What P/E Does the Canadian Market Support?

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An Honours essay submitted to
Carleton University in fulfillment
of the requirements for the course
ECON 4908, as credit toward
the degree of Bachelor of Arts with
Honours in Economics.

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Ottawa, Ontario

September 13, 2004

Introduction

If there is one lesson which every student of an undergraduate economics program will learn before graduating, it is, that the economy cannot be explained in one elegant theory. There are many variables within micro and macroeconomics which cannot be accurately modeled. It is this reason that the study of Economics, as with many other sciences, is subdivided into numerous fields, which together, are best able to cope with the complexity of an economy. These subdivisions of the field of economics attempt to explain how an economy allocates its scarce resources, which makes economics essentially a study of human behaviour. A premise which persists in all fields of economics, is that buyers and sellers of capital are rational: meaning that they enter into transactions in the public market with the sole aim of increasing utility, in the case of individual consumers and increasing profits, in the case of firms. The financial markets represent a sector of the economy which test this theory of rational decision making on a daily basis.

Financial markets have existed "for as long as individuals realized that current needs had to be balanced with future needs" (Bodie, 3). Public markets exist for the trade of numerous financial instruments such as bonds, stocks, derivatives and various contracts for the delivery of commodities. The relative importance of financial markets has risen concurrently with the amount of money being allocated into those markets over the last number of decades. As the percentage of consumer wealth allocated to financial markets has risen, so to, has the abundance of information regarding those investments. In an economy which, in recent history, has been characterized by volatile financial markets, it has become increasingly difficult for inexperienced investors to utilize this

vast aray of information in order to earn positive low-variance returns on their disposable income. As a result, more investors are turning to professionals to manager their money for them.

Investment professionals or portfolio managers, as they are commonly referred to, utilize a variety of techniques when investing, depending on the type of client they are dealing with. As an example, a married couple with two children, both aged in their mid-forties will have different goals and risk tolerance than a young professional in his or her late twenties. Therefore, the former clients would be oriented more toward a capital preservation strategy which would be predominantly invested in low-risk value equities and other strictly investment-grade securities. The latter clients may be inclined to take a more aggressive growth strategy, which would have the portfolio heavily laden in risky growth stocks and possibly non-investment grade securities.

Differentiating these two sets of clients, which are on opposite sides of the risk tolerance spectrum, is the easy part of investment management. Most investment professionals have a broad sense of what the risky and less risky equities, as measured by variance of returns, and bonds, as measured by credit rating and companies' general ability to meet payments, are. The challenge for investment professionals lies in assessing which securities to invest in and what percentage of an investor's portfolio to invest in them.

Security analysis has become ever more sophisticated over the years. Analysts employ a number of different techniques in analyzing bonds, equities and derivatives in order to determine their potential for return vis-à-vis their level of risk. These techniques, collectively referred to as valuation, such as discounted cash-flow (DCF), method of

comparables, and precedent transaction are a few of the methods analysts employ in order to extract estimated future and current stock prices which are commensurate with a company's current financial situation and its strategy for future growth. Based on these estimates, analysts provide either a buy, hold, or sell recommendation, a risk assessment of either low, average, or high and an overall rating of performance vis-à-vis their sector of either sector underperform, perform, or outperform. It is the portfolio manager's job to take the analyst reports and make the final judgement as to which securities the money should be invested into.

I have chosen to focus my essay on the aspect of investment known as valuation. The definition of valuation is intuitive. As stated previously, it is employing the use of all available information about a company in order to place a value on it and therefore on it's share in terms of a price. The paper specifically focuses on a technique used within valuation know as the method of comparables. In using comparables to value a company, an analyst uses a series of financial ratios, or multiples, which are generated from the financial statements, and compares them against industry averages. Such multiples may include debt-to-equity (D/E), a measure of financial safety, times interest earned, which is a measure of a firm's ability to make interest payment on its outstanding debt, and the multiple which I have chosen to study, the Price-earnings ratio (P/E).

Motivation

The topic of this paper involves a study of the P/E ratio and its historic relationship with other macroeconomic data. I have set forth to provide evidence which supports that a significant amount of the variation in the historic average P/E of the

Standard and Poor's Toronto stock exchange index (S&P/TSX) can be explained by a number of key macroeconomic variables.

The P/E ratio is one of the key multiples which equity analysts consider when placing a value on a company's stock. P/E is the ratio of a firm's price per share and its earnings per share. P/E is an important ratio because it represents the amount an average investor is willing to pay for one dollar of a firm's earnings. According to this reasoning "a high P/E multiple appears to indicate a firm endowed with ample growth opportunities." (Bodie, 511) A look at the mechanics of the P/E will further explicate the significance this ratio has.

P/E Broken Down

The dividend discount model (DDM) is a model which is used to find the intrinsic value of a share based on the future flow of its dividends. The model discounts each year's dividends by a discount rate and sums those values to obtain a value per share as follows: $V_0 = \frac{D_1}{1+k} + \frac{D_2}{(1+k)^2} + \frac{D_3}{(1+k)^3} + ... = \frac{D_1 + P_1}{1+k}$; where the Di's are the dividends, k is the discount rate, which is a risk adjusted rate of return derived from the *capital asset pricing model CAPM:* $k = r_f + \beta[E(r_m) - r_f]$; where r_f = risk free rate of return, $E(r_m)$ is the expected return on the market and β is the measure of a security's systematic risk, and P_1 is the future price.(Bodie, 503) Though the DDM provides a nice framework for valuing a firm's share, according to it, a firm which pays no dividends in the future has no intrinsic value. In addition to this, it assumes a constant stream of dividends with no implied growth rate. Most firms which publicly list their shares will at some point, pay out a percentage of their after-tax income as dividends, if not as one large "liquidating

dividend"(Bodie, 503). The well known *Gordon Model* $V_0 = \frac{D_1}{k-g}$; where V_0 can be restated as P_o (market price), and g is the growth rate of dividends and all other variables are as above, accounts for the later of the two discrepancies by providing for a dividend growth rate. The growth rate of dividends is based on two variables as follows: $g = ROE \times b$ where *ROE* is the return on equity or return on investment which the firm yields and *b* is the fraction of earnings which the firm reinvests into the business, known as the plowback ratio. According to this framework, if a firm earns an *ROE* which is above the industry average, then plowing back an average (ie. industry average) percentage of earnings will yield above average growth in dividends and hence stock price. The reverse, of course, will also be true.

The Gordon Model can be restated aplying the above. A firm utilizes all its productive assets in producing a product at the same time depleting these assets. If the firm's plowback ratio equals zero, then over time the cashflows it is able to generate from these assets will approach zero. In order to supplement the decreasing cashflows from its existing productive assets, a firm must generate a certain percentage of its cashflows from new assets. Hence, a firm's cashflows, and therefore, its overall value as represented by its share price, can be divided into two parts. As stated in Bodie *et al*., "we can think of the value of the firm as the sum of the value of assets already in place, or the no-growth value of the firm, plus the net present value of the future investments the firm will make, which is the PVGO [present value of growth opportunities]:

$P_0 = \frac{E_1}{k} + PVGO$"(Bodie, 506) where E_1= earnings and all other variables are as above.

By rearranging this expression we obtain $\frac{P_0}{E_1} = \frac{1}{k}\left(1 + \frac{PVGO}{E/k}\right)$ a handy breakdown of P/E. The interesting variable in this expression is the ratio $\frac{PVGO}{E/k}$. According to Bodie *et al* "It is the ratio of the component of firm value due to growth opportunities to the component of value due to assets already in place" (Bodie, 511). It is clear that PVGO has a direct relationship with P/E. It is the dynamics of this relationship which are the center of most studies on the price-earnings ratio.

The Study

The Numerous studies which have been conducted on market P/E levels all have two things in common; they attempt to explain why P/E's are at certain levels, and they try to predict when equities are overvalued. My study is no different. To date, I have not found a single study which has attempted an explanation of Canadian market P/E levels. For this study I have selected a variety of Canadian macroeconomic and market variables and have regressed them, in different combinations, on P/E with the aim of finding the best possible explanatory model for market P/E on the S&P/TSX.

