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Finance and the Business Cycle: a Kalman Filter Approach with Markov Switching*

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Abstract

This paper combines two popular econometric tools, the dynamic factor model and the Markov-Switching model, to consider three elements of the financial system and their contribution to US business cycles over the past four decades. Dynamic factor models identify a composite factor index for each financial element, and using Markov-switching models by Hamilton (1989) and Filardo (1994), this paper examines each element's index as a possible contributor to business cycles. This reexamination of the finance-business cycle link provides results that support the effect of stock market movements on business cycles.

Keywords: Dynamic Factor Model; Markov-Switching; Business Cycles
JEL Classification: C22, E32, E44

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1. Introduction

Hypotheses abound to explain the ups and downs of the economy, with modern macroeconomics focusing largely on exogenous factors, such as technology shocks, and policy mistakes to explain business cycles. However recent events have brought back the notion of endogenous factors to explain business cycle fluctuations. With recent recessions such as the 2001 US recession as well as the persistent Japanese stagnation, financial factors in particular have received a good deal of interest.

In the case of the US, discussion has centered around the run up of NASDAQ, the overvaluation of the stock market in general, and the bursting of the stock market bubble. In Japan, financial factors have also been blamed for the start of the country's ongoing troubles, with attention centring on Japan's own apparent stock market bubble as well as real estate bubble.

As a result of the talk surrounding these recessions, this paper reconsiders the role of finance in business cycles by examining US business cycles since 1960. This paper extends the existing empirical literature on the finance-business cycle link by combining two popular econometric tools, the dynamic factor model and the Markov-Switching model, to investigate whether three financial factors often cited in the existing literature (debt, money, stock market) have contributed to US business cycles over the past four decades. More specifically, this paper develops three composite measures, one for each of the three areas of the US financial market, using the dynamic factor model. A composite measure is developed for the stock market, as well as one for debt, and another for money.

Further, rather than relying on a single technique to examine the finance-business cycle link, whether a given financial market segment contributes to business cycles is based on the body of evidence resulting from the results of three different empirical techniques. First, vector autoregressive models and Granger causality tests are used to test causality between the financial measures and real GDP. As well, Hamilton's (1989) Markov-switching model is used to examine the timing of regime switching of each composite measure relative to switching in GDP regimes. Lastly, Filardo's (1994) time varying transition probability model is used to test whether each financial composite measure helps contribute to business cycle turning points.

Our results indicate that the stock market has strong robust effects on real activity, with weaker evidence pointing to a role for debt and money in business cycles. With the recent 2001 US recession included in the sample, these results also provide support to those who point to the stock market bubble as one of the ingredients that lead to the recent US economic downturn.

The rest of the paper proceeds as follows. Section 2 details some of the existing literature in this area, while section 3 provides an overview of the empirical methods used in this study. Section 4 outlines the data, as well as our approach to developing composite measures for the respective financial market segments. The empirical results are also detailed. Section 5 concludes.

2. Financial Factors as Sources of Business Cycles: An Overview of the Literature

The notion that financial market activity may result in business cycle fluctuations has been well researched in the business cycle literature. A natural area of study of course is the role of finance in the Great Depression. Bernanke (1983) considers the role of financial factors in the Great Depression, arguing that the financial crisis of 1930-1933, over and above its effects via the money supply, had real economic effects for the US largely due to a reduction in credit intermediation by the financial system. The importance of credit intermediation is tied to incomplete financial markets and the requirement of market making and information gathering by financial firms in order to link certain classes of borrowers and lenders. Bernanke argues the events of the early 1930s reduced the financial sector’s ability to perform this intermediation function, reducing access to credit and exacerbating the downturn into a full blown depression (Bernanke, 1983, p. 257). More recently, Coe (2002) uses a regime-switching approach to consider the timing of financial events and their importance during the Great Depression. Using this approach Coe argues that rather than the stock market crash of 1929, the first bank panic of October 1930 served as the beginning of the US financial crisis. As well, using lagged conditional probabilities of financial crisis as explanatory variables for growth he shows the crisis had real effects for the economy beyond any through the monetary channel, lending support to Bernanke's earlier conclusion.

Research on money's role in business cycles has fallen out of favour of late, however there was a time when it received a good deal of attention. Friedman and Schwartz's 1963 book represents a classic in the economics literature, as well as providing a basis of the monetarist view of business cycles. Friedman and Schwartz (1963b) examine the role of money in business cycles from 1867-1960, showing that the stock of money is cyclical in nature and shares a number of common features with business cycles. For example its rate of change reaches its peak before the economy's peak and similarly its trough before the economy's trough; the amplitude of the movement of money is inline with the amplitude of movements in the economy; and the stock of money is more closely associated over the business cycle with income than is investment or autonomous expenditure (Friedman and Schwartz, 1963b, p. 63). The authors conclude that for large changes in the rate of change of money income, large changes in the rate of change of money prove to be a necessary and sufficient condition. Sims (1972) focus is on Granger causality, but using money and output as his example, finds evidence that also supports the role of money in GDP. Eichenbaum and Singleton (1986) using Granger causality tests find in contrast that when combined with additional explanatory variables, money does not appear to Granger cause output over the postwar period in the US.

More recently, focus has shifted from money to financial factors more broadly in business cycles. Gertler and Hubbard (1988) focus on capital market imperfections and develop both a theoretical model as well as use empirical evidence to show that capital market frictions, which they detail are especially binding for small firms, become more significant during downturns, impacting investment by smaller firms and ultimately the severity of recessions. Friedman and Laibson (1989) focus on the stock market in economic fluctuations, with the idea that large stock price variation may affect macroeconomic activity. The empirical results for the postwar US are interpreted as supportive of the notion that stock market price fluctuations may result in real economic effects, and are tied to a story where with the passage of time since a financial crisis, investors tend to become less risk averse, opening themselves up to increasingly exposed positions such that extreme movements in stock prices may bring about a downturn in real economic activity.

Perry and Schultze (1993) consider the postwar period for the US, with particular interest in explaining the 1990-1991 recession. They find that while fiscal and monetary policies prove to be important for earlier recessions, financial factors prove to be important for the 1990-1991 recession. A shortage of bank capital is attributed to playing a role in the economic slowdown of 1989, while once the slow down occurred, increased corporate debt burdens built up during the 1980s made it difficult for firms to access capital and increased the potential of bankruptcy, thus reducing firms' engagement in real economic activity that required an increase in debt liabilities (Perry and Schultze, 1993, p. 192).

