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Abstract

This paper explores the relationship between consumer confidence, stock prices and the business cycle in the United States using a Structural Vector Autoregression (SVAR). It finds three key results. First, the addition of confidence and stock price shocks to a small SVAR has important effects on the dynamic responses of the US economy. A confidence shock of four index points changes US GNP by 0.2% (noting that it is not uncommon for confidence shocks to total 20 points in a few consecutive quarters), while a 5% change in the S&P 500 leads to a 0.4% change in GNP. Second, the influence of these two shocks on the US business cycle in the last 50 years has been important at various times. Confidence shocks accounted for 16% of the total effect of structural shocks to GNP during the early 1990s recession, while stock prices contributed 40% of the effect of structural shocks to GNP in the 2001 recession. Finally, adding confidence to the base SVAR and an AR(2) model leads to a small improvement in out-of-sample forecasting performance, while adding stock price information appears to improve forecasts in recessions but otherwise worsens them. Overall, the relative forecasting performance of the different models varies across time depending on the relative importance of various shocks.

1 Introduction

Consumer confidence and stock prices are closely monitored by economists and widely cited by forecasters as evidence for a particular view about the economy. Events in more recent history, such as the sudden falls in confidence and stock prices before the 1990-1991 recession, and record levels of consumer confidence combined with the large run up in stock prices during the subsequent 1991-2001 expansion, suggest that these two factors are potentially important and interrelated influences on the business cycle in the United States.

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This paper explores the relationship between consumer confidence, stock prices and the business cycle in the United States over the second half of the twentieth century. The underlying question is: how important are the effects of consumer confidence and stock prices on the business cycle and, therefore, how much weight should we put on shocks to these variables when assessing the current state of the economy and its future direction?

These two potential influences on the business cycle are examined using a small macroeconomic model, a Structural Vector Autoregression (SVAR), which accounts for the endogeneity of key macroeconomic variables and which, at least partially, incorporates assumptions obtained from economic theory. Following Gali (1992), I evaluate the econometric model results by comparing them against the predictions of the IS/LM macroeconomic model to see whether confidence and stock prices operate on the business cycle as the IS/LM model would suggest.

Several issues are examined in the paper. First, how does the United States economy react to confidence and stock price shocks? The multivariate nature of the SVAR means that the effects of these two variables on the business cycle can be examined after controlling for the effect of other influences such as interest rates. The SVAR model also allows us to examine how one variable may partially operate on another via a third variable. Second, what has been the influence of confidence and the stock market on the US business cycle from 1953-2003? Finally, I also examine whether confidence can add incremental predictive information about future output, which has been a key focus of the literature.

The paper proceeds as follows. Section 2 contains a brief description of the main data series. This is followed by a discussion of the SVAR models and their estimation. Section 4 examines the dynamic response of the US economy to various shocks and section 5 discusses the influence of stock prices and confidence. The influence of confidence, stock prices and other shocks on the US economy is examined using a variance decomposition analysis and a decomposition of historical movements in US GNP. This is followed by a forecasting exercise at the end of the paper and a summary of key conclusions that can be drawn from the analysis.

2 Data

Six primary data series listed below are used in the model. This data is used to form the 6 main variables in the model, $\Delta y_t, \Delta i_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t), cl_t, \Delta sp_t$. Unit root testing (see appendix A) suggests that $\Delta y_t, \Delta i_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t), cl_t, \Delta sp_t$ are all stationary.
Table 1: Primary Data Series

| \( y \): log of seasonally adjusted GNP at 2000 prices |
| \( i \): yield on 3 month US Treasury Bills |
| \( p \): log of the consumer price index |
| \( m \): log of the M1 money supply |
| \( cl \): University of Michigan overall index of consumer sentiment |
| \( sp \): Real Standard and Poors 500 index of US stock prices (nominal S&P 500 index deflated by the CPI) |

The data is quarterly in frequency and the sample period is 1952:4-2003:4. Further details on the sources and description of the data are available in appendix B.

3 The Gali SVAR Model and Extensions

3.1 The SVAR Model and Estimation

The model used in this paper is an extension of a four equation SVAR of the US economy originally estimated in Gali (1992). Gali’s model consisted of four central macroeconomic variables - output, interest rates, the money supply and prices - and was estimated over the period 1955:1-1987:3. He explored whether the dynamic responses of the post war US economy to various macroeconomic shocks were consistent with the predictions of the IS/LM model and found that the IS/LM’s predictions were largely supported by the data. As a first step I re-estimate Gali’s four-variable model over the period 1953:1-2003:4 and compare the impulse responses from this re-estimated model with the original responses. This reveals that the responses are very similar for both estimation periods suggesting that the Gali model is robust to sample period and that the original model identified some stable relations in the data.

The original four-variable model is used as a base model in the paper, against which extensions are compared and contrasted. The robustness of the Gali model to changing estimation periods and its broad consistency with a major theory model make it a good foundation from which to examine the incremental effects of adding confidence and stock prices.

The rest of the section discusses the SVAR model and its estimation. The SVAR is a simultaneous equations model with a structural form given by:

\[ B(L)z_t = b + \epsilon_t, \]  

where \( B(L) = B_0 - B_1 L - B_2 L^2 - ... - B_w L^w \) is a \( w \)th order lag polynomial and \( \epsilon_t \) is a \((n \times 1)\) vector of structural shocks, \( w \) is the number of lags of each variable in the system, \( B_j \) is a \((n \times n)\) coefficient matrix at lag \( j \).
$B_0$ is the matrix of contemporaneous coefficients and a normalisation assumption is that the elements of its main diagonal are equal to 1, i.e. part of the identification restrictions are that each equation in the system is assigned a different dependent variable.

$$B_0 = \begin{bmatrix}
1 & -b_{12}^0 & \cdots & -b_{1n}^0 \\
-b_{21}^0 & 1 & \cdots & -b_{2n}^0 \\
\vdots & \vdots & \ddots & \vdots \\
-b_{n1}^0 & -b_{n2}^0 & \cdots & 1
\end{bmatrix}$$

where $b_{ij}^0$ is the contemporaneous effect of a change in variable $2$ on variable $1$, i.e. the superscript indexes time, the first subscript indexes the dependent variable and the 2nd subscript indexes the independent variable. The inverse of $B_0$ is given by:

$$B_0^{-1} = \begin{bmatrix}
b_{11}^0 & b_{12}^0 & \cdots & b_{1n}^0 \\
b_{21}^0 & b_{22}^0 & \cdots & b_{2n}^0 \\
\vdots & \vdots & \ddots & \vdots \\
b_{n1}^0 & b_{n2}^0 & \cdots & b_{nn}^0
\end{bmatrix}$$

In the following discussion, $b_{12}^0$ is an element of $B_0$ while $b_{12}^1$ is an element of the $B_0^{-1}$ matrix (the sub- and superscripts are reversed).

The variance-covariance matrix $cov(\epsilon_t) = \Omega$ is a diagonal matrix. This assumption that the structural shocks, $\epsilon_t$, are uncorrelated is a crucial identification assumption of the SVAR approach.

We can move from the structural model to the reduced form or VAR form by multiplying (1) by $B_0^{-1}$ to give:

$$A(L)z_t = a + u_t \quad (2)$$

where $A(L) = B_0^{-1}B(L) = I_n - A_1L - \ldots - A_wL^w$ is the $w$th order lag polynomial of reduced form coefficients, $u_t = B_0^{-1}\epsilon_t$ is a $(n \times 1)$ vector of reduced form errors and $cov(u_t) = \Sigma = B_0^{-1}\Omega(B_0^{-1})$ is the variance-covariance matrix of the reduced form errors. A key point to note is that it is the $B_0$ matrix that connects the structural and reduced form representations.

The structural model given by (1) cannot be directly estimated with contemporaneous regressors because this would lead to correlation between the structural error terms, $\epsilon_t$, and the regressors in each equation resulting in biased and inconsistent parameter estimates. We therefore have to adopt a different estimation strategy. All the information that can be obtained from the data is contained in estimates of the reduced form model. One estimation method is to estimate the
reduced form model since regressors and the reduced form errors in each equation are not correlated and therefore unbiased parameter estimates can be found. The structural model parameters are then calculated using the information from the reduced form model. To do this though we need to impose further identification restrictions on the structural model, as without further restriction we have fewer distinct elements from the reduced form estimation than we require to obtain estimates of the structural parameters.

From the reduced form estimation we obtain the coefficient matrices $A_1...A_w$, which can be used to identify the structural coefficients $B_1...B_w$ as they have the same number of separate elements, $n^2$, where $n$ is the number of variables in the model. We also obtain $\Sigma$, the covariance matrix for the reduced form errors, which can be used to identify $B_0$ and $\Omega$. The variance-covariance matrix, $\Sigma$, is symmetric and so only has $(n^2 + n)/2$ distinct elements. With the normalisation restriction of ones on the main diagonal $B_0$ has $(n^2 - n)$ unknowns and with the restriction of no covariance between the structural errors $\Omega$ has $n$ distinct elements, the var($\epsilon_i$). There are, therefore, $n^2$ unknowns which must be identified from $(n^2 + n)/2$ known elements implying that we must impose $n^2 - (n^2 + n)/2 = (n^2 - n)/2$ further restrictions to exactly identify the structural model.

Another method of estimating the structural model is to estimate it equation by equation using instrumental variable (IV) estimation. The IV estimator is given by:

$$B_{IV} = (M'X)^{-1}M'z$$

where $M$ is a matrix of instruments, $X$ a matrix of regressors and $z$ a vector of the dependent variable.