When the economy is growing, in general, corporate profits are increasing. Such a time is usually characterized by great optimism, especially on behalf of investors as firms' PVGO's are necessarily increasing. However, it is common during these time periods for investors to overestimate the true value of PVGO. There have been periods in market history when equity prices have been clearly overvalued, creating what many in the industry refer to as a "bubble". Bubbles in stock markets are indicative of what

Federal Reserve board Chairman Alan Greenspan referred to as "irrational exubarence" back in 1996, when stock prices began their rise toward the height of the most recent bubble in 2000. Such a bubble takes place when market prices rise much more quickly than earnings. This happens when investors continue to enter the market anticipating significant potential earnings and thereby bidding prices constantly higher. However, as Warren Buffett once wrote "The inescapable fact is that the value of an asset, whatever its character, cannot over the long term grow faster than its earnings do."(Buffett, 216). My study will provide evidence in support of just this, that prices cannot venture higher than the levels supported by underlying economic fundamentals for an extended period of time. Above all I will attempt to show that, contrary to what many academics have written, markets are rational in the sense that there are underlying fundamentals which support equity market prices in Canada.

Fundamentals

Adam Smith wrote in 1776 that:

> Every individual necessarily labours to render the annual revenue of the society as great as he can. He generally neither intends to promote the public interest, nor knows how much he is promoting it... He intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for society that it was no part of his intention. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it. I have never known much good done by those who affected to trade for the public good. (Smith)

At the time Smith's book, *An Inquiry into the Nature and Causes of the Wealth of Nations,* was written, it was the most widely respected economics text in the world. The whole book was written without using a single formula or number in explaining how an economy operates. Since then, economists have been able to better explain 'The Wealth

of Nations' by applying complex mathematical and econometric models. The formulas developed in modern Keynsian macroeconomics have come to be known as 'The Fundamentals' and are the basis for all inquiries into macroeconomics. The most basic of these fundamentals is gross domestic product (GDP). GDP is the monetary value of all the goods and services produced by an economy over a specified period. GDP is the first measure of the health of an economy and all sectors of the economy are correlated with this measure. It is with GDP that I begin my discussion of the variables which were used in the study.

GDP Growth

"The growth rate of the economy is the rate at which the gross domestic product (GDP) is increasing."(Dornbusch et al, 11) Misinterpretation of the relative importance of GDP is not possible. All sectors of the economy feed into the GDP and are by definition correlated with this measure of economic health. In today's economy financial markets represent a significant sector and as a result, valuations of assets trading in these markets are highly correlated with GDP, specifically the change in this variable.

Investors allocate a significant part of their savings to the markets in order to increase their capital base. However, as household savings changes, so to does the amount of capital being allocated into markets. Take as an example this simple representation of the economy taken from Dornbusch *et al*: $Y = S + C$; where Y = output (or demand for GDP), S = private sector saving, C = consumption, and $Y = C + I$; where all else is as above and I = investment, in this case, investment of firms into physical or human capital not into financial markets. If the above is true, then $I = S$. Including government spending and foreign trade into this model yields the most important national

income accounting identity: Y = C + I + G + NX; where G = government spending and NX = net exports and all else is as above. According to Dornbusch *et al*, the "private sector receives net transfers (TR) in addition to national income. Disposable income (YD) is thus equal to income plus transfers less taxes: YD= Y + TR – TA, in turn YD is allocated between consumption and saving; YD = C +S. Combining the above identities yields C + S = YD = Y + TR – TA."(Dornbusch, 30) Three important conclusions may be drawn from this identity. The first is that consumers allocate their disposable income into consumption and savings. As YD increases so do C and S. The second is that YD depends on how the economy is performing in terms of growth of Y (demand for GDP). Therefore, as the rate of growth of GDP increases, so to will the YD and therefore C and S. Lastly, it is crucial to note the importance which government policy plays here. Fiscal policy in the form of TR and TA directly influence the amount Y is contributing to YD with TR's having a *direct* relationship and TA's *indirect*. Therefore, as TA's increase YD decreases and as TR increases YD increases and vice versa. Why is this important for the P/E ratio? As YD and therefore S increases, the amount of S being allocated to equity markets in registered plans and other investment accounts increases as well. This increase has the effect of bidding up equity prices and therefore pushing P/E up as well. Clearly, there is a link between the health of the economy as measured by GDP, however, what is the nature of this relationship?

Though a relationship between two given variables may exist, there is often a question of timing of relationships. It is well know that GDP takes time to adjust to central bank stabilization policies (an issue to be discussed further in the next section). The relationship between P/E, a proxy for corporate earnings and investor confidence,

and GDP, a proxy for the health of the economy, is no different. There is a time lag built into the GDP growth- P/E relationship of about one quarter, as markets price in information very quickly. However, a relationship may be observed with no time lags, as often, impending announcements of quarterly GDP growth are discounted into equity markets before the release of information. As far as such releases are concerned, today's equity markets only move if there is a surprise concerning such information. I will give evidence supporting that there is a strong, direct relationship between P/E and GDP growth with no time lags.

Inflation

"Inflation is the rate of change in prices, and the price level is the culmination of past inflations; $\pi \equiv \frac{P_t - P_{t-1}}{P_{t-1}}$ where $\pi =$ the inflation rate, P_t = today's price level and P_{t-1} = last year's price level." (Dornbusch *et al*, 35) In Canada, the primary measurement of inflation, most often cited, is the consumer price index (CPI). CPI is calculated as follows: $CPI = \frac{\sum p_t^i q_0^i}{\sum p_0^i q_0^i} \times 100$ which is called a *Laspeyres*, or base-weighted, price index. (Dornusche *et al*, 37) It is an important variable, firstly because changes in price level affect consumer purchasing power. Secondly, for an economy which is in the rising portion of the business cycle, prices begin to rise because the amount of currency in circulation or the money supply (M2 – defined as currency, demands deposits, personal savings deposits and nonpersonal notice deposits) also starts to rise (M2 was also going to be included into the study, however the BOC's database did not go far back enough in time to make it a significant explanatory variable). This happens predominantly due to the fact that holding certain assets, for example equities or

real estate, generally yields higher returns than bank accounts in a booming economy, and therefore, the demand to hold money drops. Investors enter the market and exchange their money for those other, higher yielding assets, thereby injecting more currency into the money supply. Adding to this inflationary pressure is the effect which rising world commodity and asset prices have on domestic prices. As the economy continues to improve, and firms' capacity utilization increases to full, firms must continue to pay these rising prices for their factors of production. When firms reach full capacity and there is no longer any slack in labour expenses, they must pass the rise in materials costs onto consumers thereby adding to the general increase in domestic price levels.

This trend of rising inflation can be interpreted in two ways. Fist off, inflation, as stated above, *may* be indicative of an economic boom during which asset prices are usually rising. This environment would be characterized by rising P/E's in equity markets. A positive relationship could therefore be observed between inflation and P/E without any time lags. The second interpretation has its roots in the Bank of Canada's (BOC) policies concerning inflation. The BOC is known to be hawkish on inflation. Canada's monetary regime is characterized by a central bank which practices what is known as inflation targeting. What this means is that the BOC targets a band which the increase in prices cannot exceed. In Canada this band is between 1% and 3%. It is important to note that inflation targeting central banks, like other central banks, do not just try to control inflation; they also try to mitigate output fluctuations, avoid large swings in interest rates and exchange rates, and in general, try to keep the financial system stable. Nevertheless looking at the P/E-CPI relationship in the guise of an inflation targeting regime yields a somewhat different result. Investors in such a regime

would take rising inflation as a signal of an impending rate hike. In general, this should cause a sell-off of equities in favor of securities which have a yield component built into them such as bonds, preferred shares or even trusts. This sell-off would put downward pressure on P/E's. What is interesting is that there is no lag in such a relationship meaning on its own, inflation level could be used as a leading indicator in Canada. I will provide evidence in favor of the theory that in Canada, the relationship between market P/E and inflation as measured by CPI has historically been indirect.

Treasury Bond Yield

As mentioned above, fixed income securities are directly influenced by the level of interest rates. In a rising rate environment, bonds, preferred shares and trusts become relatively more attractive then equities, as investors can, in many cases, earn a higher return while taking on less risk. A look at the bond pricing model provides a nice illustration of the interest rate-yield mechanism. P = $\sum_{t=1}^{T} \frac{Coupon}{(1+r)^t} + \frac{ParValue}{(1+r)^t}$; where P= bond price, r = interest rate t = time. As one can see, the price of a bond is the sum of a principal amount discounted at the prevailing interest rate and the stream of cash flows known as coupons discounted at their respective yearly interest rates.

Warren Buffet once wrote that interest rates "act on financial valuations the way gravity acts on matter" (Buffett, 212). It is no different for bond valuations. As can be seen in the pricing model, when interest rates rise, bond prices will drop. Conversely investors' potential holding period return (HPR), calculated as Return = $\frac{Interest + \Pr iceApprecation}{Initial \Pr ice}$ will also drop. In order to counteract this price deprecation, issuers of new bonds will offer higher coupons on their bonds thereby making them more

attractive relative to equities. Additionally, existing bonds can be bought at a discount from their face value and held until interest rates decline, and prices once again appreciate, creating a nice return.

