Information Shocks, Animal Spirits, and the Meaning of Innovations in Consumer Confidence*

Robert B. Barsky†
*University of Michigan and NBER

Eric R. Sims‡
*University of Michigan

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Abstract

We show that unexplained innovations in several variables representing survey responses to forward-looking questions on the Michigan Survey of Consumers have powerful prognostic implications for the future paths of macroeconomic variables. We attempt to distinguish the hypothesis that these impulse responses indicate a causal channel from autonomous movements in sentiment to economic outcomes (the “animal spirits” view) from the alternative interpretation that the surprise confidence movements summarize information about future economic prospects (the “information” view). In natural rate models, “animal spirits” shocks are associated with “overshooting” of (among other variables) consumption that attenuates when agents come to grips with their overreaction, while “information shocks” about the long future are followed by gradual movements in macroeconomic variables that are not subsequently reversed. In a baseline vector autoregression involving consumption, income, and confidence, the data come down sharply in favor of the information view. The impulse responses of consumption and GDP show no tendency to attenuate even after a number of years. Further, confidence innovations have strong implications for labor productivity many quarters into the future. In somewhat larger VARs with an information block that includes inflation and/or stock prices, the impulse responses to confidence innovations continue to have the permanent shape that defines information shocks, but they are smaller in magnitude. We demonstrate that this is due to the fact that both inflation and stock price innovations have prognostic implications for future productivity that are very similar to the implications of innovations in confidence. Addition of unemployment to the system induces a transitory component that changes the shape of the impulse responses and somewhat weakens the previously airtight case against animal spirits, but it does not provide constructive evidence of such effects.

†: barsky@umich.edu
‡: ericsims@umich.edu

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I. Introduction

In the popular press and much of the business community it continues to be an article of faith that “consumer confidence” has an important role – both prognostic and causal – in macroeconomics. On the other hand, the stance of the rather limited academic literature on confidence is far more ambiguous. The judgments range from the conclusion that confidence measures have an important role both in prediction and understanding the cause of business cycles, to the view that they contain important information but have little role in the assignment of causality, to the verdict that they have no value even in forecasting.

There are, broadly speaking, two contrasting approaches to the role of confidence in macroeconomics. The first, which we will refer to as the “animal spirits” view, posits autonomous fluctuations in beliefs and consumption that in turn have causal effects on economic activity. In the proceedings of a symposium on the causes of the 1990-1991 recession, both Hall (1993) and Blanchard (1993) regard exogenous movements in consumption as a cause of business cycles.\(^1\) Indeed, Blanchard proposes that the cause of the recession was a powerful, long-lasting negative consumption shock associated with an exogenous shift in pessimism that had a causal effect on consumption and overall aggregate demand. While not pursuing the idea in his brief paper, Blanchard proposes that one might be able to test this hypothesis on the basis of the observation that such an exogenous shift in pessimism ought to have only temporary effects on consumption.\(^2\)

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\(^1\) In an interesting but almost forgotten early contribution, Hall (1986) – partially repudiating Hall (1978) – argued that an important fraction of the random walk in consumption comes not from the expectational surprise in the Euler equation but from a second disturbance that he has more recently referred to as “spontaneous consumption”. In Hall (1992), this is interpreted as a shock to the taste for consumption relative to leisure.

\(^2\) In some ways, a limiting case of animal spirits appears in the “sunspot” literature. Though pinned down only by extrinsic coordinating variables, expectations in the equilibria of these models are self-fulfilling, and thus not irrational. The existence of sunspot equilibria depend on strong increasing returns, supply externalities, or other mechanisms that are typically not accepted as empirically plausible. The notion of animal spirits in this paper does
The second view of confidence – what we will call the “information view” – suggests that a relationship between innovations in measures of consumer confidence and subsequent macroeconomic activity arises because confidence measures contain information about the future evolution of the economy. For example, Cochrane (1994b) proposes that consumption surprises proxy for news that consumers receive about future productivity that does not otherwise show up in econometricians’ information sets. His attempt to reconcile VAR evidence with theory closely anticipates the “news approach to business cycles” of Beaudry and Portier (2004, 2005).

In Section II of the paper, we first show that unexplained innovations in several variables representing survey responses to forward-looking questions from the Michigan Survey of Consumers have powerful predictive implications for the future paths of macroeconomic variables. In particular, within the context of small VARs, we show that unexplained innovations in consumer confidence have significant, slowly building, and apparently permanent effects on measures of real economic activity. The predictive implications of innovations in confidence for activity variables are far stronger when one uses a select few of the purely forward looking individual questions from the survey as opposed to the overall index number.

We next attempt to distinguish the hypothesis that these impulse responses indicate a causal channel from sentiment to economic outcomes (the “animal spirits” view) from the alternative interpretation that the surprise confidence movements summarize information about future economic prospects known to consumers but unobservable to the econometrician (the “superior information” view). We present a model in which “animal spirits” shocks are associated with “overshooting” of consumption that attenuates when agents come to grips with their erroneous expectations. (See Lorenzoni (2005) for another recent model with this flavor).

Not cover sunspots. However, Susanto Basu pointed out to us that the most common sunspot models have stationary equilibria, and that these would presumably generate the same transitory impulse responses that are associated with animal spirits effects as defined here.
On the other hand, “information shocks” regarding the long future are followed by gradual movements in the macroeconomic variables that are not subsequently reversed.

We formalize an information shock as a structural innovation that is orthogonal to current output but has a permanent effect on future output. Likewise, a transitory shock or potential animal spirits shock is one that raises output over at least several quarters, but not over several years. Using agnostic identification procedures of the sort proposed by Faust (1998) and Uhlig (1999), we identify an entire range of shocks satisfying each of these criteria. We find that reduced form innovations in confidence are highly correlated with structural innovations satisfying the criteria of an information shock. Further, confidence innovations are essentially uncorrelated with structural innovations identified as having transitory consequences for output. The first result further reinforces the notion that movements in confidence are to an important extent proxies for information shocks. The second indicates that the trivariate VAR does not provide evidence of an important animal spirits channel from confidence to output.

The robustness of the “information shock” interpretation to the inclusion of information beyond output is studied in the context of slightly larger systems in Section V. Regressing observed confidence innovations on “news heard” categories from the Michigan Survey, we find that confidence innovations – which appear exogenous in the three variable system – are somewhat explicable by news about inflation, with news about unemployment and stock prices playing slightly less important, though non-negligible, roles. The inclusion of inflation and/or stock prices into the VAR generally reduces the magnitude of the impulse responses of output and consumption to orthogonalized innovations in confidence. Importantly, the responses still appear permanent – and thus consistent with the information approach and not the animal spirits view of confidence.
We show that – taken separately – innovations in confidence measures, innovations in inflation, and innovations in stock prices each predict large and permanent changes in future labor productivity, even after orthogonalization with respect to current productivity.\(^3\) The effects of each are of approximately the same magnitude and have the same temporal pattern. Within our proposed information shock context, the finding of a strong commonality between the inflation and confidence innovations helps explain the reduced magnitude of the effects of shocks to confidence in the larger block VARs discussed in Section V. This connection between inflation, confidence, and real activity variables is an intriguing one that poses questions that we only begin to address in this paper.

Finally, we expand the VARs to include unemployment as an additional variable. In contrast to the previous cases, recursive identifications of the shocks in a VAR with unemployment included indicate that the responses of output and consumption to confidence innovations show more stationary behavior. Agnostic identifications of shocks having transitory effects on output produce a wide range of possibilities – from the earlier finding that such shocks are essentially uncorrelated with innovations in consumer confidence to the polar extreme that such shocks are essentially collinear with innovations in confidence. As such, we are unable to definitively rule out an interpretation of consumer confidence in accord with the “animal spirits” hypothesis. However, none of the findings constitutes an affirmative case for an animal spirits channel.