Instruments are used for the contemporaneous regressors to eliminate the problem of correlation between these variables and the structural shocks. The total number of separate coefficients and variances that can be estimated is still given by the number of separate elements that can be estimated in the reduced form model and so the same number of identifying restrictions must be imposed. This second method, based on Blanchard and Watson (1986) and used in Pagan and Robertson (1998), for estimating the structural model by IV estimation is implemented in this paper.

### 3.2 Identification Restrictions

The identification restrictions include the normalisation restrictions and restrictions on $\Omega$ (i.e. it is diagonal) as described above. There are also restrictions on the contemporaneous effect of some structural shocks on other variables in the system. These are restrictions on the $B_0^{-1}$ matrix (short-run restrictions). Long-run restrictions imposed on the models are that the long-run effect of some
structural shocks on other variables in the system are zero - these are restrictions on $C(1)$ (see below). It is also common to impose restrictions on the coefficients on contemporaneous variables in the system, i.e. restrictions on the $B_0$ matrix.

To discuss the long-run restrictions and impulse responses coefficients more fully (1) is rewritten in moving average form:

\[ z_t = c + B(L)^{-1} \epsilon_t = c + C(L) \epsilon_t = c + (C_0 + C_1 L + ...) \epsilon_t \] (4)

The $C(L)$ give the impulse responses of the structural system given by (1) to the shocks $\epsilon_t$. $C_j$ gives the impulse response of $z_{t+j}$ to the shocks $\epsilon_t$. We can obtain the $C(L)$ in the following way:

From (1) we obtain:

\[ z_t = B_0^{-1} b + B_0^{-1} \epsilon_t + B_0^{-1} B_1 L z_t + \ldots + B_0^{-1} B_w L^w z_t \]

\[ = B_0^{-1} b + B_0^{-1} \epsilon_t + B_0^{-1} B_1 z_{t-1} + \ldots + B_0^{-1} B_w z_{t-w} \] (5)

Now, rewrite (5) in terms of the shocks, $\epsilon_t$, to find the impulse response coefficients, the $C(L)$. For example the responses of $z_t$ to shocks to $\epsilon_t$ at $t = 0$ with $\epsilon_t = 0$ for $t \neq 0$ are:

\[ z_0^* = B_0^{-1} \epsilon_0 \]
\[ z_1^* = B_0^{-1} B_1 \epsilon_0 \]
\[ = B_0^{-1} B_1 B_0^{-1} \epsilon_0 \]
\[ z_2^* = B_0^{-1} B_1 z_1 + B_0^{-1} B_2 \epsilon_0 \]
\[ = B_0^{-1} B_1 B_0^{-1} B_1 B_0^{-1} \epsilon_0 + B_0^{-1} B_2 B_0^{-1} \epsilon_0 \]

The $C_j$ are given by the coefficients on $\epsilon_0$, for example, $C_0 = B_0^{-1} B_0^{-1}$, $C_1 = B_0^{-1} B_1 B_0^{-1}$. These $C_j$ can be quickly calculated in an econometrics package such as R or Gauss. The long-run or cumulated responses are given by the sum of the $C_j$: $\Sigma C_j = C(1)$. In the models below restrictions are imposed so that these cumulated responses are zero for some shocks and variables. This type of long-run restriction is imposed by placing the equivalent linear restrictions on the coefficients of $B(L)$. The equivalent linear restrictions can be found in the following way. Since $C(L) = B(L)^{-1}$,
$C(L)B(L) = I$ and $C(1)B(1) = I$ where $I$ is the identity matrix. With the restriction that shocks to variables 2,...,n have no long-run effect on variable 1, i.e. $c_{12}...c_{1n} = 0$, we have the following:

$$
\begin{bmatrix}
  c_{11} & 0 & ... & 0 \\
  c_{21} & c_{22} & ... & c_{2n} \\
  ... & ... & ... & ... \\
  c_{n1} & c_{n2} & ... & c_{nn}
\end{bmatrix}
\begin{bmatrix}
  1 - b_{11}^0 - ... - b_{11}^w \\
  -b_{21}^0 - ... - b_{21}^w \\
  ... \\
  -b_{n1}^0 - ... - b_{n1}^w
\end{bmatrix}
= \begin{bmatrix}
  1 & 0 & ... & 0 \\
  0 & 1 & ... & 0 \\
  ... & ... & ... & ... \\
  0 & 0 & ... & 1
\end{bmatrix}
$$

where $b_{12}^0$ is the contemporaneous effect of a change in variable 2 on variable 1, i.e. the superscript indexes time, the first subscript indexes the dependent variable and the 2nd subscript indexes the independent variable.

From this we obtain $c_{11}(-b_{12}^0 - ... - b_{12}^w) = 0,...,c_{11}(-b_{1n}^0 - ... - b_{1n}^w) = 0$ which given that $c_{11} > 0$ implies the following linear restrictions on $B(L)$:

$$
(-b_{12}^0 - b_{12}^1 - ... - b_{12}^w) = 0
$$

$$
(-b_{1n}^0 - b_{1n}^1 - ... - b_{1n}^w) = 0
$$

With these linear restrictions on $B(L)$ implied by the long-run restrictions we can write the first equation in the structural system in the following form:

$$
z_{1t} = b_{11}^1 z_{1t-1} + ... + b_{11}^w z_{1t-w} + b_{12}^0 (z_{2t} - z_{2t-w}) + ... + b_{12}^{w-1} (z_{2t-w-1} - z_{2t-w}) +
... + b_{1n}^0 (z_{nt} - z_{nt-w}) + ... + b_{1n}^{w-1} (z_{nt-w-1} - z_{nt-w}) + \epsilon_t 
$$

(6)

The regressors that have no long-run effect on variable 1 have been written in difference form. Each long-run restriction reduces the number of coefficients to be estimated in (6). With the long-run restrictions we can obtain the $b_{1j}^w$, $j = 2...n$ by forming a linear combination of the estimated coefficients i.e.

$$
b_{1n}^w = -b_{1n}^0 - b_{1n}^1 - ... - b_{1n}^{w-1}
$$

The short-run restrictions that the immediate effect of some structural shocks on variables in the system are zero, i.e. restrictions on the $B_{1j}^{-1}$ matrix, arise as a consequence of using the reduced form errors as instruments for contemporaneous terms in the structural model. We know the reduced
form errors, \( u_t \), and the structural errors, \( \epsilon_t \), are related by \( u_t = B_0^{-1} \epsilon_t \). Also, from above, we know that the immediate effect of structural shocks on \( z_t \) is given by \( B_0^{-1} \epsilon_0 \).

To impose the restriction that the immediate effect of a structural shock to variable 2 on variable 1 is zero, i.e. that \( (b_{01}^{12}) = 0 \), (where \( b_{01}^{12} \) denotes the element in the 1st row and 2nd column of the \( B_0^{-1} \) matrix), we use the reduced form error from the first equation of the reduced form system (2), \( u_{1t} \), as an instrument for the contemporaneous variable, \( z_{1t} \), in the second structural equation. Using \( u_{1t} \) as an instrument in the second structural equation, which has a structural error, \( \epsilon_{2t} \), ensures \( \text{cov}(u_{1t}, \epsilon_{2t}) = 0 \) which since \( u_t = B_0^{-1} \epsilon_t \) implies \( (b_{01}^{12}) = 0 \), i.e. The IV estimator ensures the moment condition \( E(M(Y - X'B)) = E(M\epsilon) = \text{cov}(M, \epsilon) = 0 \) holds where the instrument, \( M \) in this example is \( u_{1t} \) and \( \epsilon \) is \( \epsilon_{2t} \).

### 3.3 The Gali model of the US economy and 3 extensions with consumer confidence and stock prices

#### 3.3.1 Gali (1992) Model

The original Gali model (base model) is a four-variable SVAR with \( z_t = [\Delta y_t, \Delta i_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t)]' \) and \( w = 4 \). With no restrictions other than normalisation the system of equations can be written as:

\[
\begin{align*}
\Delta y_t &= b_1 - b_{12}^0 \Delta i_t - b_{13}^0 (i_t - \Delta p_t) - b_{14}^0 (\Delta m_t - \Delta p_t) + B_{1z}(L)z_t + \epsilon_{1t} \\
\Delta i_t &= b_2 - b_{21}^0 \Delta y_t - b_{23}^0 (i_t - \Delta p_t) - b_{24}^0 (\Delta m_t - \Delta p_t) + B_{2z}(L)z_t + \epsilon_{2t} \\
(i_t - \Delta p_t) &= b_3 - b_{31}^0 \Delta y_t - b_{32}^0 \Delta i_t - b_{34}^0 (\Delta m_t - \Delta p_t) + B_{3z}(L)z_t + \epsilon_{3t} \\
(\Delta m_t - \Delta p_t) &= b_4 - b_{41}^0 \Delta y_t - b_{42}^0 \Delta i_t - b_{43}^0 (i_t - \Delta p_t) - B_{4z}(L)z_t + \epsilon_{4t}
\end{align*}
\]

where \( B_{jz}(L) = B_{j1}L + B_{j2}L^2 + B_{j3}L^3 + B_{j4}L^4 \) where \( B_{j1}L \) is a vector made up of coefficients on the 1st lag of each variable in the vector, \( z_t \), for the \( j^{th} \) equation in the system.