When investors evaluate bonds as potential vehicles to put their money into, they look at the potential for holding period return as they would for any security. However, return on bonds is evaluated somewhat differently due to the composition of that particular investment vehicle. Looking again at the familiar expression for bond price $\mathrm{P} = \sum_{t=1}^{T} \frac{Coupon}{(1+r)^t} + \frac{ParValue}{(1+r)^t}$; one can amend it by substituting in the purchase price, or par value of the bond, it's term to maturity, and the coupon offered, and solving for the interest rate which will equal the expected rate of return over the life of the bond. This expected rate is called the *yield to maturity* and it is an important indicator of potential for return, credit quality and, in the case of long term government bonds, an effective barometer for future movements in interest rates.

I have chosen bond yield as one of the independent variables because I believe that there is historically a strong relationship between it and market P/E. As mentioned before, when bond yields increase, and prices decrease, market P/E will decrease because investors will sell equities in order to invest a greater percentage of their portfolios in bonds. I used the historic 30-year Canadian Treasury bond yield for this study as long term debt tends to have a greater sensitivity to interest rate movements making it a more accurate barometer for rates. Additionally, I had included 90-day treasury bill yield in the study as well, however, due to it's relatively short term and the fact that the correlation between t-bill and t-bond yields would be excessively high, I discarded it

from the study. I will provide evidence supporting that there is a historic direct relationship between the 30 year Canadian Treasury Bond Yield and market P/E.

Canada-U.S. Treasury Bond Yield Spread

A spread is the term which is used to define the difference, between two securities' yields. Many bond trading strategies revolve around techniques which are designed to take advantage of the widening or narrowing of a particular yield spread. One such strategy is called a "intermarket spread swap [which] is pursued when an investor believes that the yield spread between two sectors of the bond market is temporarily out of line."(Bodie *et al*, 481) Such swap strategies, and others are used to take advantage of any changes in the yield spread between Canada and the U.S. on a daily basis. What is interesting, however, is that U.S. monetary policy often influences markets around world, especially Canada's. The BOC must find a balance between ensuring that the Canadian economy remains healthy in growth terms and that the currency does not loose a significant amount of value against the U.S. dollar. Including the Canadian-U.S. yield spread is an attempt at pegging down, at least a general effect of U.S. monetary policy on Canadian Equity markets. I believe that a widening of the spread, with Canadian t-bonds in deficit to the U.S., has some predictive qualities. The inclusion of the spread in my model was an extension of the yield variable.

Dividend Yield

Dividend yield is calculated by dividing the annual dividends per share by the share price ($\frac{D}{P}$). In addition to returns on strait capital gains, investors also look for equities which pay out steady streams of income knows as dividends. In general, value stocks, or those stocks of companies which have little to no growth, in terms of capital

aprecation, and steady cashflow, usually exhibit higher dividend yields. These equities are generally favored by conservative investors which are interested in low-risk capital preservation type investments. However, as mentioned in the introduction, all firms pay dividends at one point in their existence. As a result, dividend yield becomes a good indicator of the stage of the business cycle and therefore the relative health of the economy.

Again, going back to our model of GDP, as output (Y) begins to increase, so do after-tax corporate profits. As corporate profits increase, firms, whether growth or value, begin to accumulate greater amounts of cash to either pay out or reinvest in the business. As payouts increase, investors will allocate a larger percentage of their wealth into equities, even in index participation units, in order to take advantage of the potential for higher returns. Of course, buying up equities puts upward pressure on prices and therefore on P/Es. However, yield pickup isn't the only gain attracting investors to enter the market. Holding period returns have two components as follows;

$HPR = \frac{D_1}{P_0} + \frac{(P_1 - P_0)}{P_0}$. The first part of the expression is the familiar dividend yield and the second part is the capital gains yield. There are many investors which are risk averse, as stated above, and prefer a steady stream of dividends with less risk to grow their capital base. Conversely, there are investors which are willing to take on a greater amount of risk if there is some potential for growth in terms of capital gains. As P/E's continue to be bid up by those investors taking advantage of high dividend yields the other, more risk tolerant individuals, will also enter the market to take advantage of the potential for quick capital gains. This is referred to as the bandwagon or hearding phenomenon. As Warren Bufett wrote "In effect, these people superimpose an I-can't-

miss-the-party factor on top of the fundamental factors that drive the market." (Bufett, 216) In turn, P/E's will continue to rise, possibly to levels which underlying fundamentals cannot support.

Regardless of the reasons which investors have to enter the market in a booming economy, the importance of dividend yield as an explanatory variable for market price-earnings is clear. Firstly, dividend yield is a strong indicator of corporate profits and therefore the direction of P/E levels. Additionally, dividend yield can also be a leading indicator of overvalued markets, if the capital gains portion of returns is greater than the dividend yield portion. Either way, I will provide evidence which supports the expected direct relationship between P/E and dividend yield.

S&P/TSX Returns

The S&P/TSX (TSX hereafter) composite index is:

> a market value weighted index based on a very broad set of companies. It is constructed to reflect an investment in each company proportional to its total market capitalization, giving considerably more weight to large, highly valued stocks…The index is computed by calculating the total market value of the all the stocks in the index and the total market value of those stocks on the previous day of trading. The rate of return of the index equals the rate of return that would be earned by an investor holding a portfolio of all the stocks in proportion to market value, except that cash dividends paid out by those stocks are not reflected. (Bodie *et al*, 41)

Returns on securities have always played an important role in investment decision making. All decisions to invest are made for the same reason: to earn some form of risk adjusted return on an investment. However, investors seeking these returns do not always execute the most rational of strategies in search of returns. For the sake of simplicity, I group investors into two general strategies: 1. Those who buy at the height of the market, or when equity prices have far exceeded the underlying fundamentals which support them (high P/E's), and 2. Those who buy at the low point of the market

when equity prices better reflect underlying fundamentals making them seem relatively cheap (low P/E's). Resultant of these two broad categories of investor, I believe there is a P/E-Return relationship which exists with and without a one year time lag.

As I described in my sections on GDP growth and dividend yield, the market tends to move with a momentum built into it based on the relative health of the economy and growth in corporate earnings. As a result, market returns develop momentum as well. As prices rise, more investors enter the market because they perceive potential for greater returns. This investor strategy results in a direct relationship between S&P/TSX returns and P/E, and between *lagged P/E* and P/E levels for the same index which I have observed to exist historically. However, I have evidence which supports a lagged relationship as well. Building on the investor strategy of entering the market in order to earn returns based on momentum, assuming that investors are rational, then one can conclude that rational investors will sell in order to take profits on positions they established a year earlier. If this is the case, then the reflected relationship should be an indirect one between P/E and lagged S&P/TSX returns, of which I have evidence.

Other Possible Variables

When one builds a model to investigate a perceived relationship, there is no wrong or right answer in terms of quality. The key to modeling an investigation is in the selection of variables which directly influence the particular phenomenon one is trying to define. I have included variables which I believe explain a significant degree of the variation in historic market P/E. I want to include a brief discussion of a few other variables which may have enhanced the study. These variables were not included mostly due to data constraints.

Return on Equity – ROE

As was shown in the introduction, ROE is one of two key variables which are used to determine the growth rate of a firm's earnings, making it a widely observed financial ratio. And why wouldn't it be? ROE measures the amount of net profit being generated as a percentage of a firm's gross equity value: $ROE = \frac{Net\,Profit}{Equity}$. However, a breakdown of ROE into it's components best illustrates the importance of this ratio in the analysis of a firm's financial health:

$$ROE = \frac{Net\,Profit}{Pretax\,Profit} \times \frac{Pretax\,Profit}{EBIT} \times \frac{EBIT}{SALES} \times \frac{SALES}{ASSETS} \times \frac{ASSETS}{EQUITY}$$

All of the values on the right hand side of the above equality could have been handily used as variables in a multivariate regression on P/E, however I will focus in on two of the five.

The second ratio is known as the interest burden ratio and it measures the percentage of a firm's earnings which are used to service interest payments on it's debt. A lower ratio means that a greater amount of the firm's earnings are being consumed by interest payments. The last ratio on the right hand side is known as the leverage ratio and it is a measure of a firm's degree of financial leverage. In general, the higher this figure is, the greater the amount of debt the firm has on it's books. The importance of these two ratios in the ROE framework is that they are cyclical. When the economy is in an upturn, these two factors contribute positively to ROE and vice versa for an economic downturn. Therefore, the inclusion of ROE in the study may have strengthened the explanatory power of the model as a whole.