Rajan (1994) develops a theoretical model that produces low frequency business cycles driven by supply-side bank credit policies, and provides evidence in support of this theory using the case of the early 1990s New England Bank crisis. Rajan's model is based on the notion that bank managers are concerned with their reputation in the market, where the market is only able to observe bank earnings. As a result, management has the incentive to manipulate current earnings in order to shape their reputation. The key to business cycles is that managers manipulate earnings through altering their credit policy. Therefore when the probability of an adverse shock to the borrowing sector is low, banks tend to employ an overly liberal lending policy. This tends to lead to overinvestment as a result of the bank trying to convince the market of its ability. Importantly, this increases the probability of an adverse shock to the borrowing sector. Banks feel comfortable with this liberal policy, as when an adverse shock finally occurs, they know the market will tend to be forgiving of its bad performance as the entire sector slumps. Similarly, when times are bad and earnings are likely to be low due to a troubled borrowing sector, banks coordinate to overly tighten access to credit. Thus this behaviour tends to intensify expansions and accelerate contractions.

Brunner and Kamin (1998) investigate the role of financial factors in the recent Japanese recession (1990-1993 specifically), focusing particularly on bank lending and equity prices. Estimating an econometric model similar to Bernanke and Blinder (1988) which includes a role for financial factors (bank loans and equity capital), the authors find their proxies for finance entered significantly in behavioural equations for loan standards, loan demand, and aggregate demand. Further, by testing the stability of the model for the 1990-1993 period as well as using the model to generate dynamic forecasts for all the 1990-1993 model variables and subsequently forecast error decomposition, the authors consider finance in the 1990-1993 recession, finding financial factors did play a role. The authors argue falling asset prices led to increased loan standards by banks with a large subsequent reduction in the supply of loans and GDP. As well, while traditional wealth effects cannot be ruled out, the fall in asset prices also saw firms and households reduce their demand for loans and goods. Coupled together, these contributed to the resulting reduction in economic activity.

Basu and Taylor (1999) discuss various alternative business cycle models, covering such standards as the Real Business Cycle model, monetary shocks, New Keynesian models, and old Keynesian models, and consider the empirical evidence for these various models. Basu and Taylor employ a panel of fifteen countries since 1870, focusing on four distinct periods-1870-1914, 1919-1939, 1945-1971, early 1970s-present day-to look for regularities in the data in order to narrow down the set of feasible business cycle models. Their evidence proves supportive of the non-neutrality of money claim, though Basu and Taylor note its transmission mechanism remains an open question. As well they also raise the issue of international linkages in business cycles and the need for more work in this area.

Zarnowitz (1999) takes a broad theoretical and historical approach to the causes of business cycles. With the view that economics current emphasis on exogenous shocks and policy mistakes is overdone, Zarnowitz develops a theory that focuses on endogenous variables as the cause of business cycles. His theory centres on the role of expectations, and the interaction of profits, investment, credit and financial markets, where their ups and downs reinforce one another, and serve as the “enduring core of business cycles” (Zarnowitz, 1999, p. 73). An important player in this is an increasing stock market which he argues can feed expansions in a number of ways: by reducing the cost of capital, leading to increased investment; through the wealth effect which increases consumption; and by channelling some of the money growth into equities rather than goods and services, thereby reducing inflationary pressures in the economy.

Investment of course is key here as rising stock prices lead to increased risky investments and malinvestment as the market seeks higher yields. This poor investment particularly becomes an issue when growth starts to slow and optimism fades. As Zarnowitz details a number of scenarios can lead an expose an economy to a recession. With slowing growth, profits and investment slows, large business and financial failures can no longer be pushed to the side, credit markets may become risk averse leading to a credit crunch, and equity prices may fall as corporate profits fall. Individually these may not be a problem for the economy, but in combination may prove problematic.

3. Empirical Methodology

3.1 Dynamic Factor Model

A contribution of this paper is that rather than relying on a single variable for each segment of the financial market, we use the information provided by a number of financial variables within a given segment to develop composite measures for the respective financial market segment. We use a dynamic factor model with the Kalman filter based on Stock and Watson (1991)[1].

The dynamic factor model in this paper rests on the notion that the comovements of the individual financial variables in a given financial market segment have a common underlying source which can be captured by a single unobservable variable. This allows us to abstract from "noisy" variables to capture a common underlying factor with which to examine the finance-business cycle relationship. The dynamic factor model is based on deviation from means of the following general form:

$$\Delta y_{it} = \gamma_i \Delta c_t + e_{it}, \qquad i = 1,2,3,4 \tag{1}$$

$$\Delta c_t = \phi_1 \Delta c_{t-1} + \phi_2 \Delta c_{t-2} + w_t, \qquad w_t \sim i.i.d.N(0,1)$$

$$e_{it} = \psi_{i1} e_{i,t-1} + \psi_{i2} e_{i,t-2} + \varepsilon_{it}, \qquad \varepsilon_{it} \sim i.i.d.N(0, \sigma_i^2), \qquad i = 1,2,3,4$$

where $\Delta y_{it} = \Delta Y_{it} - \Delta \overline{Y}_i$ and $\Delta c_t = \Delta C_t - \delta$, Y_{it} represents the financial variable i for each respective financial market segment at time t, C_t is the unobserved common

[1] Chapter three of Kim and Nelson (1999) provides a nice overview of the Kalman filter.

component which underlies the comovement of the financial variables for a given financial market segment, and σ_w^2 is set to 1 in order to normalize the common component.

3.2 State Dependent Markov-Switching Model

Numerous time series models exist to analyze the behaviour of macroeconomic variables, however many of them are limited by their linear form. To highlight this limitation, an example commonly cited, and relevant for our paper, is GDP, which appears to exhibit different dynamics during expansions versus recessions. With a linear model, this asymmetry is unlikely to be captured. The Markov switching model however is well suited for this type of dynamics as it permits the switching of regimes and allows the model to better capture non-linear dynamics inherent in the series. For our purposes of examining a causal relationship from finance to business cycles, we are interested in seeing whether movements in financial markets contribute to movements in GDP. As such, capturing regime changes in financial markets and seeing if resulting regime changes occur in GDP provides a useful source of evidence for investigating the finance-business cycle link. The Markov switching model is therefore a natural choice for this paper.