Gali interprets the first equation as the aggregate supply function (AS), the second equation as the money supply function (MS), the third as the money demand function (MD) and the fourth as the investment-savings function (IS). The shocks, \( \epsilon_{1t}, \epsilon_{2t}, \epsilon_{3t} \) and \( \epsilon_{4t} \) are regarded as structural shocks to the AS, MS, MD and IS relations respectively. To exactly identify the model and therefore identify the four structural shocks, \( \epsilon_{1t}, \epsilon_{2t}, \epsilon_{3t} \) and \( \epsilon_{4t} \), six restrictions are imposed:
<table>
<thead>
<tr>
<th>Table 2: Identifying Restrictions Base Model</th>
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</thead>
<tbody>
<tr>
<td><strong>Long-Run Restrictions</strong></td>
</tr>
<tr>
<td>1. no long-run effects of MS shocks on $\Delta y_t$</td>
</tr>
<tr>
<td>2. no long-run effects of MD shocks on $\Delta y_t$</td>
</tr>
<tr>
<td>3. no long-run effects of IS shocks on $\Delta y_t$</td>
</tr>
<tr>
<td>$(B_0^{-1})$ Short-Run Restrictions</td>
</tr>
<tr>
<td>4-5. no immediate effect of MS or MD shocks on $\Delta y_t$</td>
</tr>
<tr>
<td>$(B_0)$ Short-Run Restriction</td>
</tr>
<tr>
<td>6. contemporaneous prices don’t enter the MS rule</td>
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</tbody>
</table>

There are three long-run restrictions which separate the supply shock from the three demand side shocks (MS, MD, IS). These long-run restrictions are based on the theory that demand shocks have only temporary effects on output and that it is only supply shocks that lead to permanent changes in output. As described in the identifying restrictions section above, these long-run restrictions are imposed through linear restrictions on $B(L)$. For example, we implement restriction 1 by imposing the following linear constraint:

$$b_{12}^4 = -b_{12}^0 - b_{12}^2 - b_{12}^3.$$

Each restriction has reduced the coefficients to be estimated by one as we no longer need to estimate the $b_{in}^4$, as these are functions of the other four estimated coefficients on the other lags of each variable. The long-run restriction allows us to rewrite the AS function with $\Delta i_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t)$ in the following difference form:

$$\Delta y_t = b_1 + \sum_{i=1}^{4} b_{11}^i \Delta y_{t-i} + \sum_{i=0}^{3} b_{12}^i (\Delta i_{t-i} - \Delta i_{t-4}) +$$
$$\sum_{i=0}^{3} b_{13}^i ((i_{t-i} - \Delta p_{t-i}) - (i_{t-4} - \Delta p_{t-4})) +$$
$$\sum_{i=0}^{3} b_{14}^i ((\Delta m_{t-i} - \Delta p_{t-i}) - (\Delta m_{t-4} - \Delta p_{t-4})) + \epsilon_{1t}$$

(11)

Restriction 6 that prices don’t contemporaneously enter the money supply rule eliminates $\Delta p_t$ from the MS rule which implies that $-b_{23}^0 = b_{23}^2$. With this restriction we can rewrite the MS function in the following form.

$$\Delta i_t = b_2 - b_{21}^0 \Delta y_t - b_{23}^0 (i_t - \Delta m_t) - B_{22}(L)z_t + \epsilon_{2t}$$

(12)
Restrictions 4 and 5 (the \( B_0^{-1} \) restrictions) are implemented in the estimation procedure. To estimate the model each structural equation is estimated separately using IV estimation. As described above the remaining contemporaneous variables after restrictions are imposed must be instrumented. The AS equation is estimated first. The three regressors that contain contemporaneous elements \((\Delta i_t - \Delta i_{t-4}), (i_t - \Delta p_t) - (i_{t-4} - \Delta p_{t-4})\) and \((\Delta m_t - \Delta p_t) - (\Delta m_{t-4} - \Delta p_{t-4})\) are instrumented with \(\Delta i_{t-1}, (i_{t-1} - \Delta p_{t-1})\) and \((\Delta m_{t-1} - \Delta p_{t-1})\) respectively. Once the restriction that contemporaneous prices don’t enter the MS rule is imposed, there are only two contemporaneous terms to estimate the model each structural equation is estimated separately using IV estimation. As described above the remaining contemporaneous variables after restrictions are imposed must be instrumented.

The residuals from the estimation of the structural AS equation, \(\epsilon_{1t}\) are used as an instrument for \((i_t - \Delta m_t)\). We then estimate the MD equation using \(u_{1t}\) as instrument for \(\Delta y_t\), which imposes restriction 5, and \(\epsilon_{2t}\) and \(\epsilon_{3t}\) as instruments for \(\Delta i_t\) and \((\Delta m_t - \Delta p_t)\) respectively. The fourth equation is then estimated using \(\epsilon_{1t}, \epsilon_{2t}\) and \(\epsilon_{3t}\) as instruments for \(\Delta y_t, \Delta i_t\), and \((i_t - \Delta p_t)\) respectively.

I estimate a further three models that are extensions of the Gali model. The variables sequentially added to the basic Gali model are confidence, stock prices and, finally, confidence and stock prices. These models and the restrictions used to identify them are summarised below.

### 3.3.2 The Gali Model including Consumer Confidence

The Gali model with consumer confidence is a five-equation SVAR with \(z_t = [\Delta y_t, \Delta i_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t), cl_t]'\) and \(w = 4\). With \(n = 5\) we require 10 restrictions to identify the structural model. Restrictions 1 to 5 are retained from the original model. The main change from the original model are the restrictions placed on the effect of confidence in the model and further \(B_0^{-1}\) restrictions on MD.

Confidence is a demand side influence so like the other demand side influences it is restricted to have no influence on \(y_t\) in the long-run. Confidence is also expected to have no immediate effect on \(y_t\) or the supply of money, \(m_t\). The central bank is assumed to wait for a while before it reacts to confidence data to be more certain a shift has taken place, and the goods market will increase supply only with a lag in response to a confidence increase, as firms will most likely want confirmation of demand increases before increasing production. Additional restrictions also include no immediate effect of money demand shocks on confidence or the real money supply, \(m_t - p_t\). 

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Table 3: Identifying Restrictions Confidence Model

<table>
<thead>
<tr>
<th>Long-Run Restrictions</th>
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<tbody>
<tr>
<td>1-4. no long-run effects of MS, MD, IS or confidence shocks on $\Delta y_t$</td>
</tr>
<tr>
<td>($B_0^{-1}$) Short-Run Restrictions</td>
</tr>
<tr>
<td>5-6. no immediate effect of confidence shocks on $\Delta y_t$, $m_t$</td>
</tr>
<tr>
<td>7-9. no immediate effect of MD shocks on $\Delta y_t$, $\Delta m_t - \Delta p_t$ and confidence</td>
</tr>
<tr>
<td>10. no immediate effect of MS shocks on $\Delta y_t$</td>
</tr>
</tbody>
</table>

With these restrictions the model can be written in the following form. The long-run restrictions implemented via linear restrictions on $B(L)$ eliminate four coefficients in the AS function and allow us to write the AS function with MS, MD, IS and confidence in difference form. The main difference from the base model is the addition of a 5th equation, the confidence function (CL function).

$$
\Delta y_t = b_1 + \sum_{i=1}^{4} b_{1i} \Delta y_{t-i} + \sum_{i=0}^{3} b_{12i} (\Delta i_{t-i} - \Delta i_{t-4}) + \\
\sum_{i=0}^{3} b_{13i} ((i_{t-i} - \Delta p_{t-i}) - (i_{t-4} - \Delta p_{t-4})) \\
+ \sum_{i=0}^{3} b_{14i} ((\Delta m_{t-i} - \Delta p_{t-i}) - (\Delta m_{t-4} - \Delta p_{t-4})) \\
+ \sum_{i=0}^{3} b_{15i} (cl_{t-i} - cl_{t-4}) + \epsilon_{1t}  \quad (13)
$$

$$
\Delta i_t = b_2 - b_{21}^{0} \Delta y_t - b_{23}^{0} (i_t - \Delta p_t) - b_{24}^{0} (\Delta m_t - \Delta p_t) - b_{25}^{0} cl_t + B_{25}^{0} (L) z_t + \epsilon_{2t}  \quad (14)
$$

$$
(i_t - \Delta p_t) = b_3 - b_{31}^{0} \Delta y_t - b_{32}^{0} \Delta i_t - b_{34}^{0} (\Delta m_t - \Delta p_t) - b_{35}^{0} cl_t + B_{35}^{0} (L) z_t + \epsilon_{3t}  \quad (15)
$$

$$
(\Delta m_t - \Delta p_t) = b_4 - b_{41}^{0} \Delta y_t - b_{42}^{0} \Delta i_t - b_{43}^{0} (i_t - \Delta p_t) - b_{45}^{0} cl_t - B_{45}^{0} (L) z_t + \epsilon_{4t}  \quad (16)
$$

$$
cl_t = b_5 - b_{51}^{0} \Delta y_t - b_{52}^{0} \Delta i_t - b_{53}^{0} (i_t - \Delta p_t) - b_{54}^{0} (\Delta m_t - \Delta p_t) - B_{54}^{0} (L) z_t + \epsilon_{5t}  \quad (17)
$$

The structural model is again estimated by IV. The instruments used are summarised in the following table. Variables and instruments are in corresponding order. $\epsilon_{nt}$ are the structural errors.
and \( u_{nt} \) are the reduced form errors with \( n = 1, 2, 3, 4, 5 \) corresponding to AS, MS, MD, IS and CL respectively.

