Corporate Innovation and its Effects on Equity Returns*

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Abstract

This paper provides an at least partial rational explanation for the performance of price momentum strategies, using the concept of corporate innovation. We define corporate innovation as the proportion of a firm's change in gross profit margin not explained by the change in the capital and labor it utilizes. We show that an aggregate measure of corporate innovation is priced in the cross-section of equity returns, and eliminates the priced information in the momentum factor. This measure is similar in nature to total factor productivity (TFP). Corporate innovation-based portfolio strategies exhibit very similar characteristics and performance to those of price momentum strategies. In addition, the returns on corporate innovation-based strategies can explain a substantial proportion of the time-series variation in price momentum strategies. The economic explanation for the performance of price momentum provided here is also consistent with long horizon return reversals and the performance of long-horizon contrarian strategies.

Keywords: Corporate innovation, price momentum, reversals, risk.

JEL classification: G12, G14.

How easily can a firm replicate the success of another? Can a firm match the profit margins of a successful firm in the same line of business by simply putting in place the same amount of capital and labor as that of the firm it tries to mimic?

Most economists and strategists would agree that matching a firm's amount of labor and capital is far from sufficient for matching its success in the market place, as measured by its market share and profits. Several other factors play a pivotal role in a firm's success including, but not limited to, the quality of its management, its commitment to innovation, marketing efforts, and brand name. Such factors can substantially differentiate two firms with otherwise identical amounts of capital and labor in place, and lead to very different levels of profits. In fact, such factors may contribute positively, or negatively to a firm's profis. For simplicity, we will refer to such non-capital and non-labor productivity factors as corporate innovation.

The purpose of this paper is to examine the effects that corporate innovation has on equity returns. In doing that, we also provide an at least partial explanation for the performance of price momentum strategies.

We measure corporate innovation as the component of a firm's change in Gross Profit Margin (GPM) not explained by the growth in capital and labor it has in place. At an aggregate level, our measure is equivalent to a scaled Total Factor Productivity (TFP) variable. We show that an aggregate measure of corporate innovation is priced in the cross-section of equity returns, when it appears in a pricing model together with the market factor. In addition, it absorbs the priced information in the momentum factor.

Total factor productivity (TFP), and consequently the measure used here is a well-known business cycle variable. In dynamic equilibrium representative agents macro models (see for instance, Kydland and Prescott (1982), Long and Plosser (1983), Hansen (1985), King, Plosser, Rebelo (1988), Danthine and Donaldson (1993) for an excellent survey of the early literature, and Horvath (1998, 2000) for more recent multi-sector examples), TFP is a state variable that affects, among other things, the investment opportunity set, and therefore equity returns. In this paper, we show that a scaled measure of TFP, which we call CI, is priced in the cross-section of equity returns and absorbs the priced information in the momentum factor.

When CI is high, most of the profits of the firm cannot be accounted for by its growth in capital and labor. Investors perceive such firms as risky, because so much of their profits depend on CI, which is a scaled TFP variable, and therefore varies with the business cycle. As a result, investors would require higher expected returns to hold stocks with high sensitivity to CI.

Our asset pricing tests verify that there is indeed a positive risk premium attached to the CI factor. Furthermore, this factor absorbs the priced information in the momentum factor. Indeed, a returns-based CI factor can help explain the returns on momentum deciles, as well as the abnormal return (alpha) of the momentum spread ("winners" minus "losers"). The momentum deciles have significant loadings on the returns-based CI factor that vary monotonically across deciles. In addition, the momentum spread has an economically and statistically significant beta with our CI factor. The above evidence suggests that CI can serve as an at least partial rational explanation for the performance of price momentum.

The link between *CI* and price momentum portfolios is further explored by examining the relation between the returns of portfolios formed on the basis of *CI* and past returns. We show that portfolios formed on the basis of *CI* and portfolios formed on the basis of past returns share several important characteristics. Portfolios constructed on the basis of *CI* exhibit monotonicity with respect to this variable by construction. However, the construction of momentum portfolios does not involve any information related to *CI*. Nevertheless, momentum portfolios exhibit the same kind of monotonicity across deciles as that found in the *CI* portfolios. Winners are the firms with the highest average *CI* among momentum deciles, whereas losers are the firms with the lowest average *CI*.

Further tests reveal that price momentum strategies deliver zero returns when they are run using exclusively stocks of low *CI* firms. In contrast, when they are run using only stocks of high *CI* firms, they are very profitable, and more so than when the winners and losers are chosen from the whole sample. In other words, the performance of momentum strategies is conditional on the long position being comprised of high *CI* stocks.

Regression analysis shows that the returns of *CI*-based strategies can explain a substantial proportion of the time-series variation in the returns of popular momentum strategies. The adjusted R-squares obtained vary between 23% and 28%. This is a large improvement over the typical 0% adjusted R-squares previously reported in the literature from regressions of momentum returns on economically-motivated variables. Furthermore, CI-based strategies and momentum strategies with similar formation and holding period characteristics share a correlation of the order of 0.50.

One of the major challenges in explaining price momentum is that the economic explanation proposed should also be consistent with the fact that price momentum is a medium-term phenomenon, and that returns exhibit reversals in 3-5 year horizons, giving rise to contrarian strategies. While the Fama-French (1993) factor can explain the spread of the contrarian strategy, as shown in Fama and French (1996), it is still useful to know whether our proposed explanation for momentum is also related to the performance of long-horizon (3-5 years) contrarian strategies. Section 5 provides some evidence in support of that. Whereas losers are the firms with the lowest average *CI* and winners the firms with the highest average *CI* at the time of portfolio formation, by the end of the holding period, losers outperform winners and they exhibit higher average *CI* than the winners at that time. In other words, the switch from return continuation to reversal is related to the evolution of *CI* at the firm level over time.

We also regress the return on the contrarian strategy on the Fama-French (FF) (1993) factors and our CI returns-based factor. It is indeed the case that the FF factors are sufficient for explaining the returns of the contrarian strategy, rendering its alpha statistically and economically equal to zero. However, it is also interesting to note that the contrarian strategy has in addition a significant loading on our CI returns-based factor. Furthermore, the inclusion of CI in the regression equation results into a moderate decrease in the market loading. These findings suggest that although CI is not the principle explanation for the performance of the contrarian strategy, it is not unrelated to it either.

Why does corporate innovation induce returns continuation? The reason is that corporate innovation is not publicly known at each point in time. It can be however inferred or estimated. As information about it is slowly revealed to the market, the prices of stocks adjust to reflect it. This process induces a return continuation.

The rest of the paper is organized as follows. Section 1 details the approach we use to measure corporate innovation. Section 2 describes the data and provides summary statistics. Section 3 contains our asset pricing results, which show that corporate innovation is priced in the cross-section of equity returns, it constitutes a risk factor, and it proxies for the priced information in the momentum factor. Section 4 reports results based on portfolio sortings that reveal the level of relation between corporate innovation and past returns – the sorting variable in the price momentum strategies. These results are supplemented with regression analysis. Section 5 relates *CI* to the performance of contrarian strategies. We conclude with a summary of our results in Section 6.

1. Measuring a Firm's Level of Corporate Innovation

As mentioned earlier, we measure corporate innovation as the change in a firm's Gross Profit Margin (GPM) not explained by the growth rate of capital and labor it utilizes. We define GPM as the difference between a firm's sales and the cost of the goods it sells. We should emphasize once more that corporate innovation need not be always positive. Just like in the case of TFP, it can take any value. Corporate innovation represents production factors other than capital and labor that have an effect on the profitability of the firm.

Although we do not aim to provide here a full-blown theoretical justification for our measure of corporate innovation, our formulation can be understood by reference to a standard Cobb-Douglas production function. In particular, assume that a firm's output is given by

$$Y_t = A_t K_t^{\alpha_1} L_t^{\alpha_2} \tag{1}$$

where Y_t denotes the firm's value of output at time t, K_t is the firm's capital stock used for the production of Y_t, L_t is the labor input in the production process, and A_t is the total factor productivity at time t, which is often interpreted in the literature as capturing technology shocks. The exponents α_1 and α_2 denote the shares of capital and labor respectively. In a competitive labor market, and assuming for simplicity absence of intermediate goods in the production function, the gross profit margin of the firm is defined as follows:

$$GPM_t = Y_t - L_t MP_L \tag{2}$$

where *GPM* denotes the gross profit margin, and MP_L is the marginal product of labor. Note that MP_L is given by

$$MP_L = a_2 A_t K_t^{a_1} L_t^{a_2 - 1} \tag{3}$$

Therefore,

$$GPM_t = A_t K_t^{a_1} L_t^{a_2} - a_2 A_t K_t^{a_1} L_t^{a_2} \Rightarrow$$
$$GPM_t = (A_t - a_2 A_t) K_t^{a_1} L_t^{a_2} \tag{4}$$

Equation (4) says that a firm's gross profit margin at time *t* is a function of the firm's capital and labor at time *t*, as well as the term $(A_t - a_2 A_t)$, which we call Corporate Innovation (*CI*). Note that *CI* is equal to a "shrunk" A_t, which corresponds to the TFP of the firm.

Our next task is to estimate the *CI* term at time *t* for all US firms. To do that, we can use the following regression equation:

$$\Delta^i gpm_{jt} = \beta_{j0} + \beta_{j1}\Delta^i k_{jt} + \beta_{j2}\Delta^i l_{jt} + \varepsilon_{jt}, \qquad i = 1, 2, 3, 4 \qquad j=1,\ldots,N \tag{5}$$

where $\Delta^i gpm_{jt} = \log\left(GPM_{jt} / GPM_{jt-i} \right)$ is the change in the j^{th} firm's log GPM from quarter $t-i$ to quarter t, $\Delta^i k_{jt} = \log\left(K_{jt} / K_{jt-i} \right)$ is the change in the log capital stock from quarter $t-i$ to quarter t for firm *j*, and $\Delta^i l_{jt} = \log\left(L_{jt} / L_{jt-i} \right)$ is the change for firm *j* in the log labor employed from quarter $t-i$ to quarter t. Note that i denotes the horizon over which the growth in the variables of interest is computed.

Corporate innovation is then given by:

$$CI^i_{jt} = \Delta^i gpm_{jt} - \left(\hat{\beta}_{j1}\Delta^i k_{jt} + \hat{\beta}_{j2}\Delta^i l_{jt} \right) \tag{6}$$

where $\hat{\beta}_{j1}$ and $\hat{\beta}_{j2}$ are the OLS estimates of β_{j1} and β_{j2} respectively. Again, notice that the computation of CI_t used here is very similar to that of TFP or Solow (1957) residuals, as it is often termed in the literature.[3]

For the purpose of our empirical analysis, we compute CI_{jt} over the horizons of past 1, 2, 3 and 4 quarters. To prevent look-ahead bias, we use only information that is available to the investor at time *t*. We obtain a time-series of CI_t's by performing rolling regressions. The CI_j at time t is computed using the parameters estimated from a regression run with data up to time t. Similarly, CI_{jt+1} is obtained by re-estimating the parameters after adding one new observation to the rolling regression window and dropping the first one.

The reader may observe that some of the production factors captured by our definition of CI can simply be intangible assets such as Research and Development (R&D) expenditure, or licensing and patents. Such factors have been considered in previous papers.[4] However, CI_t is much more general than any particular intangible asset category considered in previous research. It can be viewed as the return on capital for a particular firm, and factors such as R&D or patents simply contribute positively or negatively to this rate of return. In addition, the focus of the current paper is different. Whereas most previous work focuses on how accounting practices treat intangible assets, our paper focuses on the effects that non-capital and non-labor production factors have on a firm's gross

[3] Some assumptions of the original Solow (1957) derivation do not hold in our application. In particular, Solow (1957) assumes that the productivity growth is not directly affected by any exogenous shifts in the firm's demand function or in the prices of its factors of production. As noted in Hall (1990), when there is a correlation between an exogenous variable and the Solow residual, the assumptions of perfect competition and constant returns to scale no longer hold. Our estimation of corporate innovation is simply *in the spirit* of Solow residuals.

