

LUND UNIVERSITY

Money Supply and Stock Prices

2nd Yr. Master Thesis Economics

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We had the worst excesses in the credit markets in world history. You think we just wake up one morning and say, oh well, we had a horrible, horrible period of excess and now everything is okay, and we're just going to ignore it?

- Jim Rogers

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Abstract

This thesis deals with money supply and stock prices. Specifically it inquires what macroeconomic factors influences the stock market index. Given the high degree of equity correlation in the market, variables previously used for explaining the cross-section of expected returns are tested against the S&P500 index. The macroeconomic variables used in Chen et.al (1986) are tested for their ability to explain index movements. This is done via standard OLS and probit estimation. The properties of these estimators are then ascertained via simulation. Finally, bias-corrected maximum likelihood estimates are obtained via bootstrapping. These variables generally perform poorly but the ability of money supply to explain index movements depends crucially on an underlying systemic analysis. In addition, indications of future specifications are derived from the simulation results.

Certain relations that hold promise for future research in financial economics are also presented, particularly with respect to the extraordinary monetary policy actions undertaken in the wake of 2008.

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1. Introduction

Since the turn of the previous century the United States dollar has been the worlds reserve currency. The Federal Reserve was established in 1913, charged with the nominal purpose of back-stopping the fractional reserve commercial banking system and avoiding a repeat of the 1907 crisis. Shortly afterward World War I broke out and all belligerents who were on a gold standard realized that existing gold reserves would not be able to support the enormous amount of money bring printed to pay for the war effort. Therefore the gold standard was suspended. After the war the gold standard was re-established. At pre-war parity, in the case of Britain.¹ This lasted until the Great Depression when the dollar was devalued to 35\$ per ounce.

After WWII, the 1944 Bretton Woods accords designated full dollar to gold convertibility at 35 \$ per ounce as the basis for the new post-war monetary system. This required the US Federal Reserve to hold sufficient gold reserves to back the issuance of new dollars. Alas, this did not last very long. The inflation of the 1970's was a predictable consequence of the excesses of the 1960's. The devaluation of the dollar in the early 1930's and the closing of the gold window in the early 1970's means the United States actually defaulted twice during the 20th century. This is important to remember when considering comparisons based on risk-free investments.

It was only after the large increases in interest rates under Federal Reserve chairman Volcker in the early 1980's that inflation was arrested. Since then US interest rates have been edging downward and are now effectively at zero.² The inability to restart economic growth despite the large increases in money supply (e.g. QE1, QE2, Op. Twist etc...) should be very worrying.

When inspecting the "price of gold" over the past two centuries in graph 1, it is perhaps more apt to speak of the eroding value of the dollar.³ Especially considering the degree to which the development is the outcome of political priorities. This view is reinforced when considering the CHF/USD exchange during the 20th century, cf. graph 2. Since by law the

¹ Many economists at the time thought reviving the old parity was a mistake (e.g. Keynes). It could be compared to establishing an official exchange price today of, say, 200 USD/ounce when the ratio of liabilities to gold reserves actually implies a price in the neighborhood of 7-9000 USD/ounce.

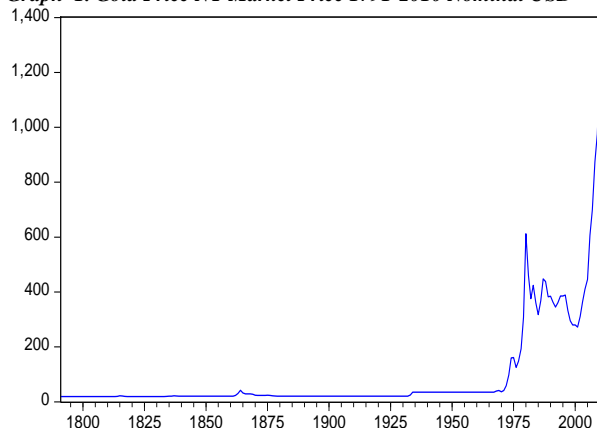
² More than half of world GDP now consists of countries in, or facing liquidity trap-like conditions.

³ As of the end of 2011, the price of gold was around 1600 dollars per ounce.

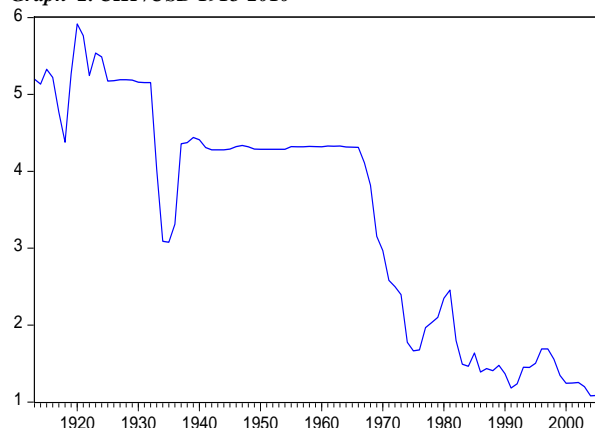
Swiss franc must be 40% backed by gold reserves, there is much greater reason to have confidence in its intrinsic value as a currency. During the 20th century the US dollar has lost about 80% of its value relative to the Swiss franc. There is no reason why the dollar should have lost such value relative to the franc. Both countries were rich throughout this period, however the main loss of relative value came after the 1970, i.e. after gold convertibility was suspended.

This begs the question; what is the “correct” amount of money in an economy? If the assumption is made that the amount of money can be controlled, what criteria decides the correct amount. If there are two goods and no money, a non-barter transaction can clearly not take place. So at least one good-price amount of money is required. If the number of goods increases, a decrease in price is the result (i.e. supply side deflation). Making the price overly conditional on the money supply, wherein the price in an “objective” sense reflects the relative valuations of goods (where labor is one of them), the introduction of the money supply as a greater factor skews the pricing process from reflecting productivity to reflecting increase in the money supply (i.e. inflation). There are many research questions of contemporary interest related to this disconnect.

Graph 1. Gold Price NY Market Price 1791-2010 Nominal USD



Graph 2. CHF/USD 1913-2010



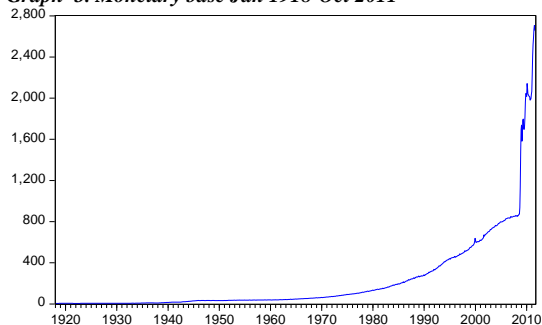
A central point of contention in economics as it relates to money supply and productivity is whether productivity generates the need for means of exchange or whether productivity stems from monetary-induced demand. The policy approach, particularly in the United States but clearly present throughout the world, is based on the latter supposition. The basic problem is defined as the insufficiency of the quantity of money. Consider graph 3 below, where the monetary base over the past 90 years in the US is plotted, and graph 4 where the unprecedented increase in the quantity of money really becomes apparent.

In addition, there has not been any increase in real activity as a result of the monetary easing. The stock market peaked in the fourth quarter 2007. According to the Bureau of Economic Analysis US GDP measured in 2005 dollars stood at 13,326 billion in the fourth quarter 2007 and 13,337.8 billion in the third quarter of this year.⁴ That is an increase of not even one tenth of one percent. This despite a tripling of the balance sheet of the Federal Reserve! Given this extraordinary growth in the money supply, and the attendant possibility of a depression, a re-examination of the implications of money supply for stock prices is warranted.

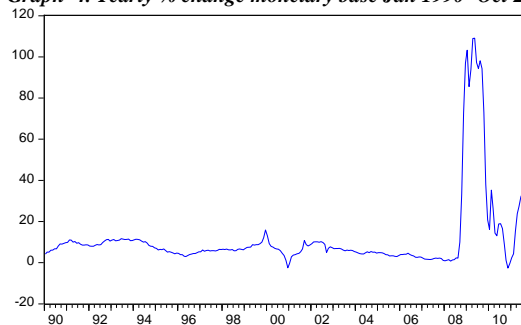
The questions in this thesis are twofold:

- 1) Does an increase in money supply cause stock prices to rise?
- 2) What is the effect of quantitative easing on the stock market?

Graph 3. Monetary base Jan 1918-Oct 2011



Graph 4. Yearly % change monetary base Jan 1990- Oct 2011



2. Previous Research

A great deal of the literature generated since the Lehman Brothers collapse has centered on the importance of leverage in understanding the crisis. Kollmann and Malherbe (Kollmann and Malherbe 2011) discuss the ways in which a “financial shock” transmits globally via leverage mechanisms, which stands in contrast to earlier wisdom that financial integration would facilitate “diffusion” of shocks to the economy. The ability of the balance sheet of intermediaries to “transmit shocks” is a perspective perhaps originally set forth by Calvo and Drazen (Calvo and Drazen 1998). Adrian and Hyun Song (Adrian and Hyun Song 2009) find that the balance sheets of financial intermediaries predate declines in state variables. In contrast Kollmann and Zeugner (Kollmann and Zeugner 2011) find that leverage would not have predicted the financial crisis better than any conventional indicator(s).

⁴ <http://www.bea.gov/national/index.htm#gdp>

Further, it is not obvious where the danger of bi-party credit stems from. Should individual A loan his own funds to individual B for whatever purpose, and B has made an erroneous decision, the matter will end there and will not constitute any inherent danger to the economy as a whole.

Fundamentally, the role of money is highly controversial with Keynesian and Chicago schools offering different interpretations, and the Austrians maintaining a relatively marginalized role. Research on money supply and finance has traditionally been focused on money as a risk factor in asset pricing. As regards the empirical relation between money supply and stock prices, Rozeff (Rozeff 1974) finds that money supply variables offer no possibility of gaining abnormal returns. For efficient markets to hold changes in one variable should not systematically predate changes in another. This is in line with findings on the direction of causality. Rogalski and Vinso (Rogalski and Vinso 1977) propose a causal relation with both variables affecting each other. Theoretical modeling of the role of cash in an investor setting include LeRoy (Leroy 1984) and Lucas (Lucas 1982).

If the economy engages in overly expansionist monetary policies whereby each loan is, in a sense, the result of an expansion in the money supply, any intolerance of deflation will prevent the liquidation of unsound investments and tend to drag the economy towards an inflationary depression. Modeling in this vein include Keen (Keen 1995), synthesizing mathematically the work of Minsky (Minsky 1986) who warned against the instability of advanced financial infrastructure. What is perhaps an under-appreciated aspect of this effort is, especially in view of the massive policy responses to bankruptcies in recent years, the willingness of the authorities to commit public/borrowed funds.

The 2008-2012 crisis has also elicited calls to theoretically link financial economics and macroeconomics in a way that allows for a more accurate understanding of their interaction. Cochrane, in Mehra (Mehra 2008), offers a pre-crisis survey of work attempting to link financial markets and the real economy. Here he offers the central research question of interest: *what is the nature of macroeconomic risk that drives risk premia in asset markets?* To the present author there can be only one answer to this question. The paramount issue for the investor is the preservation of purchasing power, i.e. protection against inflation. If possible, the investor should seek to increase this purchasing power. That is the normative answer, i.e. what *should* be at the root of all asset pricing and thoughts on investing strategy. However, there seems to be a great deal of confusion as to the correct orientation in

nominal/real space. Bodie (Bodie 1976) mentions specifically, but assumes away, the uncertainties of using the CPI as an indicator of the price level.

In terms of asset pricing the dangerous debt levels of the United States and indeed of most of the developed world means that the assumption of a risk-free investment may have to be reconsidered. Indeed, according to Walsh (Walsh 1998) money growth and price increases show a correlation of one over a longer run. In sum, asset-pricing approaches that straddle the real/nominal divide only on the basis of consumer price index will perhaps not prove as viable as new approaches giving substantially greater attention to monetary factors.