### Table 4: Confidence Model Instruments

<table>
<thead>
<tr>
<th>Equation</th>
<th>Contemporaneous Variable</th>
<th>Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AS</td>
<td>((\Delta i_t - \Delta i_{t-4}), ((i_t - \Delta p_t) - (i_{t-4} - \Delta p_{t-4})))</td>
<td>(\Delta i_{t-1}, (i_{t-1} - \Delta p_{t-1}))</td>
</tr>
<tr>
<td></td>
<td>((\Delta m_t - \Delta p_t) - (\Delta m_{t-4} - \Delta p_{t-4})), (c_{t-1} - c_{t-4}))</td>
<td>(\Delta m_{t-1} - \Delta p_{t-1}, c_{t-5})</td>
</tr>
<tr>
<td>2. MS</td>
<td>(\Delta y_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t), c_{t})</td>
<td>(u_{1t}, \epsilon_{1t}, \epsilon_{5t})</td>
</tr>
<tr>
<td>3. MD</td>
<td>(\Delta y_t, \Delta i_t, (\Delta m_t - \Delta p_t), c_{t})</td>
<td>(u_{1t}, \epsilon_{1t}, \epsilon_{4t}, \epsilon_{5t})</td>
</tr>
<tr>
<td>4. CL</td>
<td>(\Delta y_t, \Delta i_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t))</td>
<td>(u_{1t}, u_{2t}, \epsilon_{3t}, \epsilon_{1t})</td>
</tr>
</tbody>
</table>

The choice of restrictions and instruments mean that the equations must be estimated in a particular order. The actual estimation order is AS, MD, CL, MS and IS. For example, IS uses structural residuals from the other four equations, \( \epsilon_{1t}, \epsilon_{2t}, \epsilon_{3t}, \epsilon_{5t} \), so it must be estimated last. Throughout the paper though, the ordering of equations and residuals etc. for descriptive purposes will remain: AS, MS, MD, IS, CL, DSP(stock price function) so that \( \epsilon_{1t} \) and \( \epsilon_{2t} \) always refer to the structural residuals from the AS and MS functions etc.

#### 3.3.3 The Gali model including stock prices

Again the SVAR has five variables with \( z_t = [\Delta y_t, \Delta i_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t), \Delta sp_t]' \) and \( w = 4 \). \( \Delta sp_t \) denotes the first difference of the real stock price, \( sp_t \). Ten restrictions other than the normalisation and the diagonal restriction on \( cov(\epsilon_t) = \Omega \) are required again. The main difference from the original model and the confidence model is that there are now six long-run restrictions. In theory we would expect long-run changes in real stock prices to be driven by changes in the discount factor and changes in real earnings, with the latter being a function of the supply-side of the economy. Therefore, shocks that affect demand such as MS, MD and confidence would not be expected to affect real stock prices in the long-run.

### Table 5: Identifying Restrictions Stock Price Model

<table>
<thead>
<tr>
<th>Long-Run Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3. no long-run effects of MS, MD or IS shocks on ( \Delta y_t )</td>
</tr>
<tr>
<td>4-6. no long-run effects of MS, MD or IS shocks on ( \Delta sp_t )</td>
</tr>
</tbody>
</table>

\((B_0^{-1})\) Short-Run Restrictions

<table>
<thead>
<tr>
<th>Short-Run Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. no immediate effect of MS shocks on ( \Delta y_t )</td>
</tr>
<tr>
<td>8-9. no immediate effect of MD shocks on ( \Delta y_t ) or ( \Delta m_t - \Delta p_t )</td>
</tr>
</tbody>
</table>

\((B_0)\) Short-Run Restrictions

<table>
<thead>
<tr>
<th>Short-Run Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. no immediate effect of stock price shocks on ( \Delta y_t )</td>
</tr>
</tbody>
</table>
The largest model estimated in the paper is a six equation SVAR with \( z_t \) investigate what effects these variables have on the business cycle once we control for both influences with six variables in the model, 15 restrictions are required to identify the model. The restrictions from the first three models are all used in this larger model. There are eight long-run restrictions with the demand side variables, MS, MD, IS and confidence having no effect on in the long-run on \( \Delta y_t \) or stock prices, which are both regarded as being functions of the long-run supply-side potential of the economy and influenced by such things as technology. Again, the DSP and AS functions are separately identified by the short-run restriction that stock prices don’t have an immediate effect on \( \Delta y_t \). The same short-run restrictions apply to MS, MD and confidence as in the confidence only model, with MD and confidence shocks having less immediate effects than MS shocks.

The model is estimated with IV using the following instruments where \( \epsilon_{nt} \) are the structural errors and \( u_{nt} \) are the reduced form errors with \( n = 1, 2, 3, 4, 5 \) corresponding to AS, MS, MD, IS and DSP respectively.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Contemporaneous Variable</th>
<th>Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AS</td>
<td>((\Delta i_t - \Delta i_{t-4}), (i_t - \Delta p_t) - (i_{t-4} - \Delta p_{t-4})))</td>
<td>(\Delta i_{t-1}, (i_{t-1} - \Delta p_{t-1}))</td>
</tr>
<tr>
<td>2. MS</td>
<td>(\Delta y_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t), \Delta sp_t)</td>
<td>(u_{1t}, \epsilon_{3t}, \epsilon_{4t}, \epsilon_{5t})</td>
</tr>
<tr>
<td>3. MD</td>
<td>(\Delta y_t, \Delta i_t, (\Delta m_t - \Delta p_t), \Delta sp_t)</td>
<td>(u_{1t}, \epsilon_{1t}, u_{4t}, \epsilon_{5t})</td>
</tr>
<tr>
<td>4. IS</td>
<td>(\Delta y_t, \Delta i_t, (i_t - \Delta p_t), \Delta sp_t)</td>
<td>(\epsilon_{1t}, \epsilon_{2t}, \epsilon_{3t}, \epsilon_{5t})</td>
</tr>
<tr>
<td>5. DSP</td>
<td>(\Delta y_t, (\Delta i_t - \Delta i_{t-4}), ((i_t - \Delta p_t) - (i_{t-4} - \Delta p_{t-4})),)</td>
<td>(\epsilon_{1t}, \Delta i_{t-1}, (i_{t-1} - \Delta p_{t-1}))</td>
</tr>
<tr>
<td></td>
<td>((\Delta m_t - \Delta p_t) - (\Delta m_{t-4} - \Delta p_{t-4})))</td>
<td>((\Delta m_{t-1} - \Delta p_{t-1}))</td>
</tr>
</tbody>
</table>

The choice of restrictions and instruments means the actual ordering of the equations for estimation is AS, DSP, MD, MS, IS.

### 3.3.4 The Gali model with confidence and stock prices

The largest model estimated in the paper is a six equation SVAR with \( z_t = [\Delta y_t, \Delta i_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t), \Delta i_t, \Delta sp_t]^\prime \) and \( w = 4 \). The model includes both confidence and stock prices to investigate what effects these variables have on the business cycle once we control for both influences. With six variables in the model, 15 restrictions are required to identify the model. The restrictions from the first three models are all used in this larger model. There are eight long-run restrictions with the demand side variables, MS, MD, IS and confidence having no effect on in the long-run on \( \Delta y_t \) or stock prices, which are both regarded as being functions of the long-run supply-side potential of the economy and influenced by such things as technology. Again, the DSP and AS functions are separately identified by the short-run restriction that stock prices don’t have an immediate effect on \( \Delta y_t \). The same short-run restrictions apply to MS, MD and confidence as in the confidence only model, with MD and confidence shocks having less immediate effects than MS shocks.
In this section I discuss and compare the dynamic responses of the US economy in the various models and how similar these are to the predictions of the IS/LM model. The original Gali model is used as benchmark for comparison throughout. As discussed above, we can obtain $C_j$, the impulse response of the system $z_t$ at $t = j$ to shocks at $t = 0$, $\epsilon_0$. Elements of $C_j$ are denoted $c^{jk}_i$, where $c^{jk}_i$ is the response of variable $i$ at $t = j$ to a shock to variable $k$, $\epsilon_k$ at $t = 0$. The plots below show the $c^{jk}_i$.
plotted against time and therefore show the response of different variables to the different structural shocks that have been identified in the estimated models.

4.1 Aggregate Supply Shocks

Figure 1 contains a summary of the effect of an aggregate supply shock on the US economy. The impulse responses of eight variables: real GNP (level), nominal interest rates (level), inflation, M1 growth, real interest rates (level), real money balances (level), confidence (level) and the stock price (level) to a positive AS shock are shown. Changes in GNP, interest rates and money balances are expressed in percentage points. The level of confidence and stock prices are expressed in units of their original indices. The size of the shock is one standard deviation of the residual in the AS function in the stock price and confidence model (approximately a shock of 0.9% to real GNP). The same size shock is imposed on all four models responses described above, and the responses are given by: original Gali model (grey lines), confidence only model (dashed lines), stock prices only model (dotted) and stock prices and confidence model (black lines).