The base Markov-switching model we use is based on Hamilton's (1989) state-dependent Markov-switching model. In this paper, all variables used in the Markov-switching model are modelled as first-difference AR (4) processes as follows:

$$(\Delta y_t - \mu_{st}) = \phi_1(\Delta y_{t-1} - \mu_{st-1}) + \phi_2(\Delta y_{t-2} - \mu_{st-2}) + \phi_3(\Delta y_{t-3} - \mu_{st-3}) + \phi_4(\Delta y_{t-4} - \mu_{st-4}) + e_t \qquad (2)$$

$$e_t \sim i.i.d.N(0, \sigma^2)$$

$$\mu_{st} = \mu_0(1 - S_t) + \mu_1 S_t$$

$Pr\ [S_t = 1 | S_{t-1} = 1] = p$, $Pr\ [S_t = 0 | S_{t-1} = 0] = q$

where Δy_t represents the first difference of real GDP when business cycles are considered and the first difference of the respective composite measure when the financial segment is considered. We denote S_t as an unobservable state variable which takes on the value one or zero. Further, μ_{st} represents the means of the variable being studied, assumed here to be μ_0 in state 0 and μ_1 in state 1, while p indicates the probability of being in state 1 at

time t, given that you are in state 1 at time t-1, and q indicates the probability of being in state 0 at time t, given that you are in state 0 at time t-1. The AR(4) lag-length is chosen primarily due to this paper's use of quarterly data, as well as the fact that Hamilton's Markov-switching model is generally based on an AR(4) lag length in the literature.

3.3 Time Varying Transition Probability Model

An extension of the Markov switching model discussed above is the time varying transition probability model (TVTP) of Filardo (1994). The TVTP model in our paper is used to examine GDP Markov switching, with GDP regime switching modelled as a first difference AR (4) process with common variance across regimes and two states as detailed previously in equation 2. However there is a key difference. Hamilton's Markov switching model is premised on a fixed transition probability from one regime to another. More explicitly, the Hamilton model has transition probabilities as follows:

$$Pr\ [S_t = 1 | S_{t-1} = 1] = p = \frac{\exp(\theta_{p0})}{1 + \exp(\theta_{p0})}$$

$$Pr\ [S_t = 0 | S_{t-1} = 0] = q = \frac{\exp(\theta_{q0})}{1 + \exp(\theta_{q0})}$$

where θ_{p0} and θ_{q0} are constants.

In the case of the TVTP model, however, we assume that the probability of switching regimes may depend on some underlying economic fundamentals, in the case of this paper, a given financial segment composite measure. Thus the transition probabilities in the TVTP case are of the following form:

$$Pr\ [S_t = 1 |\ S_{t-1} = 1, Z_{t-j}] = p = \frac{\exp(\theta_{p0} + \sum_{j=1}^{J} \theta_{pj} Z_{t-j})}{1 + \exp(\theta_{p0} + \sum_{j=1}^{J} \theta_{pj} Z_{t-j})}$$

$$Pr\ [S_t = 0 |\ S_{t-1} = 0, Z_{t-j}] = q = \frac{\exp(\theta_{q0} + \sum_{j=1}^{J} \theta_{qj} Z_{t-j})}{1 + \exp(\theta_{q0} + \sum_{j=1}^{J} \theta_{qj} Z_{t-j})},$$

where Z_{t-j} is the lagged financial segment composite measure, j indicates the number of lags, and θ_{pj} and θ_{qj} are the coefficients that determine the effect of the jth lag of the financial segment composite measure on the time variation of p and q respectively.

The TVTP model is extremely useful for our purposes. As seen in the next section, the Hamilton Markov switching results are somewhat limited, as we must determine if there is a relationship from finance to business cycles by comparing the regime switching graphs of the respective financial composite measures with that of GDP regime switching. This more or less involves "eyeballing" the graphs to see whether regime switching in a given composite measure seems to correspond with regime switching in GDP. As well, the way a financial segment affects business cycles is through a regime change, however the effect of financial factors on business cycles may be subtler. With the TVTP model, we no longer rely on "eyeballing" of regime switches, nor do we require the composite measure to actually switch regimes. Rather, we consider only GDP regime changes, and can test statistically whether a given financial composite measure (Z_t) helps predict business cycle turning points. To the extent it does not, we can interpret this as evidence against a causal relationship from that particular financial segment to economic fluctuations. However to the extent that it does, this points towards a causal relationship. This involves considering whether the coefficients of the financial composite measure, θ_{pj} and θ_{qj}, are statistically significant, as well as testing the null hypothesis of no time variation in the transition probabilities through the use of a likelihood ratio test. The results of the TVTP model therefore can lead to fairly powerful conclusions.

We should note that Filardo's model is generally used for predictability purposes, and in fact his 1994 paper uses the case of business cycle predictability as the application of the model. While Filardo (1994) tests for the ability of financial variables to predict turning points, our paper differs significantly from Filardo's in that the goal is not predictability, but rather we are interested in causality. By using the dynamic factor model to identify the common components for each financial sector, this paper interprets the results using the Filardo model not as predictability but as causality.

3.4 Vector Autoregression Model and Granger Causality

In addition to the use of Hamilton's Markov-switching model and the TVTP model discussed above, a vector autoregression model (VAR) is used in conjunction with Granger causality tests to further examine the possible finance-business cycle relationship. The general form of the VAR models used in this paper is as follows:

$$\begin{aligned} \Delta F_t &= C_1 + \sum_{j=1}^{\rho} a_{1j} \Delta F_{1t-j} + \sum_{j=1}^{\rho} a_{2j} \Delta Y_{1t-j} + \sum_{j=1}^{\rho} A_{3j} \Delta X_{t-j} + \varepsilon_{1t} \\ \Delta Y_t &= C_2 + \sum_{j=1}^{\rho} b_{1j} \Delta F_{1t-j} + \sum_{j=1}^{\rho} b_{2j} \Delta Y_{1t-j} + \sum_{j=1}^{\rho} B_{3j} \Delta X_{t-j} + \varepsilon_{2t} \end{aligned} \tag{3}$$

where *F* represents the financial composite measure, *Y* is real GDP, *X* includes a number of control variables, C_1 and C_2 are constants, and ε_1 and ε_2 represent the error terms which are normally distributed with mean 0 and variance σ_1^2 and σ_2^2 respectively.