3. Theoretical Framework

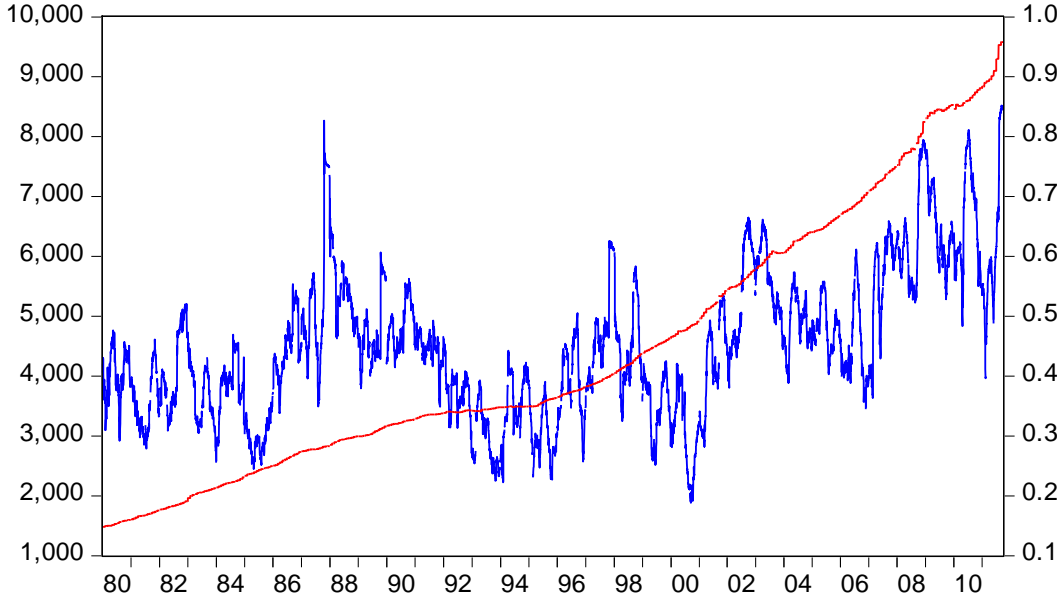
Discussions regarding the serious economic problems in the present center around leverage and credit. These usually take place outside the structural framework that allows the growth in credit. In this paper I have explicitly tried to incorporate the endogenous growth of “debt”, and not merely assuming that debt by itself is not a problem since it is a counter-party asset.

In previous research, the stock price is assumed to rise as a function of the interest rate which falls if the money supply increases. In actual fact, prices of bonds and stocks until recently moved in an inverse manner. Secondly, the general assumption in economics was that the interest rate is set as the clearing price of money in a *market*. In practice, the level of interest rates are not set via market clearing mechanisms and as such do not reflect rational savings decisions by individuals in the economy. Rather, a certain rate is targeted through the actions of an autonomous Central Bank. The Central bank cannot completely control rates since they also depend on factors outside its control (among them a change in deposits at commercial banks and their credit multiplier). The Central Bank usually targets its rate with respect to a double mandate: the highest level of employment consistent with low and stable increases in the CPI. Given the extraordinary developments in recent years it seems reasonable to extend the analysis of the divergence between real and nominal values beyond this basic understanding. Failure to do so suggests there is a chance of misunderstanding the nature, definition and workings of inflation. This means that the investor is more likely to erode the purchasing power of his wealth over time. In theory, there is a level of money supply growth at which the money supply becomes the overriding factor for stock prices and ultimately, result in large increases in the CPI.

In western economies it seems that money has become decoupled from the economic activity which it is supposed to facilitate. It is not the presence of money that causes economic growth. Productive capacity causes growth. Money should be a reflection of economic activity, not the other way around. Monetary responses to economic problems have centered on easing money supply, to make credit more easily available. Fiscal approaches have centered on stimulus spending where debt to GDP of many important countries are now reaching very dangerous levels. The individual investor does not necessarily care about the effectiveness of the approach taken to economic problems, as the preservation of purchasing power is the overriding concern. But what questions are most important, given this objective?

First of all, in inflationary environments it is very hard to know what things are actually worth. It may on the face of it appear that money supply does not impact stock prices. However, at one extreme, a hyperinflationary environment where there is essentially an infinite amount of paper money, stocks are at once infinitely valuable and worthless. Beyond the credit mechanism of fractional reserve and shadow banking, there must exist some point where the money supply becomes the overriding factor of importance for stocks. Even if an expansion of the money supply is desired it cannot, in an organic sense, grow faster indefinitely than some measure of underlying economic activity. Consider graph 5, where it is evident that as the US money supply has increased dramatically, there has been a corresponding increase in the correlation between individual stocks and the stock market index.

Graph 5. Average 50 Day Rolling Correlation between S&P Constituent Stocks (Source: Birinyi Associates) in blue (Right Scale) and M2 in red (Left Scale)



The change in purchasing power (ΔPP) is presented in Berk and DeMarzo (Berk and DeMarzo 2007) as

$$\Delta PP = \frac{\Delta \text{ money invested}}{\Delta \text{ prices}} = \frac{1 + r}{1 + i} \quad (1)$$

$$r_t = \frac{1 + r}{1 + i} - \frac{1 + i}{1 + i} = \frac{r - i}{1 + i} \quad (2)$$

where r_t denotes the real net return. Therefore, for small values of price inflation the real net return is the nominal net return minus the price inflation. However, if inflation is not defined as the growth in prices (CPI) but the growth in the money supply, then the theoretical definition of real return becomes harder to pinpoint but the uncertainties of using CPI are also eliminated. If a 1% increase in the money supply is followed by a 1% increase in the stock price, then no net increase in purchasing power has resulted from the increase in the stock price. Therefore, if market participants simply observe the increase in the stock price, they may be deluded as to the increase in productivity of the firms mass of capital.

In regards to persistent issues in finance such as the equity premium puzzle (see Mehra and Prescott (Mehra and Prescott 1985), various empirical findings regarding the excess real rate of return are compared without reference to the change in the measurement of CPI. For example, in the consumption-based model of asset pricing, the changing consumer prices are not consistently reflected in the real rate of net return on assets and therefore comparing the two series over time (consumption and real net return) may become misleading. Perhaps not surprisingly, no definitive answer to the equity premium puzzle has been forthcoming.

Calculations based on data by (Shiller 2005), using the approximation in eq. 2, suggests the S&P has yielded close to a quadrupling of purchasing power over the past 140 years (graph 6). The S&P 500 CPI adjusted index is calculated as follows.

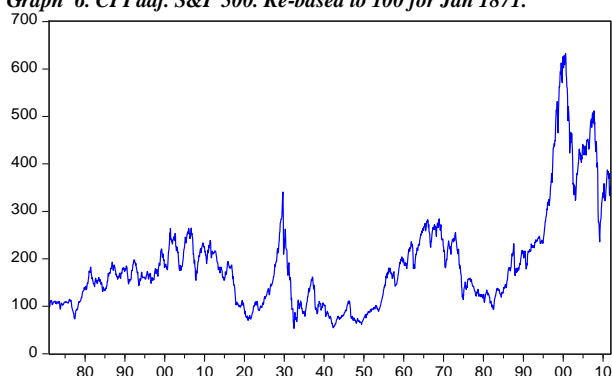
$$SPCPI_t - SPCPI_{t-1} = [\ln SP_t - \ln SP_{t-1}] - [\ln CPI_t - \ln CPI_{t-1}] \quad (3)$$

This is just the yearly percentage change in the S&P minus the percentage change in the CPI with the percentage change allotted to an index which is re-based to 100 for January 1871. For comparison consider deflating by the true money supply (TMS).⁵ This is just another way of

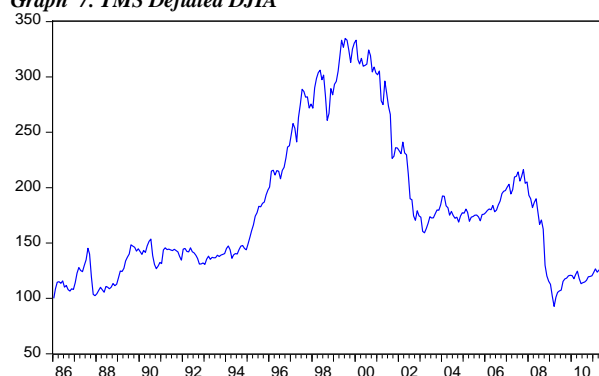
⁵ This is a nod to the Austrian School, the economics tradition most concerned with money and credit.

defining money supply. In the Austrian definition of the money supply, money is defined as money and its substitutes (Von Mises 2009). The operationalization of this definition follows Pollaro.⁶ See appendix for components of TMS. The value of the CPI adjusted Dow Jones Industrial Average (DJIA) return index was 100 in January 1986 (see graph 7). By that measure the stock market is back where it started. Viewed in this light the stock market has not yielded any “real” returns in 25 years! The graph below gives an indication that simply more money in the economy will not lift the market again in real terms. It seems rather to be drowning in cash. The nominal gains of the 2000’s suddenly look less impressive but the “recovery”, post-Lehman Brothers, looks especially pitiful.⁷

Graph 6. CPI adj. S&P 500. Re-based to 100 for Jan 1871.



Graph 7. TMS Deflated DJIA



To enlighten the relationship between the term structure and the S&P 500 the graph below shows their 250 day rolling correlation. For the whole sample 59 % of the observations are negative whereas since 1995 that figure is 65 %. Incorrect expectations are incorporated in the UCPI variable, to the extent that they are based on extrapolating from the past. If M2 is a leading indicator of CPI increases, and realized as such, a lag of M2 would seem appropriate. On the other hand this should be captured by the expected CPI. Judged by the numbers alone there has not been such a great increase in the CPI as would be expected given the increases in monetary base. This suggests that the new money is “stuck in the bank.” Deploying complicated lag dynamics in an attempt to sort out expectations, money supply, CPI etc.. risks detracting from the underlying purpose which is to see what the large increases in money supply mean for the stock market.

⁶ See his Forbes blog <http://blogs.forbes.com/michaelpollaro/money-supply-metrics-the-austrian-take/>

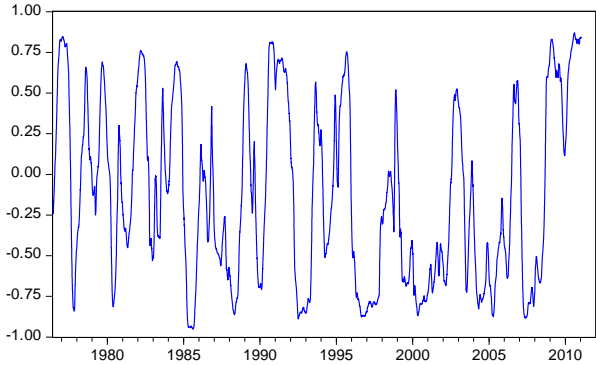
⁷ It is perhaps logical that the focus has shifted toward monitoring dividends as witnessed by e.g. the ratio of the S&P 500 dividend ETF relative to the S&P 500, which also indicates the risk/on, risk/off trade as investors value capital gains over income.

Under normal circumstances an increase in unexpected consumer price index (UCPI) should cause the S&P to go down as investors shift to real assets in order to store purchasing power. If the money supply is continually increasing and market participants incorporate their forecast errors of CPI into their expectations of CPI, then the money supply should dominate the direction of the market and initially drive down the stock market. It also means that after a while UCPI becomes zero and inflation expectations will have taken hold. Consequently, at a certain level of M2 the stock market should increase dramatically but these gains will be nominal in nature. It is the authors belief that the market volatility of the past few years is the result of this tension between real and nominal valuations.

