions include both fixed effects and year effects.

## Table 8

### Parametric Estimates of The Effect of Misvaluation on Investment
### Q Specification

| | (1) | (2) |
|---|---|---|
| Misvaluation | 0.0031106<br>(0.0000698)<br>[44.56] | 0.0031455<br>(0.0000700)<br>[44.94] |
| Fundamental Q | 0.0289500<br>(0.0005085)<br>[56.94] | 0.0280880<br>(0.0005193)<br>[54.09] |
| Cash Flow | | 0.0046464<br>(0.0005884)<br>[7.90] |
| Number of Obs | 67837 | 67756 |
| Number of Firms | 9075 | 9070 |
| F | 4.3299 | 4.3373 |
| Prob. > F | 0.0000 | 0.0000 |
| $R^2$ | 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 fundamental Q (both beginning of period), as defined in the text. The regressions include both fixed effects and year effects.

**Table 9**

**Parametric Estimates of The Effect of Misvaluation on Investment**
**Q Specification**

| | (1) | (2) |
|---|---|---|
| Fundamental Q | 0.0289500<br>(0.0005085)<br>[56.94] | 0.0280880<br>(0.0005193)<br>[54.09] |
| Cash Flow | | 0.0046464<br>(0.0005884)<br>[7.90] |
| Misvaluation | 0.0031106<br>(0.0000698)<br>[44.56] | 0.0031455<br>(0.0000700)<br>[44.94] |
| Number of Obs | 67837 | 67756 |
| Number of Firms | 9075 | 9070 |
| F | 4.3299 | 4.3373 |
| Prob. > F | 0.0000 | 0.0000 |
| $R^2$ | 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 fundamental Q (both beginning of period), as defined in the text. The regressions include both fixed effects and year effects.