Standard Deviation of Returns

In general, market volatility is measured by the variance (or standard deviation) of returns; $\sigma^2 = \sum_s p(s)[r(s) - E(r)]^2$, where; p(s) = the probability of each scenario, r(s) = the holding period return in each scenario and E(r) is the expected or mean return, which is also the best measure of risk. The average investor seeks to maximize returns while minimizing all types of risk. Market volatility varies over time, generally, in line with the economic cycle. Movements in the economy in either direction generally add volatility to the market, especially when there are surprises in economic data releases which were not previously priced into markets. These periods of volatility, proxied by σ^2, can be measured historically and possibly used as an explanatory variable for P/E's. My view is that such a relationship would be inverse as, *on average*, markets sell off during periods of high volatility.

Corporate Earnings

Warren Buffett seems to have all the answers. Maybe this is one of the reasons he's probably the most prolific investor of all time. He wrote, in an article previously discussed, that "the second thing bearing on stock prices….was after-tax corporate profits" (Buffett, 214), the first thing being the level of interest rates which was included in the model. I believe it's crucial, therefore, to touch on the importance of after tax corporate profits in determining the level of market P/E.

Dividends which are paid out on common equity are, by accounting convention, done so after all costs of doing business and taxes have been removed from gross revenue. This makes dividends an important proxy for a firm's financial strength, and consequently an indicator which is closely watched by investors, and thus, dividend yield

was included in the model. This leads into a discussion of the role which after-tax corporate profits have as an important indicator of a firm's financial strength. Just as the relationship between dividend yield is expected to be direct, so to should the one between after-tax corporate profits and P/E. This relationship should be the strongest with either a one or two quarter lag, as investors usually measure a firm's current earnings against it's earnings in the same period, usually a fiscal quarter, of the previous fiscal year. When a firm either exceeds or falls short of expectations, investors allocate their funds appropriately, which is why there should be a one quarter lag in this relationship. Having explained the underlying fundamentals of the study, I move on to a brief discussion of the literature which motivated this study.

Literature Review

In writing this paper I consulted a variety of different sources to collect all the research which I felt was pertinent to the study. My sources ranged from academic papers, to textbooks to industry journals. In this section, I will review some of the literature which both motivates and supports my study.

P/E, P/B and the Present Value of Future Dividends. – Patricia M. Fairfield

The basis for Fairfield's paper is that the dividend discount model (DDM) is of little use as a valuation tool because of the restrictive assumptions it makes about dividend payout policy, a point I touched upon in the introduction. She posits that "The P/E ratio is a function of expected changes in future profitability, and the price-to-book ratio (P/B) is a function of the expected level of future profitability." (Fairfield, 23) Her model seeks to go beyond the rigors of the DDM by "showing that different p/e-p/b combinations are associated with distinct patterns of future profitability."(Fairfield, 23)

She goes on to say that "when price is restated in terms of earnings…prices can be interpreted in terms of the market's expectations of future earnings without severing the valuation link between price and future dividends."(Fairflield, 23) The key word here is 'interpreted' which implies the presence of the human element in terms of decision making. Fairfield makes a nice link between the technicalities of modeling a complex valuation problem and the imperfection of the human element which, at times, has been observed not to be rational. This was a good paper to include because I feel the model I have used is more *rich* in terms of the amount of explanatory variables that have been included, than that of Fairfield's. As a result of this richness, I have been able to include all the technical aspects of valuation and what the historic average *human* reaction has been to them.

When are Price/Earnings Ratios Too High – or Too Low? – Walter R. Good

This short article contrasts the two extreme interpretations of market-derived valuation ratios; the idea that the market is rational and quickly discounts information as it becomes available and the premise that *high* market-derived valuations, in relative terms, are a reason to sell as prices have shot past the fundamentals which support them. Good speaks of 'two conflicting views of P/E ratios':

> One approach looks to the efficient market hypothesis for support. It holds that the P/E ratio is high or low for good reason, because information, as it becomes available, is quickly discounted by a rational stock market. The other approach has the backing contrarian logic. It considers a high P/E an opportunity to buy. According to this view, investors, driven by extremes of either greed or fear, often act irrationally. As a result, they push stock prices too high or too low, setting up the stock market for a subsequent correction or rebound.(Good, 9)

This line of enquiry directly relates to my study. By using various market and economic indicators I have attempted to account for both the fundamental determinants of P/E and

the later contrarian logic that P/E is also driven by factors that have nothing to do with underlying fundamentals.

The P/E Multiple and Market Volatility – Alex Kane, Alan J. Marcus, and Jaesun Noh

This paper discussed one important relationship between P/E and the volatility of returns which I wanted to include in my study, however, due to the unavailability of data I could not. Kane *et al* choose to investigate the relationship between P/E and market volatility and a number of additional variables. The authors hold as a convention that there is a strong relationship between P/E and the real interest rate, the expected inflation rate and the stage of the business cycle. They go on to state their findings that "Empirical results suggest that a permanent 1 percentage point increase in market volatility can, over time, reduce the market multiple by 1.8."(Kane, *et al*) The implications of this is that as volatility, measured by standard deviation of returns, rises, then investor confidence falls causing a significant selloff in the market thereby depressing the market P/E. This is the first paper cited in which the authors used a similar framework to mine in testing their hypotheses. They ran a multivariate regression on P/E including as their independent variables: Lagged P/E, annual standard deviation, default premium on corporate bonds, default premium on commercial paper, real interest rate, inflation rate (measured by CPI), dividend yield of the S&P 500, and detrended industrial production. The authors were able to achieve a number of statistically significant relationships. The coefficients on annual standard deviation and inflation were both negative and statistically significant. In addition to this, the coefficient on the real interest rate was negative, however it was not statistically significant. Finally, the coefficient on dividend yield was negative, however fell short of statistical significance. I have been able to achieve all these

expected relationships as well as a number of others with varying levels of significance in my study on the S&P/TSX.

How Little We Know…about P/E's, but also perhaps more than we think. – Steven Bleiberg

The paper by Steven Bleiberg ventures into a discussion about the use of market P/E in the prediction of returns. This is a somewhat different investigation than my own, but nevertheless an important one worth mentioning. According to Bleiberg "making a market timing call based on P/E ratios can be tricky business."(Bleiberg, 26) Bleiberg has sought to investigate "Specifically, how useful has the market's P/E ratio been as a predictor of future returns?" (Bleiberg, 26) The author used a P/E based on trailing twelve month earnings and simply compared it against the average percentage change in the S&P 500 over subsequent 6, 12, and 24 month periods. His results show that "P/E has in fact had a relationship with how well the market did in subsequent months. Over the shot term (up to one year), the relationship has been noticeable only when the P/E has moved to an extreme level. Over the longer term, though, the relationship has help up…" (Bleiberg, 27) Bleiberg goes on to include bond *prices* as an explanatory variable for P/E. He posits that falling interest rates should see a rise in equity and bond prices, which is concurrent with the direct relationship between interest rates and bond yields. These conclusions have important implications for my study in that if these relationships do actually exist, then there could be some multicollinearity between some of the explanatory variables such as bond yield and returns on the index. The main questions which this study boils down to are 1. Will the future be like the past and 2. Can our knowledge of the past be of any use to us? Bleiberg's conclusion can be summed in this last quote:

> Over the long run, stocks will go up. Over most time periods longer than one year, they will outperform bonds. On average, the returns on stocks (both absolute and relative) will be higher in the periods following low P/E values than in the periods following high P/E values. Moreover, the likelihood that the market will do well seems to rise slightly as P/E falls. (Bleiberg, 31)

The relationship between lagged returns on the index and P/E upheld these results. However, in my study, lagged return was an explanatory variable. Neveretheless, the relationship persists and can be interpreted as having momentum giving credence to the use of lagged returns as the explanatory variable.