\(^3\) The result for stock prices is similar to the finding of Beaudry and Portier (2004b).
II. Income, Consumption, and Confidence

We begin with the dynamics of income and consumption as implied by the bivariate VARs introduced by Cochrane (1994a). Figure 1, Panel A shows the impulse responses when C is ordered before Y, and Panel B presents the case in which Y is ordered first. As Cochrane (1994a, 1994b) stressed, the key feature of these impulse responses is that innovations in consumption (whether or not they are orthogonalized with respect to Y) are associated with powerful and prolonged subsequent increases in output. If C is ordered first, almost the entire permanent component of Y is explained by consumption. If Y is ordered first, the finding is less dramatic; orthogonalized innovations in both C and Y lead to large and permanent movements in Y. Yet here too innovations in consumption generate more prolonged impulses than income innovations, and more than a third of the forecast error variance in output at long horizons is accounted for by shocks to consumption conditional on income. In short, the results from the two variable VAR suggest that “consumption shocks” convey news about income many periods in the future.5

The natural explanation of this phenomenon is that agents have some advance knowledge about future income that they use when making consumption decisions. Forward-looking questions on surveys of consumer expectations and attitudes provide an alternative measure of such information. How much of the information about the future embodied in consumption is picked up by survey expectations? Conversely, do the survey expectations indicate that

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4 The variables are real GDP and real consumption of nondurables, the data are quarterly from 1960 through the second quarter of 2005, and the VARs are run in log levels with two lags. We do not impose cointegration between C and Y in the VARs reported on here because, theory aside, it is rather inconsistent with the data. We have, however, run the VAR both in first differences and with various assumptions about cointegration, and the results are very similar.

5 Cochrane (1994) emphasized the ordering with consumption first because it is suggested by the simple permanent income model in which all information is immediately reflected in consumption, and because it splits income fairly neatly into permanent and transitory components. However, the idea of an information shock, as defined below, leads to a focus on the alternative orthogonalization.
consumers receive news that is not reflected in current consumption? We turn to these questions now, introducing some expectational measures from the Michigan survey and augmenting the bivariate consumption-income VARs with these variables.

The survey measure that we will make the most use of in this paper, which we call E5Y, summarizes responses to the question “Now turning to economic conditions in the country as a whole: Do you expect that over the next five years we will have mostly good times, or periods of widespread unemployment and depression, or what?” The variable is constructed as the percentage giving a favorable answer minus the percentage giving an unfavorable answer plus one hundred. Our particular affinity for this question arises from the fact that it is aimed at gauging expectations over a relatively long horizon, and because of its specificity as to the relevant time frame. However, its correlations both with the response to a similar question specifying a horizon of only twelve months (a variable we call E12M) and with the overall expectations component of the Michigan index (based on a weighted average of these two questions and another concerning expected changes in personal financial situation over the next twelve months) exceed ninety percent. The results in this section are essentially unchanged by the substitution of either of these alternative expectations variables.

Figure 2 plots E5Y and E12M against time. Both series undergo repeated dramatic swings though (as we would expect) the twelve-month-ahead expectations are more volatile than the expectations over a five year horizon. Both variables are quite stationary. Table 1 shows the cross-correlogram between E5Y and the conventional Hodrick-Prescott detrended GDP. The expectations are by no means a reflection of current output; the contemporaneous correlation between detrended GDP and E5Y is essentially zero. E5Y is negatively correlated with the output gap lagged several periods, and positively correlated with the gap several quarters ahead.
Table 2 presents estimated coefficients and associated statistics for a trivariate VAR featuring real GDP and real nondurable consumption, along with the variable E5Y. The VAR is once again run in log levels, with two lags of each variable (as suggested by the Schwartz Information Criterion). To address the relative informational content of E5Y and consumption, we focus on two alternative orthogonalizations: $C \rightarrow E5Y \rightarrow Y$ and $E5Y \rightarrow C \rightarrow Y$. If all relevant news about future income is immediately reflected in consumption, an E5Y innovation orthogonalized with respect to consumption will have no predictive implications for the path of output. The other polar hypothesis (tested by the $E5Y \rightarrow C \rightarrow Y$ orthogonalization) is that consumption contains no information about future Y beyond that conveyed by our expectations variable.

Figure 3 presents impulse responses and Figure 4 variance decompositions for both orderings. Regardless of the ordering, orthogonalized innovations in E5Y are followed by slowly-building, large, and permanent responses of both C and Y; the long-run effects are in the neighborhood of one percentage point higher consumption and output for a one standard deviation positive innovation in E5Y. When E5Y is ordered first, the long-horizon implications of E5Y shocks actually exceed those of consumption shocks, and E5Y accounts for about half of the variance of output at twenty-four quarters. However, the response to an E5Y shock builds so slowly that consumption innovations have much larger effects than E5Y shocks at short horizons. When E5Y is orthogonalized with respect to consumption, the expectational variable never quite catches up. Still, the variance decompositions show that one third of the variance of output at long horizons is accounted for by the survey measure. Thus neither of the above polar

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6 Both consumption and GDP have unit roots, while E5Y is clearly stationary. Estimation of the VARs in this section with consumption and GDP in first differences produces nearly identical impulse responses. While our data are not in favor of a cointegrating relationship between consumption and GDP (because of the sharp upward trend in consumption relative to income in the last ten years or so), imposing such a relationship also produces very similar results.
cases applies. Innovations in E5Y and in consumption each convey relevant news about future output that is not subsumed in the other.

Regardless of ordering, E5Y responds almost entirely to its own innovations, a fact which is evident from both the impulse responses and variance decomposition. At business cycle frequencies, more than one-third, and up to more than one half, of the forecast error variances of both output and consumption are attributable to innovations in E5Y when E5Y is ordered first. When consumption is ordered first, the fraction of the forecast error variance of consumption attributable to E5Y innovations is somewhat smaller at most horizons, but still tops one third at business cycle frequencies.

For an alternative interpretation of the VAR that anticipates the approach taken in subsequent sections of the paper, we focus on an orthogonalization in which income is ordered first and consumption last, with E5Y in the middle position. This is motivated by the idea of an “information shock” – news about future output that is not reflected in current output. The impulse responses and variance decompositions for the trivariate VAR with the GDP→E5Y→C orthogonalization are shown in Figures 5 (A) and 5 (B), respectively. The key observation is the gradual but powerful and prolonged response of output and consumption to the E5Y shock. An “unexplained confidence shock” raises consumption by a modest (though non-negligible) 0.1 percent on impact (as compared with a 0.27 percent response of consumption to an income innovation and a 0.56 percent response to its own innovation). However, after twelve quarters a one standard deviation shock to E5Y has raised consumption by 0.63 percent, compared to the 0.59 percent that it would have been raised by a one standard deviation shock to income. Likewise, after twelve quarters a one standard deviation shock to E5Y has raised income by 0.67 percent. The variance decomposition confirms that negligible shares of consumption and GDP
are explained by E5Y at short horizons, but a much larger percent are explained at longer horizons. Strikingly, the responses of both income and consumption show no tendency to attenuate at long horizons.

Although it shows a statistically significant positive response to both income and consumption shocks, E5Y responds almost exclusively to its own innovation. Surprises in E5Y must be reflective either of information not contained elsewhere in the VAR or of truly exogenous animal spirits. Later we will see that a nontrivial fraction, though not the lion’s share, of E5Y innovations are explained by included variables in a larger system, especially prices.

We now examine several variations on our baseline three variable VAR. First, we use durable consumption expenditures in place of non-durables. Second, we substitute the relative score from the question on the Michigan survey concerning expected personal financial situation (PFE) in place of E5Y, and the third is to use the commonly employed ICS, which is an equally weighted composite of five backward-looking and forward-looking questions from the Michigan Survey. The impulse responses under the first two modifications are presented in Figures 6 (A) and 6 (B), respectively. The conclusions are virtually identical to those from the baseline specification with E5Y and non-durable consumption. Both income and consumption continue to have large and persistent responses to innovations in consumer confidence as measured by forward-looking questions.