Figure 1

Q Theory

Permanent Fundamental Shock

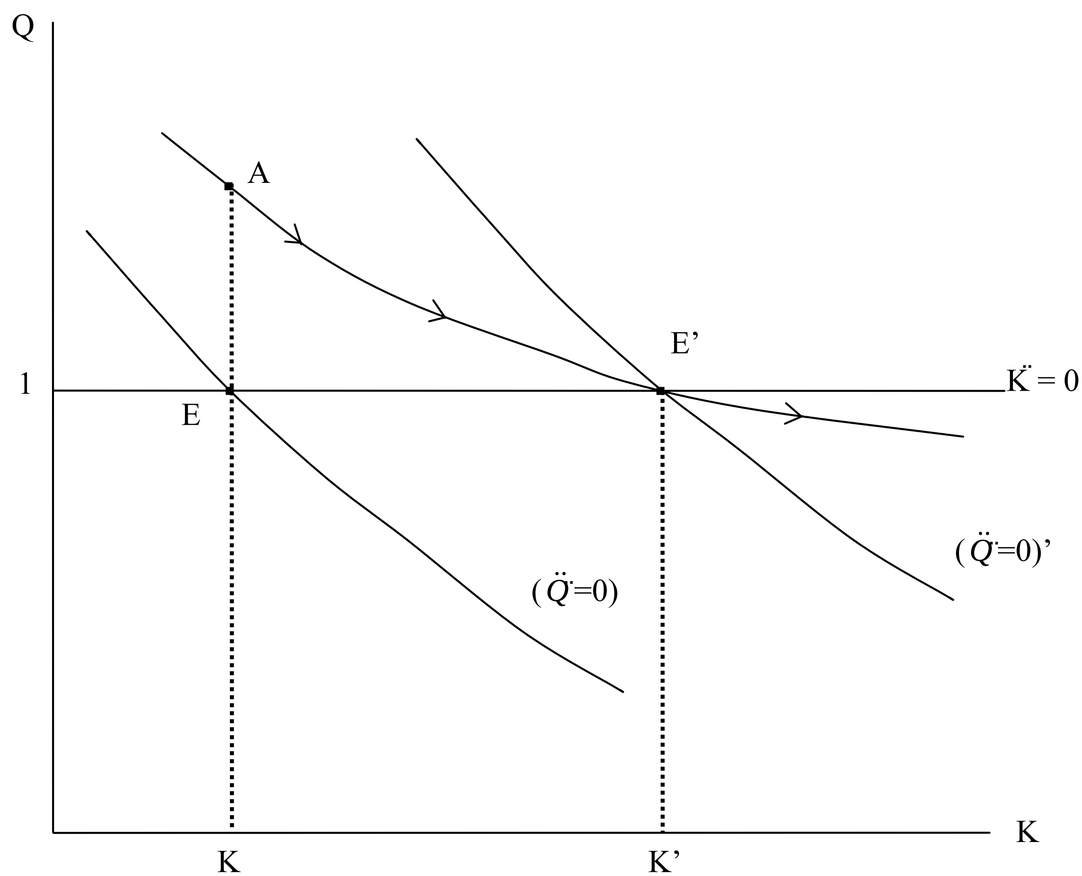

Figure 2

Q Theory

Transitory Fundamental Shock

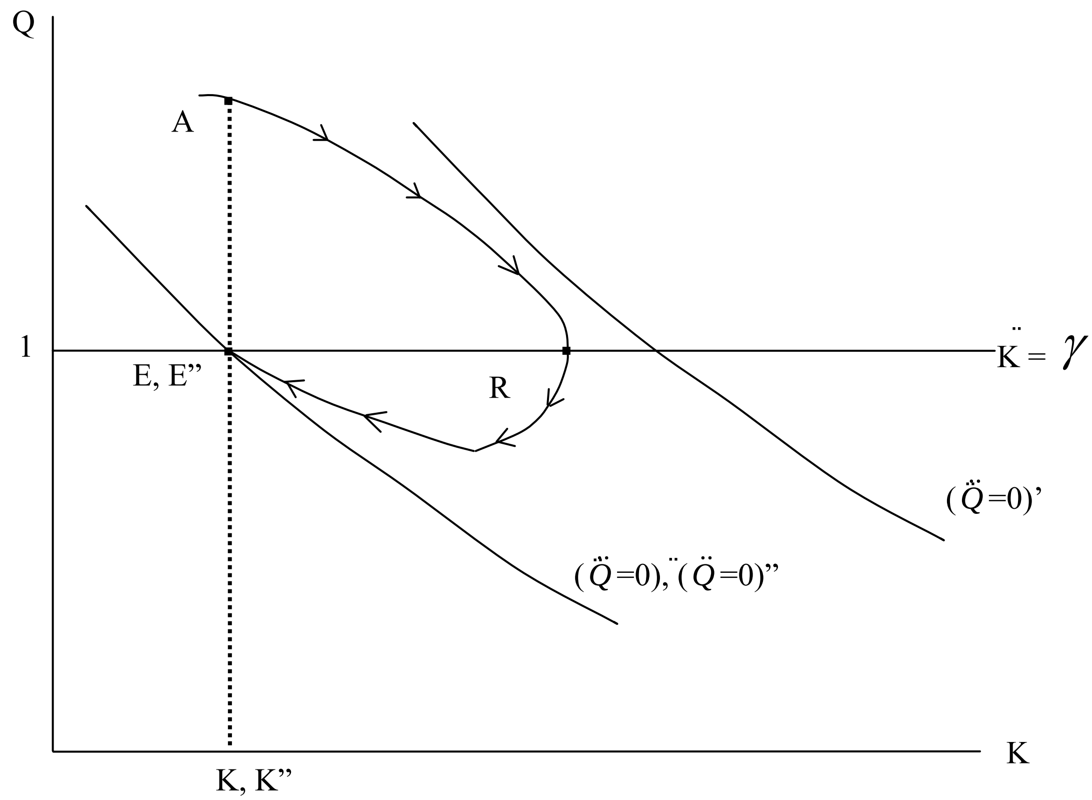

Figure 3