Valuation Ratios and the Long-Run Stock Market Outlook – John Y. Campbell and Robert J. Shiller

In beginning their paper, Campbell and Shiller make the statement that "It seems reasonable to believe that prices are not likely to ever drift too far from their normal relationships to indicators of fundamental value, such as dividends or earnings." (Campbell and Shiller, 11) This is a simple and effective statement of introduction to their study and one that is the basis for mine. Their analysis proceeds somewhat differently than mine as they used predictive models which attempt to find the predictive qualities of one variable on another, with little difference from the Bleiberg study. What was most interesting about this paper was the authors' caveat into non-quantitative explanations of market phenomenon, a constant interest of mine throughout this research project. The authors stepped away from standard forms of analyses, and made some demographical inferences in order to explain trends in the stock market. The explanation which caught my attention was that of the baby-boom demand for stock theory. In short, the authors posit that as the baby boom generation come to dominate the economy, so to do their tolerances to risk. It is said that this generation is more risk-tolerant, possibly due to the fact that they did not experience the crash in the 1930's. As a result, this

generation tends to put more of their wealth into equities thereby driving prices up. This might explain why the market P/E has been in the upper band of its historic range in the last few years. In the end, the authors conclude that the "dividend-price and price-earnings ratios have a special significance when compared with many other statistics that might be used to forecast stock prices." (Cambell and Shiller, 24)

P/E Ratios and Stock Market Returns – Ruben Trevino and Fiona Robertson

The question these two authors ask is simple: "Are price-earnings (P/E) ratios of any use in predicting subsequent returns?" (Trevino and Robertson, 76). The authors apply the now familiar reasoning that "market prices must ultimately maintain a relationship with earnings. Prices cannot drift away indefinitely from earnings." (Trevino and Robertson) This is the familiar principal on which my study is based; ascertaining what the P/E ratio should be based on the underlying fundamentals which persist in the economy. If this reasoning is correct, then one would expect major corrections in market prices subsequent to a move in prices away from fundamentals. An interesting point in this paper is that the authors revert to the DDM to make certain points concerning market P/E levels.

> …the dividend discount model states that the P/E should be affected by interest rate levels and market risk premiums. Specifically, this theory states that if interest rate levels are low or market risk premiums are low, we should expect both low stock market returns and high P/E levels. In other words, if P/E ratios are high when interest rates are low or the market risk premium is low, then the market should expect low returns when P/E ratios are high. (Trevino and Robertson, 77)

Though this is a paper mainly geared toward discussing P/E's ability to predict subsequent returns, it nevertheless makes some interesting points regarding the DDM as it is the basic foundation for equity valuation. However one of the major conclucsions of the study does corroborate my results. "…as theory suggests, P/E ratios tend to be high

when current interest rates are low and market premiums are low." (Trevino and Robertson, 83)

What P/E Will the U.S. Stock Market Support? – C. Barry White

This paper is the motivation for my entire study. It was the most comprehensive study on P/E which I had read before beginning my own study of the historic Canadian Market P/E. A brief survey of the last six papers discussed reveals that they were all done on U.S. market and macroeconomic data. White's study is no different, however it is an excellent representation of a multivariate study of a particular phenomenon.

The purpose of White's study "…was to determine the earnings multiple of the U.S. stock market (proxied by the S&P 500 Index) that can be justified by economic fundamentals at any given time." (White, 30) White's results had a high level of significance (his best model had an overall R^2 of 0.88 and eight out of ten significant variables.) The quality of the study can be attributed to the richness (number of explanatory variables used in the regressions) of the models. White was able to model the flows between the macroeconomy and the financial markets with a high degree of accuracy.

White's aim was not only to explain what the historic level of P/E has been supported but also to provide "…a tool to give some indication of when stocks have become priced irrationally high given then prevailing macroeconomic conditions…with the advantage of knowing which independent variables were significant in past studies, [White] expected to be able to develop a model that would explain a large portion of variation in P/E."(White, 31) My aim was to recreate White's results using Canadian data, and for the most part I had success in doing so. The only shortcomings of

attempting a similar study with Canadian data is that data going back further than 1976 is somewhat sparse in Canada, making such complex inferences somewhat more difficult to accomplish.

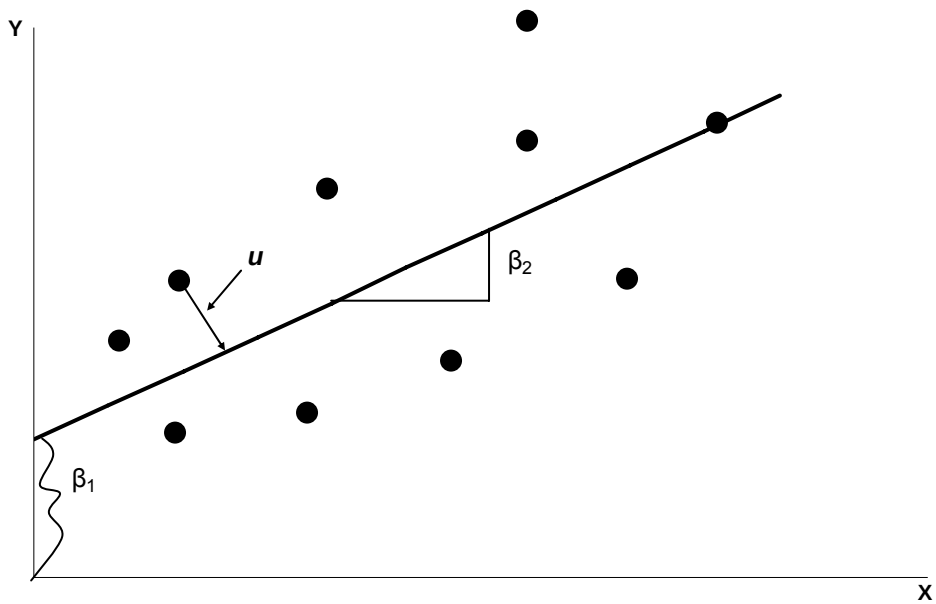
Methodology

No matter what discipline an individual works in, it is inevitable that one will encounter a problem which requires quantitative analysis, be it simple averaging, or measuring the composition of a group of objects or people, or in the case of this paper, measuring the degree of influence which a set of variables may have on one specific variable. In the end, it all comes back to *statistics*. In attempting to prove the existence of the relationships outlined in the previous section on Fundamentals, I have chosen the sub-discipline of statistics known as *Econometrics*. The best definition of Econometrics which I have been able to find, though they are all very similar, is as follows; "…econometrics may be defined as the quantitative analysis of actual economic phenomena based on the concurrent development of theory and observation, related by appropriate methods of inference." (Koopmans *et al* in Gujarati, 1) The primary tool of econometrics is known linear regression and it is with this that I begin the discussion of the methodology used in my study.

Multiple Linear Regression

A linear regression "hypothesizes that [a] dependent variable Y is linearly related to [an] explanatory variable [or a number of explanatory variables] X but that the relationship between the two is not exact; it is subject to individual variation." (Gujarati, 5). As an example take the linear function $Y = \beta_1 + \beta_2 X + u$; where Y = the dependent variable, X = the independent variable, β_1 & β_2 are the parameters and u is the

disturbance or error term. The aim of linear regression is to estimate β_1 & β_2 using some set of existing data in order to determine what the relationship, if any, exists between the Y and X(‘s). For some people it is easier to interpret visually:



where, “ β_1 & β_2 are the respectively the intercept and the slope…and u is the error term that represents all the factors that affect the variable Y but are not taken account of explicitly” (Gujarati, 5) This is the framework which will be used to describe Y, which in my study represents market P/E.

Data

All of the data which was used in the regression analysis was pulled from the Statistics Canada and Bank of Canada websites. The dataset consists of market and macroeconomic data from 1976-2003 and includes the following: S&P/TSX P/E (based on same year earnings), dividend yield, returns on the index, Canadian GDP year-on-year growth, Government of Canada 30 year bond yield, Government of Canada 90 day Treasury Bill Yield, U.S. 30 year Bond yield, M2 and CPI. All other variables were

derived from these including E/P (earnings yield), lagged P/E and lagged returns on the index.

Regressions

When one endeavors to investigate whether the variation in a particular variable can be explained by the variation in a series of explanatory variables using linear regression, it should be expected that a number of *different* regressions will be run before the best model is found. My study was no different. Using the assumptions of classical normal linear regression (to be discussed below) I ran various regressions including different variables in search of the best explanatory model.

The model which I began with was the multivariate regression

$$P/E = \hat{\beta}_1 + \hat{\beta}_2 CPI + \hat{\beta}_3 BYield + \hat{\beta}_4 DYield + \hat{\beta}_5 GDP + \hat{\beta}_6 \mathrm{Re}turns + \hat{\beta}_7 Lagged\ P/E$$
$$+ \hat{\beta}_8 Lagged\ \mathrm{Re}turns + \hat{\beta}_9 CanUSSpread + u$$

where;

P/E	Price-Earnings on the S&P/TSX
E/P	Earnings yield on the S&P/TSX
CPI	Consumer Price Index
BYield	Canadian 30-year bond yield
DYield	Dividend yield on the S&P/TSX
GDP	Canadian Gross Domestic Product
Returns	Returns on the index
LaggedP/E	Price-Earnings lagged by one year
LaggedReturns	Returns on the index lagged by one year
CanUSSpread	Spread between Canadian 30-year bond yield and US 30-year bond yield

(these definitions will be used hereafter)

I ran through a number of variations of this regression dropping some explanatory variables, including regressing each of the explanatory variables on P/E by themselves. I had varying levels of success with this model. The next model I used was as follows;

$$E/P = \hat{\beta}_1 + \hat{\beta}_2 CPI + \hat{\beta}_3 BYield + \hat{\beta}_4 DYield + \hat{\beta}_5 GDP + \hat{\beta}_6 \text{Re}turns + \hat{\beta}_7 Lagged\ P/E$$
$$+ \hat{\beta}_8 Lagged\ \text{Re}turns + \hat{\beta}_9 CanUSSpread + u$$

A number of studies, including C. Barry White's, had greater success with E/P models versus P/E. The reason for this is said to be that E/P exhibits linearity and P/E does not, which makes it a better dependent variable as these regressions look for linear relationships. I ran several variations of this model and yielded some significant results. The different results which both models yielded are discussed in detail in the next section. For now, I turn to a discussion of the assumptions regarding the classical normal linear regression model and a number of important tests for model quality which were used.