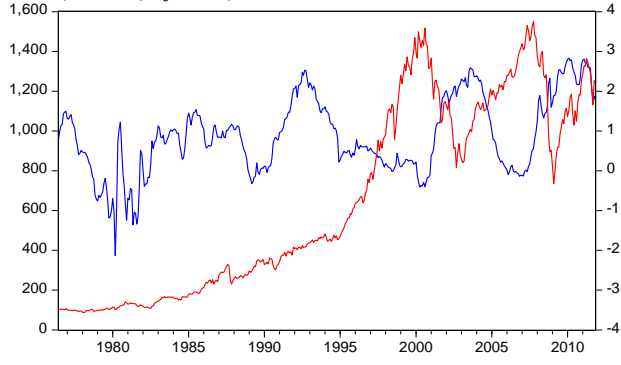
Increases in industrial production should mean increases in the stock market. Increases in oil should mean that the market loses ground as previously inexpensive but necessary economic activity becomes more expensive. In contrast, conventional wisdom holds that increases in PCE should mean a market upturn in the present period.

Since the end of the 1990's the 2 year US government bonds (GS2) and the S&P500 move in tandem. As bond prices would rise the S&P would fall. The flattening of the yield curve in the 1990's predated the NASDAQ bubble. Since the GS10 has been declining steadily for about 20 years the rises in the slope of the yield curve stem mainly from the GS2. The opposite movements in the S&P 500 and the term structure ended in the last few years of the sample (see graph 9). What sign should one expect? When the GS2 increases the term structure decreases but that pattern has been disturbed in the last few years. The previously stable relation of increasing bond prices meaning decreasing stocks is suspended. This is another consequence of interference in capital markets. An increase in the steepness of the yield curve should mean a stock market decline.

Graph 8. Rolling 250 day correlation between TS and the S&P 500 index



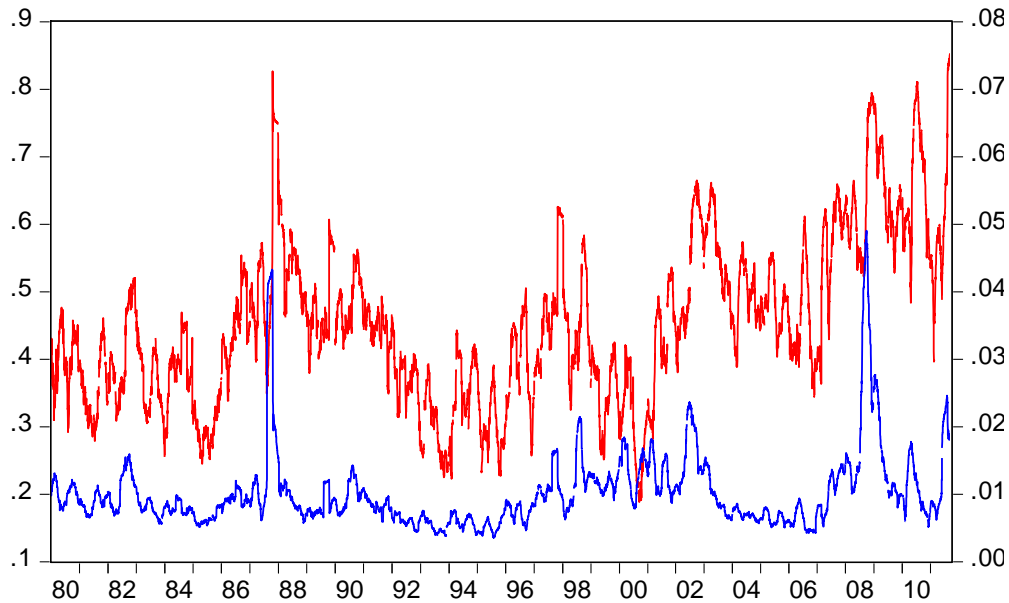
Graph 9. Term Structure (Blue line, right scale) and the S&P 500 Index (Red line, left scale)



3.1 Rolling Correlation and Volatility

Consider graph 10. Does volatility cause correlation or vice versa? It seems intuitive that when investors are spooked they are loath to stray too far from the pack. When things get volatile a herd mentality takes over.⁸ There is no reason for the size of the rolling window other than to ease comparison of volatility and correlation over time.

Graph 10. Average rolling 50-day correlation S&P 500 constituent stocks (red line, left scale) and 50 day rolling volatility of S&P as measured by standard deviation of daily returns (blue line, right scale)



Defining the risk-adjusted excess return, alpha, or Sharpe ratio as

$$\alpha_i = \frac{E(R_i - R_m)}{\sigma_i} \quad (4)$$

where R denotes excess return for asset i and the market index, respectively, and σ is the standard deviation of asset i. The formula for the average correlation at time t is

$$\frac{1}{i * j} \sum_{i=1}^{500} \sum_{j=1}^{499} \rho_{i,j} \quad (5)$$

where

⁸ It would be interesting to quantify the relationship between volatility and correlation but these two series have too much serial correlation, two data points are to 98% comprised of the same underlying data.

$$\rho_{i,j} = \frac{E[(p_i - \mu_i)(p_j - \mu_j)]}{\sigma_i \sigma_j} \quad (6)$$

Since

$$|\rho| \leq 1 \quad (7)$$

and if

$$\frac{1}{i * j} \sum_{i=1}^{500} \sum_{j=1}^{499} \rho_{i,j} \rightarrow 1 \quad (8)$$

then

$$R_i = R_m \quad (9)$$

Consequently,

$$\alpha_i = 0 \quad (10)$$

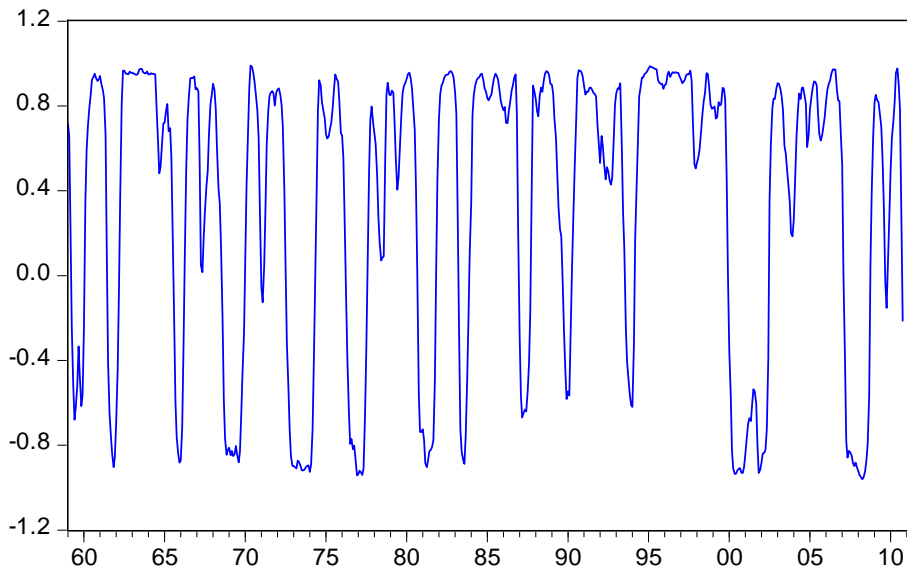
This means that the increased co-movement of individual stocks (at least on the S&P) are dominated by non-idiosyncratic factors (i.e. money supply, monetary intervention). In such an environment (i.e. inflationary), it is not possible to explain the cross section of expected excess returns. It is perhaps reasonable to argue that understanding the causes of volatility is more productive. As can be clearly in graph 10 volatility has increased in the past few years.

A potential clue is the expansion of the money supply, a precise development of which is detailed in section 3.2. For now, only consider graph 11 where the yearly correlation of the M2 money metric and the S&P index is plotted, defined as follows:

$$\rho_{t,(M2,S\&P)} = \frac{E[(M2_t - \mu_{M2,t})(S\&P_t - \mu_{S\&P,t})]}{\sigma_{M2,t} \sigma_{S\&P,t}} \quad (11)$$

where M2 denotes money supply, S&P denotes the S&P 500 index, with the standard definitions of the standard deviation and mean. The correlation between the term structure and the S&P 500 index is defined in the same way.

Graph 11. Yearly Correlation of monthly M2 and the S&P 500 Index

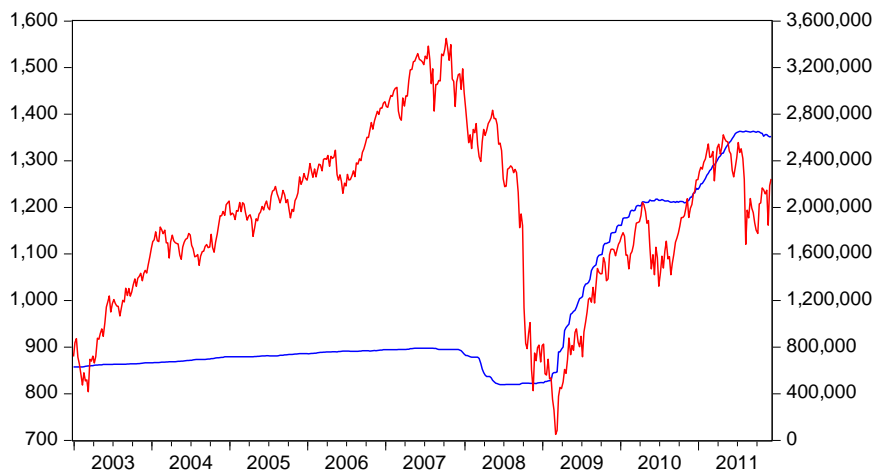


It is interesting to note what a volatile, but steadily volatile relationship the two metrics maintain up until the second to last decade of the sample. In the early 90's the relationship does not normalize, from about 1987 until the dot-com bust the relationship only strengthens. The second half of the 1990's sees the first sustained correlation, coincidental with the NASDAQ bubble. The two remaining periods of high correlation are both lower in intensity and shorter in duration than that which dominated during the NASDAQ bubble.

3.2 Quantitative Easing and the Stock Market

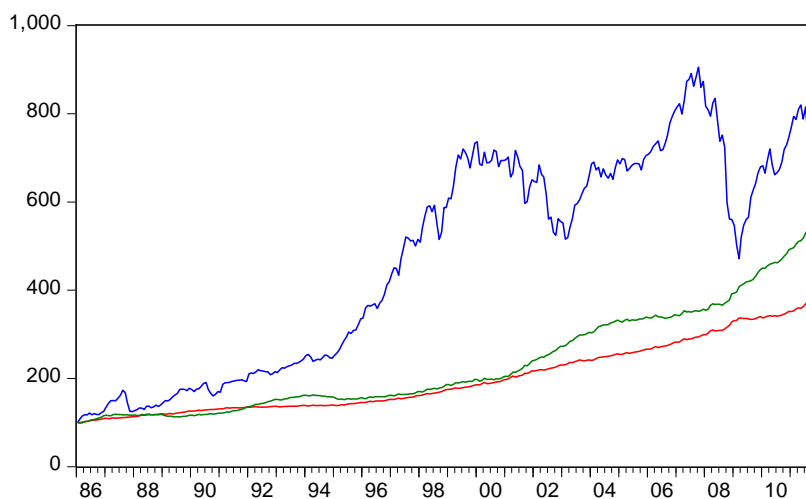
Consider graph 12, where bi-weekly observations of S&P index and the quantitative easing program, i.e. purchases of assets, are plotted. From the first round of asset purchases, launched in March 2009, these two go hand in hand. This pattern does not explicitly show up in the M2 metric because the excess reserves from the QE programs are not channeled into household credit but rather used to buy, among other things, equities. JP Morgan (Flows and Liquidity March 2001) note that in regards to QE2 the FED purchase of 300 billion USD in Treasury notes was commensurate with a reduction in bond holdings by commercial banks by 280 billion USD. If the FED had purchased these bonds from households then here would have been a direct increase in the money supply. This is important to remember when considering the estimation results, namely that M2 underestimates the effect of monetary actions on the stock market.

