TWO ESSAYS ON HEALTH CARE COSTS AND ASSET RETURNS

by

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The first essay investigates whether health care is a priced factor in asset returns. Specifically, in the search for empirical relationships between macroeconomic factors and asset returns, health care appears to be a significant US economic force receiving less attention than others such as (aggregate) inflation, production, or consumption measures. We use the medical care component of the Consumer Price Index to measure medical inflation shocks as a candidate macroeconomic factor whose riskiness the market rewards. Incorporating multiple model specifications during the period 1967-2009, we find this inflationary component to be a relatively robust source of priced risk in US stock returns.

The second essay demonstrates how a genetic algorithm (GA) technique with standard parameters and the appropriate fitness function can generate five-asset portfolios that effectively hedge macroeconomic risks, including health care cost inflation. Investigating 40 macroeconomic series-year combinations, the GA generates 36 (11) hedging portfolios that are weakly (unambiguously) preferred to unmitigated risk exposure in an out-of-sample analysis between 2005 and 2008. This same technique can

create parsimonious mimicking or tracking portfolios for investable assets such as mutual funds and exchange-traded funds (ETFs), particularly in the down market of 2008.

Dedication

I dedicate this work, as with all my efforts, to my wife, Melissa, and our children. You are simultaneously my greatest heroes and biggest fans.

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Table of Contents

List of Figures and Tables

Essay #1: Health Care as a Priced Factor in Asset Returns

Essay #2: Using Genetic Algorithms for Hedging Health Care Costs, Managing Macroeconomic Risk, and Tracking Investments

Essay #1: Health Care as a Priced Factor in Asset Returns

Introduction

Health care represents a significant—and growing—portion of the US economy. Nationally, in 2009 health care spending is expected to reach $2.5 trillion, which represents over 17 percent of the gross domestic product (GDP). In other words, currently one of every six dollars spent in this country is health care related. This percentage has doubled over the past 30 years, and the Congressional Budget Office predicts it will double again over the next 25 years.[1] The impact of such health care costs can be catastrophic to individuals, as documented by Himmelstein et al (2009). They find 62 percent of personal bankruptcies filed in 2007 were linked to medical expenses even though nearly 80 percent of those filing for bankruptcy had health insurance. This rate of medical-cost-induced personal bankruptcies has increased by almost 50 percent since 2001.

Extrapolating this result from individual agents to the firms that compose the US financial market would indicate that firms with greater exposure to health care expenses should face higher risk of financial distress. One software CFO summarizes the risk of health care costs succinctly when he states, "Health-care costs are increasing faster than pretty much any other component of our cost structure…they have the potential to crowd out investment in other areas and ultimately make us less competitive."[2] According to portfolio theory, unless this risk is diversifiable across firms, investors should price this firm-specific risk and demand greater firm-specific returns for bearing it. The purpose of

[1] http://www.forbes.com/2009/07/02/health-care-costs-opinions-columnists-reform.html

[2] O'Sullivan, Kate, "All Eyes on Reform Public Support for Health-Care Reform is High, but Some CEOs Take Different View." *CFO* December 2009, pp. 38-43. This magazine is published by a subsidiary of *The Economist*.

this research is to determine the impact of health care costs on asset prices in the US market and to assess the degree to which medical costs are a priced risk in the US economy.

Why Medical Inflation?

The cost of medical care clearly affects firms in a non-trivial way. First, medical care appears to be a major component of labor compensation. According to the Kaiser Family Foundation's 2009 Employer Health Benefits Survey, employer-sponsored insurance covers 159 million nonelderly people, with the employer contribution averaging $9,860 per year.[3] This amount represents almost 74 percent of the $13,375 total average annual health care insurance premiums for family coverage, with workers themselves contributing the $3,515 balance. Also, data indicate medical care is a benefit provided by most publicly-traded firms. According to the same Kaiser report, 98 percent of firms with over 200 workers compensated employees by paying for some level of health insurance premiums in 2009. Over the past decade, rates have remained relatively constant in terms of the fraction of premiums paid by firms versus individuals and the percentage of individuals covered by large firms. Assuming competitive labor markets, these trends indicate a labor market demand for such coverage in these large firms, signifying firms have limited ability or desire to discontinue providing them. In fact, one CFO in a recent popular press article stated his firm must "continue to offer a competitive [health care compensation] policy…We see health care as an incredibly important

[3] http://ehbs.kff.org/

recruitment and retention benefit."[4] Consequently firms face medical care costs they cannot control yet must absorb due to their need to attract and keep high-quality labor. This trend appears valid for publicly-traded (i.e., larger) firms despite recent popular press reports that unaffordable premium increases for small businesses will likely decrease the amount they cover.[5] Thus it appears escalating medical care costs represent a reasonable candidate as a systematic risk to stockholders who hold publicly-traded firms.