Figure 6 (C) presents the impulse responses of our baseline VAR using the oft-reported “Index of Consumer Sentiment” in place of E5Y. The structuralized innovation to the ICS has far weaker implications for the evolution of both total output and non-durable consumption

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7 The PFE question is as follows: “Now looking ahead – do you think that a year from now you (and your family living there) will be better off financially, worse off, or just about the same as now?”
expenditures than does either of the specific forward looking questions from the survey. In particular, the point estimates of the impulse responses of both GDP and consumption to ICS innovations are roughly half in magnitude compared with use of E5Y or PFE, and the ninety-five percent confidence bonds lie outside of zero only for the first few quarters following the innovation. This is one important explanation for the apparent incompatibility between our result that confidence measures have important predictive implications for output and spending and the results in some recent papers that argue that confidence surveys have little predictive value.⁸,⁹

In summary, innovations in expectational variables from the Michigan survey not explained by innovations in current output are powerful predictors of output and spending for the foreseeable future. Consumer confidence shocks explain relatively little of the variation in income and spending at short horizons. The effects of a confidence shock build gradually and show no tendency to attenuate as time passes. This lack of attenuation in the responses of either GDP or consumption is *prima facie* evidence in support of an information view of consumer confidence. Were the confidence innovation primarily reflective of exogenous changes in “animal spirits” we would expect such innovations to have predictably short-lived effects on output, at least within the context of natural rate models with a unique equilibrium. Non-reverting impulse responses might be consistent with a large role for animal spirits if the

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⁹ There are several other differences as well. One is that we focus on impulse responses, whereas other papers have focused on incremental R-squared statistics associated with Granger causality tests. Another issue is what happens to the importance of confidence as additional variables are added to the conditioning information set, an issue to which we will return in greater depth shortly. For some purposes, it is most interesting to consider the *incremental* role of confidence after accounting for a substantial list of macroeconomics variables. For other purposes – e.g. the above exercise studying the extent to which consumption shocks should be regarded as information shocks – it is not.
economy exhibits multiple equilibria of a sort that allows it to shift permanently from one level of productivity to another via supply externalities or other mechanisms producing very large increasing returns. However, the conditions under which an economy may exhibit such behavior are stringent, and the empirical literature has found little evidence that such conditions might be satisfied in the data.

The observation that responses of output and consumption to confidence shocks are permanent suggests that the innovation in confidence ought to reveal information about future productivity in much the same fashion as the information shocks in Cochrane (1994b) or Beaudry and Portier (2004c). As a test of this conjecture, we first run a simple bivariate VAR with the log of labor productivity and E5Y, with labor productivity ordered first. The impulse responses are presented in Figure 7. Shocks to E5Y do indeed have a quantitatively and statistically significant and approximately permanent effect on labor productivity. As we show later in the paper, the implications for future productivity of an orthogonalized innovation in E5y are comparable to those of an orthogonalized innovation in stock prices (as in Beaudry and Portier, 2004b).

It might be desirable to have an alternative test, not dependent on vector autoregressions, of the implication of the animal spirits hypothesis that when confidence is unusually high, consumption eventually reverts. Table 3 reports the results of regressing consumption growth over various horizons (one quarter, one year, two years, five years, and seven years) on E5Y. The regressor in each equation is E5Y at date \( t \), while the regressand is the growth rate in consumption from period \( t \) to \( t+k \). Newey-West standard errors are reported because of the high degree of serial correlation associated with overlapping observations. The null hypothesis is that consumption growth at each horizon is invariant to E5Y. The animal spirits alternative implies
that the coefficient of $E_5Y$ is negative at long horizons. If high levels of $E_5Y$ are associated with unsustainably high levels of spending, consumers must eventually face the reality of their lifetime budget constraints and reverse the initial increases in consumption. Table 3 reveals that at each horizon the coefficient estimate is significantly positive at better than the one percent level. Though the magnitudes may appear small, the standard deviation of $E_5Y$ exceeds twenty points, and the implied swings in consumption growth are rather large; predicted five-year consumption growth, for example, ranges from less than ten percent (two percent per annum) to more than sixteen percent (roughly three percent per annum). These long-horizon regressions corroborate the findings from the VAR that increases in $E_5Y$ lead to permanent and statistically significant increases in consumption. They do not provide support for the animal spirits hypothesis.

The finding that one-period-ahead consumption growth is predictably higher when confidence is high is the essential result of Carroll, Fuhrer, and Wilcox (1994). These authors interpret the Granger causality from confidence to consumption growth as evidence against the permanent income hypothesis. This reflects a decidedly partial equilibrium approach. Our finding that consumption tracks predictable productivity increases over periods of several years rather than jumping sharply in anticipation of them suggests that the predictability of consumption growth is better thought of in terms of a Lucas-type fruit tree economy. Consumers know that productivity and hence income will be higher in the future, but can in the aggregate do little to get their hands on the expected income in order to increase current consumption. One implication of this interpretation is that positive confidence innovations should be associated with increases in expected real rates of return. At least in terms of real interest rates on short and intermediate term bonds, this implication holds true in the data. In
particular, real interest rates fell sharply in the early to middle 1970s, where we observe a host of negative innovations in E5Y.

To what extent are our results from the recursive identifications that support the information shock rather than the animal spirits interpretation of confidence robust to a range of alternative, potentially non-recursive, identifications? Are the conclusions altered by inclusion of further variables in the information set of the VAR? The remainder of the paper is concerned with these two questions. In order to address them systematically, we begin by incorporating an information shock and an animal spirits shock into a fairly standard sticky price model. This will motivate our identification scheme and will help us to interpret the subsequent empirical results.

III. Information Shocks and Animal Spirits in an Illustrative Model

In this section we present a simple New Keynesian model formalizing our intuitive definitions of information and animal spirits shocks. Households have preferences over consumption and leisure, and maximize discounted lifetime utility subject to a budget constraint:

$$\max_{C_t, N_t, b_t} \sum_{t=0}^{\infty} \beta^t \left[ \frac{C_t^{1-1/\sigma}}{1-1/\sigma} - \psi \frac{N_t^{1+1/\eta}}{1+1/\eta} \right]$$

s.t.

$$P_t C_t + b_t \leq W_t N_t + \Pi_t + (1+i_t)b_{t-1}$$

Above, $\sigma$ is the intertemporal elasticity of substitution in consumption, $\eta$ is the Frisch labor supply elasticity, $\beta$ is the subjective discount factor, $\psi$ is a scaling factor, $b$ denotes holdings of a risk-free bond, and $\Pi$ denotes any lump sum profits that may be returned to households.

Household maximization yields the following first order conditions: one is the familiar consumption Euler equation and the other is a labor supply condition.

$$C_t^{-1/\sigma} = \beta E_t \left( 1+i_t \right) \frac{P_t}{P_{t+1}} C_{t+1}^{-1/\sigma}$$
Production in this economy is split into two sectors, as is common in New Keynesian models. Final goods production is competitive, with a production function using intermediate goods as inputs, where the intermediate goods sector is monopolistically competitive. The final good is assumed to be a CES aggregate of intermediate goods as follows:

\[
\psi N_t^{1/\eta} = C_t^{-1/\sigma} \frac{W_t}{P_t}
\]

Profit maximization yields the following demand function for intermediate goods:

\[
Y_t = \left[ \int_0^1 (Y_{jt})^{\epsilon-1} \frac{Y_t}{P_t} \, dj \right]^{-\epsilon/\epsilon-1}
\]

Above, the aggregate price level is also a CES aggregate of intermediate firm prices. Intermediate goods (denoted from the final good by the \(j\) subscript) are produced according to the following linear production function:

\[
Y_{jt} = A_t N_{jt}
\]

\(N\) denotes the quantity of labor that intermediate goods firms hire from households, and \(A\) is a measure of total factor productivity (TFP) that is common across intermediate goods firms.

Cost minimization by intermediate goods firms yields a constant desired markup of price over marginal cost. Following Calvo (1983) and much of the subsequent literature, we assume that firms are exogenously unable to freely change their prices. In particular, we assume that firms face a constant hazard equal to \((1 - \theta)\) of being able to change their price in any particular period. Solving the problem facing the typical intermediate good firm and aggregate yields a
New Keynesian Phillips Curve relating inflation with real marginal cost and expected future inflation:

\[ \pi_t = \frac{(1 - \theta)(1 - \theta \beta)}{\theta} mc_t + \beta E_t \pi_{t+1} \]

Under certain conditions, this relationship can be written in terms of an “output gap” denoting the deviation of actual output from the (second-best) flexible price equilibrium level:\(^\text{10}\)

\[ \pi_t = \kappa(y_t - y'_t) + \beta E_t \pi_{t+1} \]

We assume that the central bank follows a nominal interest rate rule of the kind exposited in Taylor (1993) and now common in the literature. In particular, the nominal rate is set according to:

\[ i_t = \phi(y_t - y'_t) + \gamma \pi_t \]

Both coefficients in the rule are assumed positive, and, to ensure stability, we assume that \( \gamma > 1 \).