Graph 12. S&P Index red line (left scale) Securities Held Outright (left scale) blue line bi-weekly, 20021230-20111205



Since it is of interest to forecast the direction of the stock market given the direction of monetary easing, it is not necessary to control for spurious results. There is no reason why the stock market and monetary intervention should both increase over time. It can be seen clearly that any withdrawal of QE makes the stock market fall back. This is clearly influencing the market but lack of observations, among other things, makes estimation difficult. Future research should try to model these extraordinary central bank activities into explaining common market movements. It can be seen in graph 13 that first order effect of TMS on the DJIA is smaller than that of M2. It is beyond the scope of this thesis to incorporate the TMS into an estimation setting, but it seems to align itself to a greater extent with the index than M2 does. Could TMS be a harbinger of purely inflation driven stock gains?

Graph 13. DJIA (Blue Line), TMS (Green Line) and M2 (Red Line) Jan 1986 to Sept 2011. (Re-based to 100 for Jan 1986)



4. Data

All data used in estimation is from the FRED database.⁹ Summarized below are the relevant statistics for the variables included. It is possible that the change in money supply at time t could cause unanticipated price inflation at time $t+1$ but it is unlikely that it feeds through to consumer prices that quickly. It would have been nice to include the M3 measure of money supply since that also covers repurchase agreements, which are a key mechanism for the transmission of credit from central banks to dealer banks to intermediaries and finally to investors. From the latter flows consumer credit and asset purchases etc.. However, M3 is a discontinued series. Variables that may be considered to grow over time (S&P, M2 and PCE) are in log form to facilitate parameter interpretation.

The variables are similar to those of Chen et.al. (Chen, Roll and Ross 1986) except the risk premium, which is excluded since the concept of risk free investment has been undermined since their work was done. Also, the market portfolios are excluded since this study focuses on common variables whereas theirs seeks to explain the cross-section of returns. All data collected for estimation purposes are monthly observations ranging from June 1976, which is the earliest observations for the 2 yr Treasury note, to November 2011.

Table 1. Descriptive Statistics of the Explanatory Variables

	<i>Mean</i>	<i>Maximum</i>	<i>Minimum</i>	<i>Std. Dev.</i>	<i>Skewness</i>	<i>Kurtosis</i>	<i>JB</i>	<i>Prob.</i>
<i>CPI</i>	0.326872	1.520910	-1.915290	0.369976	-0.306277	6.817205	265.2964	0.000000
<i>IP</i>	0.184260	2.168700	-4.138030	0.702937	-0.931300	7.347094	397.0055	0.000000
<i>M2</i>	4123.279	9639.800	1080.800	2248.406	0.680872	2.433525	38.61050	0.000000
<i>OIL</i>	33.76564	133.9300	11.28000	23.54957	1.788501	5.806765	366.9434	0.000000
<i>PCE</i>	5236.965	10865.00	1144.000	2939.821	0.383384	1.855760	33.67565	0.000000
<i>TS</i>	0.874977	2.830000	-2.130000	0.948445	0.081971	2.502640	4.867840	0.087692
<i>UCPI</i>	0.149990	2.256124	-0.863408	0.336375	0.548382	7.040477	311.1281	0.000000

Table 2. Variable Definition

<i>Acronym</i>	<i>Full Name</i>	<i>Unit</i>
<i>CPI</i>	<i>Consumer Price Index (Urban)</i>	<i>Index</i>
<i>IP</i>	<i>Industrial Production</i>	<i>Index (Seasonally Adjusted)</i>
<i>M2</i>	<i>Money Supply</i>	<i>Billions USD</i>
<i>OIL</i>	<i>Oil Price</i>	<i>Spot USD/Barrel (West Texas Int.)</i>
<i>PCE</i>	<i>Personal Consumption Expenditure</i>	<i>Billions USD (Seasonally Adj.)</i>
<i>TS</i>	<i>Term Structure</i>	<i>Percent</i>
<i>UCPI</i>	<i>Unexpected CPI</i>	<i>Percent</i>
<i>SP500</i>	<i>Standard & Poor 500</i>	<i>End-of-Month Index</i>

⁹ Maintained by the US Federal Reserve St. Louis

Unexpected price inflation (UCPI) is defined as

$$UCPI_{t+1} = E_t(CPI) - CPI_{t+1} \quad (12)$$

Expected price inflation for time t+1 is just the unconditional expectation up to and including time t. The term structure of interest rates is defined as

$$TS_t = GS10_t - GS2_t \quad (13)$$

The 3-month bond and the 2-year treasury rate are 98% correlated and the Federal Funds rate and the 2-year treasury are 97% correlated so it does not matter much which one is used to infer the historic term structure. Certainly as much information about the slope would be preferable but a simple subtraction will have to suffice. The greater the difference the steeper the yield curve.

Table 3. Descriptive Statistics of Dependent Variables

	<i>Mean</i>	<i>Maximum</i>	<i>Minimum</i>	<i>Std. Dev.</i>	<i>Skewness</i>	<i>Kurtosis</i>	<i>JB</i>	<i>Prob.</i>
<i>S&P</i>	650.3102	1549.380	87.04000	477.4321	0.330197	1.532081	45.98857	0.000000
<i>S&P(bin)</i>	0.595294	1.000000	0.000000	0.491414	-0.388294	1.150772	71.23588	0.000000

5. Methodology

The interest in econometrics is not to find beta as such but to be able to articulate the DGP for the dependent variable and estimation via OLS or Probit is one way to do that. Although the properties of each estimator are well known theoretically, a simulation of the consistency of each estimator is included in order to examine the properties in each particular case. This is of particular interest when more than one explanatory variable is included. Taken together the simulation ought to give some confidence in the reliability of the results.

Asymptotic results pertain to the properties of some function of an estimator as the sample size grows. They are functions of the estimator because they depend on the method of estimation of some a priori defined relation. That relation is derived from theory. Consistency is of primary importance (Verbeek 2008) especially since the unbiasedness of non-linear estimators may not even be possible to calculate. The initial impression is that consistency is a weaker assumption than unbiasedness, but it is not. One may hold without the other and vice versa. In the literature, the properties of the estimators under certain assumptions are derived

algebraically, but it is desirable to verify that the estimators are consistent. This is done via the following simulation procedure.

1. Estimate the model with OLS or Probit

$$Y = X\beta + \varepsilon \quad (14)$$

2. Use the estimated parameters, sample data and errors according to

$$\varepsilon_t \sim NID(0, \sigma^2) \quad (15)$$

in order to generate a simulated Y-vector.

3. Use the simulated Y-vector and repeat OLS estimation for $n = 1 \dots 426$ to generate a simulated vector of parameters (426 being the number of observations).
4. For probit simulation the simulated Y-vector in step 2 is converted into a binary vector via the following indicator function.

$$y_t = 1 \text{ if } X_t\hat{\beta} + \varepsilon_t > 0; y_t = 0 \text{ if } X_t\hat{\beta} + \varepsilon_t \leq 0 \quad (16)$$

5. To compare the consistency results assuming a normal distribution for the error terms with those generated by the actual model, repeat step two and three with a new vector of errors based on randomly re-sampling the model errors.

5.1 OLS Asymptotics

To ascertain at what sample size it might be reasonable to expect convergence consider the following DGP, the simulation results of which are in graph 23 & 24 in the appendix

$$LOGS\&P500_t = \alpha + \beta LOGM2_t + \varepsilon_t \quad \varepsilon_t \sim NID(0, \sigma^2) \quad (17)$$

where $\alpha = -6.444176$, $\beta = 1.536753$ and $\sigma = 0.310187$ as per initial OLS estimation. The coefficients seem to settle down at around $n=100$. In the initial attempt to quantify the relation between stock prices and money supply, consider the first specification.

$$LOGSP500 = \alpha + [CPI \ LOGM2 \ LOGPCE \ TS \ UCPI][\hat{\beta}_1 \dots \hat{\beta}_5]' + \varepsilon \quad (18)$$

5.2 Probit Asymptotics

If the question is formulated as to what the likelihood of observing a rise in the stock market may be given a certain level of M2 and how that likelihood changes as a result of changes in M2, probit estimation may be used. Therefore, the specification of a binary probability model where the dependent variable is a 1 if the market has risen and a zero if it has fallen.

$$S\&P_{bin} = \beta MS + \varepsilon \quad (19)$$

Estimating eq. 19 with OLS yields a linear probability model (LPM). For certain values of the explanatory variable, however, the probability of observing either of the binary outcomes may be greater than one or less than zero. This, of course, violates the concept of probability. The second point concerns the errors, which will be heteroskedastic. For ease of notation redefine S&P as y , and MS as x which gives:

$$y_t^0 = X_t \beta + u_t \quad u_t \sim NID(0,1) \quad (20)$$

where the sign of the dependent variable is determined as follows.

$$y_t = 1 \text{ if } y_t^0 > 0; \quad y_t = 0 \text{ if } y_t^0 \leq 0 \quad (21)$$

To avoid the problems associated with the LPM, it is possible to reconceptualize the level of x as an indication of the probability of a certain y observation being 1 or 0. What is of interest in the expected value of y is conditional upon the information set available at time t

$$E(y_t | \Omega_t) = F(X_t \beta) \quad (22)$$

where $F(\cdot)$ is the cumulative density function of the standard normal. This ensures that evaluating $X_t \hat{\beta}$ satisfies the definition of probability. The ML estimator is given by

$$\hat{\beta} = \max_{\beta \in B} L(\beta) \quad (23)$$

where B constitutes the parameter space and $L(\beta)$ is the log-likelihood function, defined as

$$L(\beta) = \sum_{i=1}^N y_i \log F(x_i' \beta) + \sum_{i=1}^N (1 - y_i) \log (1 - F(x_i' \beta)) \quad (24)$$

The probit model is a non-linear model in that the effect of x on y changes with the values of x, but it is not a true non-linear model since the functional form of the relationship is constant. The desired properties of the ML estimator are, of course the same as those for any estimator. In the following section the consistency simulations and bootstrap method are presented.

The final probit model estimated is:

$$S\&P_{bin} = \alpha + [IP\ LOGM2\ LOGPCE\ TS\ UCPI][\hat{\beta}_1 \dots \hat{\beta}_5]' + \varepsilon \quad (25)$$

5.3 ML Bootstrap Bias Reduction

According to Davidson and MacKinnon (Davidson and MacKinnon 2004) the elements of the vector of parameter estimates (including the constant) tend to be biased away from zero when using binary response models, such as the probit. This stems from the property of binary response models that they tend to fit too well, meaning that the evaluated function of estimates, $F(X_t\hat{\beta})$, is closer to zero than when the function is evaluated with the true values, $F(X_t\beta_0)$. Therefore a bootstrapping method of reducing the ML estimate bias was employed. The method of bias adjustment via bootstrap is as follows (for details on this method see (Davidson and MacKinnon 2004)).

1. Estimate the model to obtain vector of parameter estimates $\hat{\beta}$.
2. Use $\hat{\beta}$ and errors according to

$$\varepsilon \sim N(0,1) \quad (26)$$

in order to generate a simulated Y-vector and use indicator function (see simulation procedure) to acquire binary data.

3. Generate B (426) bootstrap samples, denoted $\hat{\beta}^*$
4. The bias was estimated via

$$Bias(\hat{\beta}) = \frac{1}{B} \sum_{j=1}^B \hat{\beta}_j^* - \hat{\beta} \quad (27)$$

5. The bias-corrected estimate is

$$\hat{\beta}_{bc} \equiv \hat{\beta} - \left[\frac{1}{B} \sum_{j=1}^B \hat{\beta}_j^* - \hat{\beta} \right] \quad (28)$$

6. Analysis

The results of OLS regression of the five variables on SP500 is presented below. With an R^2 of almost one and a DW-statistic far from 2 (0.12) the danger of spurious regression is noted. However it is also important to note the “spurious” nature of economic development. The lack of supply side deflation (except e.g. electronics) and the unprecedented expansion of asset prices versus consumption goods prices since 30-40 years coupled with non-income financed growth in the western world means that the spuriousness may not be simply a function of time but rather of crucial developments in the world economy. In addition, Cochrane (Cochrane 1991) warns against the possible low power of unit root tests in samples of limited size and notes that certain time series, like stock prices, may be especially susceptible to this weakness.