[4] See for instance, the studies of Hall (1993), Barth and Clinch (1998), and Lev, Nissim, and Thomas (2002), among others.

profits and its expected returns. In this context, we also provide an at least partial explanation for the performance of price momentum strategies.

A study that considers the effects of intangible assets on equity returns is that of Chan, Lakonishok, and Sougiannis (2001). They examine whether stock prices fully reflect R&D expenditure. They find that the average historical returns of firms that do R&D are the same as those of firms that do not. As it is apparent from the previous discussion, the focus and results of our paper differ substantially from those of Chan, Lakonishok and Sougiannis (2001).

It is also important to note that *CI* does not simply capture a firm's earnings. In the representative agent's business cycle models, free cash flows (*FCF*), which proxy for earnings, are given by

$$\begin{aligned} FCF_t &= output_t - wages_t - investments_t \\ &= Y_t - \alpha_2 Y_t - I_t \\ &= \alpha_1 A_t K_t^{\alpha_1} L_t^{a_2} - I_t \end{aligned} \tag{7}$$

where I_t denotes investments at time t, a stochastic variable. Therefore, even if *K* and *L* do not vary significantly, *FCF* will not capture the same information as *CI*, exactly because investments, *I,* are stochastic. Furthermore, whereas it is common to view *K* and *L* as not varying much over time at the economy level, there is no reason to believe that they are constant or approximately constant at a firm level. For a recent discussion of these issues, see McGrattan and Prescott (2000).

2. Data

The inputs needed to compute a firm's *CI* are obtained from COMPUSTAT.

As mentioned earlier, we define a firm's gross profit margin as the difference between a firm's sales (COMPUSTAT industrial quarterly data item 2) minus its cost of goods sold (COMPUSTAT industrial quarterly data item 30).

A firm's labor is proxied by the number of its employees (COMPUSTAT industrial annual data item 29).[5] Furthermore, the capital stock of a firm is measured using the series "Property, Plant and Equipment – Total (Net)" (COMPUSTAT industrial annual data item 8 before 1976, and COMPUSTAT industrial quarterly data item 42 after 1976).

We convert data available at an annual frequency to quarterly observations by simply assigning for the quarters of the year the annual observation of that year. As a robustness check, we also experimented with simple splicing techniques to transform annual data into quarterly. The results of the paper remain qualitatively the same, and for that reason we do not report them here.

We use the fiscal year-end month data (FYR) variable in the COMPUSTAT industrial annual file to arrange the annual data into the appropriate calendar period. To make sure that there is no look-ahead bias in our analysis, an observation is used about 3 months after it is published. For instance, in the case of an annual observation with YEARA (fiscal year) equal to 1966 and FYR (fiscal year end month of data) equal to 3, the observation is first used as an end-of-quarter observation for the second quarter of 1966. By the same token, we lag quarterly series by one quarter. In this manner, we ensure that the information used to compute CI_{lt} is known to the investors at the time of the computation of CI_{lt}.

The capital, labor, and output data are transformed into one-, two-, three-, and four-quarter growth rates, giving us a total of four different growth rates data sets. We do that in order to be able to measure CI_t over different horizons. To compute the CI_t for the current quarter, we require a firm to have at least 7 years of prior data, or a total of 28 consecutive quarterly observations for the GPM,

[5] We prefer the data item 29 over the series "labor and related expenses" (Compustat industrial annual data item 42) because the latter is only sparsely collected for most of the firms in Compustat.

labor, and capital stock series. Table 1 reports the number of firms included in each of the four data sets, as well as the mean and standard deviation of the corporate innovation measure each year.

Our analysis covers the period from the first quarter of 1967 to the last quarter of 2001, which represents the period for which data for all variables are available. Since we require a minimum of 28 consecutive observations to compute the CI_t, the first $CI's$ are computed for the first quarter of 1975. However, only a small number of firms is available for that year, making the portfolio results for 1975 relatively unreliable. For that reason, we present results on portfolio returns starting January 1976.

Monthly stock prices, book-to-market (BM), and market capitalization (ME) information is obtained from the Center for Research in Security Prices (CRSP) database. It includes firms listed on the NYSE, AMEX, and NASDAQ stock exchanges. We restrict our analysis to stocks with codes equal to 10 or 11. This ensures that we work exclusively with returns on common stocks. In other words, closed-end funds, trusts, shares of Beneficial Interest, American Depository Receipts, Real Estate Investment Trusts, etc, are excluded from our analysis. Firm size is defined as the number of shares outstanding times the monthly price. A firm's BM is defined as the COMPUSTAT industrial quarterly data item 59 divided by the firm size.

Data for the 25 Fama-French (1993) portfolios, as well as for the market factor, T-bill rate, the size factor SMB, the BM factors HML, and the momentum factor UMD are obtained from Kenneth French's website.[6]

3. The Pricing of Corporate Innovation in Equity Returns

[6] We would like to thank Kenneth French for making the data publicly available. The website URL is http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/

We start our analysis by examining whether corporate innovation represents a risk factor in equity returns. For the purpose of the asset pricing tests, we aggregate the GPM, capital stock, and labor across all firms in our sample. We then compute the growth rates of these variables over the past quarter, and construct an aggregate CI factor, which we will denote by *ACI*. The variable *ACI* is used as a factor in our asset pricing tests. As mentioned earlier, this factor is a scaled TFP, with the difference that it is computed using only publicly-traded firms, rather than all firms in the economy.

As test assets we use the familiar Fama-French (FF) (1993) 25 book-to-market and size-sorted portfolios obtained from Ken French's website. The reason we choose these tests assets has to do with the fact that one of the hypotheses we are testing refers to the pricing of the momentum factor. The pricing of this factor in the literature has been mainly demonstrated using the 25 FF portfolios as test assets.

Our asset pricing tests are performed using the Generalized Methods of Moments (GMM). Since *ACI* is a generated factor, and to avoid problems related to errors-in-variables, we stack the moment conditions for the estimation of *ACI* on top of those of the asset pricing model in question, and estimate them all simultaneously in one large GMM system. This method is proposed in Cochrane (2001) in connection with correcting for errors-in-variables problems inherent in the Fama-MacBeth procedure.

In the absence of a theoretical asset pricing model that gives rise to *ACI* as a risk factor, we need to examine whether it is priced within a reasonable empirical specification. We choose to add *ACI* to the Capital Asset Pricing Model (CAPM) specification, generating therefore a two-factor model.

An economic justification for this empirical specification can be obtained with reference to Merton's (1973) Intertemporal CAPM (ICAPM). Since *ACI* is a shrunk *TFP* variable, and *TFP* is a well-known business-cycle state variable that affects the investment opportunity set, *ACI* is bound to do the same. According to Merton's model, risk-averse investors would want to hedge against changes in the investment opportunity set. In the case of *ACI*, they will do that by selling stocks of companies whose returns are positively correlated with *ACI*. This will drive down the prices of those stocks and increase their expected returns. The end result is that *ACI* will receive a positive risk premium in the cross-section of equity returns. The findings in Table 2 confirm the above reasoning. Indeed, *ACI* carries a positive and statistically significant risk premium in the cross-section of the 25 Fama-French portfolios.

Apart from examining the pricing of *ACI* in this section, we also test an additional hypothesis, the results of which are important for interpreting the rest of the findings in this paper.

The performance of price momentum strategies and the ability of the momentum factor to explain part of the cross-section of equity returns has been one of the most puzzling anomalies in the asset pricing literature in the recent years. Grinblatt, Titman and Wermers (1995) and Carhart (1997) show that a momentum factor can explain part of the abnormal returns generated by mutual funds. Fama and French (1996) discuss the properties of their three factor model, and its inability to explain momentum. They suggest that a fourth, momentum-related factor may need to be added to their empirical specification. Recently, there have been some risk-based explanations for the performance of the Fama-French (1993) model.[7] These explanations relate the Fama-French factors to macroeconomic variables and the business cycle. In the remainder of this section we examine whether the momentum factor shares any priced information with *ACI*, an economically-motivated variable in the real business cycle literature. In that sense, the tests of the remainder of this section, amount to testing a particular rational explanation for the pricing of the momentum factor.

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[7] See for instance, Liew and Vassalou (2000), Lettau and Ludvingson (2001), Vassalou (2003), Li, Vassalou, and Xing (2003), and Vassalou and Xing (2003).

Panel B of Table 2 reports the results from GMM tests that include in the pricing kernel the market factor and the momentum factor *UMD*, obtained from Ken French's website. These results confirm previous findings that *UMD* carries a positive and statistically significant risk premium. Panel C presents results from a model that includes in the pricing kernel the market factor, *UMD*, and *ACI.* Note that while *ACI* continues to be priced as in Panel A, the risk premium attached to *UMD* ceases to be statistically significant. This implies that *ACI* and *UMD* share common priced information. In other words, the premium attached to *UMD* appears to be a hedging premium related to changes in the investment opportunity set, as captured by our shrunk *TFP*-type of variable, *ACI.*

Table 3 provides further evidence on the pricing of our corporate innovation variable, and why it explains momentum. For those tests, we construct a returns-based CI variable. In particular, we compute CI for all stocks in our sample, using growth rates in GPM, capital, and labor over the past two quarters. We then rank stocks on the basis of their CI and create 10 portfolios. The holding period of these portfolios is 6 months. Our variable HLCI is a zero-investment portfolio which is long on the decile with the highest CI stocks, and short on the decile with the lowest CI stocks.

In the same vein, we construct within our sample the 6-month/6-month momentum strategy of Jagadeesh and Titman (1993), which is considered the most popular momentum strategy. It amounts to ranking stocks on the basis of their past 6-month returns and constructing 10 portfolios. The variable MOM is a zero-investment portfolio that is long on the decile with the highest past 6-month returns (winners), and short on the decile with the lowest past 6-month returns (losers). The holding period of the portfolios is 6 months.

Table 3 reports the results from regressions of the 10 momentum deciles on factors implied by three alternative asset pricing models. The first model is the familiar CAPM, the second model is the

Fama-French (1993) model, while the third specification is one that includes the three Fama-French factors in addition to HLCI.

Panel A reports the alphas of the regressions. As it is well-known from previous work, neither the CAPM, nor the Fama-French model can explain well the returns of the momentum deciles. Their alphas are generally statistically significant for the deciles with relatively high past returns. The last column of the panel also shows that none of the two models can explain the momentum spread, MOM, either. However, the presence of HLCI in the regression equation results in an insignificant alpha for MOM, as well as all of the momentum decile alphas, except for that with the highest past returns (P10).

Panel B reports the betas of the momentum deciles with respect to HLCI. The first row reports betas from univariate regressions of the momentum portfolio returns on HLCI. The second and third rows report the loadings of the momentum deciles on HLCI, when HLCI appears in the regression together with other factors, such as the market factor (MKT) and the Fama-French (1993) factors. In all cases, the loadings of the momentum deciles on HLCI are generally statistically significant. In addition, they vary monotonically across deciles, with losers having the lowest (negative) loading, and winners the highest (positive) loading. The loading of the momentum spread, reported in the last column, is also economically and statistically significant in all cases considered. The results of Panel B show that the returns of momentum deciles co-vary with HLCI. Furthermore, the loadings are bigger, the higher the momentum decile. In other words, CI-related risk provides an at least partial explanation for momentum. Recall that evidence showing that CI represents a risk-based factor is provided in Table 2. In particular, Table 2 shows that an aggregate CI (ACI) factor is priced. As mentioned earlier, CI is an economically-motivated factor, and ACI corresponds to a measure of Total Factor

Productivity (TFP). TFP is a well-known state variable in the Real Business Cycle literature and it affects equity returns.