In all four models the level of output rises permanently and prices fall initially consistent with the prediction of the IS/LM model for a positive supply shock. The dynamic response of the economy is similar to the original Gali model (grey lines) for all four models. In terms of the business cycle the key difference is that the effect of the AS shock is larger once we add in stock prices and confidence than in the original model. With the addition of stock prices and confidence there are two more channels by which the positive AS shock will lead to increases in demand and output. The AS shock increases output which in turn leads to higher incomes which presumably cause the jump in the level of confidence and stock prices which lead to greater increases in demand and output than in the base model. This results in higher inflation and interest rates than in the original model.

4.2 Money Supply Shocks

The effect of a money supply shock is shown for all four models in figure 2. The money supply shocks have been scaled so they are approximately the same in all four models, i.e. an increase of around 0.8% in the M1 money supply. Again the dynamic responses are similar across the models and reasonably consistent with the predictions of the IS/LM model, there is a temporary increase in output but the shock is ultimately inflationary. The MS shock leads to a fall in the nominal and real interest rates which drive a temporary increase in output. However, the shock is inflationary and interest rates rise over the medium-term. A key difference between the original model and the confidence and stock price models are that the liquidity effect, i.e. nominal interest rates initially
Figure 1: Dynamic Response to an Aggregate Supply Shock. Original Gali model (grey lines), confidence only model (dashed lines), stock prices only model (dotted) and stock prices and confidence model (black lines).
fall in response to the rise in the money supply, is smaller in the extended models with interest rates falling by lesser amounts.

The effect on GNP is more muted in the extended models than in the original model. The liquidity effect on interest rates is smaller in these models but confidence and stock price effects also play a role. In the stock price only model output nearly rises to the same peak as in the original model with initially lower interest rates acting to increase stock prices and demand, offsetting the smaller increase in interest rates. However, demand and output decline more quickly from their peak in the stock price model as stock prices fall and the wealth channel to demand and output reverses. In the models involving confidence output increases to a lower peak. The inflationary consequences of the MS shock and related interest rate increases outweigh any initial liquidity effect induced decrease in interest rates, at least in the quarterly frequency observed here, and confidence falls. The confidence channel acts to dampen demand and results in a smaller overall cycle in output than in the original model.

4.3 Money Demand Shocks

The impulse responses functions in figure 3 show an increase in money demand without a completely offsetting increase in the money supply leads to an increase in nominal and real interest rates and a fall in output as would be theoretically expected. A shock of one standard deviation of the money demand residual in the confidence and stock price model has been imposed on all four models. A key difference from the original model is that, while in the original model the money supply (M1) is increased in response to the demand shock, partly accommodating the increased demand for money, this does not occur in the extended models. This leads to higher interest rates and a greater fall in demand and output in the extended models. The confidence and stock price channels also have an influence in the extended models. If the MD shocks are scaled so that the interest rate increase is the same in all four models, output still declines in the extended models by more than in the original model. This is because the interest rate increase acts to decrease confidence and the stock price and therefore the confidence and wealth effects reduce demand and output initially. Once interest rates fall to offset the decrease in output and inflation, the confidence and stock price/wealth channels reverse and contribute to faster growth in GDP. Overall, the cycle is more exaggerated after an MD shock once confidence and stock price are added to the model.

4.4 IS Shocks

The response of the economy to an IS shock (e.g. an increase in Government spending) are shown in figure 4. The dynamic response of the economy is similar across all four models. As predicted by the IS/LM model an IS shock leads to an increase in interest rates, and as it is a demand side influence,
Figure 2: Dynamic Response to a Money Supply Shock. Original Gali model (grey lines), confidence only model (dashed lines), stock prices only model (dotted) and stock prices and confidence model (black lines).
Figure 3: Dynamic Response to a Money Demand Shock. Original Gali model (grey lines), confidence only model (dashed lines), stock prices only model (dotted) and stock prices and confidence model (black lines).
inflation. It also generates a temporary increase in output. The main difference between the original model and the extended models is that interest rates operate to crowd out activity through the confidence and stock price/wealth channels. Output and inflation rise by less in the extended models because of the dampening effect of interest rate rises on spending through confidence and stock prices. In this case the addition of confidence and stock prices leads to a dampened response of the business cycle to IS shocks.

4.5 Confidence Shocks

Figure 5 shows the response of the economy to a 4 point confidence shock. In an IS/LM framework an increase in confidence should lead to an increase in demand, spending and output in the short-run. With no offsetting increase in aggregate supply, inflation and higher interest rates will also arise in response to this increase in demand. The impulse responses support this prediction with initially output rising by 0.2% in response to the confidence shock. As would be expected, stock prices also rise with the increase in confidence. This is a result of the temporary increase in output and therefore higher expected profits. It may also be a result of better expectations of future earnings prospects associated with higher confidence. The addition of stock prices to the confidence only model (dashed lines) results in a more inflationary and consequently stronger interest rate response and a slightly more muted cycle in GNP. The addition of the wealth channel effect of confidence, i.e. from confidence to stock prices, generates further demand pressure which ultimately becomes inflationary.

4.6 Stock Price Shocks

A real stock price shock is theoretically expected to increase output. This is for two reasons, firstly the increase in stock prices is expected to increase demand via wealth effects and confidence. Secondly, real stock prices are a summary of future earnings prospects which are function in part of the supply side potential of the economy. A real stock price increase should therefore be predicting increases in AS and a long-run increase in the level of output.

The impulse responses in figure 6 show an initial deflation consistent with stock prices reflecting an increase in the supply side of the economy. Confidence also rises, as would be expected, and this, combined with wealth effects from the stock price increase, appears to increase demand faster than supply, leading to inflation and interest rate increases. This is unsurprising, as while the increase in supply side potential may be genuine, it is likely to take time to be fully realised, while the stock price increase brings all this future earnings gain to the present to be spent now generating more rapid demand increases. In the stock price only model (dotted lines) these inflationary effects are not sustained and eventually disappear. Once confidence is added there is a further demand channel and the extra pressure of this appears to be enough to generate sufficient inflation to perhaps
Figure 4: Dynamic Response to a IS Shock. Original Gali model (grey lines), confidence only model (dashed lines), stock prices only model (dotted) and stock prices and confidence model (black lines).
Figure 5: Dynamic Response to a Confidence Shock. Confidence only model (dashed lines), Stock prices and confidence model (black lines).
alter expectations and set-up a permanently higher rate of inflation that would only be removed by another shock.

5 The influence of consumer confidence and stock prices

This section discusses the influence of confidence and stock prices on the US business cycle. Two methods are used: variance decomposition of the forecast error and a historical decomposition of the US business cycle.

5.1 Variance Decomposition

One method commonly used to assess the influence of various shocks on variables in the system is to conduct a decomposition of the forecast error variance.

The vector autoregressive representation of the structural model is given by (1). The structural model can also be expressed in vector moving average (VMA) form where the coefficients, \( C(L) \), on the error terms, \( \epsilon_t \), are obtained as described above:

\[
\begin{equation}
z_t = c + C(L)\epsilon_t 
\end{equation}
\]

The VMA form implies that the h-step ahead forecast errors for the \((n \times 1)\) vector, \( z_t \), are given by:

\[
\begin{equation}
z_{t+h} - E_t z_{t+h} = \sum_{j=0}^{h-1} C_j \epsilon_{t+h-j}
\end{equation}
\]

where the \((n \times n)\) matrix \( C_j \) contains the impulse of \( z_{t+j} \) to the shocks \((n \times 1)\) vector of shocks \( \epsilon_t \).

The vector of total forecast error variances, \( \sigma^2_z \), are then given by:

\[
\begin{equation}
\sigma^2_z = \text{diag}(\sum_{j=0}^{h-1} C_j V \epsilon C_j^T)
\end{equation}
\]

where \( V \epsilon \) is the variance-covariance matrix for the error vector \( \epsilon_t \). The total forecast error variances rise as the forecast period extends as the error variances are non-negative. We can then decompose
Figure 6: Dynamic Response to a Stock Price Shock. Stock price only model (dotted lines), Stock prices and confidence model (black lines).
this total forecast error into the proportions of the error due to the various structural shocks. These proportions are given by:

$$\sigma^2_{zn} = \frac{\text{diag}(\sum_{j=0}^{h-1} C_j V_n C'_j)}{\text{diag}(\sum_{j=0}^{h-1} C_j V_n C'_j)}$$ (21)

where $\sigma^2_{zn}$ is the proportion of forecast error variance of $z_t$ due to shocks to the $n^{th}$ error and the variance-covariance matrix, $V_n$, has zeros elements except for $\text{var}(\epsilon_n)$.

If the proportion of the forecast error variance of variable in $z_t$, $y_t$, explained by a structural shock to $x_t$ is zero, then $y_t$ is regarded as exogenous to shocks in $x_t$. The higher the proportion of the total forecast error variance due to a shock, the more important it is as an influence on that variable.

The results for the decomposition of the GNP forecast error at horizons from 1 to 20 quarters in the confidence and stock price model are given in Table 9. They show that approximately 80% of the total forecast error of GNP is due to AS shocks in all future periods up 20 quarters. At very short horizons of 1-2 quarters IS shocks explain most of the remainder of the error variance of GNP but then their influence tapers off to be only 5% after 5 quarters. This is consistent with IS shocks being a temporary demand influence on the business cycle. Money demand shocks appear to explain a modest amount of the forecast error of GNP accounting for a maximum of 7% of the total forecast error at a forecast horizon of 7 quarters. Stock price shocks also explain a modest proportion of the total forecast error with their influence increasing as forecast horizon increases. Stock prices explain a maximum of 10% of the total variance of GNP over the forecast horizon considered. MS and confidence shocks appear to explain very little of the forecast error of GNP, only 1 and 2% respectively of the total GNP forecast error.

