The Productivity of Cash and the Cross-Section of Expected Stock Returns

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Satyajit Chandrashekar
Advanced Research Center
State Street Global Advisors
1 Lincoln Street
Boston, MA - 02111
617-664-9603
satyajit_chandrashekar@ssga.com

Ramesh K. S. Rao*
McDermott Professor of Finance
McCombs School of Business
University of Texas at Austin
Austin, TX 78712
512-475-8756
ramesh.rao@mccombs.utexas.edu

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* Corresponding author. The views expressed in this paper are those of the authors and not necessarily those of the institutions they are affiliated with.

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ABSTRACT: We first show, analytically, that the expected return on the stock, firm size, and the book-to-market ratio (B/M) are functionally dependent on the "productivity of cash," defined as the firm's economic rents scaled by its cash holdings. We then show that, empirically, the productivity of cash is a highly significant and robust negative predictor of stock returns. Our research suggests that the predictive power of size and B/M in earlier studies may stem from their role as proxies for the productivity of cash- a new and economically-rationalized factor that explains the cross-section of stock returns.

1 Introduction

This research is motivated by the need for economic explanations for two long-standing empirical regularities that have been widely discussed in the research. The first of these, the "size effect," is the observed negative relation between stock returns and the market value of the firm's equity [Banz (1981), Reinganum (1981), Keim (1983)]. The second is the "value effect," the observed inverse relation between firms' expected stock returns and the equity's book-to-market ratio [Fama and French (1992)]. A large body of empirical work has found that, controlling for the stock's priced risk (beta), firms with small equity valuations ("small firms") and those with high book-to-market ratios ("value firms") yield higher returns than predicted by the theory. These results are puzzling because they cannot be rationalized within the standard asset-pricing theory wherein, controlling for financial risk, no other firm characteristic should influence expected returns. Thus, to the extent that the asset-pricing theory correctly reflects stock-pricing in the markets, the size and book-to-market effects are market anomalies.

Perhaps the most widely-discussed explanation for these anomalies is the Fama and French (1992, 1993) view that book-to-market and size are two "distress factors" missing from the CAPM.[1] However, this interpretation is difficult to justify

[1]Others attribute the anomalies to data-shooping bias [Lo and MacKinlay (1990), Kothari, Shanken and Sloan ((1995)], mispricing [Lakonishok, Shleifer and Vishny (1994)], learning ef-

theoretically. Shliefer (2000), for example, notes: " It is not entirely obvious ... how either size or market to book ratio, whose economic interpretations are dubious in the first place, have emerged as hitherto unnoticed but critical indicators of fundamental risk more important than the market risk itself." The empirical evidence is ambiguous. The view that the book-to-market ratio proxies for a risk factor is supported in some [e.g., Shumway (2001), Vassalou and Xing (2004)] and disputed in other studies [e.g., Dichev (1998), Griffin and Lemmon (2002) and Campbell, Hilscher and Szilagyi (2004)]. Daniel and Titman (1997) argue that size and book-to-market are not risk factors in an equilibrium pricing model but Davis, Fama and French (2000) find that the Daniel-Titman results do not hold outside their sample period. Daniel and Titman (2001) reject the Fama-French (1993) three-factor model but fail to reject the characteristics model. Some authors [e.g., Lakonishok et. al. (1994), La Porta (1996), and La Porta et. al. (1997)] attribute the value effect to investors' irrationality.

As the debate continues, firm size and the book-to-market ratio continue to be routinely used as controls in regressions. Several researchers have found this troubling since the book-to-market ratio "is not a 'clean' variable uniquely associated with economically interpretable characteristics of firms" [Lakonishok et. al. (1994)]. Moreover, the literature uses the book-to-market ratio in different ways. In corporate finance, for example, the book-to-market ratio is often viewed to be a proxy for the firm's investment opportunities and for potential agency con-

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fects [Lewellen and Shanken (2002)] and the need for multifactor models [MacKinlay (1995)]. The research in Campbell (1996), Jagannathan and Wang (1996) and Lettau and Ludvigson (2001) suggests that human capital may be important for explaining the anomalies, and the arguments in Brav et. al. (2002) is consistent with the view that the value effect is due to analysts' expectational errors. Carlson, Fisher and Giammario (2004) and Zhang (2005) suggest that these effects are due to the potential impact of the firm's growth options. Yet another explanation pertains to time-varying investment opportunities and risk premia for omitted state variables [Fama and French (1993, 1996)]. A related research strand implies that the book-to-market ratio and size depend on rates of economic growth [Liew and Vassalou (2000)] and to innovations in the state variables that predict the excess market return and the yield curve [Petkova (2006)]. Zhang (2005) invokes competitive equilibrium to study the value effect, and Campbell and Vuolteenaho (2004) argue that the size and value effects can be explained if one decomposes the beta of a stock into two components- a cash flow beta and a discount rate beta. This listing is by no means exhaustive.

flicts between stockholders and managers [Morck, Shliefer and Vishny (1998)]. This use of the book-to-market ratio as an empirical proxy in different contexts "... raises serious questions about interpreting any evidence in a normative way to give firms or managers advice about corporate financial policy" [Schwert (2003, p. 969)]. It is unclear whether firm size somehow proxies for a more fundamental source of risk or value, and our understanding of the economic or statistical causes of the apparently high average returns to small firms' stocks is incomplete [Schwert (1983)]. Not surprisingly, several authors [e.g., Berk (1995), and Berk et. al. (1999) and Schwert (2003)] argue the need for *economically motivated* explanations of the size and book-to-market effects. These authors emphasize the need to develop theoretical models that can yield new testable hypotheses that go beyond the stage of explaining the extant stylized facts. Consistent with this view, the research in Berk et. al. (1999) links the book-to-market ratio to the firm's risk relative to the scale of its asset base.

In this regard, this paper takes another forward step albeit from a different perspective. The starting point for our analysis is the extensive evidence that firms hold considerable amounts of cash and that managers view cash as important [e.g., Donaldson (1961), Harford (1972), Fazzari et. al. (1988), John (1993), Opler and Titman (1994), Opler et. al. (1999) and Graham and Harvey (2001)]. Dittmar at. al. (2003) document that in 1990 the cash and marketable securities held by large publicly-traded firms was 5% of all corporate assets. In 2003, firms' holdings of cash and marketable securities exceeded 11% of the sum of all corporate assets, and this amounted to about 10% of the nation's Gross Domestic Product. It is thus not surprising that practitioner-oriented publications (e.g., CFO Magazine) devote great attention to the management of the firm's cash, and that corporate finance textbooks [e.g., Ross et. al. (2005)] note that, in addition to investment and financing choices, working capital decisions are a key managerial responsibility.

Yet, cash remains "an unresolved finance issue" [Brealey et. al. (2006)] because the firm, in the standard [Modigliani-Miller, MM (1958)] theory, does not require any cash to generate future cash flows, and the MM model mandates full disbursement of all cash that the firm generates [DeAngelo and DeAngelo (2006)]. Thus the firm has, in standard corporate finance and asset-pricing theories, only two asset components: physical assets and economic rents (NPVs plus value of growth options). The theory assumes that the investors' expected cash flows, and hence the expected stock returns, depend only on the cash flows generated by the firm's operations (net operating income).

This raises an immediate question. Could it be that stock prices are capturing investors' expectations about changes in firms' (empirically substantial) cash holdings? Clearly, to the extent that firms hold cash (for whatever reason), investors' expected dividends must depend on their expectations of the firms' incremental (positive and negative) future investments in cash.

We take up this question, and examine stock returns from a new perspective. We begin with the assumption that firms maintain cash to increase economic rents.[2] The reason(s) *why* cash can augment rents is not important for our analysis; the fact that firms hold cash *is*. With cash holdings exogenously assumed, we shift our focus away from risk-based explanations for stock returns, and on to the firm's assets. Specifically, we examine how expected stock returns depend on the expected returns on the firm's individual asset components.

The rest of the paper is organized as follows.

In Section II we propose a simple and intuitive single-period model of firm value and expected stock returns. In our model the firm has *three* assets- physical assets, economic rents, and cash. Since the value of the firm (stock price) is the

[2] Cash can affect economic rents in many ways. The standard explanations for cash holdings is that they can serve a transactions, precautionary or speculative role. The more recent research has noted that cash can reduce the value loss arising from informational asymmetries [Myers and Majluf (1994)], and it can help firms that have limited access to external finance [Almeida et. al (2002)]. Cash can play a hedging role [Acharya et. al (2005)] and it can yield strategic benefits to firms in the product markets [Haushalter et. al. (2005)]. Cash is required in the value theory if the firm has operating risk and nonsecuritizable contracts [Rao (2005)]. Pinkowitz and Williamson (2001) argue that cash yields banking firms the power to extract rents. Blanchard et. al. (1994) discuss cash holdings that arise from windfalls. However, excessive cash can induces agency costs [Jensen (1993)]. Harford (1999) reviews the agency cost explanations for corporate cash. Dittmar et. al (2003) discuss international cash holdings in the context of corporate governance. Faleye (2004) argues that the threat of takeovers constrains the amount of cash holdings.

cumulated value of the firm's asset components (value additivity), stock prices reflect the firm's cash holdings.[3] Moreover, with cash on the firm's balance sheet the investors' expected cash flows, and hence their expected returns, depend on the firm's cash. With cash explicit in our model we then examine the firm's "productivity of cash," which we define as the rents generated by the firm per dollar of cash holdings. If two firms create identical rents, but with different cash holdings, the one with the lower cash has a higher productivity of cash. As defined, the productivity of cash is a ratio of two asset components (rents/cash).