Literature Review

For decades now research has sought to establish an empirical connection between macroeconomic events and stock price movements that theoretically ought to exist. This study extends the prior efforts that have documented a contemporaneous relationship between certain macroeconomic factors and returns. As we describe in more detail later, our focus on medical inflation augments previous findings regarding aggregate inflation. Studies show aggregate inflation surprises[6] and returns tend to be negatively-related over time (see, for example, Chen, Roll, and Ross (1986), Flannery and Protopapadakis (2002) and Hong, Torous, and Valkanov (2007)). Further, Chen, Roll, and Ross (1986) provide "weak" evidence that inflation is a priced risk factor, while the others do not investigate this result.

[4] O'Sullivan, Kate, "All Eyes on Reform Public Support for Health-Care Reform is High, but Some CEOs Take Different View." *CFO* December 2009, pp. 38-43. This magazine is published by a subsidiary of *The Economist*.

[5] http://www.gadsdentimes.com/article/20091025/ZNYT01/910253008?Title=Small-Business-Faces-Sharp-Rise-in-Costs-of-Health-Care

[6] Expected aggregate inflation can also have a negative relationship with returns depending on the time period and specification under study (see CRR (1986)).

Before summarizing the foundation of literature upon which this study will build, it is important to understand the difference between a factor explaining stock returns and the factor serving as a priced source of risk. While a macroeconomic factor, such as aggregate inflation, might exhibit high covariance with particular stock returns (i.e., have a high "beta" in a time series regression), this relationship does not say whether the market views this factor as a risky one worthy of return premia. In order for the factor to be considered risky, it is necessary for any security's "beta" to correlate with the security's excess returns in the cross-section. The Fama-MacBeth (1973) two-pass procedure represents the classical way to determine whether a factor is priced by the market. We will describe this procedure in more detail under the "Methodolgy" section.

The seminal study on the relationship between macroeconomic data and stock returns, Chen, Roll, and Ross (1986), investigates monthly stock returns between 1958 and 1984 with a goal of bridging the gap that existed between the theoretical idea that macroeconomic events drive stock prices at some level and the fact that nobody had found empirical evidence of such a connection. Specifically, the authors study whether industrial production, inflation (both expected and unexpected), a term risk premium (difference between return on long government bond and short Treasury bill), and a default risk premium (difference between return on portfolio of Bbb rated bonds and short Treasury bill) explain expected stock returns over time. They admit these macroeconomic series are by no means exhaustive in their inclusion. In briefly addressing other theoretical predictions and as a robustness test, the authors augment their model with the market risk premium, a measure of consumption, and an oil price

index (PPI for crude), ultimately concluding that the former has a negligible effect, and neither of the latter factors are priced.

Methodologically, CRR (1986) form twenty size-based portfolios whose returns are used as the dependent variables in their models, since using portfolios helps to mitigate errors-in-variables problems. They then implement a Fama-MacBeth (1973) two-pass methodology to assess whether the aforementioned macroeconomic factors are priced. While the inclusion of the market return—either value- or equal-weighted—performs well in the first-pass time series regressions, as we expect from the Sharpe (1964) and Lintner (1965) Capital Asset Pricing Model (CAPM), this factor is not priced in the presence of certain macroeconomic factors once the second-pass cross-sectional regressions are completed. The authors indicate that relatively smooth macroeconomic measures will inherently fail to explain a substantial amount of the variance in noisy stock returns. As a result, none of their models depict the coefficient of determination measure (i.e., "R-squared") for assessment. We anticipate similarly unimpressive R-squared values for our first-pass regressions that include only macroeconomic factors.

The consensus of this research is that industrial production, changes in the market risk premium, yield curve twists, and measures of unanticipated inflation and expected inflation changes are all significant in explaining expected stock returns. The effect of these variables on stock returns is robust to the inclusion of the market return factor (per CAPM) as well as to the inclusion of consumption and oil robustness variables. In sum, this study represents a hallmark effort in tying together the theory and empirical representation of macroeconomic events influencing stock returns.