In order to test for causality between the respective financial measure and GDP, Granger causality tests are considered, which use an F-test to test the hypothesis that b_{1j} =0 for $j= 1$ *to* ρ, in the case of the financial measure "Granger causing" GDP, and that a_{2j}=0 for $j= 1$ *to* ρ, in the case of GDP "Granger causing" the financial measure.

4. Empirical Results and Discussion

4.1 Debt

As detailed earlier, four variables are used in the dynamic factor model to construct each composite measure. The debt composite measure (or debt factor) is developed using the log-difference of the following variables: the debt-equity ratio, real consumer credit outstanding, real credit market instruments of non-financial firms outstanding, and real US financial liabilities outstanding (all sectors)[2]. These variables, and all variables used to develop the respective financial segment composite measures are quarterly for the period 1959:1 to 2001:4[3].

A graph of the resulting debt composite measure is seen in figure A1, while the coefficients of the respective dynamic factor models are detailed in table A. Looking at the debt factor column of table A, the loading factors γ all enter positively, such that an increase in the debt composite measure positively affects the four debt variables. One can think of this composite measure as a general measure of debt (or credit) in the economy.

Recall that this paper uses a number of approaches to examine the finance-business cycle relationship (in this case, debt and the business cycle). A first look at this involves Granger causality tests. More specifically, two VARs with tests for Granger causality are employed. One is a simple bi-variate model consisting of the log differences of the debt composite measure and real GDP. The other extends the basic model to include control variables in the form of the quarterly change in oil prices (to proxy for supply shocks), as well as the quarterly return of the Standard and Poor's 500 and a quarterly term spread based on the 10-year Treasury and 3-month Treasury[4].

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[2] For data sources please see appendix 1. Also unit root tests can be obtained by contacting the authors.
[3] Note that the money variables are an exception, with a slightly shorter sample of 1960:1 – 2001:4.
[4] See Stock and Watson (2003) for more on asset prices and output predictability.

Table B details the Granger causality results for all of the respective composite measures[5]. In the case of debt and GDP, the Granger causality results indicate one-way Granger causality from the debt composite measure to GDP in both models.

Our second approach, using Hamilton's Markov switching model, compares the regime switching of the debt composite measure with that of GDP. Intuitively, if movement in debt contributes to business cycles, one might expect to see a high growth debt regime switch to a low or negative growth debt regime in advance of a downturn in GDP. Figure B1 shows the smoothed probability of a recession for the GDP variable and the smoothed probability of a low or negative growth state for the debt composite measure[6]. Table D details the respective Markov switching parameters.

The Markov switching results indicate that the debt factor switches two quarters after the beginning of the NBER dated recession of 1960-61, one quarter after the beginning of the 1973-75 recession and in line with the start of the 1980 recession. The debt factor indicates no regime switching near the 1969-70, 1981-82 or 2001 recessions, and only a weak spike a quarter after the 1990-1991 recession begins (perhaps due partly to the credit crunch occurring at that time). Regime switching in the debt market factor does not appear to be related to recessions over this period, at least as far as a causal story would require.

A final examination of a possible debt-business cycle relationship involves Filardo's time varying transition probability model. Recall from Section 3, that with the TVTP model we no longer rely on "eyeballing" of regime switches or the requirement that the composite measure actually switch regimes. Rather, when considering GDP regime changes, the TVTP model allows us to test whether GDP regime switching exhibits time variation through the inclusion of a given financial composite measure. Table E details the TVTP estimation results for all of this paper's composite measures[7].

[5] Table B provides results based on VARs estimated with one financial segment at a time. Table C provides Granger causality results based on VAR (2) models which are estimated with all three financial segments included at the same time. Of note is the fact that the bicausal relationship between money and GDP becomes causal in one direction from GDP to money, while the stock market loses its causality on GDP for the case with control variables.

[6] The regime switching of the GDP variable does not coincide exactly with all of the NBER dated recessions however the switching is inline generally with these recessions.

[7] Please see figures C1-C4, for TVTP graphs of the probability of GDP being in a low growth state.

Column 2 of Table E details the estimated transition probabilities for the inclusion of our debt composite measure, where the parameters of interest are θ_{q1} and θ_{p1}. θ_{q1} proves to be negative and statistically insignificant, while θ_{p1} is positive and statistically significant. The fact that these parameters exhibit opposite signs eases interpretation, as the transition probabilities move in opposite directions when our debt measure (Z_t) changes. Thus intuitively an increase in the debt composite measure increases the probability of being in an expansionary state next period as both p and $1-q$ increase. Keep in mind this is limited by the fact that θ_{q1} is statistically insignificant. Taking into account only θ_{p1} we can say an increase (decrease) in the debt composite measure increases (decreases) the probability of remaining in an expansionary state. That is, high debt flows help keep the economy going, but "credit crunches" contribute to a downturn. This evidence indicates the inclusion of the debt composite measure provides some predictive power to the model of GDP regime switching and supports debt contributing to whether the economy remains in an expansionary state or not. The test for time variation further points in this direction, where with the likelihood ratio test, the null of no time variation is rejected at the 5 percent level[8].

4.2 Money

The second financial market segment considered, the money composite measure, is estimated based on the log difference of the following variables: real M1 Divisia, a spread based on M2 and M0, velocity based on M0, and real M3. The money factor column of table A indicates the loading factors γ all enter positively with the exception of γ_3 (the loading factor for velocity), which is statistically insignificant.

Granger causality tests indicate that both the simple and extended VAR find support for Granger bicausality between the money composite measure and GDP at the 5 percent level.

Figure B2 details the smoothed probability of a recession for GDP and the smoothed probability of a low or negative growth regime for the money composite measure. The money factor switches to a low growth regime in 1966 coinciding with the credit crunch

[8] Time variation is tested by using a likelihood ratio test and restricting the coefficients of the financial composite measure in the transition probabilities to be zero. Rejecting this restriction indicates that changes in the financial composite measure affect the transition probabilities.

of that period, while switching two quarters before the 1969-70 recession, two quarters before the 1973-75 recession, and one quarter before the 1980 recession. The money factor then fails to switch in the neighbourhood of any of the recessions of the past twenty years. Money switches regimes to a low growth state twice over the 1987-1990 period. This latter regime switch at best coincides loosely with the first half of the 1989-1992 credit crunch. The results appear supportive of the view of money as a contributor to business cycles, where the change from a high growth state to a tightening of money (a low or negative growth state) leads to recessions, however this is only the case for the first half of the sample. Any relationship between money and business cycles falls apart after the 1980 recession.