We assume that shocks to TFP become known in advance of when the level of TFP actually changes. One particularly simple (and empirically plausible) specification is as follows (with lowercase letters denoting logs):

\[ a_{t+1} = g_t + a_t \]

\[ g_t = g^*_t + \epsilon_t \]

\[ g^*_t = \xi g^*_{t-1} + \epsilon_t \]

Above, the log of TFP is assumed to follow a random walk with drift, where the drift term, \( g \) is itself stochastic, following what amounts to an ARMA(1,1) process. The term \( \epsilon \) is a white noise

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\(^{10}\) See Woodford (2003) or Gali and Gertler (1999) for a more thorough derivation. The slope coefficient in the NKPC is equal to \( \kappa = \frac{(1 - \theta)(1 - \theta \beta)}{\theta} \left( \sigma^{-1} + \eta^{-1} \right) \) under the assumption of economy-wide factor markets.
disturbance that affects the growth rate within any period. The term $g^*$ is an underlying trend factor that follows a persistent but stationary autoregressive process. If the variance of $\varepsilon$ is large relative to the variance of $e$, we can match the empirical fact that the growth rate of productivity is close to white noise while maintaining a structure in which the shocks to the trend factor ($e$) can have quantitatively important low frequency implications. The shock $e$ satisfies the intuitive definition of an information shock: it becomes known to agents before it has any effect on the current level of TFP.$^{11}$

We envision an “animal spirits” shock as a (temporary) misperception of lifetime resources that infects consumers alone. We model this as taking the form of a misperception by consumers of the underlying growth rate of TFP. Let individual perceptions of the underlying growth rate of TFP be given by:

$$g^*_{t} = g^*_{t-1} + \nu_t$$

We assume that $\nu$ itself follows a stationary autoregressive process:

$$\nu_t = \rho \nu_{t-1} + u_t$$

The extent to which agent misperceptions of the underlying growth rate are persistent is exogenous in the model. That these misperceptions are given exogenous persistence is not without real world justification. For instance, it is often argued that continually overestimated the economy’s underlying growth rate in both the 1990s and 1920s.

$^{11}$ There are myriad other ways in which one could write down a specification of information shocks. A natural candidate is a model in which a discrete shock to the level of TFP becomes known a number of periods before it takes affect. These types of shocks are explored in recent papers by Beaudry and Portier (2005) and Jaimovich and Rebelo (2006). Our most basic results are unchanged by such a specification, but the growth rate interpretation of information shocks best matches the smooth empirical impulse responses.
Given our assumptions concerning the stochastic process of TFP, misperceptions of the underlying growth rate then map into a deviation of consumer expectations of the level of TFP from the rational expectation in the following form:

\[ H_t(a_{t+1}) = E_t(a_{t+1}) + v_t \]

\( H \) denotes the consumer’s expectation operator and \( E \) is the familiar rational expectations operator. The residual term is \( v \) and denotes the deviation of the subjective expectation from the rational one.\(^{12}\) Imposing this structure on consumer expectations as well as the market-clearing condition that output equals consumption and log-linearizing yields an aggregate demand relationship (sometimes referred to as a “New Keynesian IS Curve”):

\[ -\frac{1}{\sigma} y_t = (i_t - E_t \pi_{t+1}) - \frac{1}{\sigma} E_t y_{t+1} - \frac{1}{\sigma} v_t \]

We impose a standard calibration on the model. We set the elasticity of intertemporal substitution in consumption to 1; this calibration is necessary to ensure the stationarity of labor hours in the presence of non-stationary technology with additive separability between consumption in leisure in the utility function (King, Plosser, Rebelo (1988)). The Frisch labor supply elasticity is set to 0.5; the coefficients of the nominal interest rate rule are 0.5 and 1.5, respectively; the Calvo parameter is 0.8; the scaling parameter on labor in the utility function is set to 1; the price elasticity of demand for intermediate goods is 11 (corresponding to a steady state price markup of 10%); and the subjective discount factor is 0.99. The persistence of the growth rate shock is set to 0.75, while the persistence of the animal spirits disturbance is set to 0.8. The qualitative results are unaffected by other reasonable calibrations.

\(^{12}\) Rather importantly, consumers are not aware that they may have been potentially “infected” by an animal spirits shock. In other words, we are not in a world (such as Lorenzoni (2005)) where consumers must solve a signal extraction problem. Whether the economy is hit by a shock to \( e \) (the information shock) or a shock to \( u \) (the animal spirits shock) consumers fully believe the shock to be one to true future levels of TFP.
Figures 8 (A) and (B) present the theoretical impulse responses to both the information and animal spirits shock. The information shock leads to a slight increase in output on impact, from which point output closely tracks the smooth evolution of TFP. Both the nominal interest rate and inflation rise on impact, with the increase in the nominal rate dominating so that the real interest rate rises. Impulse responses to the animal spirits shock look like the standard responses to any kind of demand shock (such as a monetary policy shock). Output rises maximally on impact and declines monotonically to the steady state. Inflation jumps up by less than the nominal rate, with the real interest rate once again rising on impact.

There are several noteworthy implications of these theoretical impulse responses. The partial equilibrium intuition of the PIH suggests that consumers should want to increase consumption in advance of changes in TFP. In these theoretical responses, consumption (output) in fact tracks, rather than anticipates, movements in TFP, which is entirely consistent with what we find in empirical VARs. This occurs because of the associated increases in the real interest rate and intertemporal substitution – agents would like to bring forward consumption, but general equilibrium movements in the interest rate prevent this from occurring.

Another important result of the theoretical impulse responses is that the information shock is inflationary. This finding perhaps runs counter to the intuition of many that technological improvements (whether contemporaneous or anticipated) should be deflationary. A deflation would be what one would predict by focusing only on the supply side of the model, where it can be shown that inflation is a present discounted value of future real marginal costs. Anticipated technological improvements lower future marginal costs and thus work like positive supply shocks, although smaller in magnitude relative to a contemporaneous technology shock. The inflation resulting from these shocks in the model comes from the demand side, however.
The innovation to permanent income coming from the information shock causes demand to rise, and this demand effect evidently dominates any supply effect, causing prices to rise. That the information shock is inflationary holds true for any reasonable calibration of the baseline model.

As we will show, empirically information shocks appear to be deflationary, with quite a strong negative correlation between inflation and future measures of technology or output. While this finding is inconsistent with the baseline presentation of our model, simple (and realistic) modifications will lead to a negative association between innovations to inflation and future measures of technology. For the information shock to be deflationary what is required is something that dampens the effect the information shock on the demand side economy or something which accentuates the beneficial supply effect. Habit formation in consumption or the presence of rule of thumb consumers are natural candidates as demand dampening mechanisms, and the appropriate calibration of either will in fact lead to deflationary effects of information shocks. Another demand dampening mechanism would be to close the model with a money supply rule as opposed to a nominal interest rate rule. If we were to assume that the interest elasticity of money demand were zero (i.e. the familiar quantity theory case), demand would be completely determined by money. Were money assumed to grow exogenously, demand would not be able to respond to the information shock and a deflation would necessarily result. Real wage rigidity (for example Blanchard and Gali (2005)) might play a similar role in reversing the effects of the information shock on prices, albeit wage rigidity works on the supply side of the economy as opposed to demand.