Additional evidence on the pricing of CI risk is offered in Panel C of Table 3, where we report results from regressions of HLCI on alternative sets of factors. The models considered are the CAPM, the Fama-French model, and a four-factor model that includes the momentum spread (MOM), in addition to the Fama-French factors. In all three cases, the alpha of HLCI is statistically significant and positive. This means that stocks with high sensitivity to CI offer higher expected returns, presumably because investors are averse to variations in CI, and therefore, they require a premium to hold stocks with big exposures to this variable. The reason that investors are averse to variations in CI is because in such firms, much of their profits are due to CI. Therefore, variations in CI result in substantial variations in profits, an obviously undesirable effect.

Finally, Panel D of Table 3 reports the correlation matrix of the factors considered in the previous panels. Note that HLCI is almost uncorrelated to MKT, SMB, and HML, as is MOM. However, MOM has a correlation of 0.51 with HLCI. This is consistent with our findings that HLCI helps explain MOM.

The conclusion emerging from this section is that a corporate innovation-related factor is priced in the cross-section of equity returns. In addition, such a factor helps explain the time-variation in the momentum portfolios. As a result, it maybe considered as an at least partial explanation of the price momentum effect. The following sections explore further the relation between CI and past returns, by examining the performance and characteristics of portfolios formed on the basis of these two variables.

4. Corporate Innovation and Subsequent Equity Returns

The previous section shows that, to the extent that the momentum factor is priced in the cross-section of equity returns, it appears to be because it contains business cycle-related information. In this section, we aim to understand better the relation between *CI* and past returns through portfolio formation experiments. In particular, we compare the characteristics and performance of momentum deciles to those of decile portfolios formed on the basis of *CI*.

Similarly to Section 3, the methodology we use in our portfolio construction experiments is the same as that in Jagadeesh and Titman (1993). To render our comparison more informative, we focus once more on the 6-month/ 6-month momentum strategy, which is the most popular in the literature, as well as on the equivalent 6-month/6-month *CI*-based strategy. The construction methodology for these strategies was discussed in section 3 in connection to the construction of the HLCI and MOM zero-investment portfolios. The deciles of both strategies are equally-weighted. Their performance and characteristics are reported in Table 4.

Panel A of Table 4 reports the results for the CI-based strategy, whereas Panel B reports the results for the price momentum strategy. The comparison of the performances of the two strategies reveals the following results. First, the returns from the two alternative zero-investment strategies are quite similar. The return on the zero-investment portfolio of the *CI* strategy is equal to 0.70% per month, or 8.4% per year. This is a bit higher than the corresponding momentum strategy return, which is equal to 0.67% per month, or 8.04% per year.

More importantly, the two alternative strategies have common characteristics with respect to the corporate innovations of the stocks they trade. By construction, the deciles sorted on the basis of *CI* exhibit monotonicity with respect to this variable. Note, however, that the procedure used to construct the price momentum strategy does not involve the use of any information about the *CI* 's of the firms involved. Nevertheless, the price momentum portfolios exhibit the same type of monotonicity with respect to CI as the portfolios sorted on the basis of corporate innovation. In particular, the "losers" are typically firms with negative CI 's, whereas the "winners" are the firms with the highest average CI among momentum portfolios. In addition, there is some degree of similarity across the CI and price momentum deciles with respect to their average size and BM characteristics. High CI stocks, as well as winners, tend to be larger, low BM firms, whereas low CI stocks and losers are somewhat smaller, higher BM firms. The spread, however, in terms of size and BM across the CI portfolios is smaller than that across the momentum portfolios, further suggesting that the firms comprising the deciles of the two strategies are not identical. Finally, both strategies are market beta neutral, as indicated by the beta of the zero-investment portfolios.

Table 4 also reports the firm-specific volatilities of all deciles for the CI and price momentum strategies. Average firm-specific volatility for each portfolio is computed following the method proposed in Campbell, Lettau, Malkiel, and Xu (2001). In particular, we decompose a firm's return into the return of its industry and an innovation. For this decomposition, we use the same 49 industry classification as in Campbell et al (2001). We then sum the squares of the firm-specific innovations. For each industry represented in each of the portfolios of the two strategies, we compute the weighted average of the firm-specific volatilities. We then average over industries represented within each portfolio of the two strategies to obtain a measure of average firm-specific volatility for the portfolio. The numbers reported are annualized volatilities in percentage terms.

A comparison of the average firm-specific volatilities by decile for the two strategies reveals that they exhibit a similar pattern. Specifically, the firm-specific volatilities across deciles of each strategy form an asymmetric U-shape. Firms with negative CI 's , as well as losers, have the highest firm-specific volatilities. As the level of CI increases to around zero, the average firm-specific volatility of the portfolio decreases. The same is true as we move from the losers portfolio to portfolio

6. As average *CI* becomes positive and increases across the *CI* portfolios, so does the average firm-specific volatility. This is also the case across the momentum deciles.

Table 3 also reports the average *GPM* growth per decile of the two strategies. The *CI* deciles exhibit monotonicity with respect to *GPM* growth with P10 providing the highest *GPM* growth and P1 the lowest. Note that regressions of *GPM* growth on capital and labor growth produce adjusted R-squares that vary across firms and time between zero and 95%. Therefore, the high correlation between *CI* and *GPM* is despite the fact that capital and labor growth often explains a large proportion of the time-series variation in *GPM*. *CI* enhances the profitability of firms, and therefore high *CI* firms are the most profitable ones, whereas low (negative) *CI* firms are the least profitable. This idea is consistent with the framework and predictions of dynamic equilibrium representative agents macro models.

Monotonicity across deciles with respect to GPM is also present in the case of the momentum portfolios. In particular, "winners" is the decile with the highest average GPM growth, whereas losers is the decile with the lowest.

Both in the case of CI and momentum deciles, we also report the average coefficients on capital and labor growth, as well as the constant from the OLS regressions used to compute a firm's CI each quarter. No specific pattern for the capital and labor coefficients is found across the deciles of the two strategies, implying that winners and high CI firms are not distinct from the other firms in terms of their growth in capital and labor. In other words, what differentiates winners from losers is unrelated to their capital and labor growth.

The CI strategy presented here may constitute an imperfect proxy for the momentum strategy. It is imperfect to the extent that the stocks involved in the two strategies are not identical, although the characteristics of the strategies are very similar. It may also be the “true underlying strategy”, to the extent that momentum is simply a noisy proxy for the CI strategy.[8]

To gain a better understanding of the extent to which corporate innovation and past returns proxy for each other, we perform the following tests. We sort stocks first into ten portfolios according to their current *CI* computed using growth rates over the past two quarters. We then sort stocks within each *CI* decile into ten portfolios according to their past returns. This procedure gives rise to 100 portfolios. We finally examine whether the difference in returns between winners and losers within each *CI* portfolio is positive and statistically significant.

The results are reported in Table 5. Within the first 6 *CI* portfolios with the lowest corporate innovation, the difference in returns between winners and losers is not economically or statistically significant. However, for the remaining four *CI* portfolios with the highest *CI*, the difference in returns between winners and losers is positive, statistically significant, and larger than that obtained using the whole sample, as can be seen by comparing the returns with those reported in Table 4.

These results imply that there is a nonlinear relation between corporate innovation and past returns. For the segment of the market that contains the 60% of stocks with the lowest levels of *CI*, the relation between *CI* and past returns is linear. Therefore, when stocks are sorted on the basis of *CI*, the spread in returns between winners and losers is close to zero. On the other hand, for the remaining 40% of stocks in the market, this is not the case. The implication is that for momentum strategies to be

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[8] A number of explanations for the momentum effect have been previously provided in the literature. See for instance, Barberis, Shleifer, and Vishny (1998), Daniel, Hirshleifer, and Subrahmanyam (1998), Hong, Lim and Stein (1998), and Hong and Stein (1998) for potential behavioral explanations, Conrad and Kaul (1998) and Grundy and Martin (2001) for work on risk-based explanations, and Moskowitz and Grinblatt (1999) for an analysis based on the importance of industries for momentum portfolios that can be consistent with both behavioral and risk-based explanations. The recent work of Chordia and Shivakumar (2002) provides evidence that suggests a link between the returns on momentum portfolios and the business cycle. Furthermore, Pastor and Stambaugh (2003) show that their liquidity factor can explain part of the momentum returns. Finally, Korajczyk and Sadka (2003) show that momentum profits are not robust to the presence of market frictions.

profitable, the level of corporate innovation has to be high. Put differently, corporate innovation is a necessary condition for momentum profits to exist.

Table 6 reports results from a reverse double sort. Stocks are now first sorted on past returns and then on *CI*. Similarly to Table 5, stocks are grouped into 10 portfolios according to their past returns. Subsequently, each of the ten portfolios is subdivided into ten new portfolios according to the *CI* of the stocks it contains. The results of Table 6 show that the spread in returns between high and low *CI* stocks is always positive and statistically significant, independently of the level of past returns of the stocks. Put differently, the returns of the *CI* strategy are not contingent on the past returns of the stocks, whereas the returns of the momentum strategy are crucially dependent on the level of corporate innovation that the stocks exhibit.

The results of Tables 4 to 6 reveal the existence of a strong link between corporate innovation and return continuation. Return continuation is prominent and the momentum strategy is profitable only for the high CI firms.

In our view, the reason return continuation is present only for the high CI firms has to do with the very nature of corporate innovation. As mentioned earlier, the level of corporate innovation is not known with certainty, but it can be inferred, or estimated. As information related to the level of CI is gradually revealed in the market, prices adjust to reflect this information. This process can give rise to the returns continuation observed in the data.

When CI is negative, investors know that they need to short those stocks. Learning the negative level of CI with precision is not beneficial to the investors in this case, since information gathering is costly, and the effect that this information would have on the performance of the momentum strategy is minimal. To understand this point, note that the performances of the momentum strategies in Table 5 do not crucially depend on how low the CI's of the shorted stocks are. The variation in returns across losers in the ten CI-sorted portfolios is small. However, this is not the case for the winners. The returns of winners vary substantially depending on the level of CI across deciles. In other words, the performance of the momentum strategy is dependant on going long on stocks with high levels of CI.

Consider also the following argument. Corporate innovation, being a scaled TFP variable at the firm-level, has to be persistent by nature. We verify here that this is indeed the case. The average CI's of the ten deciles are highly autocorrelated up to at least lag 12. The average absolute autocorrelation is around 0.35 with some autocorrelations being as high as 0.7. When we compute the autocorrelations of the deviation of CI's from the mean CI of all portfolios, the results are even stronger. The deviation from the mean CI is a relevant concept here, since a firm is classified as high or low CI relative to the other firms in the market. In other words, what matters is not the absolute level of CI of a firm, but rather its relative level. When we compute the autocorrelations of the deviations of CIs from the mean CI, the autocorrelations are larger and persist for at least up to lag 20. Furthermore, it is worth noting that the autocorrelations of the high CI portfolios are always positive and persist for longer periods of time that those of the other decile portfolios. To conserve space, we do not report here the autocorrelation results in more detail.

Given the high persistence of CI, and the fact that high CI firms earn higher returns than low CI firms, investors may use past returns as an indication of the robustness of their CI estimate. Furthermore, as we will see in Section 5, CIs are not always positively autocorrelated, but they eventually reverse. Therefore, investors may use past returns as a second-order information to assess the robustness of their CI estimate and the likelihood that the CI of the firm will continue to be high next period. Past returns is clearly a second-order effect in this context, since as Table 6 shows, the performance of the CI strategy is not conditional on the past returns of the stocks traded.