Lastly, in terms of the TVTP results, column 3 of Table E details the estimated coefficients given the inclusion of the money composite measure in the transition probabilities. The TVTP coefficients indicate θ_{p1} is positive and θ_{q1} negative, where an increase in the money measure increases the probability of being in an expansionary state the next period regardless of the current state of the economy. This is in line with what one would intuitively expect from a money influencing business cycles story. However these coefficients are not statistically significant, tempering the extent of their power in predicting business cycles. That said the likelihood ratio test of the zero restrictions is rejected at the 5 percent significance level, providing some empirical support for money in business cycles.

4.3 Stock Market

It is well known that financial market prices tend to be forward looking. This is potentially problematic in the stock market, where stock market prices through their incorporation of all available information, can price-in coming changes in the economy. This forward-looking price effect clearly needs to be addressed when one is interested in identifying causality rather than simply predictability. As discussed earlier, the Kalman filter is an important part of this exercise. It enables us to filter the noisy variables of a financial segment in order to capture the underlying factor which drives the comovement of the variables in that segment. Therefore, in order to control for the forward looking price problem, we include a non-price variable as one of the variables in the stock market dynamic factor model. The non-price variable is the New York Stock Exchange margin account debt balance. A potential drawback of this measure is it may have some price component to it as movements in the NYSE may impact the margin debt. However, we are fairly comfortable that our stock market factor is not picking up this forward-looking price effect. If it were, we would expect the loading factors of the three other variables (γ_1, γ_3, γ_4) to be much larger than they are in table A.

The stock market composite measure is developed using the log difference of the following stock market variables: the two-year New York Stock Exchange equal weighted return, the one-year change in the NYSE margin account debt, the six-month equal weighted return on the CRSP NYSE-AMEX-NASDAQ index, and the two-year Standard and Poor's excess return. The loading factors for the four stock market variables all enter positive and significantly. Considering the Granger causality results for the stock market composite measure and GDP, the evidence supports a one-way Granger causal relationship from the stock market measure to GDP at the 5 percent level in both models.

Figure B3 details our Markov switching results, where in the case of the stock market composite measure, the graph indicates the smoothed probability of a bear market. The stock market factor switches to a bear market regime two quarters after the beginning of the 1969-70 recession, two quarters in advance of the 1973-75 recession, two quarters in advance of the 1990-1991 recession, and one quarter ahead of the 2001 recession. The stock market factor fails to switch regimes with the 1980 and 1981-1982 recessions, however these recessions are often considered monetary induced, so this is not surprising. The graph of course also picks up the 1987 stock market crash. As a whole, the Markov switching results provides fairly favourable evidence that downturns in the stock market may have played some role in a number of the recessions experienced over the past forty years.

In terms of the TVTP results, Column 4 of Table E indicates θ_{q1} is negative and statistically insignificant, while θ_{p1} proves to be positive and statistically significant. The positive value of θ_{p1} indicates that an increase (decrease) in the stock market measure increases (decreases) the probability of staying in an expansionary state. This evidence supports the notion that a strong stock market increases the probability of remaining in an economic expansion, while a downturn in the stock market contributes to the economy moving into a recession. Providing further support, the likelihood ratio test rejects the null of no variation at the 5 percent level.

5. Conclusion

The recent US and Japanese recessions both raise financial factors as sources of the respective economic downturns, and this paper uses these events as motivation to re-examine the link between finance and business cycles. This paper adds to the existing literature on a number of margins. First, this paper considers the finance-business cycle question via a number of approaches rather than a single approach, basing decisions on the results as a whole. Second, this paper uses composite measures estimated using the dynamic factor model in order to abstract from noisy single measures typical in earlier research, in order to capture the underlying state of the financial sector. Finally, data which includes the 2001 recession is used, which allows us to consider finance's role in that most recent recession.

The basic question then is do financial factors contribute to business cycles? The answer is yes, however this depends on the aspect of finance considered and largely if one considers moving from an economic expansion to a recession rather than a recession to a recovery. In the case of the debt composite measure, Granger causality tests provide evidence of a one-way relationship from debt to GDP, and the TVTP model indicates that the debt composite measure contributes to whether the economy remains in an expansionary state or moves into recession. This is coupled with the likelihood ratio test evidence, which supports time variation. That said, the Markov switching results do little to support these results as debt regime switching bears little relation to that of business cycles.

For the money composite measure, the Granger causality results indicate a bicausal relationship between money and GDP, however the Markov switching results over the first half of the sample appear to exhibit a close relationship between money and business cycles. While the TVTP parameters exhibit the intuitively correct signs, they are statistically insignificant (the likelihood ratio test for time variation does however support time variation). Overall, the evidence points in the right direction intuitively, however it does not stand up to tests of statistical significance.

Clearly the strongest results come from the stock market composite measure. The Granger causality results support a one-way relationship from stock markets to GDP, while the TVTP results indicate that stock market movements play a role in whether the economy continues to grow or moves into a downturn (tests for time variation results further substantiate this). Finally the Markov switching results indicate the stock market measure moves into a bear market regime in advance of a number of recessions over the sample. One of the factors which motivated this research is the 2001 recession and the notion that the stock market crash contributed to it. Our results support this view.