Demand dampening mechanisms have the addition desirable property (in addition to the fact that they may force the effect of the information shock on inflation to reverse signs) that

---

Note that this discussion of the implications of information shocks applies equally as well to a specification of such shocks as anticipated level shifts in TFP as opposed to our current growth rate interpretation. The “fix” to make such shocks deflationary is also identical in either specification.
they can induce hump-shaped responses of real activity to the animal spirits shock (or to demand shocks in general). As an illustrative example, suppose that the consumers receive utility not over the current level of consumption, but rather from $C_t - \alpha C_{t-1}$, the deviation of current consumption from a constant times less period’s consumption. The consumption Euler equation (which is in turn the demand equation after imposing market-clearing) is entirely standard expressed in terms of the marginal utility of consumption: $\lambda_t = E_t(i_t - E_t, \pi_{t+1}) + E_t, \lambda_{t+1}$, where the marginal utility of consumption, $\lambda$, is defined as follows:

$$\lambda_t = \frac{1}{\sigma(1-\alpha)(1-\beta\alpha)} \left[ -(1+\beta\alpha^2)y_t + \alpha y_{t-1} + \beta\alpha y_{t+1} \right] + \frac{\beta\alpha}{\sigma(1-\alpha)(1-\beta\alpha)} v_t$$

The rest of the model is the same as before. Figures 9 (A) and (B) present the theoretical impulse responses to both animal spirits and information disturbance for a value of $\alpha = 0.9$. We can see that inflation now falls on impact in response to an information shock; furthermore, the response of output to the animal spirits shock is markedly hump-shaped. We should note that the requisite value of habit persistence for inflation to fall in response to the information shock is high; holding the other calibration constant, $\alpha$ must be above 0.86 for the sign of the impact effect on inflation to be reversed.

**IV. Information Shocks and Animal Spirits: Empirical Implementation**

We employ “agnostic” identification procedures first expounded in Faust (1998) and Uhlig (1999). The idea is to consider (separately) the universe of shocks that have the appearance of information shocks and the universe of those that behave like animal spirits shocks.
First, we address the information shock. How well does a shock identified as being contemporaneously uncorrelated with a measure of output but having a “large” influence on output at a moderately long horizon explain E5Y innovations? To answer this question, we employ the method of maximum forecast error variance identification developed in Faust (1998) and Francis, Owyang, and Roush (2005). (For a more detailed sketch of the procedure, see Appendix A). The procedure involves computing an entire family of shocks identified to be orthogonal to current output by creating orthonormal rotation vectors of an arbitrary orthogonalization of the reduced form. For each shock, we then compute the fraction of the forecast error variance of output at a horizon of eight years attributable to this shock. The shock explaining the maximum of the forecast error variance of output at this horizon is then deemed a “best case” for a shock satisfying the criteria of an “information shock”.

Among the family of shocks orthogonal to current output, we can find a shock that accounts for more than forty-five percent of the forecast error variance of output eight years subsequent to the shock. Strikingly, such a shock accounts for seventy-nine percent of the contemporaneous innovation in E5Y and upwards of eighty-five percent at longer horizons, substantially reinforcing the notion that innovations in E5Y are manifestations of news consumers receive concerning future fundamentals. Figure 10 (A) presents historical simulations of the included variables in the VARs in response to the “best case” for the identified information shock. Though it does not account for much of the business cycle variation in output, such a shock does a rather good job at explaining historical movements in consumption. It does an even better job at explaining historical movements in E5Y, lending further support to the idea that measured confidence is, in significant measure, a reflection of genuine information about the future.
How sure can we be that there is not an alternative identification that suggests that confidence includes an important animal spirits component? We proceed in a way similar to the previous exercise, but instead find orthonormal rotations of the reduced form trivariate VAR that lead to predictably temporary responses of measures of real activity. We then ask how well such shocks can account for the contemporaneous innovation in E5Y.

We are able to find shocks that have large transitory effects on both income and consumption. In particular, the “best” case for a transitory shock accounts for more than two-thirds of the forecast error variance of output at high frequencies and leads to an impulse response in which output rises by more than 0.6 percent after a year before reverting to its pre-shock level. However, such a shock accounts for less than fifteen percent of the innovation in E5Y and – worse – moves E5Y and output in opposite directions. Of all linear rotations of the VAR, only three percent lead to simultaneous increases in E5Y and income, and among these three percent the increase in E5Y is always less than one point and the associated change in output is small. It is thus impossible, within the three variable context, to find a shock which simultaneously leads to a large positive increase in E5Y and a large, temporary response of output.

Historical simulations further reinforce the case against an animal spirits interpretation of consumer confidence. As shown in Figure 10 (B), the best case for the role of the transitory shock does a reasonable job at explaining historical movements in output and a poorer job for consumption. It does a much worse job at explaining the historical movements in observed confidence. The historical simulation for E5Y from the max forecast error variance
identification and that from the impulse response shape identification portray a sharp contrast.\textsuperscript{14} The identified information shock does quite a good job at explaining the historical movements in E5Y, the transitory shocks do not. In the next section of the paper, we examine the extent to which expanding the conditioning set of the VAR might alter these findings.

V. The Role of Consumer Confidence with Richer Conditioning Information

Up to this point we have focused on a trivariate setting with only GDP and consumption in addition to our forward-looking measure of consumer confidence. This small system was motivated naturally as an extension of Cochrane’s bivariate system inspired by the permanent income hypothesis. It made sense to ask about the extent to which “consumption shocks” could be interpreted as “news shocks” that reveal information about future fundamentals, and the exercise generated results that were sensible and easily interpretable. Clearly innovations in E5Y convey important news about the relatively distant future, and we were able to conclude that in this context it is this information content and not a self-fulfilling aggregate demand effect that accounts for the lion’s share of the relationship between confidence and subsequent real activity.

On the other hand, it is also important to investigate the role of confidence variables after conditioning on a more expansive set of macroeconomic indicators, for several reasons. First, it is interesting in and of itself to understand what – if anything – helps explain movements in confidence, as we found it to be more or less exogenous in the three variable setting. Second, previous authors have found that the predictive content of consumer confidence is weakened once financial variables in particular are taken into account.\textsuperscript{15} Third, we need to know whether

\textsuperscript{14} Note that the respective “best-case” shocks are from separate identifications and their contributions are not additive. Neither method identifies a full set of structural shocks, so that these are not complete historical decompositions.

\textsuperscript{15} See, for example, Mishkin (1978) and Leeper (1992).
or not orthogonalizing confidence with respect to other macroeconomic indicators changes the
dynamics of the VAR. To the extent that it does, we may have to reassess whether the animal
spirits hypothesis has greater plausibility than the impulse responses from the trivariate system
led us to believe. Finally, we will see that confidence variables serve as a lens through which
we discover an intriguing and potentially important relationship between future productivity and
current inflation.

\( V (a): \) Determinants of Confidence Innovations

In the simple trivariate setting, E5Y and other overall confidence measures are roughly
exogenous. With E5Y ordered in between GDP and non-durable consumption in a recursive
VAR, close to ninety-five percent of the forecast error variance of confidence is explained by its
own innovation at every horizon. Even when confidence is allowed to respond
contemporaneously to consumption innovations, the fraction of the forecast error variance of
confidence attributable to its own innovation always exceeds eighty-five percent.

Are there variables other than GDP and consumption that might help explain a sizable
share of the surprise movements in consumer confidence? The Michigan Survey of Consumers,
in addition to the questions already discussed, also asks respondents to report any recent “news
heard” concerning the economy.\(^{16}\) It seems natural to begin with an investigation of the
relationship between this reported economic news and subsequent responses to survey questions
concerning macroeconomic expectations in attempting to answer the question of what – if
anything – helps explain consumer confidence.

\(^{16}\) The specific question is phrased as follows: “During the last few months, have you heard of any favorable or
unfavorable changes in business conditions. What did you hear?”
Respondents give answers to a question asking them to report favorable or unfavorable economic news, and their answers are tabulated into arbitrary, but generally well-defined, categories. Figure 11 presents spike plots for several of the more popular response categories across time. Most categories (such as trade deficit, government budget deficit, etc.) record very few responses in a typical quarter. Rather clearly, the most consistently popular concern news about prices and news about unemployment. Other responses stand out in particular time frames. Examples are a high incidence of mention of “energy crisis” during periods of the 1970s and early 1990s as well as news heard concerning the stock market sporadically across the sample period, but most frequently during the 1990s.