Classical Normal Linear Regression Model (CNLRM)

Regression analysis is based on a number of key assumptions without which any results could not be taken at face value. The assumptions of the CNLRM are as follows:

1. The regression model is linear in the parameters.
2. The X values are fixed in repeated sampling.
3. The mean value of the disturbance terms is 0.
4. The variances of the error terms are equal of homoscedastic.
5. There is no autocorrelation between disturbance terms.
6. There is zero covariance between the disturbance terms and the X's.
7. The number of observations n must be greater than the number of parameters estimated.
8. The X values in a given sample must not all be the same. (variability in the X values).
9. The regression model is correctly specified.
10. There is no perfect multicollinearity.
11. Each error term is distributed normally.

A number of these assumptions are intuitive however I will briefly discuss some of the more important ones, for the purposes of my study, and the tests used to detect them.

Multicollinearity

The first of the assumptions I will touch upon is number 10, the assumption of no perfect multicollinearity. According to Edward E. Leamer "There is no pair of words that is more misused both in econometrics texts and in the applied literature that the pair 'multi-collinearity problem'. That many of our explanatory variables are highly collinear is a fact of life.'(Leamer, 300) The term multicollinearity is used to describe the existence of either a perfect[1] or non-perfect[2] linear relationship between explanatory variables:

$\lambda_1 X_1 + \lambda_2 X_2 + ... + \lambda_k X_k = 0$ [1] and $\lambda_1 X_1 + \lambda_2 X_2 + ... + \lambda_2 X_k + v_i = 0$ [2] where the λ_i 's are constants such that not all of them are zero simultaneously. As is evident in Leamer's quote, multicollinearity may prove to be a problem, depending on the degree to which it is observed to exist.

Observing the worst case scenario, that of perfect multicollinearity, gives a good understanding of the problems this phenomenon could cause in an analysis. According to Gujarati:

> If multicollinearity is perfect, the regression coefficients of the X variables are indeterminate and their standard errors are infinite. If it is less than perfect, the regression coefficients will possess large standard errors which means the coefficients cannot be estimated with great precision. (Gujarati, 344)

A mathematical representation of the first of the two above mentioned problems will better illustrate the difficulties perfect multicollinearity causes: taking the well known expressions for the least squares estimators $\hat{\beta}_2$ and $\hat{\beta}_3$ we get:

$$\hat{\beta}_2 = \frac{\left(\sum y_i x_{2i}\right)\left(\sum x_{3i}^2\right) - \left(\sum y_i x_{3i}\right)\left(\sum x_{2i} x_{3i}\right)}{\left(\sum x_{2i}^2\right)\left(\sum x_{3i}^2\right) - \left(\sum x_{2i} x_{3i}\right)^2}, \hat{\beta}_3 = \frac{\left(\sum y_i x_{3i}\right)\left(\sum x_{2i}^2\right) - \left(\sum y_i x_{2i}\right)\left(\sum x_{2i} x_{3i}\right)}{\left(\sum x_{2i}^2\right)\left(\sum x_{3i}^2\right) - \left(\sum x_{2i} x_{3i}\right)^2}$$

assume that $X_{3i} = \lambda X_{2i}$ where λ is a nonzero constant. If we substitute this into the equation for $\hat{\beta}_2$ we get: $\hat{\beta}_2 = \frac{\left(\sum y_i x_{2i}\right)\left(\lambda^2 \sum x_{2i}^2\right) - \left(\lambda \sum y_i x_{2i}\right)\left(\lambda \sum x_{2i}^2\right)}{\left(\sum x_{2i}^2\right)\left(\lambda^2 \sum x_{2i}^2\right) - \lambda^2 \left(\sum x_{2i}^2\right)^2}$

$$= \frac{0}{0}$$

It is clear in this proof, that the parameters cannot accurately be estimated if there is mulitcollinearity in the X's. As for the second of the two problems mentioned in the above quote, a brief illustration of the mechanics of a hypothesis test for individual variable significance will show the difficulties which imperfect multicollinearity may cause. In a test of individual variable significance a researcher's goal is to try to disprove the hypothesis that β_i is not statistically different from 0; $H_0 : \beta_i = 0$, using the t-test statistic $t = \frac{\hat{\beta}_i - \beta_i}{s.e.\left(\hat{\beta}_2\right)}$. If the standard error (s.e.) is very large, which can be the case if imperfect multicollinearity exists, then the t statistic will be too low and the hypothesis that $H_0 : \beta_i = 0$ will not be rejected indicating individual variable insignificance.

Fortunately, detecting if there is multicollinearity is fairly strait forward. There are 3 methods which can be used in combination with each other to detect whether *excessive* multicollinearity is present. The first sign to look for is if the model has a high R^2 (or overall model significance) but few significant t ratios. This is the quickest way to detect multicollinearity. The second method is to construct a correlation matrix consisting of the independent variables. If any variables are seen to have a higher than

80% correlation with one another then it is safe to assume that multicollinearity is present. The last method of detection involves running a series of auxiliary regressions; regressing each individual X variable on the remaining X variables. *Klein's rule of thumb* states that if any of the R^2's obtained in the auxiliary regressions exceed the overall R^2 multicollinearity is said to be present.

The important factor regarding multicollinearity is that it is always present. The key is to minimize the degree of multocolliearity which is present in a given model. Ensuring that the model is well specified, that the sample is large enough, that all variables can be tested against each other and that the model is not overdetermined (more explanatory variables than observations) are a few ways to minimize the adverse effect that this phenomenon can have. As Gujarati has written "Mulitcollinearity is a question of degree not of kind. The meaningful distinction is not between the presence and absence of multcollinearity, but between its various degrees." (Gujarati, 341)

As was noted in Leamer's quote, multicollinearity is always present and dealing with it becomes a question of what degree is acceptable in a particular model. In my study the variables, by nature, are all related to each other to some degree as the stock and flows of an economy are forever linked to one another. The key to minimizing multicollinearity in such a model is to diversify the variables across sectors so that one independent variable is not excessively correlated with any other.

Heteroscedasticity

Heteroscedasticity is the exact opposite of assumption 4 of the CNLRM of equal variances of disturbance terms. Symbolically, homo and heteroscedasticity are written: $E(u_i^2) = \sigma^2$ i = 1, 2, …, n and $E(u_i^2) = \sigma_i^2$. Notice the subscript i for the second term

indicating that the variances are no longer constant. The question is why heteroscedasticity might be a problem if it is found in a model? The answer lies in the assumption regarding the estimators $\hat{\beta}_i$. In the CNLRM, one assumes that the $\hat{\beta}_i$'s are the best, linear, unbiased estimators (BLUE). With the existence of hetoroscedasticity, the assumptions of linearity and unbiasdness still hold, that is, "as the sample size increases indefinitely, the estimated β_i converges to it's true value."(Gujarati, 394). However, due to the fact that the variances are no longer constant with the existence of heteroscedasticity, the model is no longer 'efficient' in the class of unbiased estimators. What this means is if regressions are continued to be run ignoring the existence of heteroscedasticity the models will repeatedly over or underestimate $\text{var}(\hat{\beta}_i)$. As a result, one can

> no longer rely on the conventionally computed confidence intervals and the conventionally employed *t* and *F* tests. In short, if we persist in using the usual testing procedures despite hetorscedasticity, whatever conclusions we draw or inferences we make may be very misleading.
> (Gujarati, 399)

Unlike multicollinearity, the existence of heteroscedasticity alone is problematic for a model, and when testing is done it is to find whether it is present at all.

There are a variety of tests which exist for detecting the presence of heteroscedasticity within a model, however they are too numerous to run through all of them. All such tests seek to investigate the same hypothesis: whether there is a difference in the variances of the individual error terms. I employed 5 such tests of which two I will briefly describe. The first of these tests is visual, a simple graph of the squared residuals $\hat{u}^2$'s against the estimated independent variable $\hat{Y}_i$'s. If heteroscedascitiy is present, the

plots should yield patters such as those found in Figures 2, 3, 4 and 5. Figure 1 is random and would be representative of no heteroscedasticity.