<table>
<thead>
<tr>
<th>Shock</th>
<th>AS</th>
<th>MS</th>
<th>MD</th>
<th>IS</th>
<th>CL</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 quarter</td>
<td>81.2</td>
<td>0</td>
<td>0</td>
<td>18.7</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>2 quarters</td>
<td>83.6</td>
<td>0.4</td>
<td>1.3</td>
<td>13</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>5 quarters</td>
<td>81</td>
<td>1</td>
<td>5.2</td>
<td>4.7</td>
<td>2.1</td>
<td>6</td>
</tr>
<tr>
<td>10 quarters</td>
<td>80</td>
<td>0.7</td>
<td>6.7</td>
<td>3.1</td>
<td>1.3</td>
<td>8</td>
</tr>
<tr>
<td>20 quarters</td>
<td>84</td>
<td>0.4</td>
<td>3.8</td>
<td>1.8</td>
<td>0.8</td>
<td>10</td>
</tr>
</tbody>
</table>

From the variance decomposition it appears that supply shocks are the most important influence on GNP with 4/5 of the total forecast error being attributable to AS shocks, with money demand, stock prices and IS shocks having a modest influence. It also would appear that MS and confidence shocks have almost no influence on GNP. Overall the variance decomposition results are contrary to
the Keynesian view that demand-side shocks are the key influences on the business cycle. However, a decomposition of the business cycle in the US in the next section indicates that confidence and the other shocks besides AS have a much more important role at some points in time than the variance decomposition suggests. The variance decomposition gives some indication of the relative importance of the shocks on average, but if large movements in some types of shocks are irregular and clustered together, then they may have a much bigger effect at those points in time than the variance decomposition would indicate.

This irregularity and clustering is an important feature of both confidence and stock price shocks. As shown in figure 7 confidence oscillates in a relatively small range until it makes a large movement to a new level, and it is at these points that it may have a large influence on the business cycle. Stock prices shown in figure 8 can also exhibit very large movements at irregular intervals, for example, from the mid 1990s through to the early 2000s. The next section decomposes US GNP from 1954-2003 to determine the relative influence of the various shocks in the eight recessions and eight completed expansions in the period.

5.2 Decomposition of the US business cycle 1954-2003

As noted in the variance decomposition section above the structural model can be expressed in vector moving average (VMA) form. To decompose the series in the system, $z_t = [\Delta y_t, \Delta i_t, (i_t - \bar{i})$. 

Figure 7: United States Consumer Confidence 1952-2003. Business cycle turning points are given by the vertical dashed lines, with grey areas representing recessions.
Figure 8: Real Standard and Poors 500 Stock Index 1953-2003. Business cycle turning points are given by the vertical dashed lines, with grey areas representing recessions.

\( \Delta p_t \), \( \Delta m_t - \Delta p_t \), \( cl_t \), \( \Delta sp_t \), into parts attributable to the separate shocks we separate the moving average representation (18) into components. Each component, \( z_{it} \), is given by:

\[
z_{kt} = \sum_{j=0}^{t} C_j \epsilon_{kt-j}
\]

(22)

where \( z_{kt} \) is the part of \( z_t \) due to the \( k^{th} \) shock and \( \epsilon_{kt-j} \) is an \( (n \times 1) \) vector of errors with zero elements in all rows except the \( k^{th} \) in the time period \( t = t - j \). Note that:

\[
z_t = \sum_{k=1}^{n} z_{kt}
\]

(23)

Figure 9 shows a decomposition of GNP into the components of the GNP moving average due to each of the structural shocks. The plots show the effect that each of the shocks has on the level of GNP in percentage points. As a positive constant has already been extracted from the GNP growth rate the effects of these shocks to the GNP level are around a drift in the GNP level equal to quarterly growth of 0.8%. The dotted vertical lines represent the turning points (peaks and troughs) in the business cycle with periods of recession shaded in grey.

The plots reveal a number of notable features about the role of these six separately identified influences on the US business cycle over the last 50 years. First, is the important effect during
Figure 9: Decomposition of GNP into components due to each shock. The dotted vertical lines represent the turning points (peaks and troughs) in the business cycle with periods of recession shaded in grey.
the long 1960s expansion, of a strong series of positive supply shocks in the early to mid 1960s, which increased the level of GNP by around ten percent. The negative supply shocks caused by the OPEC’s driven oil price increases in the 1970s are also clearly visible during the 1974:1-1975:1 recession and before the 1980:3-1981:3 recession.

Money supply shocks were small up until the 1970s but appear to have played a role in a number of expansions and contractions since then. Monetary policy tightening appears to have had a clear role in the recessions in the mid 1970s and early 1980s. Money demand shocks also had significant influence on the business cycle in the late 1970s and in the 1980:3-1981:3 recession where money demand shocks lifted the level of GNP by 2% in the 1970s and then this reversed, with money demand becoming a negative influence of around 3% on the GNP level by 1982.

In contrast to supply shocks, IS shocks were relatively muted up until the end of the 1970s, but have had a more important role since then, with a clearly visible effect in all the expansions since the end of 1970. Negative consumer confidence shocks had a clear influence on recessions in the late 1950s, early 1970s, the second recession in the early 1980s and the 1990s recession. Confidence has contributed, mainly positively, to expansions, except in the 1970s when its negative influence lessened during expansions.

Finally, real stock prices, were a positive influence on GNP in the 1960s, but then became a negative influence until the mid 1990s. This is consistent with the very favorable supply-side shocks experienced in the US in the 1960s and the subsequent difficulties in the 1970s and 1980s, which would have influenced earnings expectations significantly positively and then negatively. The largest effect of stock price shocks on GNP occurred in the late 1990s and into the early 2000s, when stock prices were at first a large positive influence on GNP, but later reversed with the bursting of the US stock market bubble.

The plots show that while all shocks have had at least some influence on the cycle, and that expansions and contractions have had a number of causes, it is also important to know the relative importance of each shock. The table below gives the proportion of total GNP change due to each of the shocks arising in each of the eight recessions and eight expansions from 1954-2001 as dated by the NBER. They show that confidence and stock prices have had a much more important influence on the US business cycle at some points in time than the variance decomposition results indicated.
The variance decomposition results suggested that stock price shocks were responsible for around 5-10% of the total forecast error in GNP and this is consistent with the historical decomposition done here, at least up until the 1990s. However, in the late 1990s, and in the subsequent 2001 recession stock prices had a more important role in the US business cycle. Stock price shocks were responsible for 17% of the total movement of GNP in the 1991:2-2001:1 expansion. They were dominant in the subsequent 2001 recession producing 40% of the movement in GNP. This important role is due to the large size of the 1990s stock price bubble and subsequent crash. The price earnings multiple reached a peak of 43 in 2000 compared to 24 in 1966, 32 in 1929 and 24 in 1901 and an average over 1881-2004 of 16. Stock prices fell nowhere near as far as in the 1929 crash, but the fall in 2000-2001 was still significant, with the real S&P 500 index falling 24% from August 2000 to November 2001. While stock prices may not always be an important influence on the business cycle, it is occasions such as the 1990s bubble that suggest that, at irregular intervals, they can become a key influence.

Consumer confidence shocks have in the past often had a more important influence on the business cycle than the variance decomposition results would suggest. The strongest role of confidence was in the early 1990s recession where 16% of the total movement in GNP due to shocks was due to confidence shocks. Confidence has been identified in the literature (see Blanchard(1993)) as being a potentially important influence on the early 1990s recession, but confidence has also had a significant influence (10% and over) on a number of other recessions and expansions including the expansions during the mid 1950s, the beginning of the 1960s and subsequent long 1960s expansion, in the early