In Table 4 we present coefficient estimates from regressions of the E5Y innovations from the three variable VAR on selected categories of news. The news heard categories have coefficients of the expected signs; an increase in the percentage of respondents reporting favorable news concerning employment or prices is positively correlated with confidence innovations. Unfavorable news about employment is evidently an insignificant covariate, while favorable news about unemployment and inflation are both significant at the five percent level and unfavorable news about prices is significant at nearly the one percent level. In short, news about prices has statistically and substantively significant explanatory power for the innovation in consumer confidence, while news about employment also has marginally significant effects.

\[ V (b): \text{ Confidence, Inflation, and Stock Prices} \]

Figure 12 plots inflation (right scale) and E5Y (left scale) across time.\(^{17}\) The general negative association between the two series across time is quite marked, though it is most evident

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\(^{17}\) Inflation is measured as the first difference of the natural logarithm of the Consumer Price Index.
during the 1970s and early 1980s when inflation was most volatile. Since the 1990s there have been important movements in confidence unrelated to inflation.

We now add inflation to our baseline VAR alongside consumption, income, and E5Y. As with prior VARs, the system is run in log levels on quarterly data from 1960-2005 with a lag length of two. Figure 13 presents the impulse responses of all variables to orthogonalized inflation and confidence innovations when inflation is ordered prior to confidence, while Figure 14 covers the case in which E5Y is ordered prior to inflation. When E5Y is ordered first, the responses of consumption and income to inflation are – qualitatively and quantitatively – the mirror images of the responses to E5Y. Because the correlation between the reduced form innovations in inflation and confidence in this system is nearly -0.3, the orthogonalization matters; attributing the common component of the innovations in inflation and E5Y to inflation significantly reduces the responses of consumption and income to the structuralized E5Y innovation. Indeed, when inflation is ordered first, the impulse responses to E5Y at all horizons are in the neighborhood of one half of the magnitude obtained in the system without inflation. Importantly, the responses of the activity variables to confidence innovations have the same non-reverting shape that they had in the trivariate case. Once again, the recursive identifications do not produce anything resembling an animal spirits shock.

As in the three variable case, we employ agnostic identification procedures as robustness checks. We can find a shock explaining more than forty percent of the forecast error variance of output among those shocks orthogonal to current output. Such a shock explains slightly more than half of the contemporaneous innovation in E5Y. At somewhat longer horizons, the contribution of this shock to the E5Y forecast error variance is greater than fifty percent and reaches as high as seventy percent. While the correlation between this information shock and
the reduced form innovation in confidence is somewhat smaller than that found in the three variable system, it is nonetheless impressive.

We also impose a shape restriction to identify the family of shocks having transitory effects on output. We define the “best case” as that shock satisfying the shape restriction that has the maximal effect on output at a horizon of one year. Such a shock accounts for an increase in output of slightly more than 0.6 percent on impact. In contrast to the three variable case – where it was essentially impossible to find a transitory shock that moved confidence and output in the same direction – E5Y now rises on impact, but by a very modest one point. This “best case” for the transitory shock explains only fifteen percent of the innovation in E5Y. However, we need to investigate further other transitory shocks that produce more modest increases in output but explain much more of the variance of E5Y.

Figures 15 (A) and (B) present historical simulations of output, inflation, confidence, and consumption for the “best cases” for the information and transitory shocks, respectively. The best case for the information shock does a good job at explaining the time series variation in E5Y and inflation, and, to a lesser extent, output and consumption. In contrast, the best case transitory shock does a poor job at matching the historical movements in E5Y and inflation, though it does pick up several important movements in real activity.

Figure 16 plots the S & P 500 index (deflated by the CPI) along with E5Y. The positive correlation between the two series is not difficult to detect and is prevalent throughout the entire sample period. On any reading – information, animal spirits, or a third alternative – stock prices and confidence measures ought to reflect similar forces. Thus the finding of previous authors (Leeper (1992) and Mishkin (1978)) that the inclusion of asset prices reduces the predictive correlation.
content of measures of consumer confidence for subsequent real activity is neither unexpected nor an adverse judgment on the value of confidence data.

In Figure 17, we present impulse responses when stock prices are included in the VAR and ordered prior to E5Y. As has been the case in all VARs examined thus far, there is no tendency for either income or consumption to attenuate in response to orthogonalized innovations in E5Y. Stock price innovations appear to have qualitatively and quantitatively much the same implications for income, consumption, and E5Y as do inflation innovations (though of opposite sign). Ordering E5Y prior to inflation attributes more of the common component of the stock price and E5Y innovations to E5Y, and leads to larger and more statistically significant impulse responses of real activity to the E5Y innovation (not shown). Orthogonalizing stock prices with respect to E5Y rather significantly weakens the quantitative and statistical significance of the responses of income and consumption to stock price innovations, something which we did not see in the case of inflation when it was included in the VAR and ordered after E5Y.

Figure 18 presents the impulse responses when both inflation and real stock prices are included in the VAR and are ordered prior to E5Y. For the presented plots, inflation is ordered prior to stock prices. Innovations to E5Y continue to have the same qualitative effects on both consumption and income even after orthogonalization with respect to stock prices and inflation. In particular, the point estimates indicate no tendency for either income or consumption to revert following a positive innovation in E5Y. As in the cases in which either inflation or stock prices alone were included in the VAR, the responses of real activity to E5Y are smaller and less statistically significant than in the three variable case.
In isolation, innovations confidence, inflation, and stock prices each lead to slowly-building, quantitatively significant, and permanent responses of both income and consumption. This suggests they may possess much of the same informational content. Figure 19 plots the first principal component of inflation and stock prices (right scale) along with our forward-looking measure of consumer confidence (left scale) across time. The high degree of co-movement among the series is highly apparent. With few exceptions, the peaks and valleys of each appear to be nearly identical images of one another, with essentially every large movement in E5Y associated with a similar movement in the principal component of inflation and stock prices.\(^{18}\) Gordon and Dew-Becker (2005) highlight the strong negative relationship between inflation and productivity growth, while Piazessi and Schneider (2006) stress the negative relationship between inflation and consumption growth. Modigliani and Cohn (1979) and Campbell and Vuolteenho (2004) take note of the striking correlation between inflation and real stock prices.

We showed in Figure 7 that innovations in E5Y orthogonalized with respect to current labor productivity have slowly-building, large, and permanent implications for a measure of labor productivity. Figures 20 (A) and (B) present impulses response from a bivariate system analogous to that presented in Figure 7 but with either inflation or stock prices used in place of confidence. The results from this set of bivariate VARs, in conjunction with those presented in Figure 7, are striking. As already shown by Beaudry and Portier (2004b), stock price

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\(^{18}\) One might well conclude on the basis of this diagram that the confidence series are essentially redundant – a synthetic confidence series could be created from inflation and stock market series without incurring any data collection costs. But this relationship cannot possibly be structural. As Howard Rosenstein pointed out, in the Great Depression period inflation would have been welcomed as a harbinger of economic recovery. It just so happens that in our sample period, inflation is an excellent indicator of slow long-term productivity growth.
innovations are potent predictors of future productivity. We now see that inflation has equally
powerful prognostic implications for long run productivity.\textsuperscript{19}

The very similar response of productivity to innovations in either confidence, inflation, or stock prices, in conjunction with other evidence concerning the close connection between these three series, suggests that confidence, inflation, and stock prices convey much the same information about future productivity. In particular, all three anticipate the productivity slowdown beginning around 1970 and its reversal in the 1980s and 1990s. The fact that these series are so interchangeable in this respect helps to explain why conditioning on either inflation or stock prices (or both) tends to reduce the predictive content of E5Y innovations. The fact that the responses of consumption and income to E5Y innovations are weakened upon the inclusion of inflation and stock prices undermines the incremental value of consumer confidence as a forecasting tool but does not in any way reverse the finding that E5Y innovations are, to an important extent, manifestations of information that consumers have about the relatively far-off future.

\textit{V (c): Confidence, Unemployment and Transitory Components}

As discussed in the beginning of this section, it is consistently the case that a relatively large fraction of the survey respondents report having heard either favorable or unfavorable news concerning employment. Indeed, we might reasonably expect there to be a significant correlation between unemployment and forward-looking measures of consumer confidence.