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Dynamic Factor Model Coefficients

Table A: Parameter Estimates of the Respective Dynamic Factor Models						
	Debt		Money		Stock	
	Estimate	SE	Estimate	SE	Estimate	SE
Φ_1	0.5370	(0.0778)	0.7331	(0.0874)	1.0525	(0.089)
Φ_2	0.2714	(0.0781)	0.0118	(0.09)	-0.2536	(0.0844)
ψ_{11}	0.0515	(0.0764)	0.5002	(0.0803)	-0.1409	(0.2264)
ψ_{12}	0.1738	(0.0841)	0.3217	(0.0811)	-0.005	(0.016)
ψ_{21}	0.5300	(0.0781)	0.3337	(0.2031)	1.0659	(0.0672)
ψ_{22}	0.2016	(0.0768)	-0.0278	(0.0339)	-0.284	(0.0358)
ψ_{31}	-0.0279	(0.0752)	0.3213	(0.0764)	0.5889	(0.0886)
ψ_{32}	0.9685	(0.0756)	0.1765	(0.0808)	-0.0867	(0.0261)
ψ_{41}	-0.0293	(0.0891)	0.7459	(0.1667)	1.5329	(0.0905)
ψ_{42}	-0.0002	(0.0013)	0.0184	(0.1662)	-0.5874	(0.0696)
σ_1	0.8606	(0.0932)	0.3174	(0.0381)	0.0554	(0.0227)
σ_2	0.2463	(0.0269)	0.0794	(0.0232)	0.227	(0.025)
σ_3	0.0016	(0.0017)	0.8292	(0.0908)	0.6398	(0.0722)
σ_4	0.7175	(0.0783)	0.0694	(0.0194)	0.0355	(0.0131)
γ_1	0.1700	(0.0627)	0.5239	(0.0535)	0.5061	(0.0419)
γ_2	0.3573	(0.0447)	0.6397	(0.0448)	0.1907	(0.0399)
γ_3	0.6062	(0.0335)	-0.0447	(0.0707)	0.2855	(0.068)
γ_4	0.3468	(0.0470)	0.573	(0.0403)	0.3306	(0.0287)
LL	-102.2744		-0.8821		122.8380	

Granger Causality Results[9]

Table B: Granger Causality Results For Bivariate VARs *(p values)*			
Financial Variable (lags)	Finance does not Granger cause output	Output does not Granger cause finance	Two way or one way
Debt (2) *no controls*	0.0001	0.3153	One way
Debt (2) *controls*	0.0011	0.1095	One way
Money (2) *no controls*	0.0000	0.0019	Two way
Money (2) *controls*	0.0001	0.0053	Two way
Stock (1) *no controls*	0.0000	0.7778	One way
Stock (1) *controls*	0.0038	0.6002	One way

Controls include quarterly oil prices and the quarterly return of the Standard and Poor's 500 (both in log-differences) as well as a quarterly spread based on the 10-year Treasury and 3-month Treasury.

[9] All VAR model lag lengths are based on the Schwartz Information Criterion and Akaike Information Criterion. White standard errors are used in the VAR estimation.

Table C: Granger Causality Results For Multivariate VAR(2) - Includes All Financial Variables *(p values)*			
Financial Variable	Finance does not Granger cause output	Output does not Granger cause finance	Two way or one way
Debt *no controls*	0.1382	0.8333	None
Debt *controls*	0.2666	0.7125	None
Money *no controls*	0.3704	0.0017	One way
Money *controls*	0.2436	0.0073	One way
Stock *no controls*	0.0002	0.4917	One way
Stock *controls*	0.3757	0.3684	None

"No controls" refers to a VAR (2) estimated without the inclusion of the controls included in table B. All financial composite variables are included in the VAR estimation however. "Controls" refers to a VAR (2) estimated with all of the financial composite variables as well as the controls detailed in table B.

Markov Switching Coefficients

Table D: Parameter Estimates of the Respective Financial Market Segment Markov Switching Models						
	Factors					
	Debt		Money		Stock	
	Estimate	SE	Estimate	SE	Estimate	SE
p	0.94517	(0.02433)	0.93677	(0.03093)	0.93504	(0.02712)
q	0.40085	(0.18205)	0.76375	(0.09668)	0.56342	(0.15246)
Φ_1	0.11610	(0.07518)	0.34795	(0.09632)	0.94438	(0.09277)
Φ_2	0.50223	(0.07322)	0.11785	(0.08932)	-0.19886	(0.14846)
Φ_3	-0.06676	(0.06676)	0.25019	(0.07414)	0.28523	(0.12708)
Φ_4	0.27331	(0.06944)	0.08912	(0.07308)	-0.32669	(0.08940)
μ_0	-1.51330	(0.54951)	-0.96087	(0.46815)	-0.59351	(0.30460)
μ_1	1.32481	(0.46046)	1.32962	(0.41807)	0.92234	(0.21430)
μ_0^*	1.44707	(0.63437)	0.82720	(0.58140)	0.43610	(0.33959)
μ_1^*	-0.96132	(0.50563)	-0.89280	(0.52272)	-0.19736	(0.23993)
σ_1	0.76760	(0.05858)	0.71645	(0.05918)	0.56551	(0.06571)
σ_2	0.33728	(0.04069)	0.47430	(0.05451)	0.27538	(0.02584)
LL	-166.605		-173.948		-128.629	

Early Markov switching results largely resulted in little or no regime switching for the debt and money composite measures over the latter half of the sample. These results are available from the authors on request. Plotting the log difference in our composite measures, the likely reason for these results became apparent. The dispersion of the data becomes much narrower over the latter half of the sample. In light of research such as Stock and Watson (2002), this is not unexpected. In order to account for this, a dummy variable is used to allow for a change in the variance as well as μ_0 and μ_1 over the latter half of the sample period. The dummy variable coverage is as follows: Debt: 1986.1-2001.4; Money: 1984.1-2001.4; Stock Market: 1984.1-2001.4. As a result, $\mu_{st}= (\mu_0+\mu_0^*(\text{dmy}))(1-S_t) + (\mu_1+\mu_1^*(\text{dmy}))(S_t)$, while $\sigma^2= \sigma_1^2(1\text{-dmy})+ \sigma_2^2(\text{dmy})$.

Time Varying Transition Probability Coefficients

Table E: TVTP Results[10]			
Parameters	Z=Debt	Z=Money	Z=Stock
μ_0	-0.87305	-0.23825	-0.53928
	(0.23840)	(0.22424)	(0.29112)
μ_1	0.99259	1.05369	1.01721
	(0.07621)	(0.09309)	(0.08683)
θ_{q0}	-5.59295	0.35075	-1.11564
	(3.74321)	(0.70942)	(1.11814)
θ_{q1}	-3.61811	-1.22705	-0.71290
	(2.43487)	(0.83419)	(0.88324)
θ_{q2}	---	---	---
θ_{p0}	4.79554	5.43969	4.16202
	(1.24066)	(2.39300)	(1.05242)
θ_{p1}	1.94697	3.19463	3.47484
	(0.80627)	(1.91579)	(1.18895)
θ_{p2}	---	---	---
LR Test*	16.72398†	13.99188†	17.86352†

** Likelihood ratio test of no time variation.*
† Reject the null of no time variation (α=0.05)

[10] AIC and BIC were used to determine the order of lags of the *Z* variables in the TVTP.