Figure 1

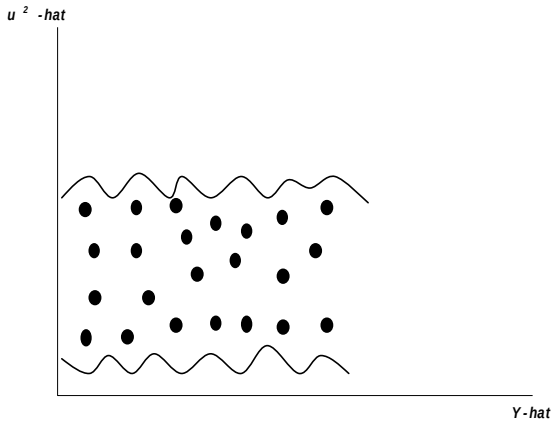


Figure 2

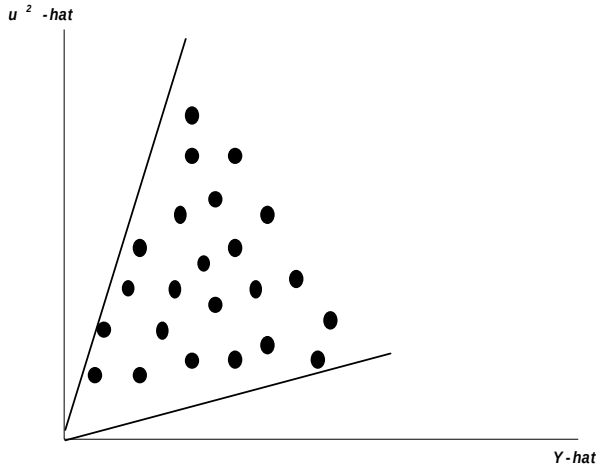


Figure 3

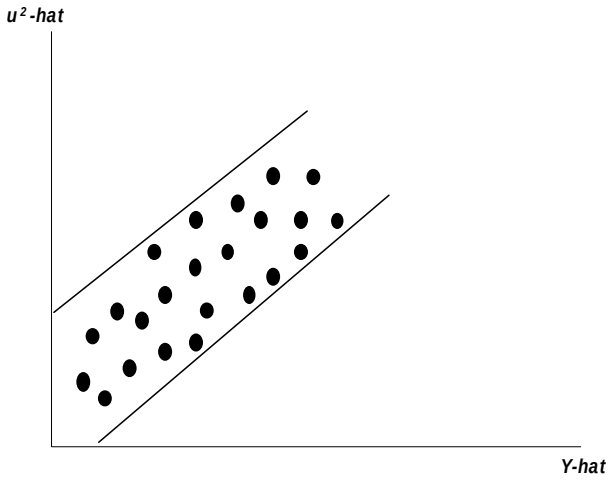


Figure 4

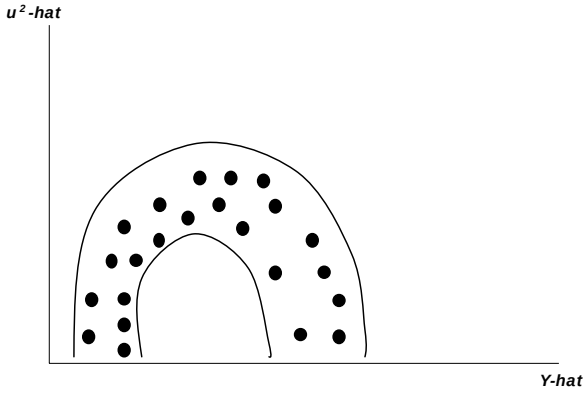
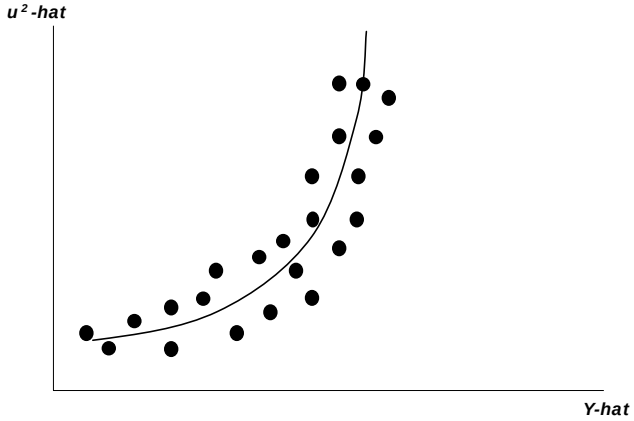


Figure 5



The same method may be repeated using the X 's. The second of the two tests is know as the *Glejser Test* and it is a solid mathematical representation of a test for heteroscedasticity. The form of this test is very similar to the others, as each test seeks to improve upon the other's short comings. The Glejser test involves regressing different variations of the X variable on the absolute values of the residuals obtained from the primary regression and looking for significant results. The four regressions are as follows:

1. $|\hat{u}_i| = \beta_1 + \beta_2 X_i + v_i$
2. $|\hat{u}_i| = \beta_1 + \beta_2 \sqrt{X_i} + v_i$
3. $|\hat{u}_i| = \beta_1 + \beta_2 \frac{1}{X_i} + v_i$
4. $|\hat{u}_i| = \beta_1 + \beta_2 \frac{1}{\sqrt{X_i}} + v_i$

The idea behind this is that if the residuals are shown to vary with the X variables, then their variance is not the same across the entire sample. The results from these two tests and the other will be discussed further in the next section.

Heteroscedascticity may be present in a model for various reasons. One reason for changes in the variances to the same variable over time can be explained by the error learning model. Over time, as individuals proceed with certain tasks, in most cases they learn from their mistakes. As a result, the variability of the outcome of each successive trial of the same task decreases over time. This phenomenon could potentially exist in my model. The BOC employs monetary stimulus to dampen the swings in the economy. Over time, as the, BOC is able to observe the outcome of it's policy, it is able to learn from it, and use this knowledge to apply the policy more effectively in the future. As a result, the variability in the outcome of the BOC's monetary stimulus will decrease.

Another reason for the presence of heteroscedasticity is when a certain variable grows, the variability in another variable may grow as well. For instance, as disposable income grows the variability in the amount of income being saved may grow as well. The most well known cause of heteroscedasticity, and many other statistical difficulties is the presence of outliers in the data. A simple remedy for this is to drop such variables from the model altogether.

Autocorrelation

The two difficulties discussed thus far are generally found to exist when using cross-sectional data. Autocorrelation is a problem most often found when using time series data which is what was used in this study. "Autocorrelation is the correlation of the error terms, often found in time series data due to the natural ordering of data over time."(Gujarati, 441) Autocorrelation causes the same problem that heteroscedasticity does in the sense that the estimators ($\hat{\beta}_i$'s) no longer satisfy BLUE because they are no longer minimum variance. Therefore, the problem that the usual t, F and chi-square tests are no longer accurate, would once again be present under autocorrelation.

The most trusted method of detecting autocorrelation is using the *Durbin Watson (DW)* test statistic $d = \frac{\sum_{t=2}^{t=n}(\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^{t=n}\hat{u}_t^2}$ "which is simply the ratio of the sum of squared differences in successive residuals to the residual sum of squares."(Gujarati, 467) The DW test is quite complex and explaining the exact operation of this test is beyond the scope of this paper. Most statistical packages such as the one which was used in this study compute a DW test statistic which can either be rejected to conclude that no autocorrelation exists or not.

Autocorrelation may exist in a specific dataset for a number of reasons. The first reason, and probably the one which has the most implication for this study, is that some data, especially economic, has a form of 'inertia' built into it. Inertia means that certain variables, for example inflation (CPI), take time to adjust to monetary policy. This would cause the model to have a form of momentum built into it. Another reason for the existence of autocorrelation within a model is if the dependent variable has been lagged and used as an explanatory variable. One must weigh the benefit of including such a variable and make the appropriate adjustments if the model is found to have too many insignificant explanatory variables.

Having discussed the methodology which I have employed in my study I move on a synopsis of my results.

Results

After running a series of regressions on both P/E and E/P I obtained two models which, in my belief, best represent the relationship between P/E (E/P) and the underlying fundamentals which support them. Below is a table containing the final results.