Certainly the presence of outliers may cause residuals to be non-normal but to exclude Black Monday and the market volatility from the fall of 2008 onward risks severely distorting the historical record.

As for the signs of the variables, it is clear that an unexpected increase in CPI should, at least initially, add downward pressure on the index. Real assets will appreciate in this environment. A change in TS may refer to either a lowering of the short rate or an increase in the long term, but both imply a greater risk of longer-term holdings. Should longer bonds offer a higher return, stocks will fare less well. Increases in CPI also lead to a lowering of the market. From a Keynesian perspective it may be that after a certain level of CPI additional increases will only fuel expectations of a reversal in the business cycle and with it the prospect of tighter money.

Table 4. OLS Estimation Results

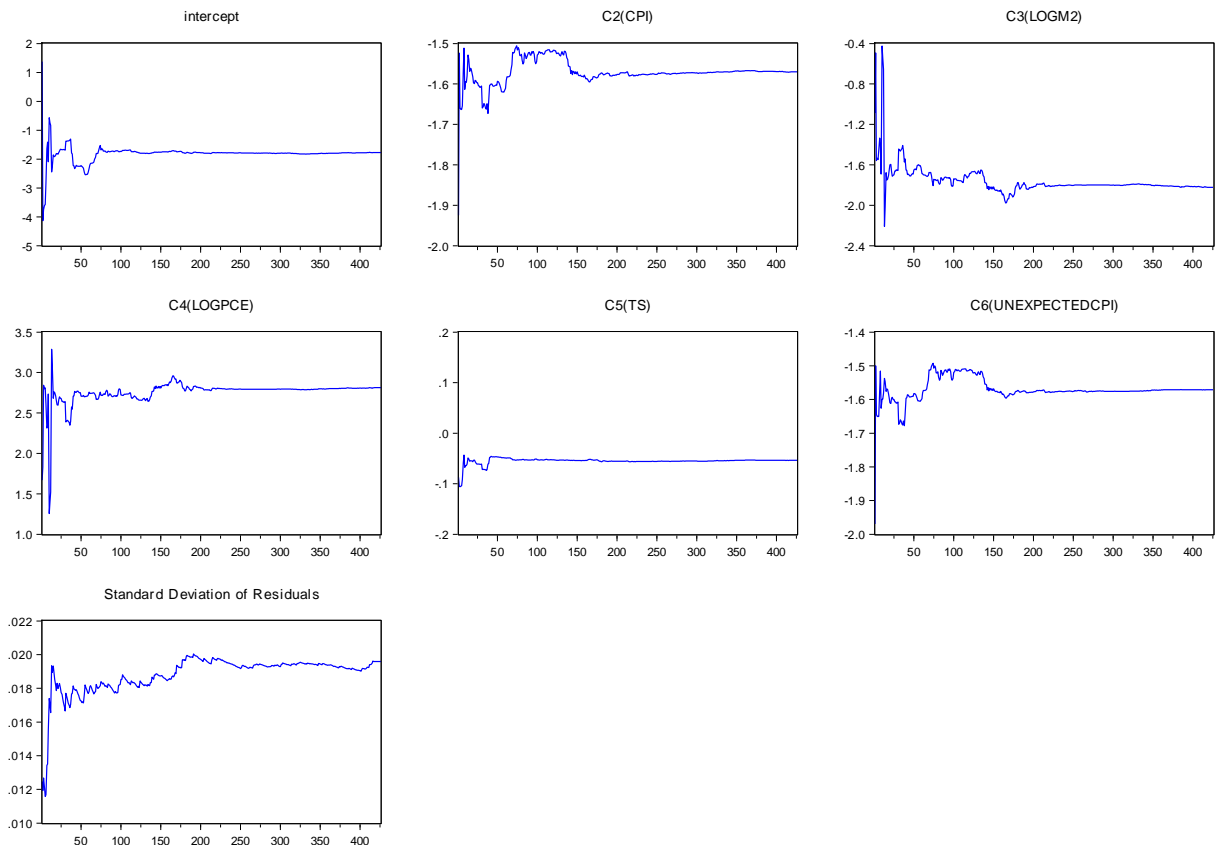
<i>Variable</i>	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>Prob.</i>
<i>C</i>	168.7441	68.64271	2.458296	0.0144
<i>CPI</i>	-354.2639	102.5453	-3.454705	0.0006
<i>LOGM2</i>	-0.318230	0.021483	-14.81288	0.0000
<i>LOGPCE</i>	0.384082	0.017696	21.70389	0.0000
<i>TS</i>	-53.55736	8.808336	-6.080304	0.0000
<i>UNEXPECTEDCPI</i>	-367.0036	103.4297	-3.548337	0.0004

Refer to graph 14 and 15 for simulation of these results. Also, before doing the same for probit estimation, consider the standard deviation of the simulation results. There is something happening after around 225 observations. In any event something clearly something happened around 1995. Taken together it suggests a breakpoint in the sample. It is

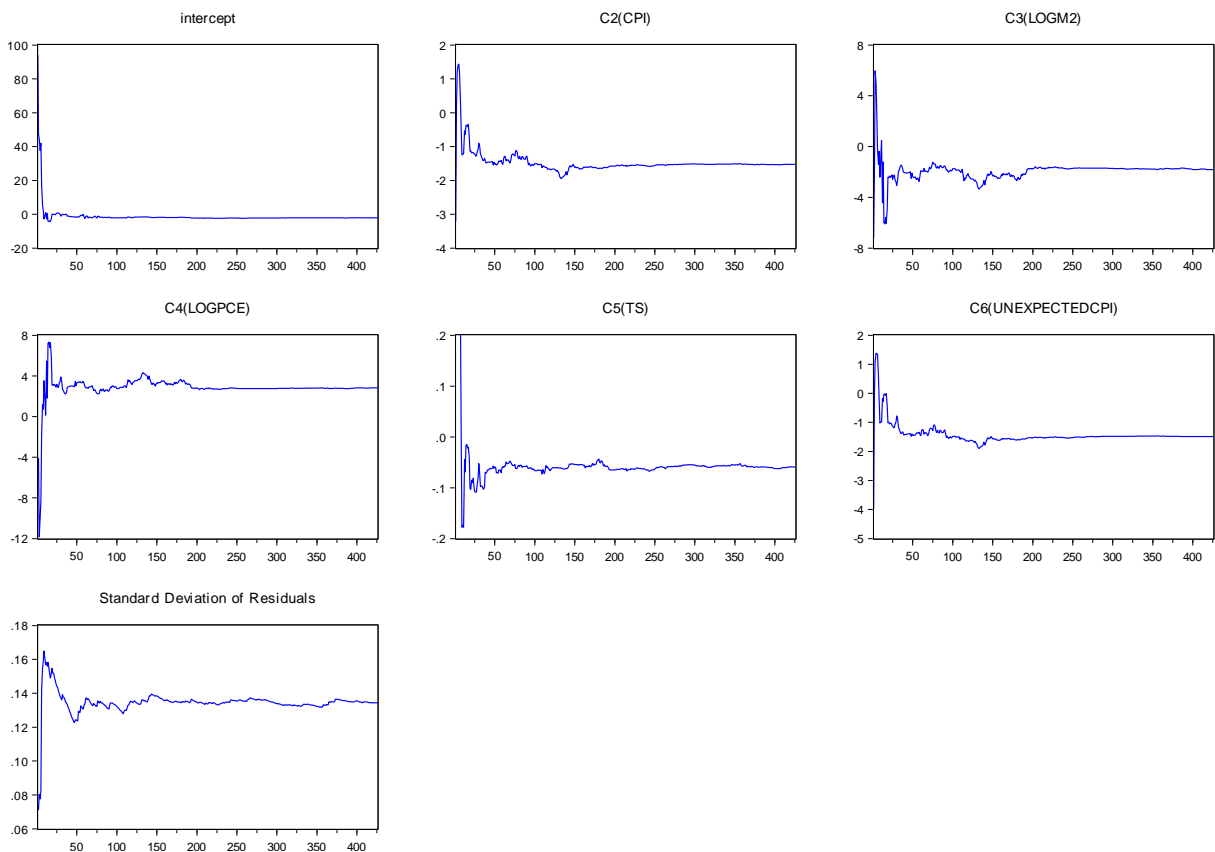
evident that after around 150-200 observations the coefficients have settled down. More observations would have been welcome.

Taken together graphs 14 and 15 gives some confidence that the coefficients may be consistently estimated. Some convergence is achieved both with normal and model errors. To ease comparison the graphs for normal and model errors are plotted on the same page.

Graph 14. Consistency Simulation of OLS Parameter Estimation (With Model Errors) eq. 18



Graph 15. Consistency Simulation of OLS Parameter Estimation (with Normal Errors) eq. 18

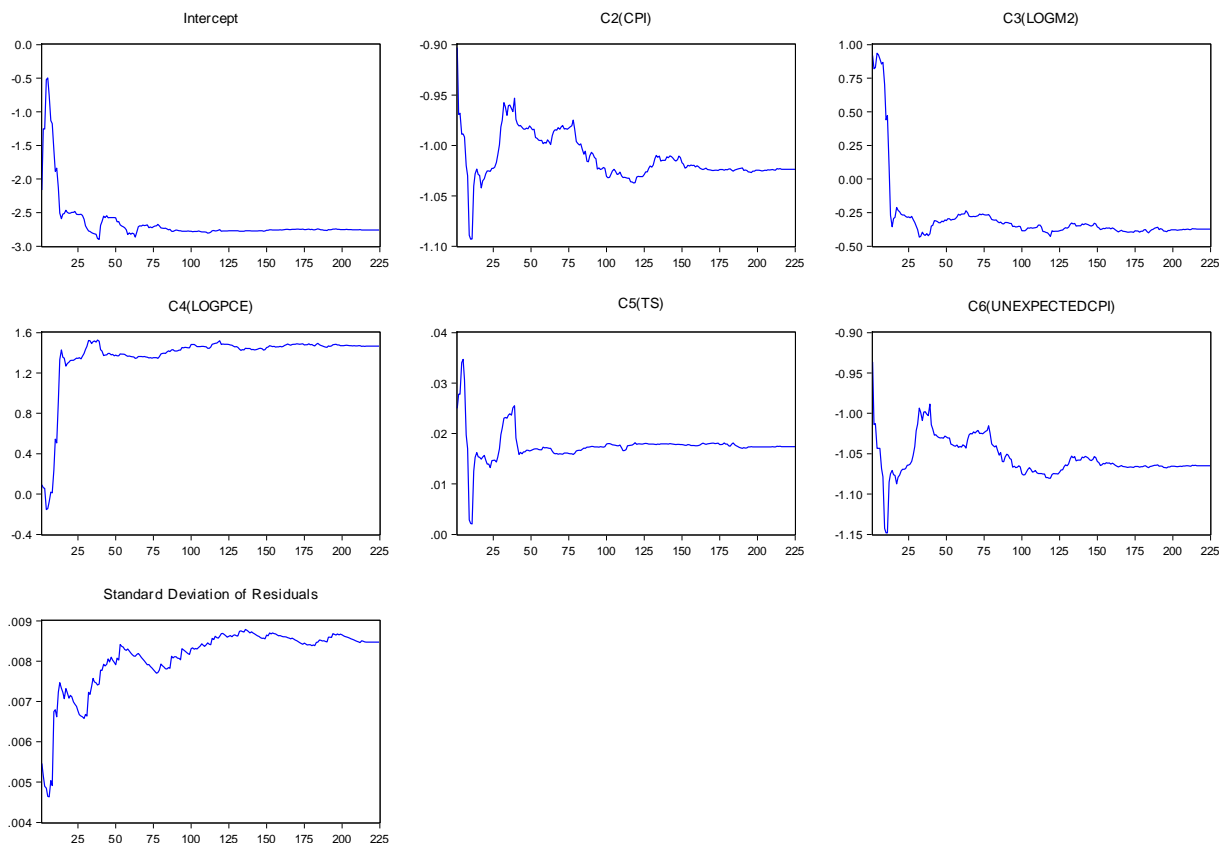


Repeating the previous equation for the two subsamples the following is obtained.