Financial Market Factor Graphs

Figure A1: Debt Factor and GDP

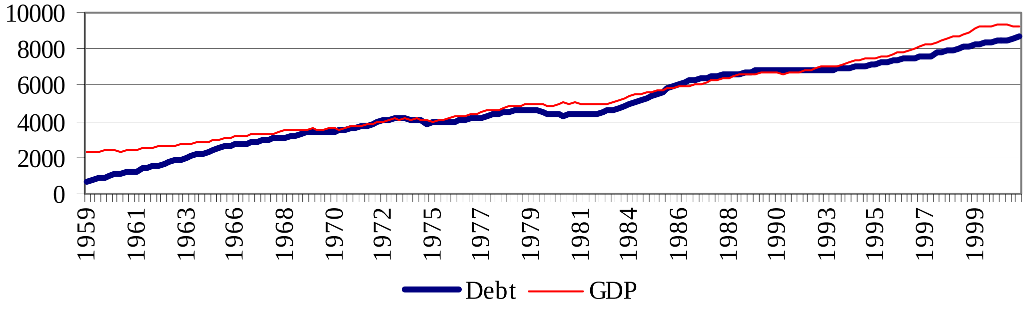


Figure A2: Money Factor and GDP

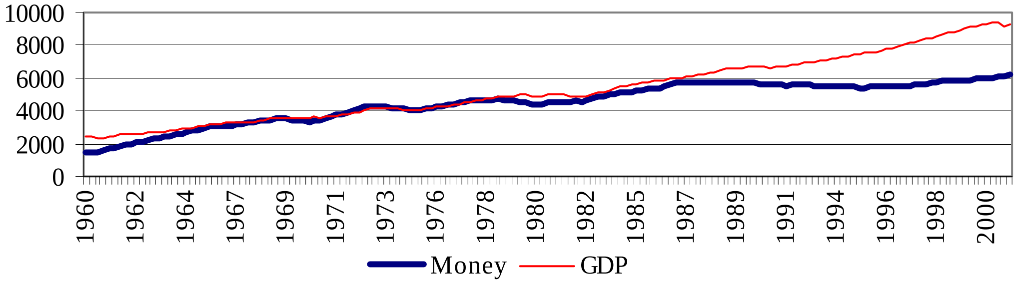
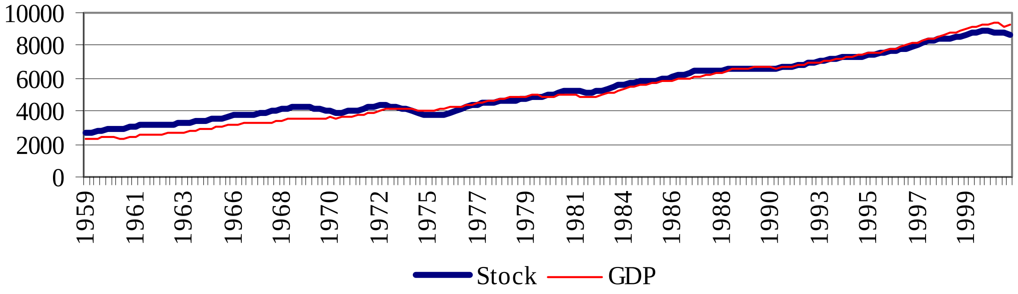


Figure A3: Stock Factor and GDP



Markov Switching Graphs

Figure B1: Debt Factor and Real GDP Markov Switching

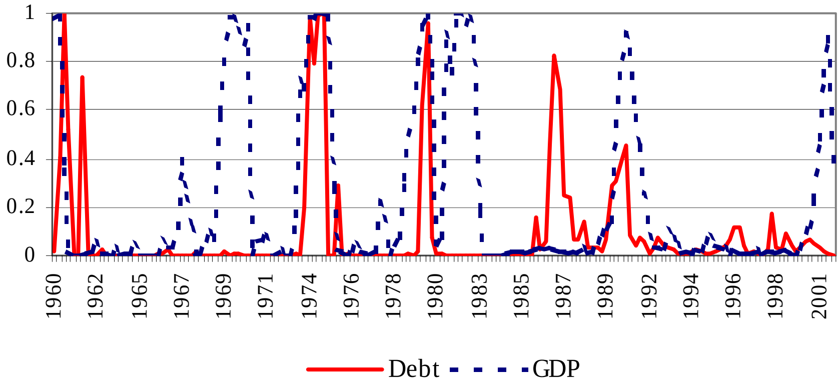


Figure B2: Money Factor and Real GDP Markov Switching

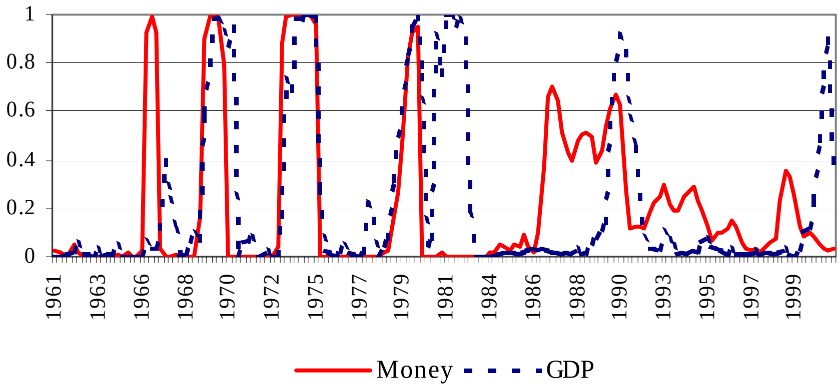
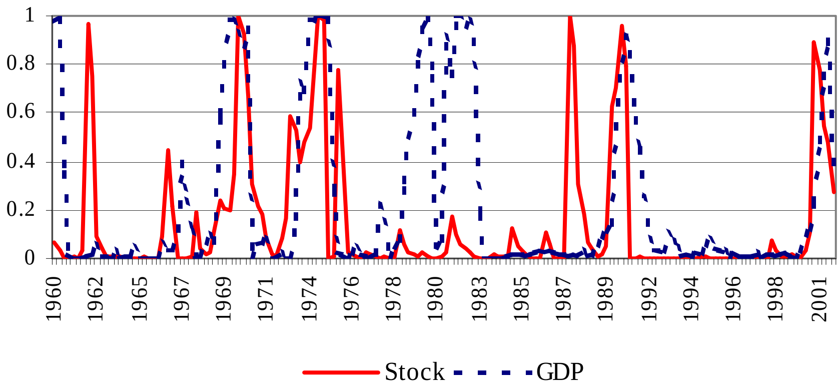