In contrast to the study of macroeconomic factors, Fama and French (1993) study and find evidence of a parsimonious factor model that explains the variation in both stock and bond returns. Specifically, they contend that the following five factors explain the returns: excess market return (value-weighted market return minus one-month Treasury bill), SMB (Small-minus-Big, calculated by subtracting the return of the decile of the largest stocks—by market capitalization—from the decile of smallest stocks), HML (High-minus-Low, calculated by subtracting the return of the stock decile having the lowest book-to-market equity ratio from the decile with the highest book-to-market equity ratio), DEF (default risk premium, calculated by subtracting the long government bond from a Baa-and-below portfolio of similar duration corporate bonds), and TERM (term risk premium, calculated by subtracting the one-month Treasury from the long government bond).

These authors investigate monthly returns from 1963 to 1991 for 32 different portfolios of returns, which include 25 stock portfolios and 7 bond portfolios. They form the stock portfolios by intersecting the quintiles of size and book-to-market equity ratio. Their bond portfolios include two government portfolios, short- and long-term, and five corporate portfolios ranging in grade from Aaa to low-grade (or junk) bonds.

While their model is admittedly atheoretical and strictly empirically-founded, the Fama and French (1993) results are econometrically impressive. Their model parameters are highly statistically significant, and the coefficient of determination values are extremely large across the 32 portfolios. They do not price these particular factors in the traditional Fama-MacBeth (1973) two-pass manner, since they indicate adding bonds to the cross-sectional regressions would be difficult because “size and book-to-market

equity have no obvious meaning for government and corporate bonds." Instead of pricing their factors, the authors test for their cross-sectional effectiveness in the market by jointly-testing whether the intercept terms for all 32 portfolios are zero using the Gibbons, Ross, and Shanken (1989) methodology. While this test does not unequivocally support their model—mainly due to the small/low book-to-market portfolio having a non-zero intercept—their results indicate the factors explain stock and bond returns rather well. Finally, they perform a variety of robustness tests, including examining the January effect and bisecting the sample, and find the results tend to hold.

Since theory indicates macroeconomic factors should influence stock returns by serving as nondiversifiable risk factors (Ross (1976)), Flannery and Protopapadakis (2002) investigate the impact of 17 macroeconomic series on daily stock return mean and conditional volatility for the period between 1980 and 1996. Ultimately the authors confirm that inflation (CPI), the Producer Price Index (PPI), and a monetary aggregate (M1 and M2) influence stock returns, as previous research has indicated. Additonally, they make the novel discoveries that balance of trade (BOT), employment, and housing starts explain stock returns' conditional volatility. They determine news for these six variables is also associated with higher trading volume, an expected empirical result. Meanwhile, they fail to find influences from Industrial Production or GNP, as previous research has documented.

Their data set of macroeconomic series is arguably the most comprehensive to date, and the authors utilize a convincing means to measure the "surprise" component of the measures. Their method is important, because it is the surprise, or unexpected component, of macroeconomic data that should theoretically induce stock price changes,

or returns.[7] The authors measure surprise by using data from MMS International (now a subsidiary of Standard & Poor's) on analysts' expectations of macroeconomic data values for a given date. By comparing these expectations to the actual announced value, the authors quantify the surprise component. In using daily returns and volatility, the authors argue they can quantify most precisely the effect the news has on the market.

To mitigate criticism, Flannery and Protopapadakis (2002) employ various techniques. To avoid allegations of model misspecification, they include a host of conditioning variables, including: lagged market return, lagged risk-free rate, lagged junk bond premium (AAA-BAA returns), lagged term risk premium, lagged dividend-to-price ratio, lagged firm size value, and a host of timing controls to account for post-holiday returns and the January effect. Addtionally, they forestall the econometric problem of heteroskedasiticity by employing a generalized autoregressive conditional heteroskedasticity (GARCH) model to investigate returns.

We aim to augment and extend Flannery and Protopapadakis (2002) since (1) their study looks at aggregate inflation (versus medical inflation) as one of the macroeconomic series and (2) their study identifies priced factor candidates, but they never determine whether these candidates are priced. While we also confirm the negative relationship between contemporaneous inflation (and its surprise), we also investigate inflation's sub-component related to medical costs. Finally, whereas these authors determine which macroeconomic factors explain stock returns (and volatility) over time (i.e., they complete the Fama-MacBeth first-pass), our study investigates whether any

[7] Theory tells us factors proxy for the stochastic discount factor (SDF), which is a ratio of the present and expected future marginal utilities of consumption. Under the permanent income hypothesis, consumption is a random walk, which induces prices that necessarily deviate from expected levels and generate returns.

candidate factors we discover are indeed priced in equilibrium. That is, we complete both the first- and second-pass for the relevant factor candidates.