Our model implies that with value additivity one *must* expect to see firm size increasing, and the book-to-market ratio decreasing, in the productivity of cash. It also implies that the stock's expected return is inversely related to the productivity of cash and firm size, and directly related to the equity's book-to-market ratio. Thus, firms with higher (lower) productivity of cash will have lower (higher) expected returns. Stated differently, firms with lower productivity of cash will have higher costs of capital. Similarly, firms with higher (lower) book-to-market ratios will have higher (lower) expected stock returns. These theoretical results are economic explanations for the observed size and value effects because both size and book-to-market are, in our model, functionally related to the productivity of cash.

In Section III we reconcile the new results with the traditional risk-based intuition. We do this in two parts. We first show that there is an inverse relation between stock betas and the productivity of cash. This explains why high productivity firms have lower expected rates of return. We then provide intuition for *why* the productivity of cash matters. We note that whereas the firm's cost of capital in finance (under the no-arbitrage condition) depends only on beta, the cost of capital in economics (under competitive equilibrium) depends also on the assets required to generate the firm's cash flows. Since the productivity of cash measure contains information about both the discount rate (this is implicit in the rents) *and* the assets needed to generate the cash flows, it is more likely to explain expected

[3] Consistent with this intuition, there is a growing literature in finance that investigates the implications of cash for stock prices [e.g., Pinkowitz and Williamson (2004), Faulkender and Wang (2006)].

stock returns in competitive equilibrium.

Section IV describes the data used in the paper's empirical analyses.

Section V presents the results of our empirical tests. We document evidence that is strongly supportive of the model's implications. We find that the productivity of cash is a strong and robust negative predictor of returns. Firms with high cash productivity have low subsequent stock returns, and low-productivity firms have high future returns. Moreover, we find that the productivity of cash subsumes the size and book-to-market effects. This suggests that the predictive power of size and book-to-market that has been noted in the empirical research may stem from their role as proxies for a more fundamental economic factor- the productivity of cash.

Section VI concludes the paper.

2 Expected Stock Returns and Asset-characteristics

2.1 The Economic Environment

Consider a firm established at t_0 and liquidated at t_1. The firm makes a t_0 investment, $I,$ in plant and equipment. In addition it must maintain, for some exogenous reason, cash in an amount $L.$ Thus, the total cash investment in the firm at t_0 is $I + L.$ Assume that the cash is invested in riskless marketable securities yielding the riskless interest rate, $r_f.$ Now assume that the investment yields operating income $\tilde{X}$ at t_1. The total cash flows available for distribution to investors at t_1 is now the sum of two components - operating income (earnings), and the t_1 value of the cash carried over from $t_{0.}$ The investors' cash flows at t_1 are thus $E(\tilde{X}) + L(1 + r_f).$

The firm generates economic rents, denoted by $R.$ The firm's rents at t_0 are the risk-adjusted present value of $[E(\tilde{X}) + L(1 + r_f)]$ less the total t_0 investment of $(I + L).$ Note that the firm's rents contain information about expected cash flows, the discount rate and the assets required to generate the cash flows. The interesting question now is: How productively is the firm using its cash?

Stock Price and the Productivity of Cash. The value of the unlevered firm (stock price), $M,$ is the cumulated market value of the firm's individual asset components. Thus, the stock price at t_0 is:

$$M = I + L + R \tag{1}$$

Now define the productivity of cash, $\eta,$ as the economic rents per dollar of cash held by the firm:

$$\eta = \frac{R}{L} \tag{2}$$

As defined, η is a scaled variable that measures the efficiency with which the firm creates wealth. As with rents, the productivity of cash implicitly contains information about the expected cash flows, the discount rate for valuing these flows, and the investment required to generate the flows. The firm's stock price in equation (1) can now be expressed as:

$$M = I + L(1 + \eta) \tag{3}$$

It is obvious from equations (1) and (3) that that firm size is increasing in the firm's rents and in the productivity of cash:[4]

$$\frac{\delta M}{\delta R} = 1 > 0 \tag{4}$$

$$\frac{\delta M}{\delta \eta} = L > 0 \tag{5}$$

Partial differentiation of (1) with respect to L yields $\frac{\delta M}{\delta L} = 1 + \frac{\delta R}{\delta L}$. If the firm choose that level of cash that maximizes its rents, the cash level satisfies $\frac{dR}{dL} = 0.$ Thus, with optimal cash holdings, firm value increases, dollar for dollar, with

[4] Our goal is to identify propositions that can be empirically tested using cross-sectional returns data. Partial derivatives suffice for this purpose.

cash.[5]

$$\frac{\delta M}{\delta L} = 1 \tag{6}$$

This result is useful for subsequent comparative statics analysis.

Size, Book-to-market ratio, and the Productivity of Cash. As seen, the firm's owners must supply capital at t_0 in the amount of $I + L$. The t_0 book value of the equity, $B,$ is therefore $I + L.$ The market value of the firm in (3) can therefore be written in terms of the book-to-market ratio:

$$M = B + \eta L \tag{7}$$

Equation (7) implies that the equity's book-to-market ratio, B/M, is

$$\frac{B}{M} = 1 - \eta \frac{L}{M} \tag{8}$$

Thus, the book-to-market ratio is negatively related to the productivity of cash:

$$\frac{\delta(B/M)}{\delta \eta} = \frac{-L}{M} < 0. \tag{9}$$

2.2 Expected Stock Returns and Asset-Characteristics

From (1), the expected return on the stock, r, is the weighted average of the expected returns on the firm's asset components. Thus,

$$r = \frac{1}{M}[Ir_I + Lr_L + Rr_R] \tag{10}$$

where r_I,$r_L,$ and r_R are the expected rates of return on the firm's investment in plant and equipment, on cash, and on the rents, respectively. Since the cash is invested at the riskless rate $r_L = r_F$. The firm's economic rents evaporate at t_1

[5] Some recent research [e.g, Faulkender and Wang (2006)] documents that a dollar of cash held by the firm adds less than a dollar to firm value. Since our focus is on asset-pricing we do not include the myriad "frictions" that this literature considers–these can reduce the value of the cash.

(the firm ceases to exist) and thus $r_R = -1$. Equation (10) reduces to:

$$r = \frac{1}{M}[Ir_I + Lr_f - R] \tag{11}$$

Stock Returns and Firm Size. Partially differentiating the expected stock return in (11) with respect to firm size, and recognizing that the firm's investment in I and its return r_I are determined exogenously, we have:

$$\frac{\delta r}{\delta M} = \frac{1}{M^2}(-Ir_I + Mr_f\frac{\delta L}{\delta M} - Lr_f - M\frac{\delta R}{\delta M} + R) = \frac{1}{M^2}[(-Ir_I - Lr_f + R) - M(1 - r_f)] \tag{12}$$

since, from (4) and (6), $\frac{\delta R}{\delta M} = \frac{\delta L}{\delta M} = 1$ at the optimum. Substituting into (12) the implication from (11) that $-Ir_I - Lr_f + R = -rM$ and rearranging terms yields, for a stock with positive financial risk:

$$\frac{\delta r}{\delta M} = \frac{-1}{M}[1 + (r - r_f)] < 0 \tag{13}$$

TESTABLE IMPLICATION 1: *Expected stock returns should, in cross-section, be inversely related to firm size.*

Stock Returns and the Book-to-Market Ratio. Partially differentiating (11) with respect to the equity's book-to-market ratio yields:

$$\frac{\delta r}{\delta(B/M)} = \frac{1}{M^2}[-Ir_I\frac{\delta M}{\delta(B/M)} + Mr_f\frac{\delta L}{\delta(B/M)} - Lr_f\frac{\delta M}{\delta(B/M)} - M\frac{\delta R}{\delta(B/M)} + R\frac{\delta M}{\delta(B/M)}]$$

$$= \frac{1}{M}[(-r\frac{\delta M}{\delta(B/M)} + r_f\frac{\delta L}{\delta(B/M)} - \frac{\delta R}{\delta(B/M)}]$$

But $\frac{\delta M}{\delta(B/M)} < 0$,$\frac{\delta L}{\delta(B/M)} > 0$,and $\frac{\delta R}{\delta(B/M)} < 0$.[6] This implies that:

[6]Partial Derivatives:

a. To show $\frac{\delta M}{\delta(B/M)}$<0, begin with equation (8) and note that $\frac{\delta(B/M)}{\delta M} = -\eta\frac{\delta(L/M)}{\delta M} - \frac{L}{M}\frac{\delta\eta}{\delta M} = \frac{-\eta}{M^2}[M\frac{\delta L}{\delta M} - L] - \frac{L}{M}(\frac{1}{L}) = \frac{-1}{M}[\eta(\frac{M-L}{M}) + 1]$. Since 1>$(\frac{M-L}{M})$>0, $\frac{\delta(B/M)}{\delta M}$<0 which implies

$$\frac{\delta r}{\delta(B/M)} > 0 \tag{14}$$

TESTABLE IMPLICATION 2: *Expected stock returns should, in cross-section, be increasing in the equity's book-to-market ratio.*

Stock Returns and the Productivity of Cash. Differentiating (11) with respect to the productivity of cash we have:

$$\frac{\delta r}{\delta \eta} = \frac{1}{M^2}[(-Ir_I - Lr_f + R)\frac{\delta M}{\delta \eta} + Mr_f\frac{\delta L}{\delta \eta} - M\frac{\delta R}{\delta \eta}]$$

Since from (5) $\frac{\delta M}{\delta \eta} = L$, and from (3), $\frac{\delta L}{\delta \eta} = \frac{-L^2}{R} = \frac{-L}{\eta}$, and $\frac{\delta R}{\delta \eta} = L$, we have:

$$\frac{\delta r}{\delta \eta} = \frac{-L}{M}(1 + r + \frac{r_f}{\eta}) < 0. \tag{15}$$

TESTABLE IMPLICATION 3 : *Expected stock returns should, in cross-section, be decreasing in the productivity of cash.*

The implication that expected stock returns are lower for firms with higher productivity of cash may initially appear non-intuitive. However, expected stock returns are the firm's cost of equity capital. Equation (15) simply states that less productive firms will have a higher cost of capital.

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that $\frac{\delta M}{\delta(B/M)}$<0.

b. Again, from (8), $\frac{\delta(B/M)}{\delta L}$=$-\eta\frac{\delta(L/M)}{\delta L} - \frac{L}{M}\frac{\delta\eta}{\delta L}$=$\frac{-\eta}{M^2}[M\frac{\delta L}{\delta L} - L\frac{\delta M}{\delta L}]$-$\frac{L}{M}(\frac{-R}{L^2})$. But at the optimum, $\frac{\delta M}{\delta L} = 1$. Thus we have: $\frac{\delta(B/M)}{\delta L}$=$\frac{\eta}{M}[1 - (\frac{M-L}{M})]$. Since $(\frac{M-L}{M}) < 1, \frac{\delta(B/M}{\delta L}$, and hence, $\frac{\delta L}{\delta(B/M)}$>0.

c. From (8), $\frac{\delta(B/M)}{\delta R} = -\eta\frac{\delta(L/M)}{\delta R} - \frac{L}{M}\frac{\delta\eta}{\delta R} = \frac{-\eta}{M^2}[M\frac{\delta L}{\delta R} - L\frac{\delta M}{\delta R}]$-$\frac{L}{M}(\frac{1}{L})$. But, at the optimum, $\frac{\delta L}{\delta R} = 0$. Thus $\frac{\delta(B/M)}{\delta R} = \frac{1}{M}(\frac{\eta L}{M} - 1) = \frac{1}{M}(\frac{R-M}{M})$<0. Thus, $\frac{\delta R}{\delta(B/M)} < 0$.

3 Reconciliation with the Risk-based Intuition

3.1 The Productivity of Cash and Stock Betas

The preceding discussion shows how the stock's expected returns are affected by the firm's asset-characteristics. It is useful to reconcile these findings with the standard risk-based intuition for expected stock returns. For this purpose, rewrite the productivity of cash in (2) as

$$\eta = \frac{M - I - L}{L} \tag{16}$$

With cash in the firm earning r_f, the investors' expected cash flows at t_1 now have, as already noted, two components: the cash flow from operating income, $\tilde{X}$, as in the standard theory, plus $L(1 + r_f)$. Now assume that expected returns can be described by the single-factor arbitrage pricing theory (APT):[7]

$$r = r_f + \beta[E(\tilde{r}_e) - r_f] \tag{17}$$

where $\tilde{r}_e$ is the return on some unspecified exogenous factor generating economic shocks (not necessarily the market portfolio). Then, the productivity of cash in equation (16) can be represented as

$$\eta = \frac{\frac{E(\tilde{X})+L(1+r_f)}{1+r_f+\beta[E(\tilde{r_e})-r_f]} - I - L}{L} \tag{18}$$

Solving for the stock's priced risk in (18) shows that

$$\beta = \frac{E(\tilde{X}) + L(1 + r_f)}{I + L(1 + \eta)(\overline{r}_e - r_f)} - \frac{1 + r_f}{\overline{r}_e - r_f} \tag{19}$$

It is obvious that the firm's financial risk is inversely related to the productivity of cash:

[7] Fama and French (2006) conclude that the CAPM beta has no independent role in explaining stock returns. We emphasize that our reconciliation does not assume the CAPM.

$$\frac{\delta\beta}{\delta\eta} < 0 \tag{20}$$

The findings that expected stock returns are related to the firm's asset-characteristics make intuitive sense. As the productivity of cash increases, the stock becomes less risky, and its expected return decreases. Also, the equity's book-to-market ratio decreases. Taken together, this means that value stocks (those with higher book-to-market ratios) have greater financial risk [as in Chen and Zhang (1998)]. Since firm size increases with the productivity of cash, the implication is also that large firms have less financial risk.

3.2 Productivity determines the Cost of Captial in Competitive Equilibrium.

The intution for why the productivity of cash should affect expected stock returns hinges on two observations. First, as noted, the expected return on the stock is the firm's cost of (equity) capital. Second, two firms that are perfect substitutes should have the same cost of capital (to preclude arbitrage).

These two ideas are the core of the MM no-arbitrage theory. In MM, two firms are perfect substitutes if they are in the same "risk class," and they are in the same risk class if their earnings (cash flows) are strictly proportional to one another. The research has since replaced their risk class notion with the firms' returns beta. Thus two firms are perfect substitutes, and should hence have the same cost of capital, if both have identical returns beta. Since a firm's returns beta is its cash flow beta scaled by firm value, only the cash flow distribution and firm value matter for determining the cost of capital. The magnitude and composition of assets required to generate the cash flow distribution, and hence firm value, are altogether irrelevant in the no-arbitrage theory. Two firms with identical expected cash flow distributions, even if they are generated by vastly different initial investment in assets, will have the same value and are perfect substitutes. Although Fama and Miller (1972) have long noted that this view is only an approximation, the significance of this observation has not received adequate attention in the research.[8]

The notion of perfect substitutes is diffferent in the vast cost of capital literature in economics.[9] In economic theory the focus is on competitive equilibrium, not the absence of arbitrage. (As is well known competitive equilibrium implies no-arbitrage, but the converse is not true.) Two firms are considered perfect substitutes only if they have the same operating efficiency or productivity (broadly defined as some measure of output per unit of input). Capital flows in search of the most productive investments and the profit-maximizing firm under competition *must* maximize operating efficiency, or it is destined to be displaced by the competition.[10] Efficiency is the basis for the "fundamental theorems of welfare economics" [Mas Collell et. al (1995)]. It is thus not enough to simply maximize firm value; *how* these cash flows are generated matters. Two firms with identical expected cash flow distributions are perfect substitutes in competitive equilibrium only if the capital required to generate these flows is also the same.

However, there is no consensus in the literature on how productivity should be defined. For this reason, we focus on the productivity of cash. The firm's total assets include "productive assets" (plant, machinery etc.) and "unproductive assets" (cash, by itself, is a zero-NPV investment). Thus, η reflects the efficiency with which the firm creates wealth out of its holdings of unproductive assets. Since the firm's rents are the present value of the expected cash flows discounted at the appropriate risk-adjusted discount rate minus the capital required to support the cash flows, η reflects three factors– the firm's β, its cash holdings, L,and the investment in I. It thus contains more of the information that determines the cost

[8]"Intuitively, even if their earnings are proportional, the securities of the two firms need not be perfect substitutes if the earnings streams are obtained with nonproportional and uncertain investment outlays" (Fama and Miller, p. 161 footnote 14).

[9]The seminal work is by Jorgensen (1963). Jorgensen's cost of capital notion is also related to Tobin's *q* (1969). For a comprehensive survey of the theory and empirical work on cost of capital in economics the reader is referred to, for example, Lau (2000).

[10]Jensen (1993) discusses the importance of productivity, free entry and exit in the early and recent economic experience.

of capital in competitive equilibrium and, as such, it is more likely to better explain expected stock returns.

The next section conducts tests of the three testable implications identified in Section 2.

4 Data and Empirical Methodology

4.1 Data construction

The firm-level data for this study comes from the intersection of the Center for Research in Security Prices (CRSP) and COMPUSTAT databases. The CRSP monthly stock file contains monthly stock returns, shares outstanding, and dividends for NYSE, AMEX and NASDAQ stocks, and information about the risk-free rates. COMPUSTAT provides accounting information for most publicly trades U.S. stocks. Our sample period spans 498 months, from July 1962 through December 2003. To be included in this study, we require firms to have sufficient financial and accounting data to compute the requisite variables. This requirement results in an initial sample size of 2,829,586 firm-month observations.