Predictor	P/E	E/P
Constant	29.17	0.013
p-value	0.213	0.537
CPI	-2.018	0.003
p-value	0.478	0.228
Bond yield	3.215	-0.004
p-value	0.826	0.249
Dividend Yield	1.855	0.014
p-value	0.807	0.053
GDP	1.557	0.004
p-value	0.303	0.005
Returns	0.039	-0.002
p-value	0.864	0.336
Lagged P/E	0.447	-0.0002
p-value	0.053	0.245
Lagged Returns	-1.012	0.002
p-value	0.569	0.237
R-Square Adjusted	0.3717	0.7869
Durbin-Waston d	1.66185	1.64053

In the P/E regression all seven variables are shown to have the relationships which were predicted in the section on fundamentals. This is a good start, as the basic relationships seem to be intact. However, the P/E regression has problems with overall significance, coming in at an adjusted R-Square value of only 0.3717 meaning that the overall model explains only 37% of the variation in P/E. In addition to this, not all the individual variables are significant. Only one of the seven variables, lagged P/E is statistically different from zero with a p-value of 0.053. At first glance, Multicollinearity does not seem to be a problem as the R-square value is quite low. Each of the tests for heteroscedasticity, namely the *Park test, Glejser Test, Breusch-Pagan-Godfrey Test Koenker-Bassett test* and the graph test (see Appendix 1) disproved the existence of heteroscedasticity in the P/E model. Testing for multicollinearity was done using a

correlation matrix and running auxilliary regressions. According to the correlation matrix, only two sets of variables had correlations greater than 0.80 – Dividend Yield-CPI and Dividend Yield-Bond Yield. This outcome has no footing in any of the fundamentals discussed previously. The auxilliary regressions painted a different picture of multicollinearity in this model. According to the auxilliary regressions, there is excessive collinearity between CPI, bond yield, dividend yield, GDP, returns, and lagged returns. The fact that so many of the explantory variables are intercorrelated with each other is an indication that multicollinearity is in fact a problem in this model, and that individual variable significance has been incorrectly rejected. Finally, the Durbin-Watson d statistic was run in order to test for the existence of autocorrelation. Unfortunately, the hypothesis of negative autocorrelation could not be rejected due to a high p-value of 0.974619 indicating that negative autocorrelation is present within the P/E model.

As expected, the E/P model returned a better overall significance, an adjusted R-square of 0.7869. However, five of the seven variable were insignificant. The two significant variables, dividend yield and GDP both exhibited the direct relationships which were expected, while the insignificant variables did not. Due to the high overall significance of the model and few significant variables, multicollinearity is surely a problem. The correlation matrix shows the same two pairs of explanatory variables with correlation coefficients above 0.8 as follows: CPI-Dividend yield and Bond yield-dividend yield, which is a confusing result as there is no fundamental reason for these relationships to persist. Auxilliary regressions show only two explanatory variables as being correlated with the others; CPI and Bond yield. All the same tests for

heteroscedasticity were run on this model and each dismissed the existence of heteroscedasticity. Finally, the d-statistic was computed and again, the p-value for the existence of negative autocorrelation was to high to be rejected indicating the existence of this phenomenon.

Though there were positive factors in both of the regressions mentioned above, the results were somewhat inconsistent. In order to ensure that relationships based on economic fundamentals do in fact exist, I ran a series of univariate regresssions on P/E. The results are stated in the table below:

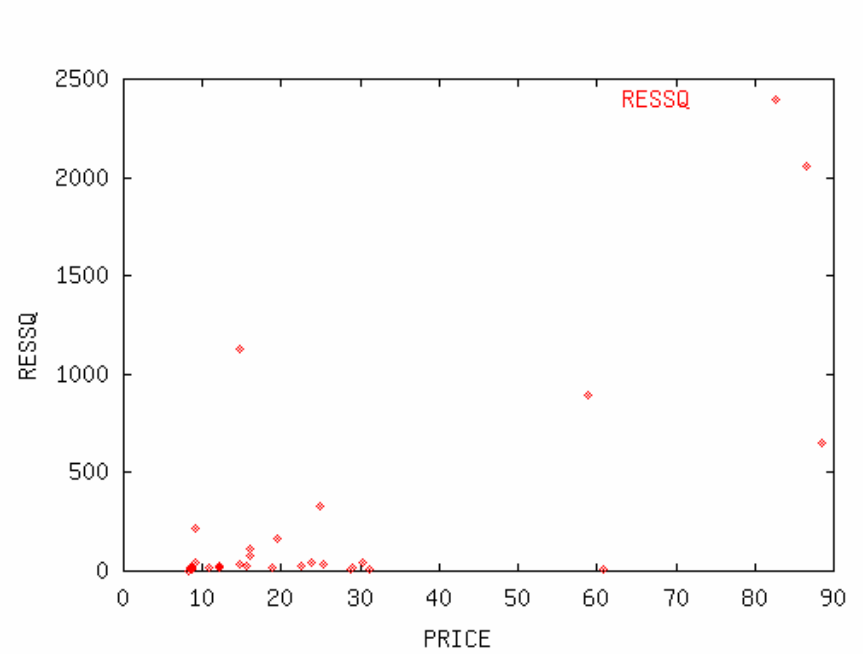
Predictor	**P/E**
CPI	-3.86
p-value	0.01
R-Square Adjusted	0.309
Bond Yield	-3.127
p-value	0.039
R-Square Adjusted	0.121
GDP	-3.1572
p-value	0.005
R-Square Adjusted	0.240
Lagged P/E	0.64199
p-value	0
R-Square Adjusted	0.3973

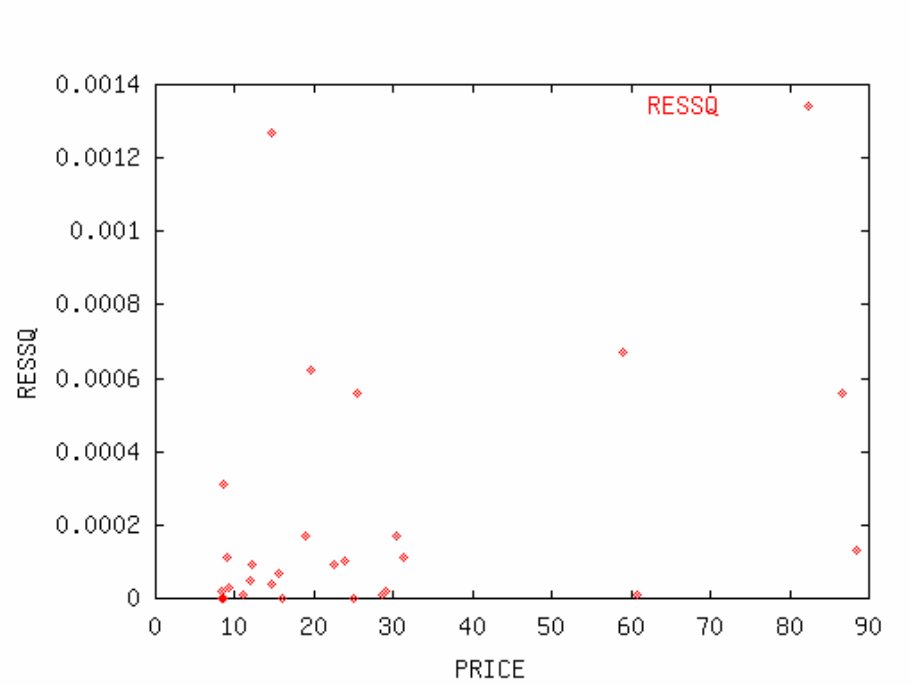
As can be seen, the individual variables are all significant, and the three variables CPI, Bond yield, and lagged P/E exhibit the correct coefficient given the underlying fundamentals. The low R-Square values should not be seen as problematic. The R-squares represent the perecentage of variation in the dependent variable which can be explained by the model. The low number means that there are additional variables that could have been included to better explain the variation in the dependent variable.

Concluding Statements

Walter R. Good wrote that "Imperfections in the statistical evidence in favor of one explanation do not automatically prove the opposite conclusion." (Good, 11). This is an important statement to remember when analyzing evidence in the form of a statistical model. In the case of this model, one cannot conclude that movements in equity prices are not governed by underlying fundamentals based solely on a *strict* intepretation of a statistical model. I believe that the P/E and E/P models provide evidence that a significant portion of the variance in equity prices can be explained by the fundamentals defined previously. The model's shortcomings arise from the lack of a large sample size going back further than 30 years. Both models exhibit similar significance problems which may be attributed to the relatively small size of the sample. The two models constructed here may have fallen short of my aim of predictive quality, however this inference is a good start in the Canadian context. Given additional time and resources, it is my belief that a truly predictive model can be designed and used to value equities based on the historic levels which market fundamentals have supported.

Appendix 1.
Plots of Squared Residuals Versus Dependent Variables





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