4.1. The Performance of CI Strategies Over Different Formation and Holding Periods

Since there is a plethora of price momentum strategies documented in the literature (see, Jagadeesh and Titman (1993, 2001), and Rowenhorst (1998)), it is important to examine if strategies based on *CI* can be similarly profitable when we allow the formation and holding periods to vary. To conserve space, we will only present results based on CI strategies, and not those on price momentum strategies. For stylized facts on the performance of price momentum strategies, we refer the reader to the cited momentum studies.

Table 7 reports the returns of portfolios formed on the basis of past one-quarter *CI* 's, but held for a period of 3, 6, 9, or 12 months. The return of the zero-investment portfolio, P10-P1, decreases as the holding period increases, indicating that the *CI* characteristics of stocks change substantially over time. Indeed, the turnover of portfolios reported in Panel E confirms this indication. Turnover is defined as the proportion of firms in a portfolio that leaves that portfolio each quarter. It is evidently very high for all deciles. High levels of turnover have also been reported in the literature for price momentum portfolios (see for instance, Jagadeesh and Titman (1993, 2001)).

Tables 8, 9, and 10 report the returns of the *CI* strategies when the portfolios are formed on the basis of *CI* 's computed using growth rates in GPM, capital, and labor over the past two, three, and four quarters. The following conclusion emerges from those tables. As formation period increases, the profitability of the zero-investment *CI* strategy increases, whereas as the holding period increases, its profitability decreases. The result is that the most profitable *CI* strategy is the one formed on the basis of the past 4 quarters of *CI* and held for 3 months. Its average return is equal to 13.7% per annum.

As the period over which we compute the growth in GPM, capital and labor increases, the turnover of the decile portfolios decreases. This implies that *CI* exhibits greater stability when it is measured over longer periods of time (in our case, four quarters). In contrast, when stocks are ranked on the basis of *CI* over the past quarter, the relative ranking takes into account potentially small changes in *CI*, which may be highly transient, or simply due to estimation noise. The intuition offered here is consistent with that presented at the end of the previous section with respect to the performance of momentum strategies across different *CI* deciles. The thrust of this argument is that *CI* is not observable. It can be estimated though, albeit with noise.

The general message that emerges from this section is that strategies based on *CI*, constructed along the lines of price momentum strategies, are at least as profitable as the price momentum strategies examined in the literature.

4.2. Further Comparisons of CI and Price Momentum Strategies

This section provides further evidence on the relation between the momentum and *CI* strategies, by reporting the correlation matrix of various *CI* and price momentum strategies, as well as results based on regression analysis.

Table 11A reports the correlation matrix of the various *CI* strategies reported in the previous section, and their corresponding momentum strategies. The correlations are relatively high, ranging from 0.31 to 0.55, with an average correlation of 0.47. Table 10B reports the correlation matrix for the various *CI* strategies presented earlier. The correlations are again relatively high, and vary between 0.16 and 0.95. It seems that the main element that leads to low correlations between two different *CI* strategies is a large difference in the holding periods of the long and short portfolios.

Table 12, Panel A provides results from regressions of the returns on zero-investment price momentum strategies (winners minus losers) on the returns of zero-investment *CI* strategies. The adjusted R-squares vary between 23% and 28%, suggesting that the *CI* strategies can explain a substantial proportion of the returns of the price momentum strategies. These adjusted R-squares are much larger than those previously reported in the literature from regressions of momentum portfolios on economic variables. For a recent examination of the ability of other economic variables to explain momentum, see Griffin, Li, and Martin (2003). The average adjusted R-square from analogous regressions reported in that study is around zero. Contrary to previous findings, the results of Table 12 show that the returns of our strategy, which is based on an economically-motivated variable, can explain a substantial proportion of the returns to the momentum strategy.

Panel B of Table 12 reports results of predictive regressions, where the returns of zero-investment momentum strategies are predicted by past month's returns of zero-investment *CI* strategies. The adjusted R-squares vary now between zero and 3%, implying that the returns of *CI* strategies have a rather limited ability to predict the returns of momentum strategies one month ahead. This implies that *CI* and momentum strategies share a strong contemporaneous relation, rather than a lagged one.

5. Corporate Innovation, and its Relation to Contrarian Strategies

Some of the skepticism in the literature about the idea that a rational explanation for the price momentum may exist, stems from the fact that price continuation is a medium-horizon phenomenon. In horizons longer than 12 months, and most notably in horizons of 3 to 5 years, losers tend to outperform winners, which is the opposite to what we observe in momentum. This observation, attributed to Bondt and Thaler (1985) gave rise to the contrarian strategies. As the term implies, contrarian strategies aim to buy securities that performed poorly in the past and short securities that did well. The holding period for such strategies is typically 3 to 5 years.

Whereas the Fama-French factors can explain the performance of contrarian strategies rather well, and therefore it is no longer considered an anomaly, it is still interesting to know whether an economically-motivated explanation for price momentum is consistent with long-horizon return reversals. The reason is that both medium-term returns continuation and long-horizon reversals are properties of the same underlying distribution of returns. It is therefore instructive to investigate whether an economic variable that is important for explaining the medium-horizon return continuation also plays a role in long-horizon reversals.

To address this question, we rank stocks on the basis of their past 5-year returns and form 10 portfolios.[9] We go long on the past winners and short on the past losers, as we would do in a momentum strategy. We then hold this zero-investment portfolio for 5 years. If a reversal is present in the return continuation of stocks over long horizons, the return of the zero-investment portfolio should be negative.

Table 13 shows that this is indeed the case. It confirms previous findings that a contrarian strategy may be profitable in long horizons, although the return difference in our results is not highly statistically significant.

Table 13 also reports the evolution over time of the average *CI* for the ten portfolios, measured using growth rates in GPM, capital and labor over the past 4 quarters. We chose to compute *CI's* over the past four quarters since the results of Section 4 show that *CI's* are more stable over time at this horizon. Consistent with the results of Table 4, we observe monotonicity with respect to current average *CI* across the portfolios. The losers have the lowest level of current *CI* and the winners the highest. However, as we track the evolution of *CI* over time for these 10 portfolios, the above monotonicity gets distorted. By the end of the holding period (year 5), the losers have a higher average

[9] We choose for our experiment the 5-year horizon because contrarian strategies over this period are considered the most popular and profitable. In tests not presented here, we verify that our results remain unchanged when the formation and holding period horizons vary between 3 and 5 years.

level of *CI* than the winners. According to our analysis, this is consistent with the fact that in that horizon, the losers outperform the winners.

What is the reason that losers end up in the long run with higher average levels of *CI* than the winners? In our view, the reason is again related to the very nature of corporate innovation. Losers are firms that use scarce resources such as labor and capital inefficiently. They cannot afford to be losers in the long-run or they will be punished with extinction (bankruptcy). Therefore, they will need to innovate in order to continue to exist. Similarly, while there is some degree of persistence in corporate innovation, top levels of *CI* may not be sustainable over very long periods of time. Successful ideas are often imitated by competitors, leading innovators to lose their competitive edge, unless they can continuously produce and implement innovative ideas of the same caliber. This may not be always possible. As a result, past winners are likely to regress to a lower level of *CI* in the horizons considered here, whereas losers are bound to enhance their relative position in the area of *CI* so as to survive.

Table 14 provides further evidence of the relation between performance of the contrarian strategy and CI. It reports results from regressions of the return on the contrarian zero-investment strategy of Table 12 on various factors. As can be seen by the alphas (intercept of regressions) reported, the Fama-French factors are sufficient to explain the returns of this strategy. This is consistent with the evidence presented in Fama and French (1996). Note, however, that when HLCI is added to the regression, the beta of the contrarian spread (long minus short position) is positive and statistically significant. In addition, the inclusion of HLCI in the regression model results in a moderate decrease in the beta of the contrarian spread with respect to the market factor (MKT). These results imply that although CI is not the principle explanation for the performance of the contrarian strategy, it is not unrelated to it either. In that sense, medium-term return continuation and long-horizon reversals are related phenomena through their link to our concept of corporate innovation.

6. Conclusions

This paper proposes the concept of corporate innovation as an important risk factor that explains part of the cross-sectional variation in equity returns. It also deepens our understanding of the mechanics of price momentum, by showing that corporate innovation constitutes an at least partial explanation for the performance of momentum strategies.

We define corporate innovation (CI) as the change in a firm's gross profit margin not explained by the change in the capital and labor it has in place. Our measure of corporate innovation corresponds to a "shrunk" firm-level total factor productivity, or Solow residual. In the business cycle literature, Solow residuals are interpreted as capturing broadly defined technology shocks. In that sense, corporate innovation is not always positive, but can take any value over time and across firms.

We show that corporate innovation is priced in the cross-section of equity returns and absorbs the priced information in the momentum factor. We also show that a CI returns-based factor can help explain the momentum spread ("winners" minus "losers"), and that momentum portfolios have significant loading with respect to the CI factor that vary monotonically across momentum deciles.

Portfolios sorted on the basis of corporate innovation have very similar properties to those sorted on the basis of past returns. In particular, "winners", the portfolio with the highest past returns in the price momentum strategy, are firms with the highest levels of corporate innovation. Similarly, "losers", the portfolio with the lowest past returns, are firms with the lowest (negative) levels of corporate innovation.

Further experiments confirm the existence of a strong relation between corporate innovation and return continuation. For momentum strategies to be profitable, the level of *CI* of the firms held long needs to be high. Momentum strategies performed using only low *CI* stocks deliver zero average returns.

Regression analysis reveals that a substantial proportion of the time-variation in the returns of momentum strategies can be explained by the returns of *CI*-based strategies. To our knowledge, this is the first study to show that an economically motivated variable can explain a significant proportion of the time-variation in momentum strategy returns.

Finally, we provide evidence that medium-term momentum and long-horizon contrarian strategies are related through their link to CI. The contrarian spread loads significantly on the return-based CI factor. Furthermore, losers outperform winners in horizons of 3 to 5 years, because by the end of that period, they exhibit higher levels of CI than the winners. This is despite the fact that at formation time, losers have the lowest levels of CI and winners have the highest.

Overall, our empirical findings show that corporate innovation is an important risk factor in equity returns, and it can viewed as an at least partial explanation for price momentum.

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TABLE 1: Description of data

We report the number of firms available for the period during which we construct portfolios based on firms' corporate innovation (CI). A firm's CI is measured over four different horizons, depending on the period over which growth rates for gross profit margin (GPM), labor and capital are measured. As a result, four different datasets are created. One-quarter CI reports the firms available every year when CI is computed using the growth rates in GPM, labor and capital over the previous one quarter. Similarly, four-quarter CI reports the firms available every year when CI is computed using the growth rates in GPM, labor and capital over the previous four quarters. We also report the mean CI for each year and its standard deviation. To compute the CI of a firm at time t, the firm must have a minimum of 28 consecutive quarterly observations, including the current quarter, for GPM, capital and labor data.