4.2 Measuring the productivity of cash

Recall that the productivity of cash, η, measures the economic rents per dollar of cash held by the firm. Economic rents are the net present value of all the firm's present and future projects. Rents can also been computed as the difference between the firm's market value and the market value of the its total investments (total assets e.g. physical investments and cash). As seen from the additivity equation (1), $R = M - I - L = M - TPA$ where $TPA = I + L$ is the firm's total physical assets. Empirically, we cannot observe the market value of the firm's investment in physical assets. We therefore assume that the book value of the assets is also their market value. We compute rents R_t at time t, as follows:

$$R_t = MV_t - TPA_t \tag{21}$$

where MV_t is the market value of the firm's equity plus the book value of the firm's debt based on COMPUSTAT. Specifically, the market value of equity is the number of shares from COMPUSTAT (data item 25) multiplied by the share price (data item 199) and the book value of debt (data item 6 - Book Equity).[11] Book equity, BE_t is defined as the stockholders equity, plus balance sheet deferred taxes (data item 74) and investment tax credit (data item 208) (if available), plus post-retirement benefit liabilities (data item 330) (if available) minus the book value of preferred stock. Depending on availability, we use redemption (data item 56), liquidation (data item 10), or par value (data item 130) (in that order) for the book value of preferred stock.

We calculate the stockholders equity in the above formula as follows: the stockholders equity number reported by COMPUSTAT (data item 216) is preferred. If COMPUSTAT data 216 is not available, we measure stockholders equity as the book value of common equity (data item 60) plus the par value of preferred stock. If common equity is not available, we compute stockholders equity as the book value of assets (data item 6) minus total liabilities (data item 181), all taken from COMPUSTAT.

Since market value of Total Physical Assets (TPA) is not available, we use the book value of assets (data item 6) instead. We impose several requirements to mitigate the impact of data errors. A valid market equity number must be available for *t-1, t-2,* and *t-3.* There should be a valid trade during the month immediately preceding the period *t* return. This ensures that the return predictability is not spuriously induced by stale prices or other similar market microstructure issues. There should be at least one monthly return observation during each of the preceding five years, from *t-1* to *t-5.* To reduce the influence of extreme observations, we trim all independent variables at the 1% and 99% levels.

[11] Since data on the debt's market value is unavailable, we make the standard assumption in the literature that the debt's market value is also its book value.

Next, we compute the productivity of cash at time *t* as:

$$\eta_t = \frac{Rents_t}{Cash_t} = \frac{R_t}{L_t} = \frac{MV_t - TPA_t}{L_t} \tag{22}$$

We measure $Cash_t$ (L_t) directly from COMPUSTAT as Cash and Short-Term Investments (data item 1) and we compute $Rents_t$ as shown in equation (21).

4.3 Other asset pricing variables

Our research focus is on the the cross-sectional determinants of stock returns. Size, book-to-market and prior return proxies have been shown to explain the cross-section of returns with varying degrees of success. To distinguish the productivity of cash effect from the other cross-sectional effects it is important to control for the known variables that affect stock returns such as size, book-to-market and past returns. Size of the firm is the market value of its common equity measured as the closing price at fiscal year end multiplied by the number of shares outstanding. Book-to-market ratio is the book value of equity divided by market value of equity, measured at fiscal year end. The past return variables used in this study are included to control for the 1-month short-term reversal, 12-month momentum effect, and 3-year contrarian (reversal) effect. Ret(-1:-1) is the return on the firm's equity in the prior month *t -1*; Ret (-12:-2) is the cumulative return from month *t-12* through month *t -2*; and Ret(-36:-13) is the cumulative return from month *t-36* through *t-13*. Note that variables such as size, book-to-market and the productivity of cash are updated every 12 months but control variables for returns are updated every month.

5 Results

5.1 Summary statistics

We form decile portfolios monthly from 1963-2003 based on the productivity of cash measure of the previous fiscal year, with a minimum four month lag between fiscal year end and portfolio-formation month. Following Hirshleifer et. al (2004), we use a minimum 4-mongh gap between fiscal year end and the portfolio-formation month to ensure that investors have access to the financial and accounting statements.

In Table 1 we report the mean values of financial returns and firm characteristics for the productivity of cash (η) decile portfolios. Decile 1 firms are the lowest, and decile 10 firms are the highest, productivity firms. The values for the productivity of cash for the lowest and highest efficiency decile range from 0.45 to 109.88. The low productivity firms tend to be smaller firrms on average with a size of $260 million in market equity, whereas the highest productivity firms tend to be larger than average, with a market value of equity of $860 million. It appears that investors reward firms that have cash productivity; the high productivity firms sell at a premium (higher market value) to low productivity firms which tend to be smaller in size. Low productivity firms have higher book-to-market values (0.84) and the high productivity firms have lower book-to-market values (0.32). Since the high η firms appeard to behave like value firms and the low η firms behave like growth firms, it is important to differentiate our productivity of cash results from the value and growth effects. The low η firms have high short-term (prior one month) returns of 1.7% per month, but have low long-term (loser firms with prior 3 years cumulative) returns of 9.75% over three years. In contrast, high η firms have low prior one-month returns of 0.5% per month but very high long-term prior cumulative three year returns of 67%.

[Insert Table 1 about here]

Table 2 reports the industry distribution, of our sample, across the productivity of cash deciles. The data is pooled and we report the average across all sample years. Following Hirshleifer at al. (2004), we group our sample into fourteen industry groups using 4-digit SIC codes. The first column in table 2 contains the names of the fourteen industries, and columns two through eleven contain the productivity of cash decile portfolios with the percentage of firms in each industry group for each decile. The lowest productivity decile has a higher presence in Durable Manufacturers, Retail and Textile and Printing industry groups. The highest productivity decile 10 has a relatively higher concentration of Durable Manufacturers, Retail and Computers industry groups. Thus, there appears to be an industry-wide variation in in this sample.

[Insert Table 2 about here]

5.2 Univariate results

Table 3 reports the Pearson correlation coefficients among the productivity of cash measure at time *t* (our main variable of interest), various other firm characteristics, and stock returns.

[Insert Table 3 about here]

The positive and significant correlation of 0.73 between *t* and *t-1* indicates that the productivity of cash measure is persistant over time. Persistence, however, reduces with time, as indicated by the lower correlation coefficient of η_t and η_{t-2} (0.416). As predicted by the model, η_t is *negatively* correlated with time *t* returns. The correlation coefficient between η_{t-1}, η_{t-2} and ret(*t*) is negative and significant, implying that the productivity of cash effect is not a short-term phenomenon. It is sustainable. In fact, the effect lasts for more than two years. The univariate results also indicate that the prooductivity of cash is positivey correlated with size and negatively correlated with the log book-to-market variable. The implication is that without controlling for other characteristics, larger firms and lower book-to-market firms have a higher productivity of cash on average than smaller and high book-to-market firms. The correlation table also indicates that multicolinearity does not pose a major problem in a Fama-MacBeth (1973) type regression when all the control variables are included. Correlation of other characteristics, such as size and book-to-market, confirm the existing findings. Size is negatively correlated and the book-to-market ratio is positively correlated with contemporeneous returns.

5.3 Fama-MacBeth (FM) monthly cross-sectional regressions

The univariate analysis in Table 3 shows a negative relationship between the productivity of cash measure and stock returns. A multivariate analysis is required to evaluate whether our results are driven by some other known risk factors or anomalies. Using the Fama-MacBeth (1973) cross-sectional regressions, we investigate the relation between the productivity of cash and expected returns using a wide range of control variables such as *Ln(Size)*, *Ln(B/M)*[12] returns over prior one month, prior one year and prior three years. The prior one month returns controls for the short-term contrarian effect, the prior one year returns controls for the momentum effect, and the prior three year returns controls for the long-term (winner/loser) contrarian effect.

5.3.1 FM procedure

Each month, from 1962-2003, we regress the cross-section of stock returns on *Ln(Size)*, where size is the log of the firms' market capitalization, *Ln(B/M)*, the log of the book-to-market ratio, r_i(-1 : -1), the previous months return on the stock, r_i(-12 : -2) the previous year's return on the stock from month *t-12* to *t -2*, r_i(-36 : -13), the returns on the stock from month *t-36* to *t-13*, the productivity of cash defined as market value of the firm minus market value of the total investments divided by balance sheet cash and short-term investments. There is a minimum four month lag between the fiscal year end and month *t*. We report the time series

[12] Following the convention in the research we exclude firms with negative book values.

average of the monthly coefficient estimates and their time-series *t*-statistics.

5.3.2 FM regression results:

Table 4 reports the Fama-MacBeth coefficients where firm level stock returns measured at time *t* are regressed on the productivity of cash, measured at times *t, t-1* and *t -2.* The table contains panels A, B and C, and each panel contains three models. Model 1 includes *Ln(Size)* and *Ln(B/M)* variables. Model 2 has the standard asset-pricing variables and includes variables from Model 1 and additional controls for past returns. Model 3 additionally includes our main variable of interest, the productivity of cash, η.