\textsuperscript{19} The underlying reason that inflation innovations predict productivity slowdowns is the subject of a follow-up paper in preparation. The version of the New Keynesian Phillips Curve spelled out by Gali and Gertler (2000) in the presence of real wage rigidity provides a possible answer. Inflation today reflects expectations of future real unit labor costs. Expectations of low productivity in the future combined with a refusal of real wages to fall accordingly means high expected unit labor costs and thus high inflation today. However, the nexus between inflation and these real variables may be too low frequency in nature to be merely a consequence of sticky prices and wages.
Figure 21 plots the civilian unemployment rate with E5Y across time from 1960-2005. While there are fewer high frequency fluctuations in the unemployment rate than in E5Y, large movements in the two series seem to track one another reasonably well, with the period of the early 1980s being one notable exception, where confidence generally rose from its forty year low while the unemployment rate generally also trended upward. Because confidence is related to both inflation and unemployment, it is not surprising that the strongest co-movements between confidence and unemployment appear during stagflationary periods.

Figure 22 presents the impulse responses from a recursive identification of our baseline three variable VAR augmented with the unemployment rate, which is ordered after income and before E5Y. While most of the differences are not statistically significant, the presence of unemployment in the VAR does alter the general dynamics of the system. In sharp contrast to all of our previous results, the impulse responses to E5Y innovations now display a tendency towards reversion after a couple of years.

Not only does the presence of unemployment alter the system’s dynamics in response to E5Y innovations, it also does so for both income and consumption innovations. Income’s response to its own innovation is now very clearly transitory, and its response to the consumption innovation is essentially zero at all horizons. Like income, consumption has a hump-shaped impulse response to its own innovation as well as to the innovation in income. Rather surprisingly, it now appears that the primary source of permanent movements in both income and consumption is innovations to unemployment. These dynamic responses turn out not to be a result of the particular ordering of unemployment in the VAR, but rather its presence. For all recursive identifications, income and consumption have transitory responses to E5Y innovations,
and unemployment innovations want to be the primary source of the unit roots in income and consumption.

Figure 23 presents impulse responses from our basic system with both unemployment and inflation included – both ordered after income but prior to E5Y. If anything, the result that unemployment is the primary source of the non-stationarity of income and consumption is only strengthened by the inclusion of inflation in the VAR. Responses of real activity variables to orthogonalized E5Y innovations continue to appear stationary. Whereas innovations in inflation led to permanent negative responses of consumption and output in systems without the unemployment rate, they now appear to have transitory effects on real activity – much like E5Y innovations. The overall dynamics of the VARs with unemployment are unchanged by the inclusion of stock prices in replacement of, or in addition to, inflation.

It is not possible to rule out an animal spirits channel via shape restrictions when unemployment is included in the VAR. Agnostic identifications of shocks having transitory effects on output produce a wide range of possibilities – from the earlier finding that such shocks are essentially uncorrelated with innovations in consumer confidence to the polar extreme that such shocks are essentially collinear with innovations in confidence. Importantly, these impulse responses cannot be used to construct an affirmative case for animal spirits. A reverting impulse response is a necessary, but certainly not sufficient, condition for an animal spirits shock. The impulse responses to many other shocks – monetary shocks and temporary supply disturbances, for example – are also hump-shaped and reverting. Future research might conceivably lead to a more complete specification under which affirmative identification of an animal spirits shock may be possible.
VI. Concluding Remarks

Taken as a whole, our results support an interpretation of consumer confidence based neither on autonomous movements in sentiment nor on precautionary responses to uncertainty about future economic conditions, but rather on the aggregation of knowledge concerning future fundamentals, and, in particular, productivity. In this sense, we have found an empirical analogue of “information shocks”. Does this mean that we have found support for the “news approach to business cycles”? Beaudry and Portier (2004, 2005) attempt to ascertain both the information structure and real features of the economy necessary for a viable theory in which news about future productivity generates broad-based movements in measures of economic activity well in advance of the realization of the productivity change.\(^{20}\) The fact that Beaudry and Portier’s (2004c) solution requires multiple sectors and a large amount of complementarity has somewhat dampened enthusiasm for this brand of business cycle theory. More recently, Jaimovich and Rebelo (2005) have developed a one-sector model which delivers the desired positive co-movement, but the assumptions of the model seem rather tenuous.

Our paper points to even more serious obstacles for this approach on the empirical front. Our results do support the notion that agents receive advance signals concerning future productivity, and provide data in addition to Beaudry and Portier’s (2004b) stock prices that serve as an empirical counterpart of these information shocks. However, the movements in consumption, output, and other activity variables in the quarters directly following an information shock are generally rather negligible. Only after a long delay do consumption and output show quantitatively substantial responses to a shock satisfying the qualitative criteria of an information shock. The behavior of consumption and output appear to track rather than

\(^{20}\) Earlier, Cochrane (1994) had foreshadowed the difficulties in producing positive co-movement of consumption, investment, and labor input in response to such information shocks.
anticipate movements in productivity. Consequently, information shocks alone are likely only a weak candidate source of short run business cycle fluctuations.
References


Appendix A: Sketch of Agnostic Identification Procedures

(A) Max Forecast Error Variance

Letting \( x \) be the vector of endogenous variables, suppose that an arbitrary structural moving average representation can be written as:

\[
x_t = C(L)GG^{-1}e_t
\]

Where \( G \) is any matrix satisfying \( GG' = \Sigma \), where \( \Sigma \) is the variance-covariance matrix of reduced form innovations. For any such orthogonal decomposition, the fraction of the forecast error variance of the \( i^{th} \) variable to the \( j^{th} \) structural shock at horizon \( h \) is given by:

\[
\omega_{ij}(h) = \frac{e_i' \left( \sum_{t=0}^{h-1} C_t Ge_j e_j' G'C_t' \right) e_j}{e_i' \left( \sum_{t=0}^{h-1} C_t \Sigma C_t' \right) e_i}
\]

Here \( e_i \) and \( e_j \) are selection vectors with one in the \( i^{th} \) or \( j^{th} \) places and zeros elsewhere.

For any orthonormal matrix \( D \), the structural moving average representation can equivalently be written as:

\[
x_t = C(L)GDD'G^{-1}e_t
\]

The above gives us the entire space of orthogonal identifications. After applying this linear rotation, the expression for the forecast error variance is now given by:

\[
\omega_{ij}(h) = \frac{e_i' \left( \sum_{t=0}^{h-1} C_t G\alpha \alpha' G'C_t' \right) e_j}{e_i' \left( \sum_{t=0}^{h-1} C_t \Sigma C_t' \right) e_i}
\]

Where \( \alpha \) is the \( j^{th} \) column of the orthonormal matrix \( D \). The maximum forecast error variance identification is accomplished by choosing \( \alpha \) to maximize the contribution of the \( j^{th} \) shock to the forecast error variance of the \( i^{th} \) variable at some arbitrarily chosen horizon, subject to the restriction that \( \alpha'\alpha = 1 \). The \( j^{th} \) structural shock is then identified as \( \alpha' G^{-1} e_i \) and the structural moving average coefficients to the \( j^{th} \) shock are \( C(L)G\alpha \). That the vector \( \alpha \) is restricted to have unit length maintains the scaling of the variance of the structural shock to unity.

To identify the “best case” for an information shock, we adhere to the following procedure:

1. Estimate the reduced form
(2) Perform a Choleski decomposition to attain an arbitrary orthogonalization of the reduced form, $G$

(3) Create several thousand vectors $\alpha$ satisfying the unit length assumption with a zero in the $i^{th}$ position, where $i$ corresponds to the position of output in the VAR

(4) Compute the forecast error variance decomposition of output for each rotation vector $\alpha$

(5) The “best case” for the information shock is then defined as that rotation which explains the maximal portion of the forecast error variance of output at a horizon of eight years

(B) Impulse Response Shape Restriction

Similar to the max forecast error variance identification, suppose that an arbitrary structural moving average representation can be written as:

$$x_t = C(L)GG^{-1}e_t$$

Where $G$ is any arbitrary orthogonalization of the reduced form. For any orthonormal matrix $D$, the moving average representation can alternatively be written:

$$x_t = C(L)GDD'G^{-1}e_t$$

Taking the $j^{th}$ shock as the shock of interest, the moving average representation can then be written:

$$x_t = C_iG\alpha\alpha'G'C_i'e_{ij}$$

Where $\alpha$ is the $j^{th}$ column of the matrix $D$. $C_iG\alpha$ then gives the moving average coefficient of all variables in the VAR to shock $j$ while $\alpha'G'C_i'e_{ij}$ defines structural shock $j$.