### Table 10: Proportion of GNP growth due to structural shocks 1954-2001

<table>
<thead>
<tr>
<th>Period</th>
<th>Rec/Exp</th>
<th>AS</th>
<th>MS</th>
<th>MD</th>
<th>IS</th>
<th>CL</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954:2-1957:3</td>
<td>E</td>
<td>0.47</td>
<td>0.04</td>
<td>0.08</td>
<td>0.26</td>
<td>0.10</td>
<td>0.05</td>
</tr>
<tr>
<td>1957:4-1958:2</td>
<td>R</td>
<td>0.58</td>
<td>0.02</td>
<td>0.07</td>
<td>0.21</td>
<td>0.08</td>
<td>0.04</td>
</tr>
<tr>
<td>1958:3-1960:2</td>
<td>E</td>
<td>0.55</td>
<td>0.04</td>
<td>0.12</td>
<td>0.18</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>1960:3-1961:1</td>
<td>R</td>
<td>0.56</td>
<td>0.06</td>
<td>0.10</td>
<td>0.13</td>
<td>0.11</td>
<td>0.04</td>
</tr>
<tr>
<td>1961:2-1969:4</td>
<td>E</td>
<td>0.47</td>
<td>0.05</td>
<td>0.08</td>
<td>0.19</td>
<td>0.11</td>
<td>0.09</td>
</tr>
<tr>
<td>1970:1-1970:4</td>
<td>R</td>
<td>0.48</td>
<td>0.04</td>
<td>0.15</td>
<td>0.19</td>
<td>0.05</td>
<td>0.09</td>
</tr>
<tr>
<td>1971:1-1973:4</td>
<td>E</td>
<td>0.43</td>
<td>0.07</td>
<td>0.12</td>
<td>0.20</td>
<td>0.12</td>
<td>0.06</td>
</tr>
<tr>
<td>1974:1-1974:4</td>
<td>R</td>
<td>0.47</td>
<td>0.05</td>
<td>0.14</td>
<td>0.21</td>
<td>0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>1975:1-1980:1</td>
<td>E</td>
<td>0.49</td>
<td>0.08</td>
<td>0.12</td>
<td>0.18</td>
<td>0.09</td>
<td>0.06</td>
</tr>
<tr>
<td>1980:2-1980:3</td>
<td>R</td>
<td>0.53</td>
<td>0.04</td>
<td>0.02</td>
<td>0.33</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>1980:4-1981:3</td>
<td>E</td>
<td>0.20</td>
<td>0.07</td>
<td>0.23</td>
<td>0.26</td>
<td>0.16</td>
<td>0.09</td>
</tr>
<tr>
<td>1981:4-1982:4</td>
<td>R</td>
<td>0.18</td>
<td>0.05</td>
<td>0.30</td>
<td>0.26</td>
<td>0.12</td>
<td>0.09</td>
</tr>
<tr>
<td>1983:1-1990:3</td>
<td>E</td>
<td>0.34</td>
<td>0.08</td>
<td>0.13</td>
<td>0.25</td>
<td>0.11</td>
<td>0.08</td>
</tr>
<tr>
<td>1990:4-1991:1</td>
<td>R</td>
<td>0.36</td>
<td>0.07</td>
<td>0.08</td>
<td>0.22</td>
<td>0.16</td>
<td>0.11</td>
</tr>
<tr>
<td>1991:2-2001:1</td>
<td>E</td>
<td>0.30</td>
<td>0.08</td>
<td>0.13</td>
<td>0.20</td>
<td>0.12</td>
<td>0.17</td>
</tr>
<tr>
<td>2001:2-2001:4</td>
<td>R</td>
<td>0.35</td>
<td>0.04</td>
<td>0.04</td>
<td>0.11</td>
<td>0.05</td>
<td>0.40</td>
</tr>
</tbody>
</table>
expansion in the 1970s and in all expansions and recessions from 1980:4-2001:1. This stronger historical influence than the variance decomposition might suggest arises from the clustering of large movements in confidence at certain points in time.

While it appears that confidence shocks have had a significant effect on the US business cycle historically, another key issue, which has been a central focus of the consumer confidence literature, is whether confidence assists in forecasting US output. In the next section I conduct an out-of-sample forecasting exercise to examine this question.

6 Do confidence and stock prices help forecast US GNP?

Forecasting output and, more particularly, the turning points in the business cycle is a difficult exercise, because as the historical decomposition shows, the switches from one phase (expansion/contraction) to another occurs due to a combination of shocks that vary in type and relative strength over time.

A key question in the empirical literature has been whether confidence data provides incremental predictive information beyond that contained in other macroeconomic variables considered determinants of consumption and total output. The underlying question is whether confidence is an independent cause of fluctuations in the economy or it just forecasts future economic activity using various economic indicators and is not a separate cause. The approach of most of the literature is to add lags of consumer confidence to a model explaining consumption or GDP or probability of recession with a variety of controls such as lags of the dependent variable interest rates and stock prices. The latter two are particularly popular controls because they have been shown to be useful in predicting output (see Estrella and Mishkin (1998)) and are available at high frequency. The aim of most exercises is to test for Granger-causality from confidence to consumption or output. This approach focuses on the average effect of lagged confidence on consumption.

The main finding for the United States is that there is, on average, a small amount significant predictive information in confidence for consumption spending and total output (see Carroll, Fuhrer and Wilcox (1994), Kumar, Leone, Gaskins (1995), Howey (2001), Ludvigson (2004), Slacalek (2004)) Matsusaka and Sbordone (1995) and Howrey (2001) show that confidence contains incremental predictive information about GNP and the probability of recession respectively. However there are some contrary findings, Chopin and Durrat (2000), Ivanova and Lahiri (2001), Mehra and Martin (2003) find there is on average no significant incremental predictive information in confidence for consumption spending. These conflicting results most likely arise from using different sample periods, data frequency and components of both consumption and the two main consumer confidence series, the Conference Board and University of Michigan series.

Overall, the evidence from the United States suggests that consumer confidence data does contain some incremental predictive information about consumption and total output, and therefore that it
maybe an independent source of fluctuations in the U.S. economy. The finding in the literature of a small size for this effect, may arise because confidence does not always play a role in fluctuations and that some potentially important predictive information is being averaged with small noisy movements in confidence that have no information content.

In this section I conduct an out-of-sample forecasting exercise with all four models discussed above and compare these to forecasting with an AR(2). The AR(2) was estimated using the general to specific estimation strategy, dropping lags until the last one is significant at the 5% level. The issue is whether confidence and stock prices provide additional information in predicting output beyond that contained in output itself and other key variables such as interest rates. Given that stock prices and confidence shocks have been a significant influence on the business cycle, at least at some points in time, it is expected they will provide some additional assistance in forecasting output.

The forecasts are one quarter ahead out-of-sample forecasts of $\Delta y_t$ over the period 1979:1-2003:4. All reduced form equations are estimated from 1953:1-1978:4 and a forecast is constructed for 1979:1. The equations are then re-estimated from 1953:1-1979:1 and forecasts are constructed for 1979:2, and so on. Forecasting is done with the reduced form equations as it is not necessary to identify particular structural shocks in a forecasting exercise because we are interested in $e_t = \Delta y_t - E_{t-1} \Delta y_t$, the one step ahead forecast errors for the growth rate of GNP. The forecasts are assessed using the root mean square error (RMSE)$^1$ over different forecast periods.


The results are summarised in the table below, which gives the ratio of the RMSE for the forecast from the various models to the RMSE from the base model (the original Gali model). Columns 1 to 4 contain results from an AR(2) and autoregressive distributed lag models (ARDL) with 2 lags.

\[
RMSE = \sqrt{\frac{1}{T} \sum_{t=1}^{T} (\Delta y_t - E_{t-1} \Delta y_t)^2}
\]
of confidence and 2 lags of GNP (column 2) and so on. Columns 5 to 8 contain results from the four VARs described earlier. An AR(2) of US GNP is estimated and compared to other models to determine the effect of additional information beyond that contained in the series itself. In the forecasting exercise only 2 lags of each variable are used so that the effect of adding variables can be identified separately from increasing the lag order to four.

<table>
<thead>
<tr>
<th>Model</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979:1-2003:4</td>
<td>0.88</td>
<td>0.82</td>
<td>0.94</td>
<td>0.93</td>
<td>1</td>
<td>0.97</td>
<td>1.04</td>
<td>1.04</td>
</tr>
<tr>
<td>1979:1-1983:4</td>
<td>1.26</td>
<td>1.09</td>
<td>0.97</td>
<td>1.03</td>
<td>1</td>
<td>1.03</td>
<td>0.97</td>
<td>1.02</td>
</tr>
<tr>
<td>1984:1-1989:4</td>
<td>0.39</td>
<td>0.42</td>
<td>1.05</td>
<td>0.68</td>
<td>1</td>
<td>0.95</td>
<td>1.05</td>
<td>1.04</td>
</tr>
<tr>
<td>1990:1-1994:4</td>
<td>0.76</td>
<td>0.74</td>
<td>0.98</td>
<td>0.67</td>
<td>1</td>
<td>0.96</td>
<td>0.99</td>
<td>0.95</td>
</tr>
<tr>
<td>1995:1-1999:4</td>
<td>0.69</td>
<td>0.69</td>
<td>1.19</td>
<td>1.30</td>
<td>1</td>
<td>0.88</td>
<td>1.19</td>
<td>1.17</td>
</tr>
<tr>
<td>2000:1-2003:4</td>
<td>0.88</td>
<td>1.02</td>
<td>1.05</td>
<td>0.97</td>
<td>1</td>
<td>1</td>
<td>1.05</td>
<td>1.03</td>
</tr>
<tr>
<td>recessions</td>
<td>1.14</td>
<td>0.99</td>
<td>1.05</td>
<td>0.97</td>
<td>1</td>
<td>0.99</td>
<td>0.90</td>
<td>0.88</td>
</tr>
<tr>
<td>booms</td>
<td>1.07</td>
<td>0.98</td>
<td>1.13</td>
<td>1.13</td>
<td>1</td>
<td>0.95</td>
<td>1.13</td>
<td>1.18</td>
</tr>
</tbody>
</table>

Over the whole out-of-sample forecast period, the AR(2) has a better forecast performance than the VAR models. However, confidence does contain additional information that improves out-of-sample forecast performance. This can be seen by comparing the AR(2) results with the $\Delta y_t, cl_t$ column. If two lags of confidence, $cl_t$, are added to the AR(2) the RMSE falls from 88% to 82% of the base model’s RMSE over the whole period. Comparing the confidence and base columns shows that adding confidence to the base (Gali) VAR model, which has a number of controls including real interest rates and the real money supply, also lowers the RMSE over the whole period.

When stock prices and stock prices and confidence are added to the AR(2) (columns 3 and 4 respectively) there is no improvement in forecast performance over the whole sample. The stock price and confidence and stock price model also show no improvement over the base model if compared over the whole forecast period. However, during recession periods, when there is intense interest in the business cycle from economists and policy makers, the confidence, stock price and stock price and confidence models all predict better than the base model and the AR(2). This is particularly the case for the VAR models including stock prices. During booms, also periods of heightened interest in the business cycle, adding confidence improves the forecasts compared to the base model and the AR(2). Adding stock prices or stock prices and confidence together worsens the forecast compared to an AR(2) and the base model during boom periods.