[Insert Table 4 about here]

The coefficients in Model 1 confirm the results of the past literature on size and book-to-market effects. The coefficient on *Ln(Size)* is negative and significant whereas the coefficient on *Ln (BM)* is positive and significant. When the additional past return variables are included, the coefficients confirm the one month short term contrarian effect (negative coefficients), one year momentum effect (positive coefficients) and 3 year long term contrarian effect (negative coefficients). In the Model 3 regressions, the productivity of cash is highly significant and negatively related to cross-sectional stock returns even with the standard asset-pricing controls. The coefficient on η is -0.0012 and its *t*-statistic is highly significant at -3.60. It is very interesting to note that once the productivity of cash is included in the regression, it drives down the book-to-market effect by more than half and the *t*-statistic for *Ln(B/M)* becomes insignificant at conventional levels of confidence. In addition, the *Ln (Size)* variable becomes insignificant, with a *t*-statistic of -1.83.

Panels B and C contain results of the regression where the productivity of cash variable is measured with one and two year lags respectively. In panel B, the *t*-statistic for productivity measured at *t-1* remains highly significant at -3.67, suggesting that the productivity of cash lagged by one year is able to explain the firm level stock returns at time *t*. Panel C contains the *t*-statistic for productivity measured at *t-2*, which remains significant at -2.22.

Comparing Models 2 and 3, the adjusted r-squares of the cross-sectional regression when η is included in the analysis goes up from 4.3% to 4.8% indicating the incremental explanatory power of the productivity of cash measure.

Panel D of the table presents results for sub-periods. In model 6 (1963-1982) the η variable is highly significant, but the book-to-market variable is insignificant. In model 7 (1983-2003), both the size and the book-to-market variables lose significance, and the only variables that explain returns are η and past returns.

These findings confirm the ability of the productivity of cash variable to predict returns incremental to the other well-known predictive asset-pricing variables, and that the effect is sustainable for over two years.

5.4 Test of abnormal returns

It is important to test this ability of η to predict firm-level stock returns after controlling for standard asset-pricing independent varaibles such as size, book-to-market, and past returns. Table 5 reports the average returns of portfolios sorted on the productiviy of cash characteristic.

Each month, from 1965-2003, we form decile portfolios by ranking stocks based on η of the previous fiscal year, with a minimum four month lag between fiscal year end and the portfolio-formation month. After forming the decile portfolios, we compute equally-weighted and value-weighted monthly raw returns and abnormal returns. We construct a hedge portfolio by taking a long position in the lowest ranked η decile and an offsetting short position in the highest ranked η decile.

Table 5 presents results for the equally weighted (Panel A) and the value weighted (Panel B) portfolio where portfolios are formed at scal year end *t, t+1* and *t+2*, respectively. The table reports intercepts, α, from monthly time-series regressions of the raw returns on the Carhart (1997) four-factor model which contains the excess return of the market portfolio, size factor-mimicking portfolio

(SMB), the book-to-market factor-mimicking portfolio (HML) and, the momentum effect factor (MOM). The α is the returns in excess of the risk-free rate that are uncorrelated with the excess returns of the benchmark factors. If we get an α that is significantly different from zero, we can conclude that the portfolio strategy of ranking by the productivity of cash measure produces excess returns that cannot be explained by the other known systematic risk factors.

[Insert table 5 about here]

The first column in Panel A contains portfolio deciles; the second through the seventh columns contain αs and their *t*-statistics respectively. For the portfolios formed at fiscal year end *t*, the αs for the lowest decile are positive and highly significant. The abnormal returns, α, for this decile is 0.69% per month. As we move towards higher deciles, the abnormal returns tend to get smaller. For the highest productivity decile, the αs are negative and significant at -0.35% per month. The results are similar when the portfolios are formed at fiscal year end *t+1* and *t+2*. The last row in the table contains results for an equally-weighted hedge portfolio strategy of going long on the lowest decile firms and shorting the highest decile firms. The hedge portfolio is a zero-cost portfolio and, if sorting on η adds no value, we should expect the portfolio returns to be zero on average. The results show that the hedge portfolio earns an abnormal return of 1.04% per month (approximately 12% annually) with a *t* -statistic of 6.36. When portfolios are formed with a one year lag and a two year lag, the zero-cost portfolio earns abnormal returns of 0.77% per month and 0.63% per month, respectively, which are significantly different from zero. The results are stronger for the equally-weighted portfolio than the value-weighted portfolio, as is commonly observed in most other empirical studies. The value-weighted zero-cost (hedge) portfolio formed at fiscal year ended *t*, earns an abnormal return of 0.9% per month, which is statistically different from zero (*t*-statistic of 5.73). These results confirm the hypothesis that lower productivity of cash firms earn, on average, larger abnormal returns than higher productivity of cash firms.

5.4.1 Characteristic adjusted abnormal returns

We next use the characteristics-based approach to compute abnormal returns. Daniel and Titman (1997) argue that firms' actual size and book-to-market ratios contain more explanatory power than the time series estimates of the loadings on the factor-mimicking portfolios. In order to rigorously test the empirical results of the previous section, we calculate abnormal returns using a characteristics-based benchmark to control for standard measures such as size, book-to-market, and momentum. The literature continues to debate whether the return premia associated with size, book-to-market and momentum are driven by risk or by mispricing. In either case, this paper aims to test for an effect over and above these known determinants.

To implement the characteristics-based approach for computing abnormal returns we use the Daniel et. al. (1997) (henceforth DGTW) benchmark portfolio returns.[13] Each month, all firms in the sample are sorted into size quintiles. Then, within each size quintile, stocks are sorted into book-to-market quintiles. This yields 25 (5x5) portfolios. Each of these 25 size and book-to-market portfolios are further sorted into quintiles based on the firm's past 12-month cumulative returns. This gives us 125 (5x5x5) portfolios. After completing this sorting procedure, we calculate equally-weighted and value-weighted returns for each of the 125 benchmark portfolios. We employ the equal-weighted benchmarks against our equal-weighted portfolios, and employ the value-weighted benchmarks against our value-weighted portfolios. We compute the the monthly equally-weighted (value-weighted) abnormal return for any individual stock by subtracting the return of an equal-weighted (value-weighted) benchmark portfolio matched by size, book-to-market and momentum from the return of the stock. If size, book-to-market and momentum (past-return) are the only characteristics or attributes that affect the cross-section of expected stock returns, the expected value of this ab-

[13] We are grateful to Russ Wermers for allowing us to use his data. The DGTW benchmarks are available via http://www.smith.umd.edu/faculty/rwermers/ftpsite/Dgtw/coverpage.htm. Wermers (2004) uses industry-adjusted book-to-market ratios while constructing the benchmark portfolios.

normal return should, on average, be zero.

Table 6 reports the average returns of the portfolios sorted on η. We form decile portfolios monthly from 1975-2003 based on the η of the previous fiscal year, with a minimum four month lag between fiscal year end and portfolio-formation month. Panels A, B and C present results where portfolios are formed at fiscal year end *t, t+1* and *t+2,* respectively. We compute the monthly equal-weighted (value-weighted) abnormal return for any individual stock by subtracting the return of an equal-weighted (value-weighted) DGTW benchmark portfolio. We then average these abnormal returns within each η decile. We construct a hedge portfolio by taking a long position in the lowest-ranked η decile and an offsetting short position in the highest-ranked η decile. The time series averages of the monthly raw and DGTW-adjusted returns along with their *t* -statistics are reported.

[Insert table 6 about here]

The DGTW-adjusted abnormal returns in Table 6 are generally similar to the abnormal returns (αs) obtained from the intercepts of the time-series factor regressions seen in Table 5. The DGTW-adjusted abnormal returns provide strong evidence supporting the hypothesis that there is a robust negative relationship between the firm's productivity of cash and its expected returns. In Table 6 panel A, equally-weighted abnormal returns for the lowest η decile is 0.49% per month and the *t*-statistic is highly significant at 4.24. For the highest decile, the abnormal returns are -0.24% with a *t* -statistic of -2.44. The average monthly characteristics-adjusted equally-weighted return spread between the lowest and highest ηdeciles is 0.73% per month which is highly significantly different from zero (*t* -statistic of 5.68).

The abnormal returns effect is sustainable even two years after the firm's productivity of cash is measured. In year *t+1,* for an equally-weighted portfolio, the average abnormal return for a zero-cost hedge strategy is 0.76% (*t*=6.09) per month, in year *t+2* this effect remains strong with abnormal returns of 0.44%

(t=3.31). A closer look at the table shows that the gains on the portfolio strategy occur on both the long-side and the short-side of the trades, although the gains on the long-side tend to be larger than on the short-side of the trade. The mean abnormal equally-weighted monthly return on the three lowest η deciles are 0.49%, 0.44% and 0.42%, respectively, and for the three highest η frms they are -0.24%, -20% and -0.04%, respectively. Thus, it appears that the abnormal returns are monotonically decreasing in η.