year	One-Quarter CI			Two-Quarter CI			Three-Quarter CI			Four-Quarter CI		
	Number of Firms	mean	std	Number of Firms	mean	std	Number of Firms	mean	std	Number of Firms	mean	std
1976	104	-0.0101	0.0192	99	0.0465	0.0270	95	0.0572	0.0294	38	0.0571	0.0421
1977	153	0.0658	0.0403	144	0.0557	0.0196	142	0.0874	0.0225	109	0.1171	0.0281
1978	197	0.0671	0.0154	187	0.0805	0.0374	183	0.1598	0.0380	167	0.1532	0.0373
1979	240	0.0392	0.0128	231	0.0924	0.0139	227	0.1465	0.0173	207	0.1869	0.0165
1980	276	0.0524	0.0209	269	0.0894	0.0256	265	0.1309	0.0165	242	0.1276	0.0168
1981	325	0.0614	0.0178	305	0.0492	0.0192	296	0.0639	0.0278	277	0.1011	0.0296
1982	631	-0.0302	0.0135	546	-0.0118	0.0149	495	-0.0327	0.0176	321	0.0323	0.0201
1983	1005	-0.0071	0.0121	970	0.0196	0.0158	921	0.0534	0.0153	629	0.0082	0.0172
1984	1094	0.0589	0.0111	1082	0.0525	0.0111	1067	0.1345	0.0128	939	0.1375	0.0163
1985	1051	0.0148	0.0097	1037	0.0150	0.0106	1026	0.0469	0.0138	982	0.0716	0.0105
1986	1000	0.0352	0.0103	989	0.0465	0.0116	978	0.0654	0.0119	954	0.0579	0.0113
1987	917	0.0323	0.0128	901	0.0526	0.0117	895	0.0749	0.0127	885	0.0583	0.0101
1988	1238	-0.0108	0.0110	1138	0.0520	0.0125	1058	0.0463	0.0114	829	0.0728	0.0109
1989	1304	0.0105	0.0100	1271	0.0271	0.0104	1249	0.0402	0.0110	1187	0.0602	0.0115
1990	1339	0.0254	0.0105	1312	0.0200	0.0114	1286	0.0290	0.0115	1224	0.0288	0.0108
1991	1380	0.0137	0.0123	1348	0.0157	0.0123	1320	0.0281	0.0108	1283	0.0217	0.0097
1992	1449	0.0109	0.0090	1411	0.0290	0.0103	1386	0.0672	0.0112	1323	0.0458	0.0107
1993	1591	0.0115	0.0091	1539	0.0399	0.0103	1481	0.0659	0.0109	1403	0.0636	0.0104
1994	1725	0.0316	0.0084	1677	0.0554	0.0092	1638	0.0760	0.0088	1559	0.0655	0.0087
1995	1826	0.0423	0.0078	1763	0.0799	0.0090	1738	0.1144	0.0087	1670	0.0974	0.0080
1996	1860	0.0227	0.0078	1825	0.0408	0.0083	1791	0.0669	0.0086	1728	0.0571	0.0082
1997	1858	0.0380	0.0082	1826	0.0456	0.0084	1791	0.0759	0.0085	1748	0.0646	0.0079
1998	1842	0.0137	0.0080	1797	0.0448	0.0088	1769	0.0791	0.0087	1709	0.0631	0.0078
1999	1826	-0.0017	0.0082	1782	-0.0107	0.0089	1753	0.0293	0.0091	1696	0.0040	0.0090
2000	1764	0.0097	0.0082	1721	0.0282	0.0090	1695	0.0696	0.0093	1644	0.0654	0.0094
2001	1755	-0.0023	0.0080	1716	-0.0030	0.0094	1680	0.0334	0.0099	1624	0.0306	0.0095

TABLE 2: Asset pricing tests on the Fama-French 25 portfolios using Corporate Innovation and Momentum as factors: 1970Q1 – 2001Q4

Panel A: Market Factor and Momentum (UMD) factor model				
	Constant	Market	UMD	
Coefficient	0.9169	-1.9081	-3.6769	
t-value	16.8854	-1.8581	-2.2380	
Premium		0.0196	0.0222	
t-value		2.3899	2.5218	
	Over-identification Test	P-Wald(b)		
	25.1872			
p-value	0.3407	0.0000		
Panel B: Market Factor and Aggregate Corporate Innovation (ACI) factor model				
	Constant	Market	ACI	
Coefficient	1.2341	-3.7224	-8.6366	
t-value	18.7217	-3.9510	-2.7843	
Premium		0.0243	0.0134	
t-value		3.2472	2.4009	
	Over-identification Test	P-Wald(b)		Wald(UMD)
	23.8654			2.6668
p-value	0.4113	0.0000		0.1025
Panel C: ;Market Factor, Aggregate Corporate Innovation (CI) + Momentum (UMD) factor model				
	Constant	Market	ACI	UMD
Coefficient	1.3474	-4.0012	-9.8423	-2.4365
One Step t-value	13.9764	-3.7236	-2.8814	-1.6415
Premium		0.0229	0.0146	0.0072
One Step t-value		3.0798	2.4940	1.0191
	Over-identification Test	P-Wald(b)		
	23.5373			
p-value	0.3719	0.0000		

Note: The data for the test assets, the market factor, the risk-free rate, and UMD are obtained from Ken French's website. The corporate innovation factor ACI is the aggregate of the firm-level corporate innovation series, estimated following the methodology of Section 1. The Wald(UMD) test examines the ability of UMD to explain the test assets when it is added to the pricing kernel of the model in Panel B.

Table 3: Regression Analysis on the Relation between CI and Momentum

Panel A Alphas of momentum deciles

Deciles	1	2	3	4	5	6	7	8	9	10	MOM (10-1)
CAPM alpha	0.0008	0.0014	0.0025	0.0024	0.0036	0.0040	0.0032	0.0039	0.0047	0.0063	0.0055
	(0.29)	(0.70)	(1.54)	(1.51)	(2.46)	(2.89)	(2.44)	(3.00)	(3.32)	(3.06)	(2.11)
Fama-French alpha	0.0010	0.0006	0.0000	-0.0003	0.0009	0.0012	0.0007	0.0015	0.0026	0.0057	0.0067
	(-0.41)	(-0.38)	(0.03)	(-0.29)	(0.95)	(1.53)	(0.96)	(2.08)	(3.00)	(4.49)	(2.28)
Fama-French+HLCI alpha	0.0057	0.0025	0.0018	0.0007	0.0016	0.0013	0.0003	0.0009	0.0015	0.0043	-0.0014
	(1.40)	(1.22)	(1.19)	(0.58)	(1.48)	(1.49)	(0.39)	(1.23)	(1.73)	(3.38)	(-0.32)

Panel B Betas of momentum deciles w.r.t to HLCI

Factors\Deciles	1	2	3	4	5	6	7	8	9	10	MOM (10-1)
HLCI	-0.8327	-0.3022	-0.0942	0.0172	0.0638	0.1517	0.2351	0.261	0.3443	0.4024	1.2350
	(-1.61)	(-1.12)	(-0.46)	(0.10)	(0.43)	(1.07)	(1.64)	(1.74)	(2.02)	(1.75)	(3.38)
MKT+HLCI	-1.0606	-0.4954	-0.2706	-0.1533	-0.1028	-0.0164	0.0633	0.0837	0.1550	0.1709	1.2314
	(-2.48)	(-2.80)	(-2.34)	(-1.83)	(-1.70)	(-0.32)	(1.36)	(1.65)	(2.45)	(1.77)	(3.27)
Fama-French+HLCI	-1.0280	-0.4835	-0.2690	-0.1560	-0.1090	-0.0211	0.0592	0.0855	0.1672	0.2194	1.2474
	(-2.65)	(-2.95)	(-2.38)	(-1.82)	(-1.65)	(-0.40)	(1.41)	(2.38)	(4.26)	(3.83)	(3.20)

Panel C Regressions of HLCI on alternative sets of factors

	alpha	Market beta	HML beta	SMB beta	MOM beta
CAPM	0.0066	0.0454			
	(6.11)	(1.57)			
Fama-French	0.0065	0.0592	0.0284	-0.0179	
	(5.51)	(1.53)	(0.41)	(-0.39)	
Fama-French+MOM	0.0050	0.0612	0.0772	-0.0147	0.2168
	(4.46)	(2.06)	(1.52)	(-0.39)	(5.34)

Panel D Correlation matrix of factors

	MKT	SMB	HML	HLCI	MOM
MKT	1.0000				
SMB	0.2279	1.0000			
HML	-0.5317	-0.4297	1.0000		
HLCI	0.0957	-0.0176	0.0117	1.0000	
MOM	0.0646	0.0491	0.1323	0.5134	1.0000

Note on Table 3: Panel A reports the alphas from regressions of the 6-month/6-month momentum deciles on the factors of the alternative models. T-values appear in parentheses. HLCI is the return on a zero-investment portfolio that is long on high CI stocks (top decile) and short on low CI stocks (bottom decile). The formation period for the portfolio covers the past two quarters, and the holding period is six months. Panel B reports the loadings of the momentum portfolio returns on HLCI, in the context of three alternative specifications. The first one contains only HLCI as an explanatory variable. The second specification includes both the market factor (MKT) and HLCI. Finally, the third specification includes the three Fama-French (1993) factors in addition to HLCI. The column "10-1" in both Panels A and B reports the alphas and betas respectively of the momentum spread (MOM). This is the return on the zero-investment portfolio that goes long on past winners (10) and short on past losers (1). Panel C reports the results from regressions of HLCI on alternative sets of factors. Panel D reports the correlation matrix of the various factors considered.

Table 4: Returns on Corporate Innovation-based and Momentum Strategies.
This table is split into two parts. Panel A reports results for a simple corporate innovation (CI) strategy, where the CI of a firm is measured using growth rates in the input and output variables over the past two quarters. The holding period for the portfolios is 6 months. Panel B reports results on the popular 6-month/ 6-month price momentum strategy. In the case of the CI strategy, stocks are ranked on the basis of their current CI, measured using growth rates over the past two quarters, and ten portfolios are formed. In the case of the price momentum strategy, stocks are ranked on the basis of their past 6 month returns. In the case of the CI strategy, Portfolio P1 contains stocks with the lowest CI's, whereas in the case of the momentum strategy, it contains stocks with the lowest past 6 month returns. Similarly, portfolio P10 contains the stocks with the highest CI's in the case of the CI strategy, and the stocks with the highest prior 6 month returns in the case of the momentum strategy. In both strategies, portfolios are held for a period of six months. The period for which returns are computed is from January 1976 to December 2001. Portfolio characteristics such as CI, size, and BM are averages of the characteristics of the portfolios each time they are rebalanced (i.e., at formation dates). Size denotes the average market capitalization of the portfolio, and it is measured in millions of dollars. Beta is the market beta of the portfolio returns, computed over the whole time period. T-values for the mean returns appear in parentheses. The column labeled Volatility denotes the firm-specific average volatility of each portfolio. Firm-specific volatilities are computed following the methodology outlined in Campbell, Lettau, Malkiel, and Xu (2001). They are reported annualized and in percentage terms. GPM growth is the average 2-quarter growth of the GPM of each stock in the portfolio. Constant, Capital and Labor denote the average coefficient estimates from the regressions ran to compute the CI's of the firms in each portfolio.