The results show that confidence is useful in increasing forecast accuracy overall and during recessions and booms, when the focus by policy-makers is at its strongest. The usefulness of stock
prices is more limited, but they do appear to help forecasting GNP during recession periods. This is consistent with Estrella and Mishkin (1998) who found that stock prices were useful in predicting the probability of recession.

An average of a variety of forecasts normally predicts better than any single forecast and in this case taking a average of the AR(2) and other model forecasts combines the relative stability of the AR(2) forecast, which has good overall forecast performance, with extra information from confidence and stock prices, which are particularly useful in forecasting extreme periods. The results of averaging the forecasts from the VARs with the AR(2) are shown in the table below. Over the whole sample period, the prediction formed by calculating the average of the forecasts from the AR(2) and the confidence model produces the lowest RMSE. This combination also performs relatively well during recessions and booms compared to all single and average forecast combinations.

<table>
<thead>
<tr>
<th>Model</th>
<th>Base</th>
<th>Confidence</th>
<th>Stock Prices</th>
<th>Confidence &amp; Stock Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979:1-2003:4</td>
<td>0.79</td>
<td>0.78</td>
<td>0.81</td>
<td>0.81</td>
</tr>
<tr>
<td>1979:1-1983:4</td>
<td>0.92</td>
<td>0.92</td>
<td>0.95</td>
<td>0.97</td>
</tr>
<tr>
<td>1984:1-1989:4</td>
<td>0.60</td>
<td>0.58</td>
<td>0.63</td>
<td>0.62</td>
</tr>
<tr>
<td>1990:1-1994:4</td>
<td>0.79</td>
<td>0.76</td>
<td>0.76</td>
<td>0.75</td>
</tr>
<tr>
<td>1995:1-1999:4</td>
<td>0.81</td>
<td>0.76</td>
<td>0.88</td>
<td>0.86</td>
</tr>
<tr>
<td>2000:1-2003:4</td>
<td>0.89</td>
<td>0.89</td>
<td>0.83</td>
<td>0.85</td>
</tr>
<tr>
<td>recessions</td>
<td>0.90</td>
<td>0.88</td>
<td>0.87</td>
<td>0.86</td>
</tr>
<tr>
<td>booms</td>
<td>0.95</td>
<td>0.93</td>
<td>1</td>
<td>1.02</td>
</tr>
</tbody>
</table>

Because the type and intensity of shocks varies over time the usefulness of variables in forecasting will also vary. This suggests caution in dismissing an indicator or model because it hasn’t improved forecast performance in the past. For example, while an average of the AR(2) and the forecast from the stock price model is not always the best predictor of output growth, it does outperform all other forecasts in the 2000:1-2003:4 period when stock price shocks were having a large influence on the business cycle.

Overall, the above results suggest that including confidence in the model makes a small improvement in forecasting performance over the base and AR(2) models and that an average of the AR(2) and the confidence model will produce the best performing forecasts over the longer-run during most events. Using stock prices can also improve forecast performance during recessions, and when stock prices are an important influence on the business cycle, which is not always the case.
7 Conclusion

The results in this paper show that adding consumer confidence and stock prices to a small SVAR model of the US economy has important effects on the dynamic response of the US economy. A positive shock to consumer confidence of 4 index points will temporarily increase the level of GNP by 0.2% and it is not uncommon for confidence shocks to total a net of 20 points in one direction in a few consecutive quarters. Stock prices also have an effect on the business cycle with a 40 point shock (equivalent to 5% of the December 2003 real S&P 500) leading to a permanent 0.4% increase in the level of GNP. Adding confidence and stock prices to the model also provides two further channels through which other shocks can affect the economy. MS and IS shocks have a more moderate influence on the business cycle with the confidence and stock price/wealth channels operating, while the effect of AS and MD shocks are more exaggerated.

Although the variance decomposition analysis reveals that shocks to confidence and stock prices explain a maximum of 2% and 10% respectively of the forecast error variance of GNP, a historical decomposition of US GNP shows that at certain times the influence of confidence and stock prices has been much larger. Confidence shocks were responsible for 16% of the total effect of structural shocks on GNP growth in the early 1990s recession, and the proportion of total shocks to GNP attributable to confidence has often been above 10% in various phases of the US business cycle between 1957 and 2001. Stock prices have also been more important than the variance decomposition would suggest, especially in the late 1990s and early 2000s at the time of the stock-price bubble. The more important historical influence of these shocks has arisen because large shocks to consumer confidence and stock prices often cluster in irregular short periods, and this leads to a greater effect on GNP than an experiment where the shocks to these variables is the same in every period, as is the case with the variance decomposition.

The out-of-sample forecasting exercise shows that over the whole forecast period, 1979:1-2003:4, the addition of confidence to the base (Gali) model and AR(2) models leads to a small improvement in forecasting performance. Adding stock price information appears to improve forecasts during recessions, but otherwise worsens the forecasts. Combining forecasts can improve performance, and an average of the forecasts from the confidence model and the AR(2) is found to provide the best out-of-sample forecasting performance overall. Finally, the relative forecasting performance of the various models/methods varies quite markedly across time depending on the relative importance of various shocks. This indicates that a variable’s importance for forecasting cannot be dismissed on the basis of one historical period.

Overall, the above analysis provides evidence that both consumer confidence and stock prices have an important role in the United States business cycle, especially at times when a cluster of large shocks to either of them occurs.
References


## A Unit Root Tests

This appendix summarises unit root tests on the main variables in the model, $\Delta y_t, \Delta i_t, (i_t - \Delta p_t), (\Delta m_t - \Delta p_t), cl_t, \Delta sp_t$. Augmented Dickey Fuller (ADF) tests suggest that all series are I(0).

The general form of the ADF test is given by:

$$
\Delta y_t = \alpha_0 + \gamma y_{t-1} + \alpha_2 t + \sum_{i=2}^{j} \beta_i \Delta y_{t-i+1} + \varepsilon_t
$$

(24)

The final form of the test equation is selected using the general to specific method. The lag length is selected by reducing the number of lags from a maximum until the longest lag is significant at the 5% level using the usual t-test. The deterministic regressors are included if their coefficients are significant at the 5% level using the critical values provided by Enders (1997) for testing these coefficients in the presence of a unit root. Once the final form of the test equation is determined the null hypothesis of a unit root ($\gamma = 0$) is tested using the Dickey Fuller critical values appropriate for that functional form. If $\gamma$ is significantly different from zero at the 5% level we conclude there is no unit root, i.e. the series is stationary or I(0).

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\alpha_0$</th>
<th>$\gamma$</th>
<th>$\alpha_2$</th>
<th>$\beta_1$</th>
<th>$\beta_2$</th>
<th>$\beta_3$</th>
<th>$\beta_4$</th>
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<tbody>
<tr>
<td>$\Delta y_t$</td>
<td>0.05</td>
<td>-0.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t statistic</td>
<td>6.54(*)</td>
<td>-10.15(*)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta i_t$</td>
<td></td>
<td>-1.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t statistic</td>
<td>-14.83(*)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$(i_t - \Delta p_t)$</td>
<td>-0.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t statistic</td>
<td>-2.65(*)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$(\Delta m_t - \Delta p_t)$</td>
<td>-0.38(*)</td>
<td></td>
<td>-0.21</td>
<td>-0.08</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t statistic</td>
<td>-4.96(*)</td>
<td></td>
<td>-2.6(*)</td>
<td>-1</td>
<td>-2.4(*)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$cl_t$</td>
<td>8.27</td>
<td>-0.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>t statistic</td>
<td>3.12(*)</td>
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<td>-3.14(*)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta sp_t$</td>
<td>-0.55</td>
<td></td>
<td>-0.39</td>
<td>-0.27</td>
<td>-0.19</td>
<td>-0.17</td>
<td>-0.27</td>
<td></td>
</tr>
<tr>
<td>t statistic</td>
<td>-3.89(*)</td>
<td></td>
<td>-2.9(*)</td>
<td>-2.2(*)</td>
<td>-1.63</td>
<td>-1.7</td>
<td>-3.49(*)</td>
<td></td>
</tr>
</tbody>
</table>
(*) indicates significance at the 5% level, critical values vary depending on the coefficient being tested and the functional form.

B Data Description and Sources

<table>
<thead>
<tr>
<th>Name</th>
<th>Symbol</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNP</td>
<td>y</td>
<td>Log of real seasonally adjusted chain-linked GNP at 2000 prices</td>
<td>Bureau of Economic Analysis Table 1.7.6</td>
</tr>
<tr>
<td>Money Supply</td>
<td>m</td>
<td>log of the M1 money supply</td>
<td>Federal Reserve, Rasche (1987)</td>
</tr>
<tr>
<td>Confidence</td>
<td>cl</td>
<td>University of Michigan overall Index of Consumer Sentiment</td>
<td>University of Michigan Survey Research Centre</td>
</tr>
<tr>
<td>Stock Prices</td>
<td>sp</td>
<td>Real Standard and Poors 500 Index of U.S. stock prices (Nominal SP Index deflated by the CPI)</td>
<td>Robert Schiller <a href="http://www.econ.yale.edu/">www.econ.yale.edu/</a> shiller</td>
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