Table 5. OLS estimation first subsample 1976M06-1995M01

<i>Variable</i>	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>Prob.</i>
<i>C</i>	59.66000	16.10719	3.703937	0.0003
<i>CPI</i>	-157.5540	20.18341	-7.806112	0.0000
<i>LOGM2</i>	-0.064983	0.011095	-5.856902	0.0000
<i>LOGPCE</i>	0.149484	0.008040	18.59358	0.0000
<i>TS</i>	4.379042	2.252581	1.944011	0.0532
<i>UNEXPECTEDCPI</i>	-171.6594	19.36436	-8.864705	0.0000

Graph 16. OLS Estimation of Subsample 1976M06-1995M01 OLS eq.18 model errors



Graph 17. OLS Estimation of Subsample 1976M06-1995M01 OLS eq.18 Normal errors

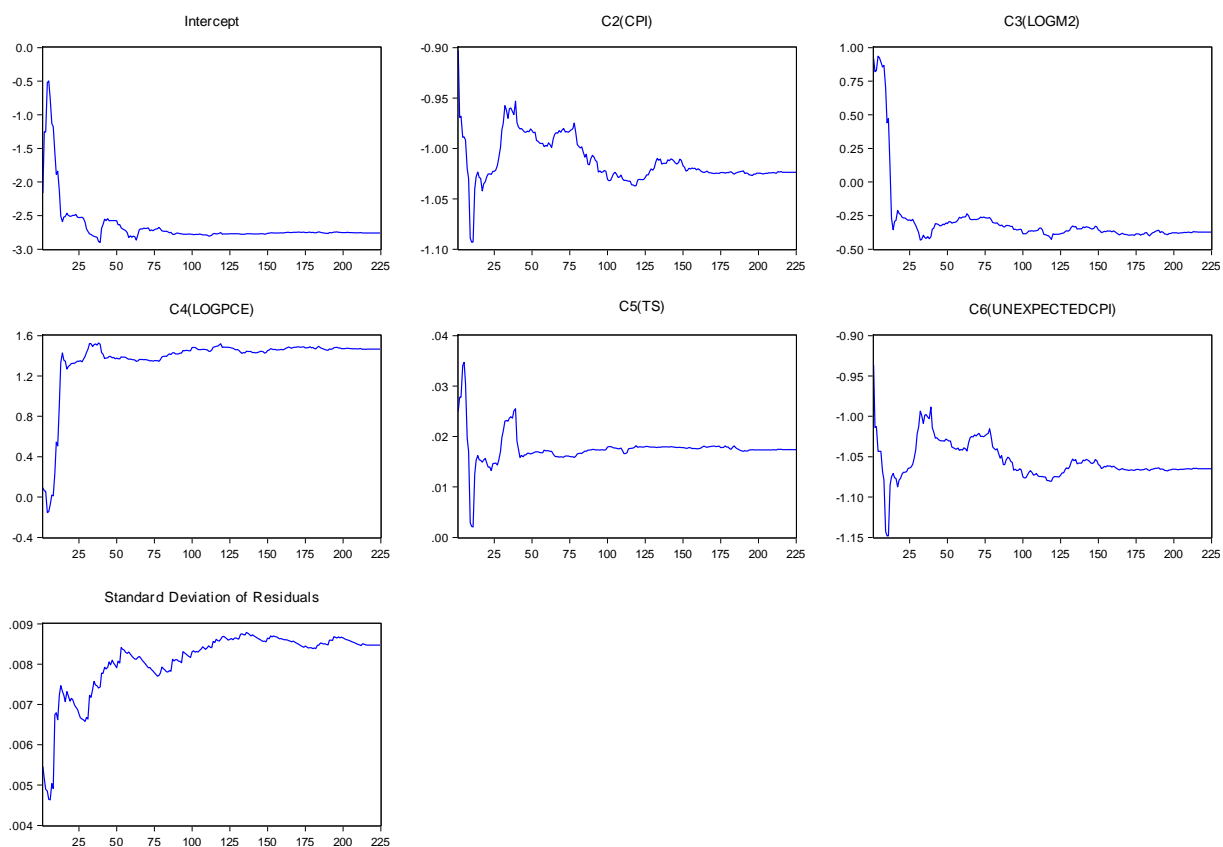
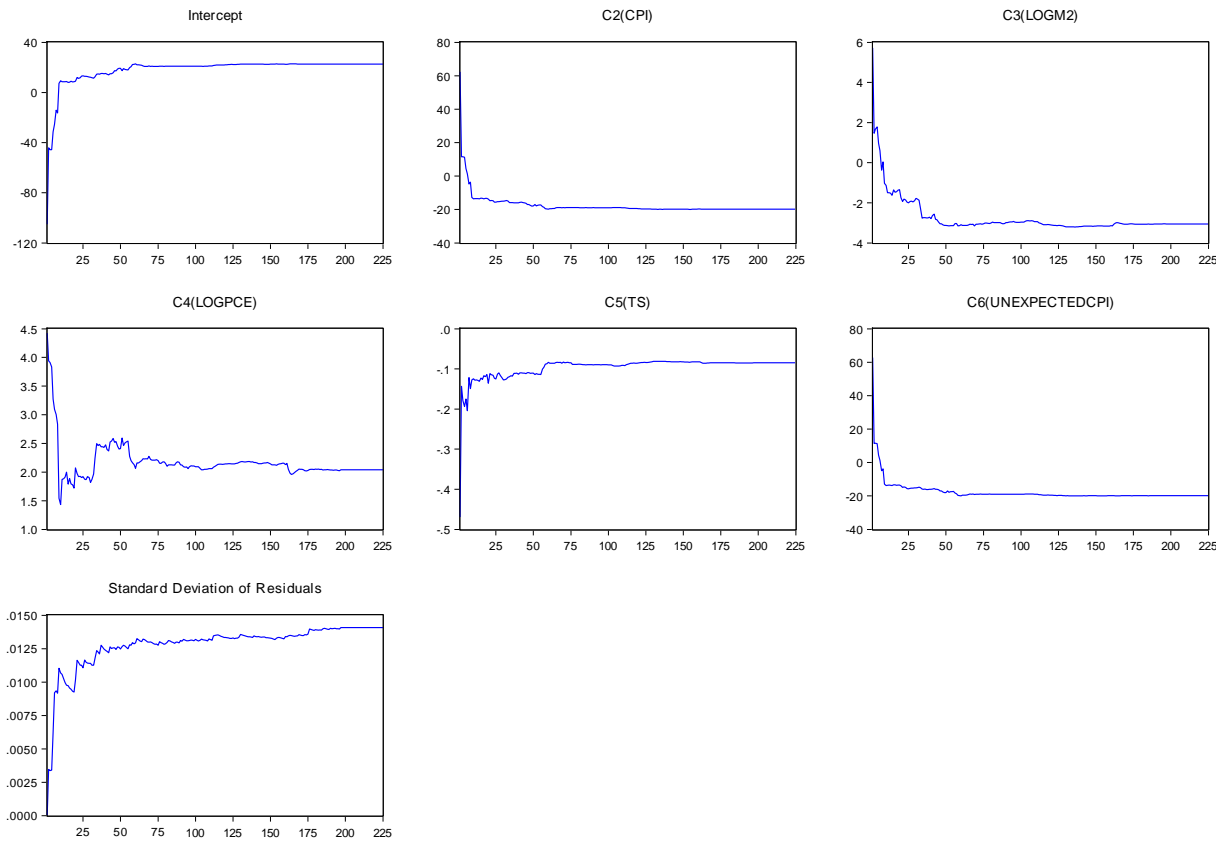


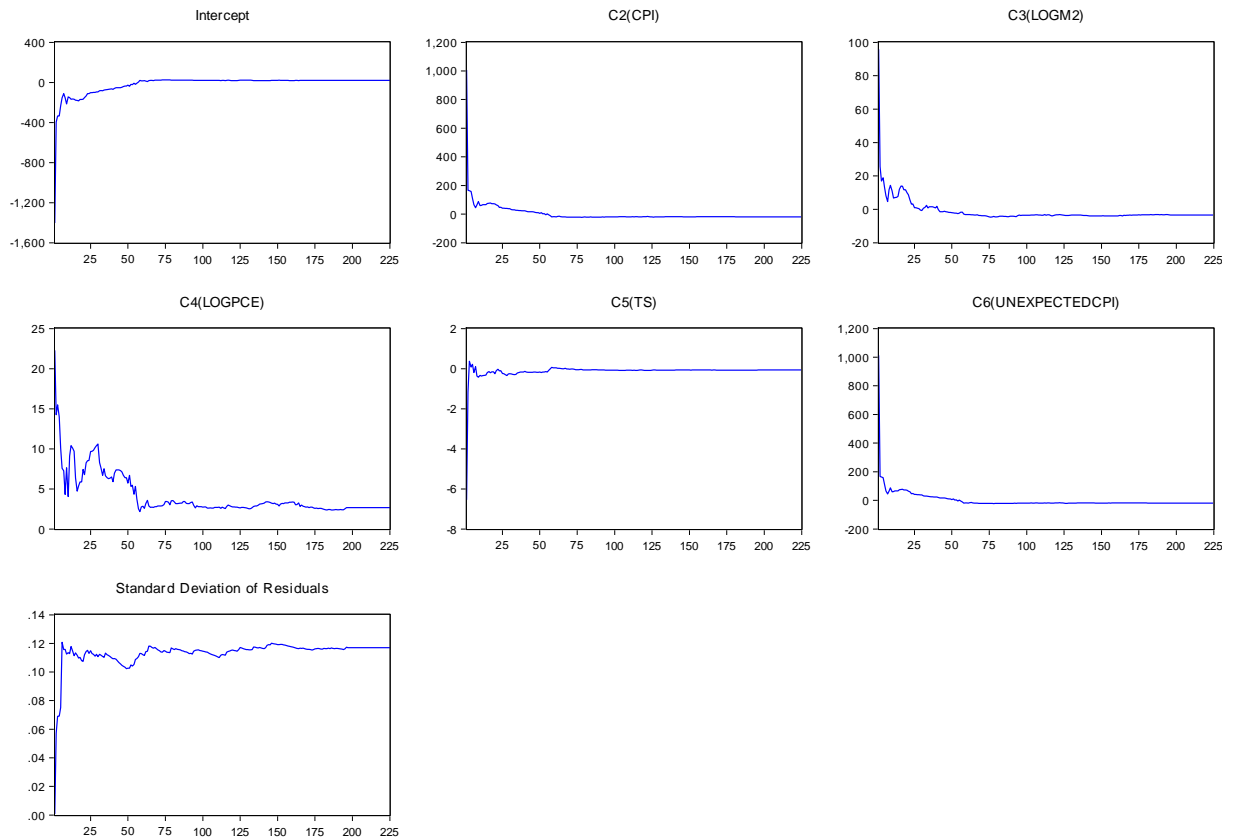
Table 6. OLS estimation second subsample 1995M2-2011M11

<i>Variable</i>	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>Prob.</i>
<i>C</i>	6528.685	714.5111	9.137276	0.0000
<i>CPI</i>	-12820.85	1408.205	-9.104398	0.0000
<i>LOGM2</i>	-0.217653	0.039600	-5.496230	0.0000
<i>LOGPCE</i>	0.103020	0.045097	2.284425	0.0234
<i>TS</i>	-132.2990	15.77435	-8.386973	0.0000
<i>UNEXPECTEDCPI</i>	-12883.81	1411.443	-9.128111	0.0000

Graph 18. OLS Estimation of Subsample 1995M02-2011M11 OLS eq.18 Model Errors



Graph 19. OLS Estimation of Subsample 1995M02-2011M11 OLS eq.18 Normal Errors



The error series from both subsamples are normally distributed which provides reasonable grounds for expecting consistency.