Supply and Demand for Capital

Favorable Fundamental Shock

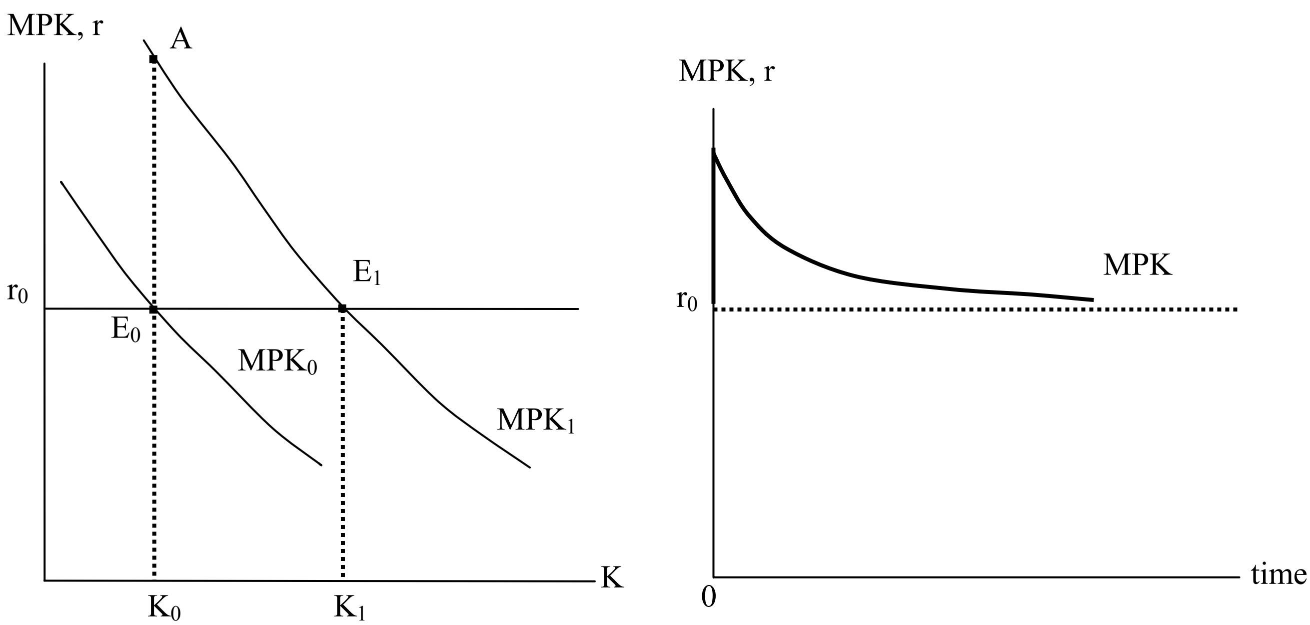

Figure 4

Supply and Demand for Capital

Favourable Misvaluation Shock