Figure B3: Stock Market Factor and Real GDP Markov Switching



Time Varying Transition Probability Graphs[11]

Figure C1: GDP TVTP; Z=0

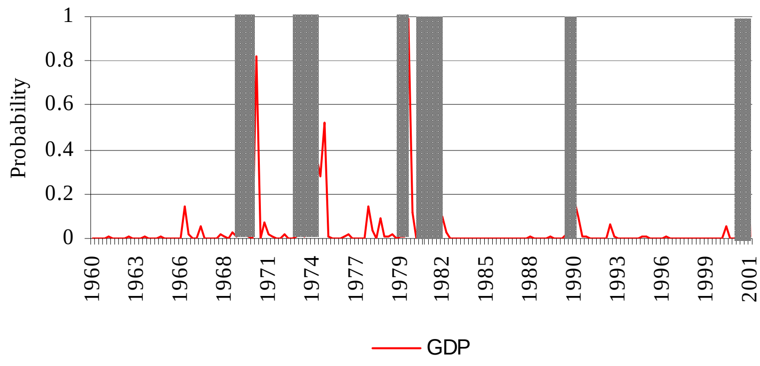


Figure C2: GDP TVTP; Z=Debt

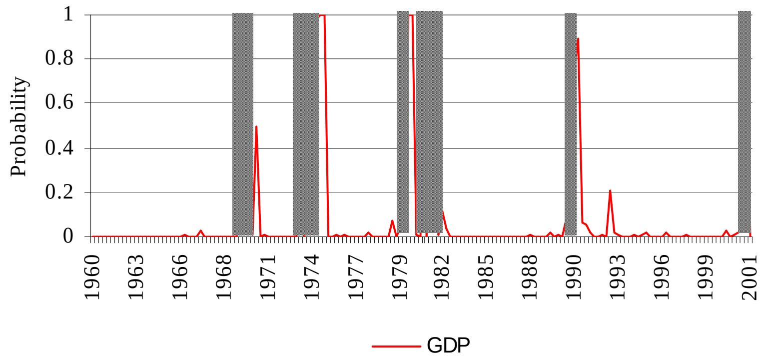
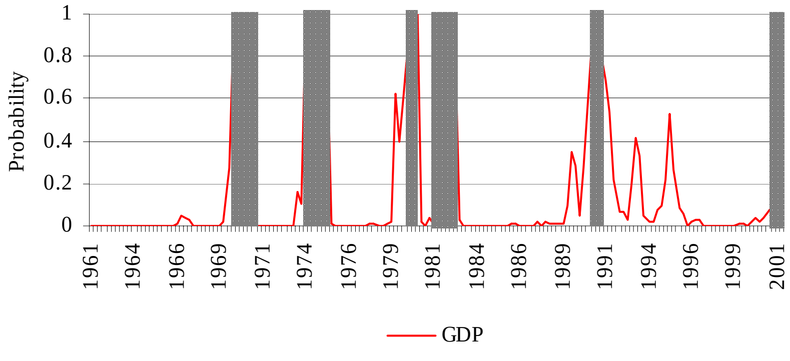
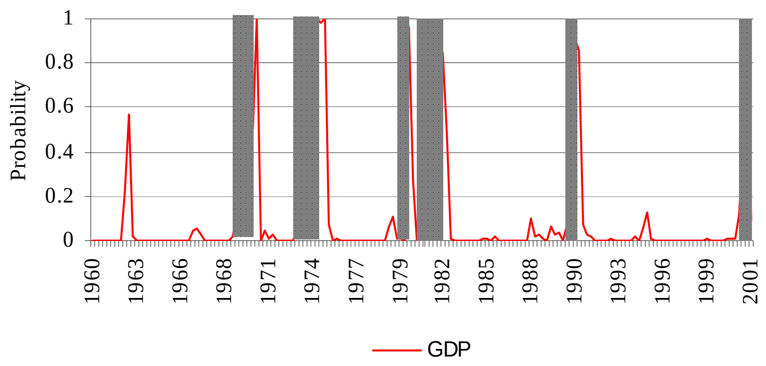


Figure C3: GDP TVTP; Z=Money



[11] The shaded areas indicate NBER-dated recessions.

Figure C4: GDP TVTP; Z=Stock



Appendix 1: Data

Data Sources	
Variables	**Source**
Debt	
Debt (Credit Market Instruments (non-farm non-financial))	Federal Reserve Flow of Funds Accounts of the US
Net Worth Market Value (non-farm non-financial corporations)	Federal Reserve Flow of Funds Accounts of the US
Consumer Credit Outstanding	Datastream
Financial Liabilities (All Sectors)	Datastream
Credit Market Instruments (Private Non-financial Firms)	Datastream
Money	
Monetary Services Index M1 (Divisia)	Federal Reserve Bank of Saint Louis
MO	Datastream
M1	Datastream
M2	Datastream
M3	Datastream
Stock Market	
Standard & Poor's 500 Index (Common Stock)	Datastream
NYSE-AMEX-NASDAQ Equal Weighted Share Price Index	CRSP
NYSE Debt Balances in Margin Accounts	Financial Market Center*
NYSE Equal Weighted Return	CRSP
Others	
Spot Oil Price: West Texas Intermediate	Dow Jones Energy Services
CPI	Datastream
3 Month Treasury Bill	Datastream
10 Year Treasury Bond Yield (Composite)	Datastream

* Compiled from Federal Reserve Banking and Monetary Statistics, Federal Reserve Annual Statistics and New York Stock Exchange

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