Table 7. OLS Residuals from each Sub-Sample Estimation

	<i>JB</i>	<i>Prob.</i>
<i>RESIDOLS3</i> <i>1976M06 1995M01</i>	<i>0.419510</i>	<i>0.810783</i>
<i>RESIDOLS4</i> <i>1995M02 2011M11</i>	<i>0.903859</i>	<i>0.636399</i>

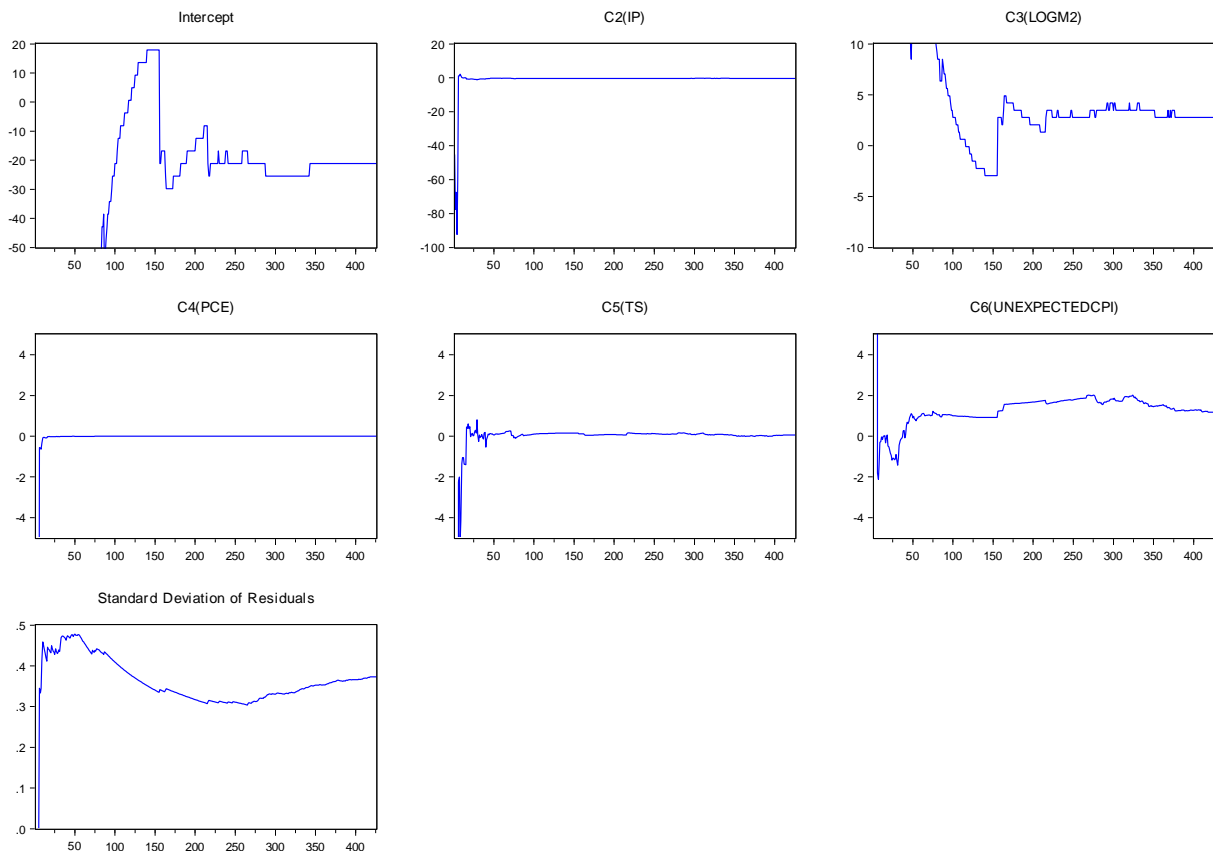
Binary estimation fares little better. See graphs 20 & 21 for consistency simulation results. The perfect classifier problem manifested itself for the variables OIL and CPI. These two were removed for that reason. Possibly the sample size of 426 observations is too small. M2 was quite consistently estimated but is so close to zero as to be insignificant. Unexpected price inflation is acceptable at the 10% significance level. The estimation consistency of UCPI was, however, disappointing. It is interesting to see how the parameter estimates behave at different sizes of the sample. Several of the variables are different from zero at certain sample sizes.

Table 8. Probit Estimation Results

<i>Variable</i>	<i>Coefficient</i>	<i>Std. Error</i>	<i>z-Statistic</i>	<i>Prob.</i>
<i>C</i>	<i>-5.989230</i>	<i>3.538237</i>	<i>-1.692716</i>	<i>0.0905</i>
<i>IP</i>	<i>-0.052784</i>	<i>0.091071</i>	<i>-0.579592</i>	<i>0.5622</i>
<i>LOGM2</i>	<i>0.866266</i>	<i>0.494693</i>	<i>1.751119</i>	<i>0.0799</i>
<i>LOGPCE</i>	<i>-0.000164</i>	<i>9.52E-05</i>	<i>-1.727032</i>	<i>0.0842</i>
<i>TS</i>	<i>-0.012590</i>	<i>0.074463</i>	<i>-0.169083</i>	<i>0.8657</i>
<i>UNEXPECTEDCPI</i>	<i>0.254046</i>	<i>0.207077</i>	<i>1.226815</i>	<i>0.2199</i>

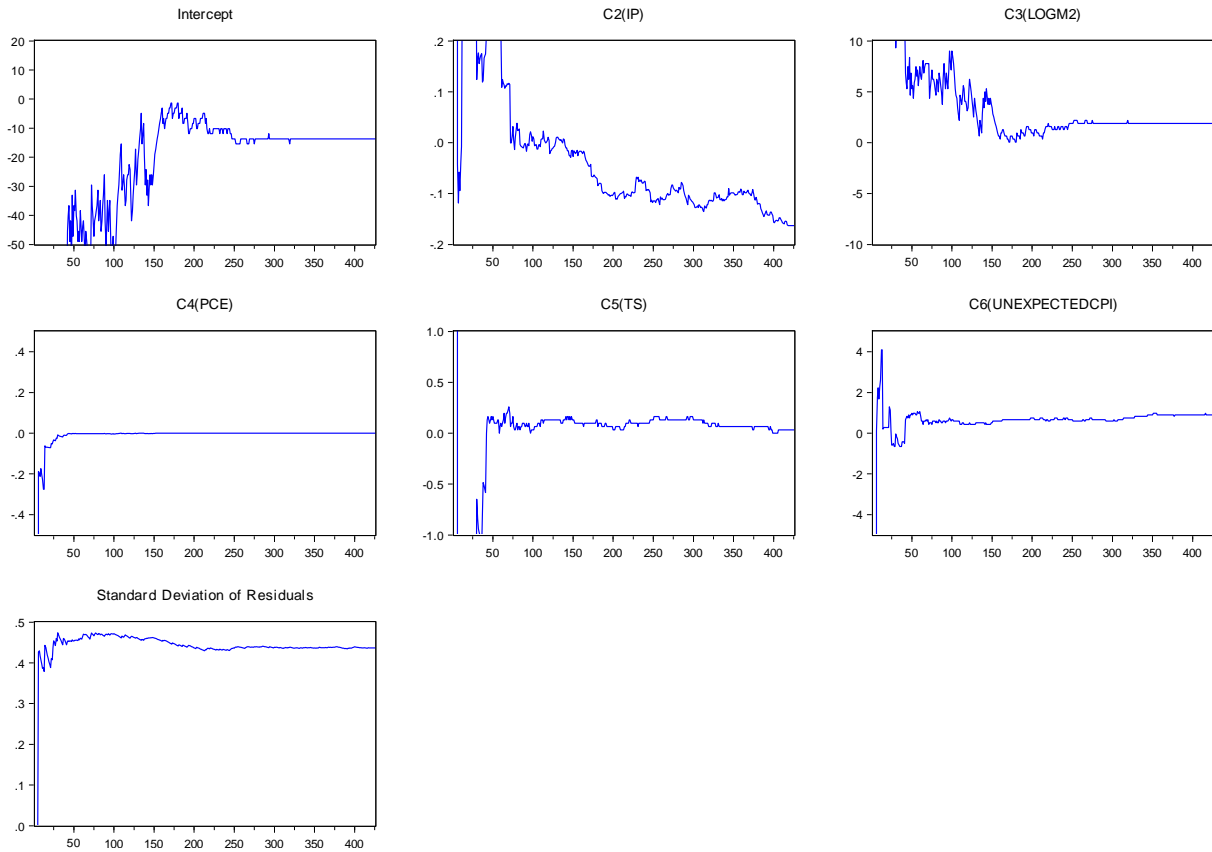
This model does not fare well with the LR test having an associated probability of 0.20. This means that it is possible that the unconditional mean of the dependent variable is the best estimate of each periods conditional expectation. If so all coefficients are zero except the aforementioned constant.

Graph 20. Consistency Simulation of Initial Probit Estimation (with Model Errors)



It seems as if money supply and unexpectedcpi converge whereas the other variables are zero. The inability of the standard deviations to settle down is worrying since large fluctuations will cause a loss of confidence in the cumulative likelihood estimates as the sample increases.

Graph 21. Consistency Simulation of Initial Probit Estimation (with Normal Errors)



In graph 21 it seems money supply actually converges to some value, with normal errors. Probit coefficient estimates are a little tricky since the likelihood of observing either binary outcome depends on the level of the explanatory variable. The coefficient is therefore not to be confused with an average effect. Instead, the interpretation of the coefficients obey the following logic: denoting the likelihood of observing a rise in the stock market by P yields

$$\begin{aligned}
 P_t &\equiv E(y_t | \Omega_t) = F(X_t \hat{\beta}) \\
 &= F(-12.393463 + 0.022406 * IP + 1.732623 \\
 &\quad * LOGM2 - 0.000394 * LOGPCE - 0.060175 * TS \\
 &\quad - 0.253299 * UNEXPECTEDCPI)
 \end{aligned} \tag{29}$$

where $F(z)$ is the cumulative standard normal distribution evaluated at z . The effect of a one unit increase in money supply is different if this probability is evaluated with the other variables at zero or whether it is evaluated with them at their sample means.

$$\begin{aligned}
 &F(-12.393463 + 0.022406 * 0.18 + 1.732623 * 8.17 - 0.000394 \\
 &\quad * 5237 - 0.060175 * 0.87 - 0.253299 * 0.15) \\
 &= \mathbf{0.35}
 \end{aligned} \tag{30}$$

When the function is evaluated at the sample means there is a 35% chance of observing a rise in the stock market. If all variables except LOGM2 are held at zero the probability of observing a one probability for LOGM2 may be recorded, which is 96%. Graph 22 shows the change in probability of observing a rise in the stock market as LOGM2 increases by whatever it increases by from one period to the next. It is important to remember that this is no longer ordered chronologically but merely a change of probability as a function of *chromatically* ascending LOGM2. What is immediately visible is how small the change in probability is. Also striking is that as the level of M2 gets larger the increase in probability tapers off quickly. A cautious implication is that initial expansions of the money supply yield the greatest likelihood of increasing the stock. The effect is clear in the plotted probabilities but the model suffers certain drawbacks so careful conclusions are in order. These are calculated from the bootstrapped parameter values.

Graph 22. Change in Probability of Observing a rise in the stock market as LOGM2 increases chromatically by each interval in the data.