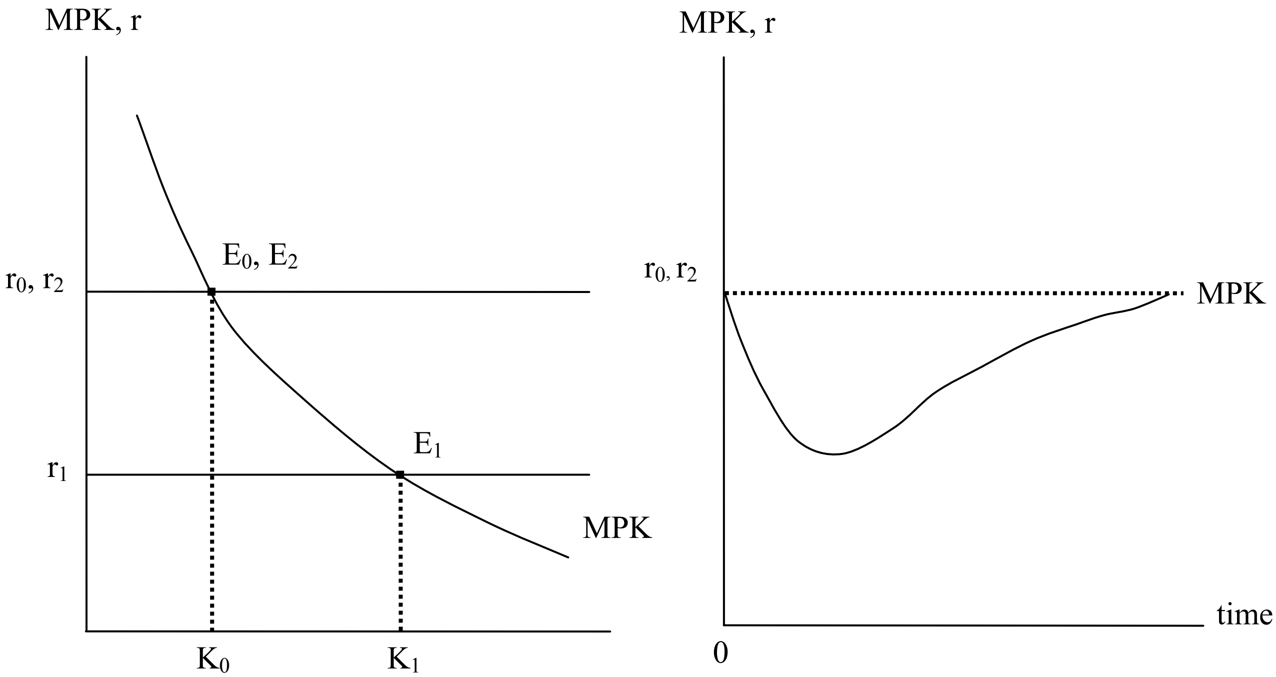

**Figure 5**
**Mean Marginal Product of Capital: Glamour Firms**

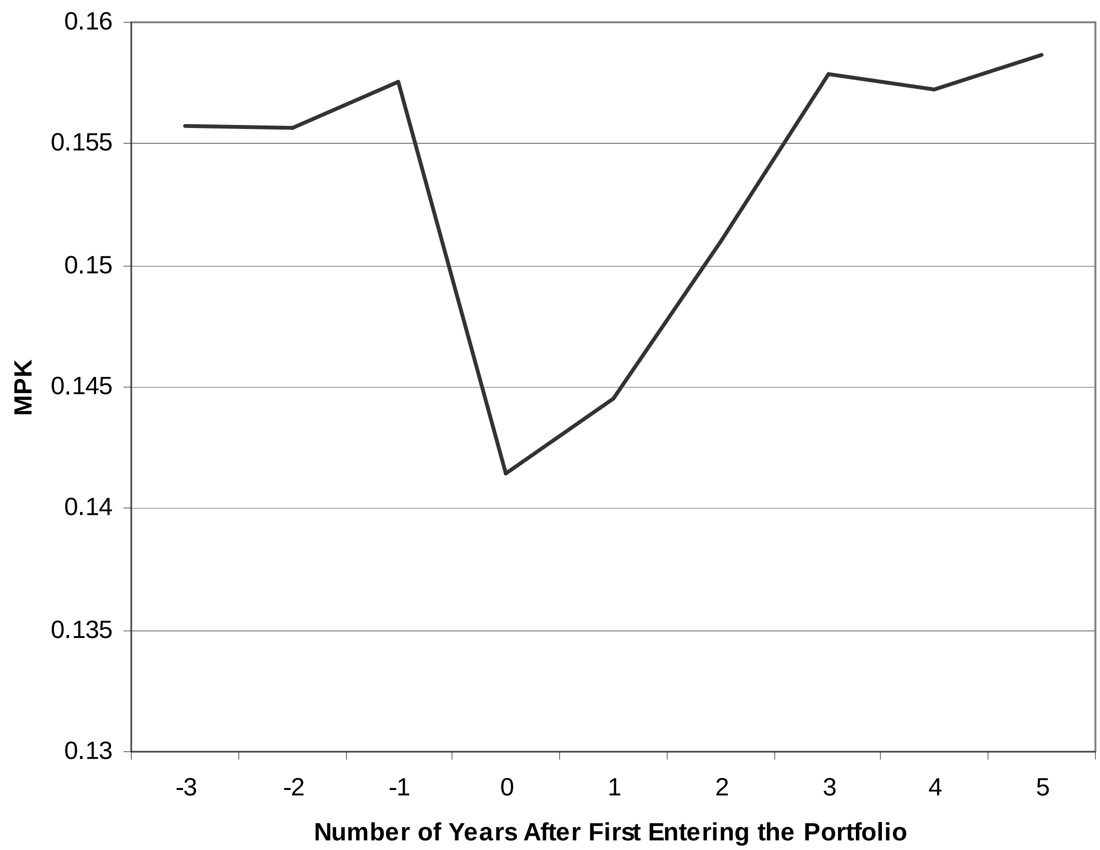

**Figure 6 Impulse response of investment to a sale shock**