These empirical results add further evidence to the results in sub-section 5.3 strongly supporting the hypothesis of an inverse relation between the cross-section of expected returns and the productivity of the firm's cash holdings.

5.4.2 Year-by-year analysis of the trading strategy based on the productivity of cash.

Our results above present average abnormal returns for the trading strategy of going long on low-η stocks and shorting high-ηstocks. It is entirely possible that these results may be driven by just one or two very strong years. For this reason, it is important to break down the abnormal returns year by year to investigate if our strategy is consistently profitable over the whole sample or whether our strategy yields earns abnormally high returns only for a small period.

Figure 1a graphs the equally-weighted DGTW-adjusted abnormal returns for the zero-cost hedge strategy broken down year by year. We first compute the monthly equally-weighted abnormal return for any individual stock by subtracting the return of a DGTW characteristics benchmark portfolio matched by size, book-to-market, and momentum from the return of the stock. We then average these abnormal returns within each decile. The strategy is consistently profitable for 24 years out of the total 29 years, with only 5 years resulting in a loss. The results are robust to the exclusion of the strongest year, 1999, from the analysis.

[Insert Figure 1a about here]

Figure 1a provides evidence of strong predictive power of the productivity of cash in explaining returns incremental to the other well known determinants of the cross-section of expected returns.

The results for the value-weighted hedge portfolio strategy are presented in Figure 1b. The general conclusions for the value-weighted returns are similar to the equally-weighted returns. It is interesting to note, in both figures, that the abnormal profits are larger on average in the recent years.

[Insert Figure 1b about here]

6 Conclusion

There is extensive empirical evidence that firms hold, for one reason or another, cash on their balance sheets. This paper develops a simple and intuitive model that shows that if firms hold cash, the expected returns on the stock, the firm's size, and the book-to-market ratio are functionally related through the productivity of cash measure, defined as the firm's economic rents per dollar of cash holdings. This value measure is independent of any specific theory of financial risk and discount rates. Examining firm value through the lens of the productivity of cash measure shows that stock returns are increasing in the book-to-market ratio (the value effect), decreasing in size (the size effect) and decreasing in the productivity of cash. These findings are compatible with standard risk-based explanations since, as seen, the stock's priced risk is inveresly related to the productivity of cash. In addition, they are consistent with the view that expected stock returns (cost of equity capital), in competitive equilibrium, depend on the magnitude of the assets employed to generate the firm's cash flows.

The empirical evidence is strongly supportive of these model implications. Fama-Macbeth (1973) regressions of monthly stock returns on size, book-to-market, past returns and the productivity of cash indicate that the coefficient on the productivity of cash measure is negative and highly significant, and that the size and book-to-market effects are subsumed by the productivity of cash. A portfolio strategy of going long in the lowest productivity of cash stocks and shorting stocks of firm with the highest productivity produces excess returns of 1.04% per month when the Carhart (1997) four-factor model is used as a benchmark. A similar long-short hedge strategy produces Daniel, Grinblatt, Titman and Wermers (DGTW, 1997) characteristics-adjusted excess returns of 0.8% per month. The productivity of cash factor predicts returns two years into the future.

The overall conclusion of this research is that the productivity of cash is a new, and economically-motivated, factor that explains the cross-section of stock returns. It has been noted that "...by understanding the role variables such as book-to-market, size, or past returns play in a *theoretical* (emphasis added) model, we can better understand the source of their explanatory power in the data" [Berk et al. (1999)]. Our simple model implies, and the empirical evidence supports the view, that the explanatory power of firm size and the book-to-market ratio in the earlier research stems from its role as a proxy for an economic factor that measures how efficiently the firm creates wealth- the productivity of cash. A limitation of our model is that it presupposes the existence of cash on the firm's balance sheet- it does not address the question of exactly why cash enters into the theory. We may need a theory of stock prices in which there is an *endogenous* role for cash if we are to better understand why the productivity of cash influences stock returns. This is an important issue for future research.

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Table 1: Mean values of financial returns and firm characteristics for decile portfolios sorted by Productivity of Cash (η)

Decile portfolios are formed monthly from 1963-2003 based on the 'Productivity of Cash' (η) of the previous fiscal year, with a minimum four month lag between fiscal year end and portfolio formation month. The table reports the mean values of financial returns and firm characteristics for the productivity decile portfolios. η(t) is computed as the log of market of the firm minus total assets divided by cash held by the firm. ME ($M) is the market value of equity, BM is the book value of equity divided by market value of equity measured at fiscal year end. The past return variables used in this study are included to control for the 1-month short term reversal, 12-month momentum effect, and 3-year contrarian (reversal) effect. *Ret(t)* is the current month return on the firm's equity; *Ret(-1:-1)* is the return in the prior month *t-1*; *Ret(-12:-2)* is the cumulative return from month *t-12* through month *t-2*; and *Ret(-36:-13)* is the cumulative return from month *t-36* through *t-13*.

Decile	η(t)	ME ($M)	BM	Ret(t)	Ret(-1:-1)	Ret(-12:-2)	Ret(-36:-13)
Lowest	0.45	259.041	0.84369	0.0174	0.0171	0.1200	0.0975
2	1.36	352.253	0.66918	0.0150	0.0146	0.1168	0.1974
3	2.38	387.984	0.57148	0.0137	0.0140	0.1350	0.3249
4	3.62	446.631	0.49969	0.0121	0.0115	0.1312	0.3806
5	5.27	561.435	0.44924	0.0102	0.0103	0.1332	0.4711
6	7.53	650.043	0.41619	0.0098	0.0093	0.1394	0.5505
7	11.05	731.986	0.39052	0.0079	0.0080	0.1530	0.6291
8	17.24	809.679	0.37326	0.0077	0.0073	0.1448	0.6426
9	31.03	891.885	0.35282	0.0062	0.0062	0.1314	0.6284
Highest	109.88	858.427	0.32038	0.0054	0.0052	0.1209	0.6728

Table 2: Industry composition for the decile portfolio sorted by Productivity of Cash

Productivity of Cash is defined in Table 1. This table reports percentage of the firms in each industry group for each productivity decile. The percentages are the averages across all sample years. The numbers in parentheses are the SIC codes for the respective industries.

Industry Name	Portfolio Rankings based on Operating Efficiency (η)									
	Lowest	2	3	4	5	6	7	8	9	Highest
Agriculture (0–999)	0.54%	0.34%	0.19%	0.29%	0.34%	0.22%	0.35%	0.33%	0.48%	0.47%
Mining and Construction (1000–1299, 1400–1999)	3.32%	3.93%	2.65%	2.65%	2.92%	2.83%	2.73%	3.07%	2.58%	2.64%
Food (2000–2111)	3.24%	3.52%	2.04%	1.91%	1.87%	2.30%	2.65%	2.70%	3.01%	3.25%
Textiles and Printing/Publishing (2200–2790)	12.14%	8.22%	3.99%	4.18%	4.81%	5.17%	5.24%	5.90%	5.98%	7.02%
Chemicals (2800–2824, 2840–2899)	1.93%	2.49%	1.60%	1.72%	2.38%	2.59%	3.14%	3.53%	3.87%	3.36%
Pharmaceuticals (2830–2836)	0.51%	0.69%	1.23%	2.70%	4.39%	5.54%	5.59%	5.03%	4.46%	3.19%
Extractive (1300–1399, 2900–2999)	3.42%	3.99%	3.14%	3.55%	4.07%	4.64%	4.99%	5.25%	5.91%	6.40%
Durable Manufacturers (3000–3569, 3580–3669, 3680-3999)	30.16%	26.55%	18.07%	19.52%	22.92%	24.00%	23.65%	24.15%	24.08%	22.56%
Computers (3570–3579,3670–3679, 7370–7379)	3.43%	5.86%	8.33%	10.46%	13.65%	14.26%	14.38%	13.00%	11.19%	9.68%
Transportation (4000–4899)	3.76%	5.03%	3.83%	4.45%	4.84%	5.01%	5.01%	5.11%	5.22%	7.19%
Utilities (4900–4999)	6.01%	3.73%	2.03%	2.19%	2.62%	3.02%	3.29%	4.18%	4.91%	5.64%
Retail (5000–5999)	15.05%	14.47%	7.66%	7.93%	8.81%	9.47%	10.19%	10.45%	11.31%	10.61%
Financial and other (6000–6999, 2111–2199)	10.03%	13.28%	38.51%	30.02%	17.32%	11.40%	8.74%	7.73%	7.52%	8.57%
Services (7000–7369, 7380–9999)	6.44%	7.88%	6.75%	8.44%	9.04%	9.57%	10.04%	9.58%	9.48%	9.43%

Table 3: Pearson correlation coefficients among the Productivity of Cash (η) and other characteristics.