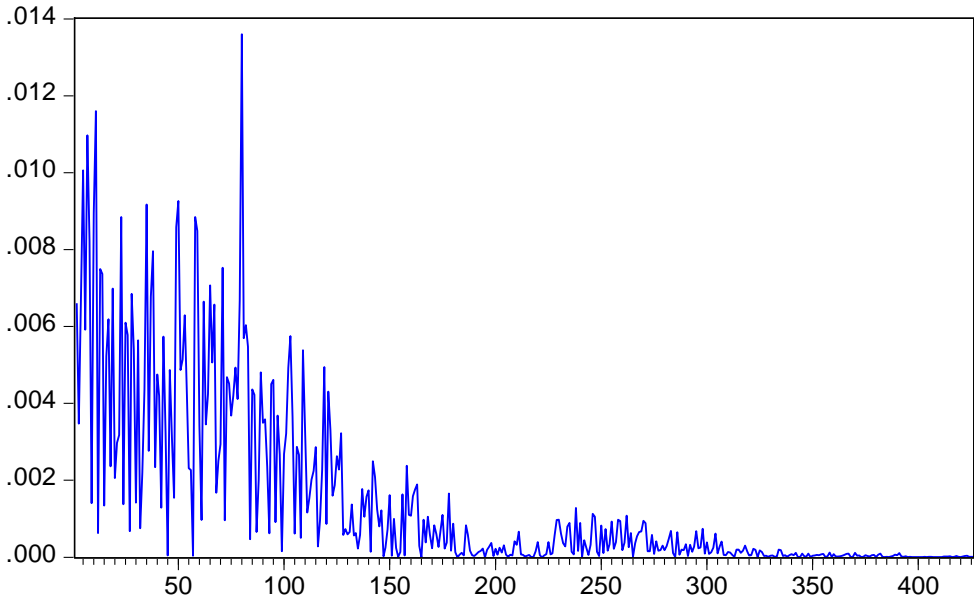


Table 9. Results of Bootstrap Bias Reduction Procedure

Variable	$\frac{1}{B} \sum_{j=1}^B \hat{\beta}_j$	$\frac{1}{B} \sum_{j=1}^B \hat{\beta}_j^* - \hat{\beta}$	$\hat{\beta}$	$\hat{\beta}_{bc}$
Intercept	0.415003	6.404233	-5.989230	-12.393463
IP	-0.127974	-0.075190	-0.052784	0.022406
LOGM2	-0.000091	-0.866357	0.866266	1.732623
LOGPCE	0.000066	0.000230	-0.000164	-0.000394
TS	0.034995	0.047585	-0.012590	-0.060175
UNEXPECTEDCPI	0.761391	0.507345	0.254046	-0.253299

The results of reducing the bias shows how important this procedures is since the signs change for some variables. It means, *ceteris paribus*, that it is not certain whether an increase/decrease can be expected once bias-reduction is considered.

7. Conclusion (Implications)

In a world where the conceptual underpinnings of risk and return have been heavily undermined by monetary policy, the need for the individual investor to think creatively about protecting his purchasing power has become acute. Expansionist monetary actions have also reduced the ability of well-run firms to be rewarded in the marketplace. The incremental credit market distortions over the past 40-odd years are now coming to a head with true market forces. This is behind the correlation and volatility in the markets and the inability of countries to jumpstart their economies. The fact that the USA has experienced zero real growth since 2007 despite massive fiscal and monetary stimulus should signal that something is not right. Before applying any normal valuation methods the investor needs to let the index find its “normal” level, free of central bank interference. Further quantitative easing will lift the market. However, the effect of monetary easing comes at the expense of the purchasing power of the dollar. Since almost all countries inflate in tandem with the US this development is most worrisome and highlights the weakness of a global dollar based monetary arrangement.

Implication 1. QE will surely lift the market but at the expense of currency debasement.

Implication 2. Future research must incorporate monetary actions into asset pricing.

An extreme example is the Zimbabwean stock market which certainly witnessed an exponential increase in nominal stock values, accompanied by the destruction of things of real values.

Figure 1. Zimbabwe Industrial Index



The relative speeds of increase in goods prices versus asset prices is a key component. It makes it very difficult to know what real gains are realized in the stock market. This essay represents an attempt to evaluate the ability of variables previously used to explain the cross-section of expected returns to explain the common movements in stocks.

Basic log-log OLS estimations indicate a 1.5% increase in the S&P for every percentage point increase in the money supply. The issue of the relation being the result of some underlying growth factor is noted. On the other hand, real US GDP has not grown in four years indicating this is a smaller problem at the end of the sample. The majority of the monetary expansion took place toward the end of the sample.

In probit modeling the CRR macroeconomic variables do not predict a rise or fall in the stock market any better than the unconditional expectation of the binary variable, which is 0.6.

However, future probit modeling should focus on M2 and UCPI since there is at least some minor indication that these can be estimated consistently.

There are two things that are important to remember in connection to this. Firstly, M2 does not capture all relevant monetary expansion. Secondly, theory suggest a stronger connection

between money supply and the stock market. This means that at some level money supply becomes the most important factor for common stock movements.

The consistency simulation shows clear indication of a breakpoint in the sample around 1995. Future research should explore this further.

8. Appendix

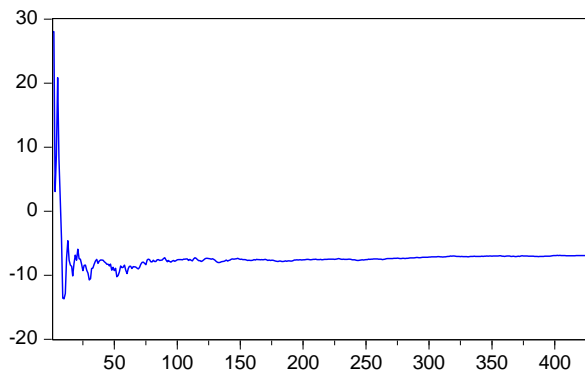
Table 10. Correlation Matrix of the Explanatory Variables

	CPI	IP	M2	OIL	PCE	TS	UNEXPECTEDCPI
CPI	1						
IP	0.031931	1					
M2	-0.35427	-0.10726	1				
OIL	-0.05151	-0.16507	0.764622	1			
PCE	-0.36239	-0.0983	0.987782	0.722901	1		
TS	-0.35754	0.01137	0.489498	0.280688	0.429408	1	
UNEXPECTEDCPI	-0.93976	-0.04477	0.081123	-0.0846	0.077237	0.214261	1

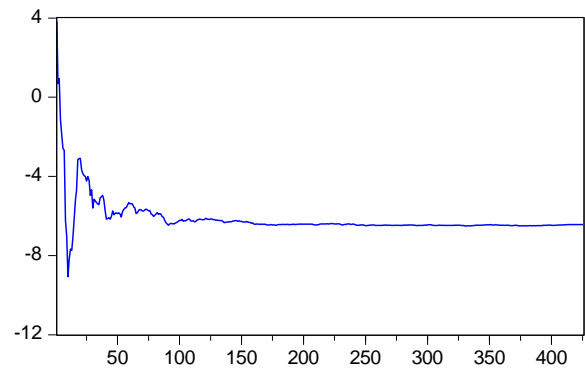
Table 11 Components of True Money Supply (TMS)

OCDCBN	Other Checkable Deposits at Commercial Banks (OCDCBN), Billions of Dollars, Monthly, Not Seasonally Adjusted
DDDFCBNS	Demand Deposits Due to Foreign Commercial Banks (DDDFCBNS), Billions of Dollars, Monthly, Not Seasonally Adjusted
DDDFOINS	Demand Deposits Due to Foreign Official Institutions (DDDFOINS), Billions of Dollars, Monthly, Not Seasonally Adjusted
USGDCB	U.S. Government Demand Deposits at Commercial Banks (USGDCB), Billions of Dollars, Monthly, Not Seasonally Adjusted
WTREGEN	Deposits with Federal Reserve Banks, other than Reserve Balances: U.S. Treasury, General Account (WTREGEN), Billions of Dollars, Monthly, Not Seasonally Adjusted
NBCB	U.S. Government Note Balances at Depository Institutions (NBCB), Billions of Dollars, Monthly, Not Seasonally Adjusted
CURRNS	Currency Component of M1 (CURRNS), Billions of Dollars, Monthly, Not Seasonally Adjusted
DEMDEPNS	Demand Deposits at Commercial Banks (DEMDEPNS), Billions of Dollars, Monthly, Not Seasonally Adjusted
OCDTIN	Other Checkable Deposits at Thrift Institutions (OCDTIN), Billions of Dollars, Monthly, Not Seasonally Adjusted
SVGCBNS	Savings Deposits at Commercial Banks (SVGCBNS), Billions of Dollars, Monthly, Not Seasonally Adjusted
SVGTNS	Savings Deposits at Thrift Institutions (SVGTNS), Billions of Dollars, Monthly, Not Seasonally Adjusted

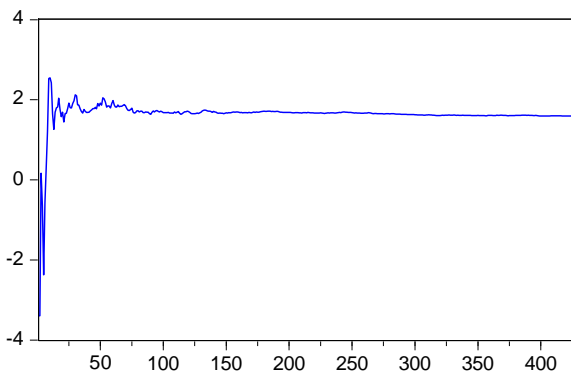
Graph 23. Simulation of Equation 17 with Normal Errors
Intercept



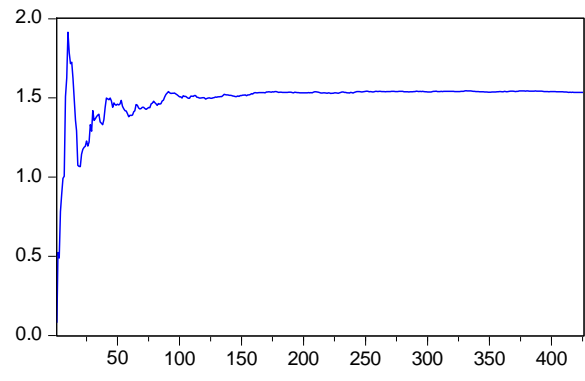
Graph 24. Simulation of OLS equation 17 with Model Errors
Intercept



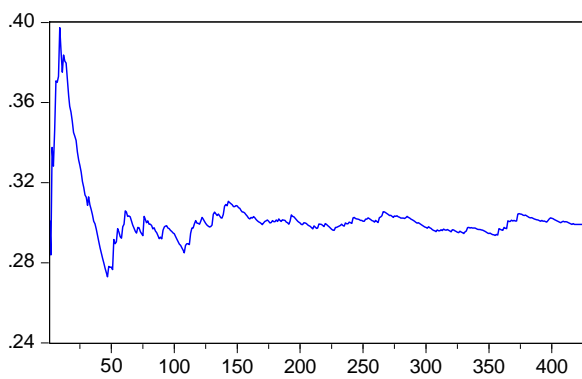
C2 (LOGM2)



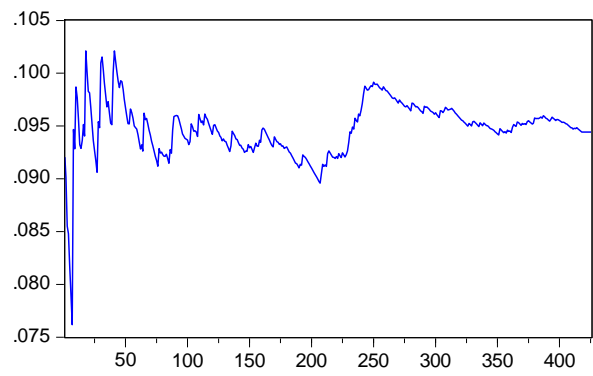
C2(LOGM2)



Standard Deviation of Residuals



Standard Deviation of Residuals



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