While prior studies have investigated contemporaneous macroeconomic variables' association with stock returns, Hong et al (2007) investigate the information diffusion theory by determining that certain industry returns lead the broad market returns. These authors determine that portfolios for retail, services, commercial real estate, metal, and petroleum forecast the stock market, in some cases by up to two months. Their finding is generally robust to the eight-largest non-US stock markets. Additionally, they relate their results to economic theory by discovering that industries that forecast the market also generally forecast two macroeconomic series (Industrial Production Growth and the Stock and Watson (1989) coincident index of economic activity) that explain returns.

Using monthly returns from 1946-2002, Hong et al (2007) investigate the ability of the Fama-French 38 industry sectors to explain broad market returns. Their intent is to test the information diffusion hypothesis (see Merton (1987) and Stein (1999)), which assumes that news travels slowly across markets and due to limited information-processing capacity, implying investors might not pay attention to or extract information from asset prices of industries they do not pay close attention to. Excluding five industries for missing data and generating a commercial real estate industry portfolio, the authors ultimately determine 14 of the 34 industries lead the market by one month. These industries are: commercial real estate, mines, apparel, print, petroleum, leather, metal, transportation, utilities, retail, money or financial, services, non-metallic minerals, and television. They interpret this finding as evidence that information diffuses less-than-

instantly across industry sectors to have an effect on the aggregate market and that information takes on the order of two months to be incorporated from industries into the broad market index. With respect to international data, the authors study returns for Japan, Canada, Australia, UK, Netherlands, Switzerland, France, and Germany for the period 1973-2002 and find the results hold up remarkably well.

These authors also control for similar factors as the other studies, specifically, lagged values for: excess market return, inflation, default spread (BAA-AAA), market dividend yield, and market volatility. Notably, these authors highlight that, "from the literature on stock market predictability that being able to predict next month's return is already quite an achievement, as it is notoriously difficult to predict the market at long horizons."

The gaps in this research we intend to fill are that health care is not an explicit US sector these authors studied, so its leading ability in the US is not clear. Notably, the other international stock markets studied have a health care sector, and its leading effect is unfortunately indeterminate based on the presented results. Additionally, our health care measure is a macroeconomic series versus a composition of returns series, so we are bridging a gap between leading indicators and macroeconomic factors that is not addressed in previous literature.

Another study, Lamont (2001), presents a purely atheoretical model to estimate, or track, non-investable macroeconomic series over time. The author uses 13 base assets and their lagged returns to track these macroeconomic series. The base asset series include four bond portfolios, eight industry-sorted stock portfolios, and the market portfolio for the stock market. The key macroeconomic series estimated include:

industrial production growth, real-consumption growth, real labor income growth, inflation, excess stock returns, excess bond returns, and Treasury bill returns.

To ensure he is not capturing the effect of other key variables known to predict stock and bond returns as well as the macroeconomy, he controls for nine lagged variables (with a constant term): Treasury bill returns, term premium for long-term government bonds (long bond yields minus Treasury bill), term premium for one-year government notes (one-year note yield minus Treasury bill yield), default premium on corporate bonds (BAA minus AAA yield), default premium on commercial paper (paper yield minus Treasury bill yield), the dividend yield on the CRSP value weight aggregate portfolio, 12-month production growth, CPI inflation, and excess stock returns. Ultimately, with partial R-squared values of between 0.04 and 0.23, Lamont (2001) concludes that, controlling for other known relationships, these investable portfolios do indeed track non-investable macroeconomic variables at some level.

The relevance of Lamont's study to this research assumes we find that medical inflation is a priced factor in security returns. If this result occurs, the natural next step will be to investigate ways firms can hedge the risk presented by medical inflation and its associated costs. Specifically, whereas Lamont analyzes the ability of these investable assets to track aggregate inflation, we look more closely at an investable portfolio's ability to track, or mimic, the behavior of medical inflation.

Finally, as a caveat to our anticipated results, one must consider these conclusions cautiously since the contemporaneous relationships documented are based on ex post corrected macroeconomic data, an issue highlighted by Christoffersen, Ghysels, and Swanson (2001). In their study, the authors demonstrate how markets adapt to