Panel A: Current Two-Quarter Corporate Innovation/6 Month Returns

	Returns	CI	ln(Size)	BM	Beta	Volatility	GPM Growth	constant	Capital	Labor
P 1 (Low CI)	0.0110	-0.6141	6.8325	1.1550	0.9183	13.8338	-0.5967	0.0158	0.2905	0.2977
	(3.76)									
P 2	0.0129	-0.1856	7.2493	1.0255	0.8918	11.7680	-0.1708	0.0402	0.1681	0.1945
	(4.93)									
P 3	0.0127	-0.0818	7.4550	1.0055	0.9006	10.9185	-0.0710	0.0457	0.1169	0.1314
	(4.92)									
P 4	0.0133	-0.0215	7.5816	0.9243	0.8841	9.8020	-0.0123	0.0469	0.1362	0.1288
	(5.26)									
P 5	0.0154	0.0219	7.6998	0.8834	0.8804	9.0536	0.0266	0.0513	0.1128	0.0719
	(6.15)									
P 6	0.0157	0.0604	7.7238	0.8917	0.9302	9.5002	0.0643	0.0533	0.1250	0.0665
	(6.01)									
P 7	0.0165	0.1031	7.7551	0.8499	0.9157	9.4133	0.1014	0.0593	0.0344	0.0830
	(6.43)									
P 8	0.0177	0.1619	7.6678	0.8745	0.9930	10.1960	0.1543	0.0648	-0.0037	0.0624
	(6.42)									
P 9	0.0177	0.2612	7.3799	0.9003	1.0075	11.1909	0.2449	0.0705	-0.0546	-0.0055
	(6.20)									
P 10 (High CI)	0.0180	0.6540	7.0083	0.9931	0.9541	11.9160	0.6156	0.0876	-0.3471	-0.1265
	(6.37)									
P 10 – 1 (High CI-Low CI)	0.0070				0.0409					
	(5.68)									

Table3 cont'd

Panel B: 6-Month/6 Month Momentum

	Returns	CI	ln(Size)	BM	Beta	Volatility	GPM Growth	constant	Capital	Labor
P 1 (Losers)	0.0130	-0.0675	6.4198	1.3602	1.0920	17.9227	-0.0815	0.0499	0.1238	0.0550
	(3.31)									
P 2	0.0133	-0.0001	7.0681	1.1114	0.9420	11.3761	-0.0045	0.0530	0.0488	0.0705
	(4.59)									
P 3	0.0141	0.0174	7.3254	1.0336	0.8720	9.9151	0.0149	0.0510	0.0327	0.1176
	(5.47)									
P 4	0.0136	0.0254	7.4949	0.9649	0.8452	8.9149	0.0215	0.0514	0.0224	0.1270
	(5.55)									
P 5	0.0148	0.0398	7.5754	0.9324	0.8266	8.3982	0.0395	0.0523	0.0123	0.1163
	(6.24)									
P 6	0.0154	0.0486	7.6414	0.9089	0.8388	8.2985	0.0494	0.0519	0.0424	0.0886
	(6.49)									
P 7	0.0149	0.0529	7.7288	0.8991	0.8661	8.1940	0.0541	0.0525	0.0510	0.1176
	(6.17)									
P 8	0.0158	0.0607	7.7881	0.8311	0.8897	8.5832	0.0633	0.0541	0.0841	0.1115
	(6.37)									
P 9	0.0166	0.0742	7.7611	0.7865	0.9504	9.5022	0.0788	0.0574	0.0688	0.0688
	(6.22)									
P 10 (Winners)	0.0197	0.1189	7.3137	0.6821	1.1527	13.3605	0.1296	0.0627	0.0823	0.0209
	(5.71)									
P 10 – 1 (Winners-Losers)	0.0067				0.0657					
	(2.31)									

Table 5: Returns of Portfolios Sorted First on Current two-quarter Corporate Innovation and then on Past 6-month Returns.
The holding period is 6 months. Returns are from May 1977 to December 2001, as before May 1977 there are not enough stocks in our sample to ensure that none of the 100 portfolios will be empty at any point in time.

Current Two-Quarter Corporate Innovation	6 Month Past Returns										
	Loser	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**Winner**	**Winner - Loser**
Low CI	0.0127	0.0076	0.0079	0.0106	0.0100	0.0112	0.0104	0.0104	0.0102	0.0121	-0.0006
	(1.92)	(1.69)	(2.25)	(3.35)	(3.48)	(3.93)	(4.06)	(4.17)	(3.67)	(3.33)	(-0.10)
P 2	0.0151	0.0115	0.0120	0.0099	0.0113	0.0117	0.0104	0.0132	0.0121	0.0167	0.0016
	(3.16)	(3.32)	(4.11)	(3.62)	(4.28)	(4.53)	(4.06)	(5.30)	(4.13)	(4.76)	(0.41)
P 3	0.0122	0.0110	0.0107	0.0105	0.0128	0.0129	0.0130	0.0119	0.0122	0.0162	0.0040
	(2.86)	(3.45)	(3.75)	(4.01)	(4.98)	(5.08)	(5.13)	(4.61)	(4.49)	(4.60)	(1.13)
P 4	0.0140	0.0134	0.0135	0.0134	0.0134	0.0127	0.0132	0.0133	0.0126	0.0138	-0.0002
	(3.27)	(4.38)	(5.04)	(4.98)	(5.24)	(4.99)	(5.06)	(5.33)	(4.54)	(4.23)	(-0.06)
P 5	0.0158	0.0152	0.0147	0.0144	0.0157	0.0153	0.0146	0.0149	0.0137	0.0165	0.0007
	(4.16)	(5.42)	(5.64)	(5.60)	(6.20)	(5.97)	(5.68)	(5.70)	(4.95)	(5.04)	(0.23)
P 6	0.0150	0.0163	0.0158	0.0146	0.0146	0.0164	0.0157	0.0144	0.0172	0.0155	0.0004
	(3.58)	(5.38)	(5.47)	(5.73)	(5.64)	(6.28)	(6.02)	(5.31)	(6.05)	(4.57)	(0.13)
P 7	0.0108	0.0139	0.0140	0.0139	0.0172	0.0163	0.0169	0.0174	0.0165	0.0216	0.0108
	(2.71)	(4.74)	(5.07)	(5.34)	(6.66)	(6.18)	(6.43)	(6.78)	(5.84)	(6.17)	(3.31)
P 8	0.0148	0.0154	0.0164	0.0164	0.0180	0.0180	0.0179	0.0181	0.0190	0.0223	0.0075
	(3.78)	(4.64)	(5.49)	(5.89)	(6.58)	(6.60)	(6.58)	(6.22)	(6.07)	(5.59)	(2.28)
P 9	0.0125	0.0150	0.0158	0.0169	0.0158	0.0158	0.0173	0.0177	0.0206	0.0213	0.0089
	(3.10)	(4.53)	(5.50)	(6.06)	(5.97)	(5.75)	(6.14)	(5.87)	(6.13)	(4.92)	(2.33)
High CI	0.0150	0.0157	0.0174	0.0155	0.0149	0.0169	0.0167	0.0177	0.0183	0.0257	0.0107
	(3.28)	(4.59)	(5.91)	(5.49)	(5.61)	(5.81)	(5.70)	(5.88)	(5.13)	(5.69)	(2.43)
High - Low	0.0023	0.0081	0.0094	0.0049	0.0049	0.0058	0.0063	0.0073	0.0081	0.0135	
	(0.53)	(3.05)	(4.29)	(2.67)	(2.77)	(3.11)	(3.51)	(4.33)	(3.93)	(4.89)	

Table 6: Returns of Portfolios Sorted First on Past 6-month Returns and then on Current two-quarter Corporate Innovation.
The holding period is 6 months. Returns are from May 1977 to December 2001, as before May 1977 there are not enough stocks in our sample to ensure that none of the 100 portfolios will be empty at any point in time.

6 Month Past Returns	Current Two-Quarter Corporate Innovation										
	Low CI	P2	P3	P4	P5	P6	P7	P8	P9	High CI	High - Low
Loser	0.0084	0.0117	0.0143	0.0113	0.0147	0.0158	0.0128	0.0137	0.0139	0.0154	0.0070
	(1.47)	(2.29)	(3.21)	(2.63)	(3.56)	(3.61)	(3.12)	(3.33)	(3.46)	(3.45)	(1.82)
P 2	0.0073	0.0128	0.0110	0.0118	0.0130	0.0147	0.0152	0.0137	0.0137	0.0152	0.0079
	(2.28)	(3.85)	(3.70)	(3.86)	(4.08)	(4.74)	(4.83)	(4.28)	(4.19)	(4.61)	(4.03)
P 3	0.0102	0.0108	0.0101	0.0118	0.0139	0.0147	0.0147	0.0165	0.0152	0.0165	0.0063
	(3.38)	(3.95)	(3.78)	(4.41)	(5.20)	(5.37)	(5.18)	(5.63)	(5.01)	(5.61)	(3.54)
P 4	0.0091	0.0104	0.0112	0.0119	0.0147	0.0147	0.0134	0.0146	0.0165	0.0152	0.0061
	(3.27)	(4.03)	(4.33)	(4.67)	(5.73)	(5.55)	(5.08)	(5.47)	(5.67)	(5.45)	(3.80)
P 5	0.0130	0.0120	0.0129	0.0130	0.0141	0.0153	0.0153	0.0160	0.0181	0.0149	0.0019
	(5.00)	(4.71)	(5.01)	(5.13)	(5.54)	(5.98)	(5.83)	(6.02)	(6.59)	(5.59)	(1.35)
P 6	0.0106	0.0124	0.0141	0.0139	0.0154	0.0151	0.0166	0.0167	0.0166	0.0160	0.0054
	(4.07)	(5.07)	(5.66)	(5.52)	(5.93)	(5.89)	(6.41)	(6.40)	(6.22)	(6.03)	(3.93)
P 7	0.0099	0.0129	0.0130	0.0135	0.0139	0.0154	0.0167	0.0159	0.0158	0.0155	0.0056
	(3.87)	(5.02)	(5.30)	(5.26)	(5.48)	(6.10)	(6.33)	(6.05)	(5.79)	(5.71)	(4.20)
P 8	0.0093	0.0137	0.0125	0.0149	0.0156	0.0157	0.0179	0.0173	0.0173	0.0170	0.0077
	(3.56)	(5.33)	(4.77)	(5.51)	(5.81)	(5.88)	(6.55)	(6.41)	(6.21)	(5.88)	(4.92)
P 9	0.0145	0.0123	0.0142	0.0150	0.0150	0.0172	0.0198	0.0193	0.0190	0.0177	0.0032
	(4.47)	(4.28)	(4.99)	(5.20)	(5.42)	(5.77)	(7.02)	(6.30)	(6.04)	(5.90)	(1.59)
Winner	0.0146	0.0149	0.0159	0.0176	0.0191	0.0208	0.0212	0.0218	0.0232	0.0242	0.0096
	(3.57)	(4.03)	(4.33)	(4.94)	(5.50)	(5.46)	(5.45)	(5.50)	(5.49)	(5.71)	(3.58)
Winner - Loser	0.0062	0.0032	0.0016	0.0064	0.0045	0.0051	0.0084	0.0082	0.0093	0.0088	
	(1.26)	(0.72)	(0.42)	(1.76)	(1.35)	(1.35)	(2.55)	(2.46)	(2.59)	(2.13)	

Table 7: Portfolios formed on the basis of CI measured over the past 1 quarter

Corporate innovation (CI) is measured using growth rates for the input and output variables over the past 1 quarter. Returns span the period from January 1976 to December 2001. Portfolio P1 denotes the portfolio that contains the stocks with the lowest current CI, while portfolio P10 contains the stocks with the highest current CI. The row labeled "beta" refers to the market beta of the portfolio computed using the whole time-series of the portfolio. Portfolio characteristics such as CI, size, and BM are computed at the portfolio formation date. T-values for the mean returns appear in parentheses. The turnover of each portfolio refers to the proportion of firms that exits the portfolio from one quarter to another. Size denotes the average market capitalization of the portfolio, and it is measured in millions of dollars.