This table reports the correlations among η(t) and other firm characteristics. The data covers NYSE, AMEX and Nasdaq firms from July 1963 through December 2003. Data are annual except stock returns which are updated each month. η(t) is computed as the log of market of the firm minus total assets divided by cash held by the firm. η(t-1) is 1-year lagged productivity; η(t-2) is the 2-year lagged productivity variable. Ln(Size) is the log of market value of equity, Ln(BM) is the log of book value of equity divided by market value of equity measured at fiscal year end. The past return variables used in this study are included to control for the 1-month short term reversal, 12-month momentum effect, and 3-year contrarian (reversal) effect. *Ret(t)* is the current month return on the firm's equity; *Ret(-1:-1)* is the return in the prior month *t-1*; *Ret (-12:-2)* is the cumulative return from month *t-12* through month *t-2*; *Ret(-36:-13)* is the cumulative return from month *t-36* through *t-13*.

	η(t)	η(t-1)	η(t-2)	ln(Size)	Ln(BM)	Ret(t)	Ret(-1:-1)	Ret(-12:-2)	Ret(-36:-13)
η(t)	1	0.730	0.416	0.171	-0.388	-0.018	-0.018	-0.006	0.107
		<.0001	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*
η(t-1)	0.730	1	0.482	0.166	-0.341	-0.016	-0.016	-0.047	0.095
	<.0001		*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*
η(t-2)	0.416	0.482	1	0.154	-0.271	-0.010	-0.010	-0.036	0.001
	<.0001	*<.0001*		*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*
Ln(Size)	0.171	0.166	0.154	1	-0.385	-0.021	-0.022	-0.014	0.157
	<.0001	*<.0001*	*<.0001*		*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*
Ln(BM)	-0.388	-0.341	-0.271	-0.385	1	0.034	0.036	-0.010	-0.257
	<.0001	*<.0001*	*<.0001*	*<.0001*		*<.0001*	*<.0001*	*<.0001*	*<.0001*
Ret(t)	-0.018	-0.016	-0.010	-0.021	0.034	1	-0.021	0.006	-0.019
	<.0001	*<.0001*	*<.0001*	*<.0001*	*<.0001*		*<.0001*	*<.0001*	*<.0001*
Ret(-1:-1)	-0.018	-0.016	-0.010	-0.022	0.036	-0.021	1	0.003	-0.020
	<.0001	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*		*<.0001*	*<.0001*
Ret(-12:-2)	-0.006	-0.047	-0.036	-0.014	-0.010	0.006	0.003	1	-0.026
	<.0001	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*		*<.0001*
Ret(-36:-13)	0.107	0.095	0.001	0.157	-0.257	-0.019	-0.020	-0.026	1
	<.0001	*<.0001*	*0.1151*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	

Table 4: Fama-MacBeth Monthly regression of stock returns on Productivity of Cash (η) and other characteristics.

Each month, from 1962-2003, the cross-section of stock returns is regressed on Ln(Size), where size is the defined as the log of the firm's market capitalization, and Ln(BM) is the log of the book-to-market ratio. *Ret(-1:-1)* is the previous month's return on the stock, *Ret(-12:-2)* is the previous year's return on the stock from month *t-12* to *t-2*, *Ret(-36:-13)* is the return on the stock from month *t-36* to *t-13*, Productivity of Cash, η(t), is computed as the log of market value of the firm minus total assets divided by cash and short term investments. There is a minimum four-month lag between the fiscal year end and month *t*. The time-series average of the monthly coefficient estimates and their time-series *t*-statistics are reported. The *t*-statistics are corrected for autocorrelation of 6-lags using Newey-West method. Panels A, B and C present results where η is measured at fiscal year end *t*, *t-1* and *t-2*, respectively whereas all other characteristics are measures at time *t*.

	Ln(Size)	Ln(BM)	Ret(-1:-1)	Ret(-12:-2)	Ret(-36:-13)	η	N. Obs	Adj R-Sqr
Panel A: Productivity and other characteristics measured at time t								
Model 1	-0.0014	0.0035					488	0.022
	-2.33	**3.39**						
Model 2	-0.0013	0.0032	-0.0649	0.0068	-0.0030		488	0.043
	-2.25	**3.10**	**-13.89**	**4.50**	**-3.04**			
Model 3	-0.0010	0.0018	-0.0617	0.0071	-0.0024	-0.0012	488	0.048
	-1.83	1.41	**-13.07**	**4.40**	**-2.43**	**-3.60**		
Panel B: Productivity measured at time t-1 and other characteristics measured at time t								
Model 4	-0.0011	0.0019	-0.0648	0.0070	-0.0014	-0.0011	481	0.050
	-1.97	1.62	**-12.57**	**4.08**	**-1.42**	**-3.67**		
Panel C: Productivity measured at time t-2 and other characteristics measured at time t								
Model 5	-0.0014	0.0023	-0.0699	0.0064	-0.0024	-0.0005	468	0.051
	-2.41	**2.13**	**-14.20**	**3.76**	**-3.19**	**-2.22**		
Panel D (Sub-Period Analysis): Productivity and other characteristics measured at time t								
Model 6	-0.0019	0.0010	-0.0723	0.0102	-0.0015	-0.0009	236	0.064
(1963-1982)	**-2.15**	0.81	**-9.33**	**3.68**	-1.32	**-3.54**		
Model 7	-0.0003	0.0026	-0.0528	0.0041	-0.0023	-0.0014	252	0.034
(1983-2003)	-0.46	1.17	**-9.77**	**2.53**	**-3.77**	**-2.41**		

Table 5: Intercepts from the Carhart four-factor time series regression for Productivity of Cash decile portfolios.

Decile portfolios are formed monthly from 1965-2003 based on the 'Productivity of Cash', of the previous fiscal year, with a minimum four-month lag between fiscal year-end and portfolio-formation month. This table presents results for portfolios formed at fiscal year end *t*, *t-1* and *t-2*, respectively. The hedge portfolio is constructed by taking a long position in the lowest-ranked productivity decile and an offsetting short position in the highest-ranked productivity decile. Panel A and B contains results when portfolios returns are equally-weighted and value-weighted respectively. The intercepts, α, from monthly time-series regressions of the raw returns on the Carhart (1997) four factor model which contains the excess return of the market portfolio, size factor-mimicking portfolio (SMB), the book-to-market factor-mimicking portfolio (HML), the momentum effect (MOM) are reported. *t*-statistics in bold indicate statistical significance at the 5% level.

Panel A: Equally-Weighted Abnormal returns

	time t		*time t-1*		*time t-2*	
Productivity Decile	alpha	t_a	alpha	*t_a*	alpha	*t_a*
Low Productivity	0.69%	**5.18**	0.66%	**4.68**	0.48%	**2.81**
2	0.55%	**4.29**	0.58%	**4.02**	0.53%	**4.35**
3	0.40%	**3.13**	0.47%	**4.12**	0.36%	**3.03**
4	0.34%	**2.57**	0.42%	**2.95**	0.38%	**3.40**
5	0.25%	**2.26**	0.30%	**2.35**	0.33%	**2.78**
6	0.25%	1.75	0.21%	1.72	0.21%	1.65
7	-0.08%	-0.70	0.05%	0.48	0.24%	**2.32**
8	-0.08%	-0.70	0.01%	0.08	0.08%	0.76
9	-0.24%	**-2.03**	-0.16%	-1.38	-0.08%	-0.61
High Productivity	-0.35%	**-2.71**	-0.11%	-0.71	-0.15%	-1.18
Hedge (L-H)	1.04%	**6.36**	0.77%	**4.06**	0.63%	**3.27**

Panel B: Value-Weighted Abnormal returns

	time t		*time t-1*		*time t-2*	
Productivity Decile	alpha	*t_a*	alpha	*t_a*	alpha	*t_a*
Low Productivity	0.56%	**4.80**	0.54%	**4.53**	0.38%	**2.49**
2	0.45%	**3.91**	0.51%	**4.07**	0.42%	**4.13**
3	0.34%	**3.14**	0.41%	**4.11**	0.30%	**2.74**
4	0.28%	**2.45**	0.31%	**2.67**	0.26%	**2.76**
5	0.25%	**2.54**	0.30%	**2.53**	0.24%	**2.41**
6	0.21%	1.71	0.19%	1.86	0.20%	**2.08**
7	-0.02%	-0.17	0.10%	1.09	0.18%	**2.23**
8	-0.06%	-0.66	0.00%	0.02	0.11%	1.32
9	-0.21%	**-2.00**	-0.11%	-1.13	-0.12%	-1.17
High Productivity	-0.34%	**-2.94**	-0.11%	-0.77	-0.16%	-1.44
Hedge (L-H)	0.90%	**5.73**	0.65%	**3.54**	0.51%	**2.62**

Table 6: Average monthly raw and characteristic adjusted abnormal returns for Productivity of Cash decile portfolios.

Decile portfolios are formed monthly from 1975-2003 based on the 'Productivity of Cash' of the previous fiscal year, with a minimum four-month lag between fiscal year end and portfolio-formation month. Panels A, B and C present results where portfolios are formed at fiscal year end *t*, *t+1* and *t+2*, respectively.