	P 1	**P 2**	**P 3**	**P 4**	**P 5**	**P 6**	**P 7**	**P 8**	**P 9**	**P 10**	**P 10 - 1**
						3 Month Holding Period					
Returns	0.0111	0.0135	0.0145	0.0146	0.0150	0.0171	0.0166	0.0160	0.0190	0.0178	0.0067
	(3.71)	(5.04)	(5.31)	(5.50)	(5.77)	(6.33)	(6.13)	(5.81)	(6.94)	(6.43)	(4.71)
Beta	0.93	0.90	0.95	0.93	0.91	0.95	0.96	0.96	0.96	0.92	-0.01
						6 Month Holding Period					
Returns	0.0111	0.0142	0.0143	0.0143	0.0148	0.0165	0.0167	0.0162	0.0180	0.0171	0.0061
	(3.84)	(5.37)	(5.40)	(5.53)	(5.82)	(6.24)	(6.34)	(5.89)	(6.55)	(6.25)	(5.86)
Beta	0.93	0.90	0.92	0.91	0.89	0.94	0.94	0.98	0.97	0.91	-0.01
						9 Month Holding Period					
Returns	0.0117	0.0142	0.0144	0.0142	0.0148	0.0164	0.0163	0.0160	0.0170	0.0169	0.0052
	(4.16)	(5.45)	(5.53)	(5.53)	(5.96)	(6.30)	(6.21)	(5.83)	(6.17)	(6.23)	(6.27)
Beta	0.91	0.89	0.91	0.91	0.88	0.92	0.94	0.98	0.98	0.91	0.00
						12 Month Holding Period					
Returns	0.0125	0.0146	0.0149	0.0143	0.0148	0.0161	0.0158	0.0154	0.0162	0.0163	0.0038
	(4.57)	(5.68)	(5.74)	(5.66)	(5.97)	(6.29)	(6.05)	(5.67)	(5.91)	(6.09)	(5.71)
Beta	0.90	0.88	0.90	0.90	0.88	0.91	0.94	0.98	0.97	0.90	0.01
						Portfolio Characteristics					
Turnover	0.8650	0.9216	0.9072	0.8891	0.8421	0.8569	0.8730	0.9098	0.9068	0.8737	
CI	-0.5404	-0.1707	-0.0792	-0.0289	0.0062	0.0373	0.0718	0.1186	0.2017	0.5437	
ln(Size)	6.9126	7.2416	7.4534	7.6661	7.6688	7.7373	7.6764	7.6198	7.4131	6.9809	
BM	1.0858	0.9518	0.9252	0.8806	0.8724	0.8338	0.8289	0.8448	0.8855	0.9731	

Table 8: Portfolios formed on the basis of CI measured over the past 2 quarters

Corporate innovation (CI) is measured using growth rates for the input and output variables over the past 2 quarters. Returns span the period from January 1976 to December 2001. Portfolio P1 denotes the portfolio that contains the stocks with the lowest current CI, while portfolio P10 contains the stocks with the highest current CI. The row labeled "beta" refers to the market beta of the portfolio computed using the whole time-series of the portfolio. Portfolio characteristics such as CI, size, and BM are computed at the portfolio formation date. T-values for the mean returns appear in parentheses. The turnover of each portfolio refers to the proportion of firms that exits the portfolio from one quarter to another. Size denotes the average market capitalization of the portfolio, and it is measured in millions of dollars.

	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10	P 10 - 1
3 Month Holding Period											
Returns	0.0104	0.0128	0.0130	0.0130	0.0150	0.0165	0.0171	0.0178	0.0187	0.0191	0.0087
	(3.48)	(4.68)	(4.88)	(4.91)	(5.92)	(6.25)	(6.62)	(6.43)	(6.43)	(6.61)	(5.66)
Beta	0.92	0.91	0.92	0.92	0.88	0.93	0.91	0.97	1.01	0.96	0.04
6 Month Holding Period											
Returns	0.0110	0.0129	0.0127	0.0133	0.0154	0.0157	0.0165	0.0177	0.0177	0.0180	0.0070
	(3.76)	(4.93)	(4.92)	(5.26)	(6.15)	(6.01)	(6.43)	(6.42)	(6.20)	(6.37)	(5.68)
Beta	0.91	0.89	0.91	0.89	0.88	0.93	0.91	0.99	1.01	0.96	0.06
9 Month Holding Period											
Returns	0.0117	0.0137	0.0134	0.0140	0.0154	0.0153	0.0165	0.0175	0.0167	0.0169	0.0053
	(4.14)	(5.32)	(5.25)	(5.55)	(6.24)	(5.92)	(6.50)	(6.42)	(5.90)	(5.97)	(5.08)
Beta	0.90	0.88	0.89	0.88	0.88	0.92	0.91	0.99	1.00	0.97	0.07
12 Month Holding Period											
Returns	0.0127	0.0141	0.0137	0.0144	0.0155	0.0151	0.0160	0.0169	0.0160	0.0159	0.0033
	(4.57)	(5.58)	(5.40)	(5.74)	(6.32)	(5.93)	(6.31)	(6.21)	(5.65)	(5.68)	(3.51)
Beta	0.89	0.87	0.89	0.88	0.87	0.90	0.91	0.98	1.00	0.96	0.07
Portfolio Characteristics											
Turnover	0.7116	0.8267	0.8602	0.8492	0.8457	0.8448	0.8508	0.8580	0.8262	0.7204	
CI	-0.6173	-0.1857	-0.0819	-0.0215	0.0218	0.0601	0.1024	0.1608	0.2593	0.6558	
ln(Size)	6.8291	7.2547	7.4779	7.6011	7.7002	7.7387	7.7648	7.6927	7.4153	7.0293	
BM	1.1037	0.9833	0.9479	0.8927	0.8761	0.8410	0.8300	0.8358	0.8465	0.9595	

Table 9: Portfolios formed on the basis of CI measured over the past 3 quarters

Corporate innovation (CI) is measured using growth rates for the input and output variables over the past 3 quarters. Returns span the period from January 1976 to December 2001. Portfolio P1 denotes the portfolio that contains the stocks with the lowest current CI, while portfolio P10 contains the stocks with the highest current CI. The row labeled "beta" refers to the market beta of the portfolio computed using the whole time-series of the portfolio. Portfolio characteristics such as CI, size, and BM are computed at the portfolio formation date. T-values for the mean returns appear in parentheses. The turnover of each portfolio refers to the proportion of firms that exits the portfolio from one quarter to another. Size denotes the average market capitalization of the portfolio, and it is measured in millions of dollars.

	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10	P 10 - 1
					3 Month Holding Period						
Returns	0.0097	0.0107	0.0131	0.0126	0.0154	0.0166	0.0183	0.0179	0.0196	0.0204	0.0107
	(3.27)	(3.97)	(5.01)	(4.96)	(6.07)	(6.32)	(6.67)	(6.55)	(6.69)	(6.99)	(6.64)
Beta	0.92	0.91	0.89	0.86	0.88	0.91	0.96	0.96	1.02	0.98	0.07
					6 Month Holding Period						
Returns	0.0112	0.0120	0.0142	0.0133	0.0155	0.0159	0.0170	0.0173	0.0181	0.0185	0.0073
	(3.87)	(4.59)	(5.51)	(5.27)	(6.20)	(6.29)	(6.36)	(6.40)	(6.31)	(6.32)	(5.25)
Beta	0.90	0.90	0.89	0.86	0.88	0.90	0.95	0.96	1.01	1.00	0.10
					9 Month Holding Period						
Returns	0.0117	0.0130	0.0148	0.0142	0.0157	0.0152	0.0166	0.0164	0.0170	0.0168	0.0051
	(4.14)	(5.11)	(5.79)	(5.69)	(6.31)	(6.09)	(6.32)	(6.10)	(5.96)	(5.75)	(3.99)
Beta	0.89	0.88	0.88	0.86	0.88	0.89	0.94	0.96	1.01	1.00	0.12
					12 Month Holding Period						
Returns	0.0128	0.0134	0.0151	0.0145	0.0154	0.0149	0.0160	0.0160	0.0166	0.0156	0.0028
	(4.58)	(5.33)	(5.97)	(5.91)	(6.24)	(5.99)	(6.17)	(6.00)	(5.85)	(5.42)	(2.47)
Beta	0.88	0.86	0.88	0.85	0.87	0.88	0.93	0.96	1.00	0.99	0.11
					Portfolio Characteristics						
Turnover	0.6983	0.8318	0.8534	0.8551	0.8479	0.8386	0.8433	0.8578	0.8321	0.7093	
CI	-0.6062	-0.1878	-0.0800	-0.0146	0.0345	0.0779	0.1248	0.1885	0.2916	0.6727	
ln(Size)	6.8619	7.3120	7.5591	7.5400	7.6865	7.7517	7.7069	7.6852	7.4780	7.2089	
BM	1.1282	1.0102	0.9475	0.9050	0.8851	0.8542	0.8477	0.8235	0.8386	0.9112	

Table 10: Portfolios formed on the basis of CI measured over the past 4 quarters

Corporate innovation (CI) is measured using growth rates for the input and output variables over the past 4 quarters. Returns span the period from January 1976 to December 2001. Portfolio P1 denotes the portfolio that contains the stocks with the lowest current CI, while portfolio P10 contains the stocks with the highest current CI. The row labeled "beta" refers to the market beta of the portfolio computed using the whole time-series of the portfolio. Portfolio characteristics such as CI, size, and BM are computed at the portfolio formation date. T-values for the mean returns appear in parentheses. The turnover of each portfolio refers to the proportion of firms that exits the portfolio from one quarter to another. Size denotes the average market capitalization of the portfolio, and it is measured in millions of dollars.

	P 1	**P 2**	**P 3**	**P 4**	**P 5**	**P 6**	**P 7**	**P 8**	**P 9**	**P 10**	**P 10 - 1**
3 Month Holding Period											
Returns	0.0099	0.0121	0.0138	0.0138	0.0140	0.0161	0.0166	0.0174	0.0193	0.0213	0.0114
	(3.15)	(4.47)	(5.51)	(5.56)	(5.68)	(6.25)	(6.39)	(6.49)	(6.53)	(6.29)	(6.19)
Beta	0.92	0.90	0.84	0.85	0.86	0.89	0.91	0.93	1.03	1.12	0.20
6 Month Holding Period											
Returns	0.0114	0.0131	0.0141	0.0143	0.0146	0.0159	0.0163	0.0161	0.0178	0.0189	0.0074
	(3.71)	(5.03)	(5.70)	(5.83)	(6.00)	(6.34)	(6.36)	(6.07)	(6.06)	(5.63)	(4.10)
Beta	0.91	0.87	0.84	0.84	0.86	0.88	0.90	0.94	1.03	1.11	0.21
9 Month Holding Period											
Returns	0.0119	0.0140	0.0144	0.0147	0.0145	0.0156	0.0157	0.0158	0.0171	0.0172	0.0053
	(3.97)	(5.36)	(5.91)	(6.13)	(6.05)	(6.31)	(6.15)	(5.99)	(5.93)	(5.19)	(3.17)
Beta	0.91	0.87	0.83	0.83	0.84	0.86	0.90	0.94	1.03	1.11	0.20
12 Month Holding Period											
Returns	0.0131	0.0143	0.0146	0.0148	0.0145	0.0154	0.0151	0.0155	0.0164	0.0162	0.0031
	(4.42)	(5.56)	(6.07)	(6.24)	(6.11)	(6.26)	(6.00)	(5.95)	(5.74)	(4.95)	(2.01)
Beta	0.90	0.87	0.83	0.83	0.84	0.86	0.90	0.93	1.02	1.10	0.20
Portfolio Characteristics											
Turnover	0.5314	0.7459	0.7906	0.8055	0.8121	0.8204	0.7951	0.7745	0.7253	0.5164	
CI	-0.5153	-0.1283	-0.0378	0.0162	0.0564	0.0929	0.1328	0.1841	0.2690	0.6050	
ln(Size)	6.9801	7.2714	7.4749	7.6301	7.7009	7.6672	7.7455	7.6472	7.6666	7.2424	
BM	1.1827	1.0228	0.9617	0.9175	0.8766	0.8482	0.8198	0.8399	0.8328	0.8762	

Table 11A: Correlation coefficients between CI and price momentum zero-investment strategies

This table presents correlation coefficients between various zero-investment corporate innovation (CI) and price momentum strategies. The strategies are labeled based on the formation and holding periods. The letter “Q” stands for quarter, whereas the letter “M” stands for month. For instance, the label 1Q/3M indicates that the portfolio was formed based on the CI over the past one quarter, and held for 3 months. Similarly 3M/9M denotes the momentum zero-investment portfolio formed on the basis of past 3 month returns, and held for 9 months.

CORPORATE INNOVATION ZERO-INVESTMENT PORTFOLIOS	PRICE MOMENTUM ZERO-INVESTMENT PORTFOLIOS															
	3M/3M	3M/6M	3M/9M	3M/12M	6M/3M	6M/6M	6M/9M	6M/12M	9M/3M	9M/6M	9M/9M	9M/12M	12M/3M	12M/6M	12M/9M	12M/12M
1Q/3M	0.40	0.44	0.43	0.39	0.42	0.43	0.40	0.35	0.42	0.39	0.35	0.31	0.36	0.34	0.29	0.26
1Q/6M	0.47	0.51	0.50	0.46	0.49	0.50	0.47	0.42	0.50	0.47	0.43	0.38	0.44	0.41	0.36	0.32
1Q/9M	0.48	0.50	0.52	0.48	0.49	0.50	0.48	0.44	0.51	0.48	0.44	0.38	0.45	0.42	0.36	0.32
1Q/12M	0.47	0.50	0.51	0.50	0.48	0.50	0.49	0.47	0.49	0.47	0.44	0.40	0.45	0.44	0.40	0.36
2Q/3M	0.44	0.48	0.49	0.48	0.48	0.49	0.49	0.46	0.50	0.49	0.47	0.43	0.48	0.48	0.44	0.41
2Q/6M	0.46	0.48	0.53	0.52	0.49	0.52	0.53	0.49	0.54	0.53	0.51	0.45	0.54	0.51	0.47	0.42
2Q/9M	0.45	0.46	0.51	0.51	0.47	0.50	0.52	0.50	0.52	0.52	0.50	0.45	0.52	0.51	0.47	0.43
2Q/12M	0.44	0.46	0.50	0.52	0.47	0.51	0.53	0.52	0.52	0.53	0.52	0.48	0.53	0.53	0.50	0.46
3Q/3M	0.41	0.43	0.50	0.49	0.44	0.49	0.50	0.47	0.50	0.50	0.47	0.42	0.48	0.46	0.43	0.39
3Q/6M	0.43	0.45	0.51	0.53	0.46	0.51	0.54	0.53	0.52	0.53	0.52	0.49	0.52	0.52	0.50	0.47
3Q/9M	0.41	0.43	0.49	0.51	0.45	0.50	0.53	0.53	0.50	0.51	0.51	0.49	0.51	0.51	0.49	0.47
3Q/12M	0.39	0.41	0.47	0.50	0.44	0.49	0.53	0.55	0.48	0.51	0.52	0.52	0.51	0.52	0.52	0.51
4Q/3M	0.38	0.43	0.48	0.49	0.44	0.49	0.52	0.51	0.49	0.50	0.49	0.46	0.52	0.51	0.49	0.45
4Q/6M	0.35	0.40	0.46	0.48	0.41	0.46	0.50	0.51	0.47	0.50	0.50	0.48	0.52	0.52	0.50	0.48
4Q/9M	0.30	0.34	0.40	0.44	0.36	0.42	0.47	0.49	0.43	0.46	0.48	0.47	0.49	0.50	0.50	0.49
4Q/12M	0.26	0.31	0.37	0.41	0.33	0.39	0.45	0.48	0.40	0.44	0.47	0.48	0.47	0.50	0.51	0.51

Table 11B: Correlation matrix of various CI-based zero-investment strategies

This table presents the correlation coefficients among various zero-investment corporate innovation (CI) portfolios. The portfolios are labeled based on the formation and holding periods. For instance, the label 1Q/3M indicates that the portfolios were formed based on the CI over the past one quarter, and held for 3 months. Similarly 3Q/9M denotes the portfolios formed on the basis of CI measured over the past 3 quarters, and held for 9 months.

CORPORATE INNOVATION ZERO-INVESTMENT PORTFOLIOS	CORPORATE INNOVATION ZERO-INVESTMENT PORTFOLIOS															
	1Q/3M	1Q/6M	1Q/9M	1Q/12M	2Q/3M	2Q/6M	2Q/9M	2Q/12M	3Q/3M	3Q/6M	3Q/9M	3Q/12M	4Q/3M	4Q/6M	4Q/9M	4Q/12M
1Q/3M	1.00															
1Q/6M	0.79	1.00														
1Q/9M	0.68	0.88	1.00													
1Q/12M	0.62	0.80	0.92	1.00												
2Q/3M	0.67	0.85	0.70	0.61	1.00											
2Q/6M	0.43	0.74	0.79	0.70	0.84	1.00										
2Q/9M	0.32	0.60	0.73	0.75	0.66	0.91	1.00									
2Q/12M	0.37	0.60	0.69	0.76	0.63	0.83	0.96	1.00								
3Q/3M	0.52	0.65	0.71	0.60	0.72	0.81	0.73	0.68	1.00							
3Q/6M	0.29	0.55	0.66	0.67	0.58	0.81	0.88	0.84	0.85	1.00						
3Q/9M	0.28	0.48	0.62	0.65	0.49	0.72	0.86	0.88	0.77	0.95	1.00					
3Q/12M	0.31	0.48	0.56	0.62	0.50	0.66	0.80	0.86	0.70	0.88	0.96	1.00				
4Q/3M	0.30	0.47	0.54	0.57	0.49	0.65	0.68	0.68	0.68	0.77	0.75	0.70	1.00			
4Q/6M	0.21	0.43	0.52	0.56	0.43	0.65	0.72	0.74	0.64	0.79	0.80	0.77	0.95	1.00		
4Q/9M	0.16	0.36	0.47	0.51	0.37	0.59	0.68	0.72	0.58	0.75	0.78	0.78	0.90	0.98	1.00	
4Q/12M	0.16	0.33	0.41	0.46	0.35	0.53	0.61	0.68	0.53	0.69	0.74	0.78	0.84	0.93	0.97	1.00

TABLE 12: Regressions of Momentum Strategies Returns on CI-Strategies Returns.

The returns are from January 1976 to December 2001. The R-squares are adjusted for degrees of freedom. T-values computed from Newey-West standard errors appear in parentheses below the coefficient estimates.

Panel A: Contemporaneous regressions of the returns of momentum strategies on the returns of CI-based strategies.

Formation Period \ Holding Period	3 Months			6 Months			9 Months			12 Months		
	Constant	CI	R-square	Constant	CI	R-square	Constant	CI	R-square	Constant	CI	R-square
One-Quarter CI, 3-Month Past Returns	-0.01	0.86	0.16	0.00	1.21	0.26	0.00	1.34	0.27	0.00	1.27	0.24
	(-1.48)	(2.41)		(-1.23)	(3.39)		(-1.05)	(3.17)		(-0.67)	(5.17)	
Two-Quarter CI, 6-Month Past Returns	0.00	1.04	0.23	0.00	1.21	0.27	0.00	1.22	0.27	0.00	1.18	0.27
	(-0.93)	(3.57)		(-0.69)	(3.81)		(-0.30)	(5.08)		(0.01)	(7.54)	
Three-Quarter CI, 9-Month Past Returns	-0.01	1.07	0.25	0.00	1.11	0.28	0.00	1.04	0.26	0.00	1.07	0.26
	(-1.24)	(3.72)		(-0.58)	(6.02)		(-0.29)	(6.53)		(-0.22)	(6.81)	
Four-Quarter CI, 12-Month Past Returns	-0.01	0.93	0.27	0.00	0.84	0.27	0.00	0.80	0.25	0.00	0.83	0.26
	(-1.49)	(5.02)		(-0.71)	(5.59)		(-0.78)	(5.23)		(-0.77)	(5.55)	

Panel B: One month ahead predictive regressions of the returns of momentum strategies on the returns of CI-based strategies.

Formation Period\Holding Period	3 Months			6 Months			9 Months			12 Months		
	Constant	CI	R-square	Constant	CI	R-square	Constant	CI	R-square	Constant	CI	R-square
One-Quarter CI, 3-Month Past Returns	0.00	-0.37	0.03	0.01	-0.39	0.02	0.01	-0.49	0.03	0.01	-0.39	0.02
	(0.82)	(-1.53)		(2.55)	(-1.43)		(3.16)	(-1.61)		(3.10)	(-1.74)	
Two-Quarter CI, 6-Month Past Returns	0.01	-0.30	0.02	0.01	-0.42	0.03	0.01	-0.40	0.03	0.00	-0.25	0.01
	(2.55)	(-1.34)		(3.60)	(-1.78)		(3.40)	(-1.94)		(2.25)	(-1.59)	
Three-Quarter CI, 9-Month Past Returns	0.01	-0.34	0.02	0.01	-0.33	0.02	0.01	-0.14	0.00	0.00	0.00	0.00
	(2.94)	(-1.37)		(3.39)	(-1.76)		(2.25)	(-0.90)		(1.18)	(0.04)	
Four-Quarter CI, 12-Month Past Returns	0.01	-0.19	0.01	0.01	-0.09	0.00	0.00	-0.03	0.00	0.00	0.07	0.00
	(2.29)	(-1.14)		(1.79)	(-0.87)		(0.98)	(-0.29)		(0.34)	(0.72)	

Table 13: **Average monthly returns of 60-month/60-month momentum strategy.**

This strategy is equivalent to a 5-year, 5-year contrarian strategy. The returns are from January 1976 to December 2001. Portfolio characteristics such as Corporate Innovations (CI) and average annualized firm level volatility (see Campbell, Lettau, Malkiel, and Xu (2001)) are computed for the date of the portfolio formation. The average CI of the portfolios at formation (current) and 1, 2, 3, 4, and 5 after the formation date are reported. T-values appear in parentheses.

60-Month/60-Month Momentum								
	Returns	CI(current)	CI(1 year ahead)	CI(2 year ahead)	CI(3 year ahead)	CI(4 year ahead)	CI(5 year ahead)	Volatility
P 1	0.0155	0.0057	0.047	0.1041	0.0384	0.0578	0.0537	17.8339
	-4.88							
P 2	0.0149	0.035	0.0828	0.045	0.0626	0.0632	0.0733	11.2878
	-5.39							
P 3	0.0144	0.0575	0.0749	0.0578	0.0596	0.0603	0.0536	9.2373
	-5.85							
P 4	0.015	0.0713	0.0697	0.0748	0.0604	0.0516	0.0487	8.2693
	-6.33							
P 5	0.0145	0.0848	0.0736	0.075	0.0682	0.0574	0.0485	7.6247
	-6.2							
P 6	0.0142	0.0719	0.0738	0.0719	0.0639	0.0654	0.0484	7.2392
	-6.16							
P 7	0.0136	0.0893	0.0722	0.0683	0.0722	0.0474	0.045	7.1944
	-5.92							
P 8	0.0134	0.1054	0.0831	0.0665	0.0561	0.0942	0.0387	7.3776
	-5.57							
P 9	0.0125	0.1078	0.07	0.072	0.0648	0.0464	0.0506	7.8698
	-4.88							
P 10	0.0117	0.1433	0.0819	0.0528	0.0574	0.0569	0.0402	8.8261
	-3.87							
P 10 -1	-0.0038							
	(-1.70)							

Table 14: Regressions of the Contrarian Spread on Alternative Sets of Factors

	alpha	Market beta	HML beta	SMB beta	HLCI beta
CAPM	0.0036	0.2444			
	(-1.87)	(4.31)			
Fama-French	0.0006	0.1207	-0.4880	-0.3680	
	(-0.36)	(2.36)	(-5.69)	(-4.77)	
Fama-French+HLCI	0.0024	0.1047	-0.4957	-0.3631	0.2708
	(-1.35)	(2.01)	(-6.35)	(-4.87)	(3.46)

Note: This table contains the results from regressions of the contrarian spread ("losers" minus "winners") on factors implied by alternative asset pricing specifications. The first model considered is the CAPM. The second model is the Fama-French (1993) model. The third specification is one that includes the Fama-French (1993) factors in addition to HLCI. HLCI is a zero-investment portfolio that is long on high CI stocks and short on low CI stocks. The column labeled "alpha" reports the intercept of the regressions. T-values computed using standard errors corrected for heteroskedasticity and serial correlation up to 3 lags are reported in parentheses, below the coefficient estimates.