The monthly equally-weighted (value-weighted) abnormal return for any individual stock is computed by subtracting the return of an equal-weighted (value-weighted) benchmark portfolio matched by size, book-to-market and momentum from the return of the stock. It is then averaged within each productivity decile. The hedge portfolio is constructed by take a long position in the lowest-ranked productivity decile and an offsetting short position in the highest-ranked productivity decile. The time series averages of the monthly raw and DGTW adjusted returns along with their *t*-statistics are reported.

Panel A: Productivity decile portfolio formed at time t

Portfolio Ranks	Equal Weighted				Value Weighted			
	Raw ret	t_raw	DGTW xret	t_xret	Raw ret	t_raw	DGTW xret	t_xret
Low Productivity	2.00%	**5.73**	0.49%	**4.24**	1.83%	**5.44**	0.36%	**3.41**
2	1.85%	**5.19**	0.44%	**3.95**	1.71%	**4.89**	0.32%	**3.06**
3	1.75%	**4.82**	0.42%	**3.72**	1.63%	**4.59**	0.34%	**3.12**
4	1.61%	**4.46**	0.31%	**2.87**	1.49%	**4.25**	0.21%	**2.12**
5	1.29%	**3.71**	0.04%	0.44	1.25%	**3.68**	0.02%	0.22
6	1.32%	**3.66**	0.15%	1.27	1.21%	**3.49**	0.07%	0.63
7	1.11%	**3.27**	-0.06%	-0.62	1.13%	**3.45**	-0.01%	-0.11
8	1.11%	**3.28**	-0.04%	-0.40	1.05%	**3.25**	-0.08%	-0.94
9	0.91%	**2.77**	-0.20%	**-2.03**	0.88%	**2.80**	-0.22%	**-2.73**
High Productivity	0.86%	**2.65**	-0.24%	**-2.44**	0.81%	**2.57**	-0.28%	**-3.41**
Hedge (L-H)	1.14%	**6.25**	0.73%	**5.68**	1.02%	**5.81**	0.64%	**5.57**

Panel B: Productivity decile portfolio formed at time t-1

Portfolio Ranks	Equally-Weighted				Value-Weighted			
	Raw ret	t_raw	DGTW Adj xret	t_xret	Raw ret	t_raw	DGTW xret	t_xret
Low Productivity	2.09%	**5.90**	0.56%	**5.11**	1.92%	**5.61**	0.42%	**4.24**
2	1.87%	**5.11**	0.47%	**3.74**	1.74%	**4.92**	0.37%	**3.39**
3	1.74%	**4.93**	0.38%	**3.89**	1.62%	**4.69**	0.30%	**3.32**
4	1.54%	**4.22**	0.28%	**2.45**	1.39%	**3.99**	0.14%	1.41
5	1.42%	**4.11**	0.17%	1.77	1.30%	**3.88**	0.07%	0.72
6	1.31%	**3.73**	0.16%	1.44	1.25%	**3.69**	0.10%	1.00
7	1.14%	**3.35**	0.01%	0.16	1.11%	**3.40**	0.00%	0.04
8	1.12%	**3.32**	-0.02%	-0.24	1.06%	**3.26**	-0.07%	-0.80
9	0.97%	**2.96**	-0.13%	-1.22	0.94%	**3.04**	-0.15%	-1.84
High Productivity	0.86%	**2.62**	-0.21%	**-2.08**	0.80%	**2.54**	-0.25%	**-2.86**
Hedge (L-H)	1.23%	**6.74**	0.76%	**6.09**	1.12%	**6.20**	0.66%	**5.87**

Panel C: Productivity decile portfolio formed at time t-2

Portfolio Ranks	Equally-Weighted				Value-Weighted			
	Raw ret	t_raw	DGTW xret	t_xret	Raw ret	t_raw	DGTW xret	t_xret
Low Productivity	1.84%	**5.22**	0.35%	**2.89**	1.71%	**4.95**	0.25%	**2.20**
2	1.92%	**5.38**	0.51%	**4.82**	1.72%	**4.98**	0.35%	**3.65**
3	1.71%	**4.70**	0.37%	**3.56**	1.59%	**4.54**	0.29%	**3.11**
4	1.54%	**4.36**	0.23%	**2.24**	1.40%	**4.10**	0.12%	1.32
5	1.51%	**4.36**	0.25%	**2.40**	1.40%	**4.22**	0.16%	1.72
6	1.36%	**3.87**	0.14%	1.30	1.30%	**3.87**	0.11%	1.26
7	1.32%	**3.92**	0.13%	1.38	1.21%	**3.79**	0.03%	0.38
8	1.17%	**3.54**	-0.03%	-0.35	1.12%	**3.55**	-0.05%	-0.63
9	1.08%	**3.29**	-0.05%	-0.51	0.94%	**3.03**	-0.17%	**-2.09**
High Productivity	1.05%	**3.23**	-0.09%	-0.76	0.96%	**3.15**	-0.15%	-1.71
Hedge (L-H)	0.79%	**4.39**	0.44%	**3.31**	0.74%	**4.13**	0.40%	**3.29**

Figure 1a: Equally-weighted hedge portfolio returns based on Productivity of Cash strategy.

Portfolios are formed monthly by assigning firms to decile based on their Productivity of Cash factor in the previous fiscal year, with a minimum four month lag between the fiscal year end and the returns it is matched against. The monthly equally-weighted abnormal return for any individual stock is computed by subtracting the return of a benchmark portfolio matched by size, book-to-market and momentum from the return of the stock. It is then averaged within each productivity decile. The hedge portfolio is constructed by take a long position in the lowest-ranked productivity decile and an offsetting short position in the highest-ranked productivity decile.

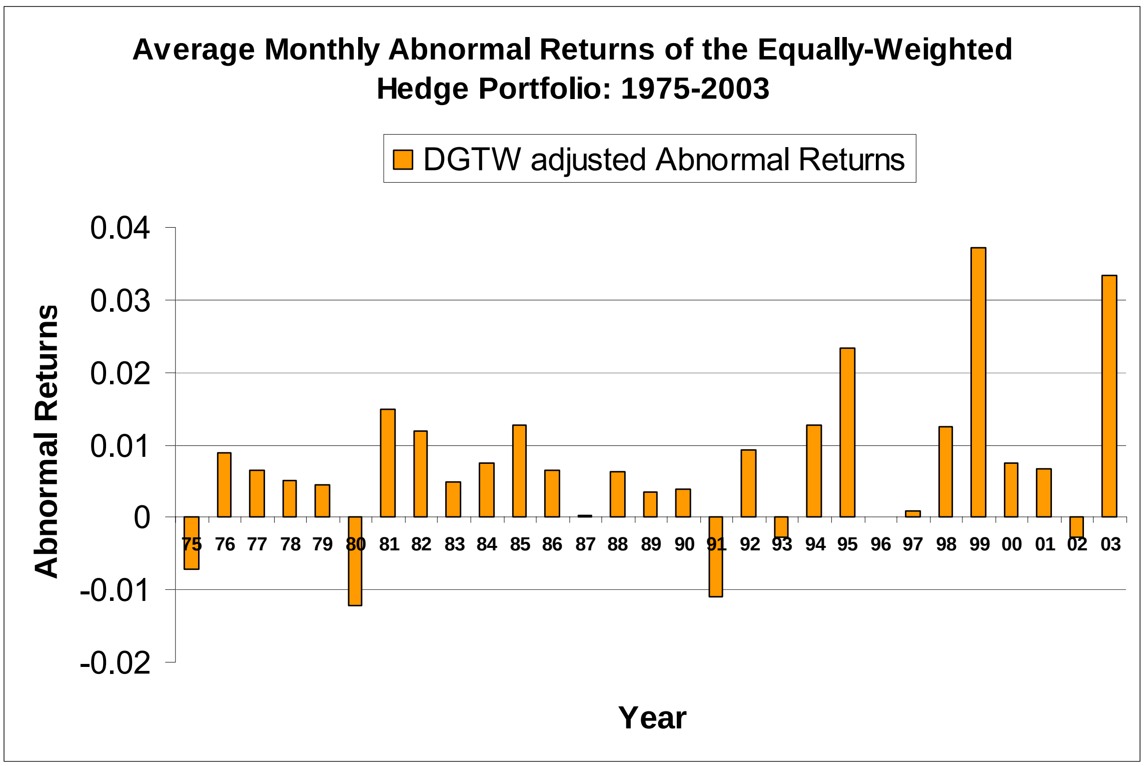

Figure 1b: Value-weighted hedge portfolio returns based on Productivity of Cash strategy.

Portfolios are formed monthly by assigning firms to decile based on their Productivity of Cash factor in the previous fiscal year, with a minimum four month lag between the fiscal year end and the returns it is matched against. The monthly value-weighted abnormal return for any individual stock is computed by subtracting the return of a benchmark portfolio matched by size, book-to-market and momentum from the return of the stock. It is then averaged within each productivity decile. The hedge portfolio is constructed by take a long position in the lowest-ranked productivity decile and an offsetting short position in the highest-ranked productivity decile.