To identify the “best case” for a transitory shock, we adhere to the following procedure:

(1) Estimate the reduced form
(2) Perform a Choleski decomposition to attain an arbitrary orthogonalization of the reduced form, $G$
(3) Create several thousand vectors $\alpha$ satisfying the unit length assumption (as opposed the max forecast error variance case, we no longer require that $i^{th}$ element of $\alpha$ be zero)
(4) Keep all rotations which satisfy the following conditions
   a. The response of output on impact is non-negative
   b. The response of output at one year is positive
   c. The response of output at one year is greater than the response at four years
   d. The response of output at eight years is within 0.2 percent of zero
(5) The “best case” for a transitory shock is then defined as that rotation yielding the maximal effect on output at one year of those rotations satisfying the requirements in (4).
Appendix B: Tables

Table 1
Cross-Correlogram of E5Y and HP Detrended GDP

Cross Correlogram of E5Y and LRGDP-HPTREND01

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<td>-0.1336 0.0887</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
<td>-0.0806 0.0789</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>-0.0228 0.0721</td>
</tr>
</tbody>
</table>
Table 2
Estimates from VAR with GDP, E5Y, and Non-Durable Consumption

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>GDP</th>
<th>E5Y</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP(-1)</td>
<td>1.18590***</td>
<td>-65.29044</td>
<td>0.175881***</td>
</tr>
<tr>
<td></td>
<td>(0.08118)</td>
<td>(84.6742)</td>
<td>(0.06669)</td>
</tr>
<tr>
<td>GDP(-2)</td>
<td>-0.154147*</td>
<td>75.97706</td>
<td>-0.167825**</td>
</tr>
<tr>
<td></td>
<td>(0.08329)</td>
<td>(86.8752)</td>
<td>(0.06842)</td>
</tr>
<tr>
<td>E5Y(-1)</td>
<td>0.000154**</td>
<td>0.811427***</td>
<td>0.00148**</td>
</tr>
<tr>
<td></td>
<td>(0.000075)</td>
<td>(0.07775)</td>
<td>(0.000061)</td>
</tr>
<tr>
<td>E5Y(-2)</td>
<td>-0.0000841</td>
<td>0.097227</td>
<td>-0.0000765</td>
</tr>
<tr>
<td></td>
<td>(0.000072)</td>
<td>(0.07539)</td>
<td>(0.000059)</td>
</tr>
<tr>
<td>C(-1)</td>
<td>0.231661**</td>
<td>189.8963*</td>
<td>1.000133***</td>
</tr>
<tr>
<td></td>
<td>(0.10211)</td>
<td>(106.502)</td>
<td>(0.08388)</td>
</tr>
<tr>
<td>C(-2)</td>
<td>-0.189288*</td>
<td>-203.3877*</td>
<td>-0.009382</td>
</tr>
<tr>
<td></td>
<td>(0.10453)</td>
<td>(109.028)</td>
<td>(0.08587)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.030584</td>
<td>20.60121</td>
<td>0.004470</td>
</tr>
<tr>
<td></td>
<td>(0.03493)</td>
<td>(36.4294)</td>
<td>(0.02869)</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.999633</td>
<td>0.836197</td>
<td>0.999618</td>
</tr>
</tbody>
</table>

* Significant at 10 % level
** Significant at 5 % level
*** Significant at 1 % level

Chi-Square Statistics for Block Exogeneity:

<table>
<thead>
<tr>
<th>Chi-Square Statistic</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>E5Y → GDP</td>
<td>7.092</td>
</tr>
<tr>
<td>GDP → E5Y</td>
<td>0.575</td>
</tr>
<tr>
<td>C → GDP</td>
<td>6.440</td>
</tr>
<tr>
<td>GDP → C</td>
<td>5.216</td>
</tr>
<tr>
<td>E5Y → C</td>
<td>11.014</td>
</tr>
<tr>
<td>C → E5Y</td>
<td>3.376</td>
</tr>
</tbody>
</table>
Table 3
Long Horizon Regressions

\[ 100 \times (\ln C_{t+h} - \ln C_t) = \alpha + \beta E5Y_t + \varepsilon_t \]

<table>
<thead>
<tr>
<th>Horizon</th>
<th>E5Y</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 quarter</td>
<td>0.011</td>
<td>.09</td>
</tr>
<tr>
<td>(0.003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 year</td>
<td>0.032</td>
<td>.15</td>
</tr>
<tr>
<td>(0.011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 years</td>
<td>0.043</td>
<td>.13</td>
</tr>
<tr>
<td>(0.017)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>0.078</td>
<td>.19</td>
</tr>
<tr>
<td>(0.021)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 years</td>
<td>0.083</td>
<td>.16</td>
</tr>
<tr>
<td>(0.026)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Sample period is fixed at 1960.1 – 1998.2 (quarterly) to account for the seven years of leading observations. Consumption is non-durable consumption expenditures. Robust (Newey-West) standard errors are in parentheses and \(p\)-values are in square brackets.

Table 4
Regressions of Confidence Innovations on Selected News Heard

<table>
<thead>
<tr>
<th>News Heard</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fav. Employment</td>
<td>0.320</td>
</tr>
<tr>
<td>(0.101)</td>
<td></td>
</tr>
<tr>
<td>Un. Employment</td>
<td>-0.049</td>
</tr>
<tr>
<td>(0.042)</td>
<td></td>
</tr>
<tr>
<td>Fav. Prices</td>
<td>1.028</td>
</tr>
<tr>
<td>(0.520)</td>
<td></td>
</tr>
<tr>
<td>Un. Prices</td>
<td>-0.393</td>
</tr>
<tr>
<td>(0.164)</td>
<td></td>
</tr>
</tbody>
</table>

Adjusted \(R^2 = 0.12\)

Notes: Sample period is 1960.1 – 2005.1 (quarterly). The dependent variable is the innovation in E5Y from a three variable system including consumption and GDP with two lags. The independent variables are defined as the percentage of all respondents in a given quarter reporting having heard news in that particular category.
Appendix C: Figures

Figure 1
Bivariate VARs with Output and non-durable Consumption

(A) Ordering: $C \rightarrow Y$

(B) Ordering: $Y \rightarrow C$
Figure 2
E5Y and E12M Across Time
Figure 3
Trivariate VARs with C, E5Y, and Y
Impulse Responses

(A) Ordering: E5Y→C→Y
(B) Ordering: C→E5Y→Y
Figure 4
Trivariate VARs with C, E5Y, and Y
Variance Decompositions

(A) Ordering: E5Y → C → Y

(B) Ordering: C → E5Y → Y
Figure 5 (A)
Impulse Responses from VAR with ordering GDP → E5Y → C
Figure 5 (B)
Variance Decomposition with ordering GDP, E5Y, Non-Durable C
Figure 6 (A)
Impulse Responses from VAR with ordering GDP→E5Y→Durable C

Response to One S.D. Innovations ± 2 S.E.
Figure 6 (B)
Impulse Responses from VAR with ordering GDP→PFE→C
Figure 6 (C)
Impulse Responses from VAR with ordering GDP → ICS → C
Figure 7
Bivariate VAR with labor productivity and E5Y
Ordering: productivity, confidence

Response to Cholesky One S.D. Innovations ± 2 S.E.

Notes: For these and future figures including productivity, productivity is defined as the difference between log real output and total hours (the hours measure is the standard one from the BLS).
Figure 8 (A)
Theoretical Impulse Responses to Information Shock
Figure 8 (B)
Theoretical Responses to the Animal Spirits Shock

[Graphs showing the theoretical responses to the Animal Spirits Shock]
Figure 9 (A)
Theoretical Impulse Responses to the Information Shock with Habit Formation
Figure 9 (B)
Theoretical Impulse Responses to the Animal Spirits Shock with Habit Formation
Note: The above simulation is from the identification of a shock satisfying the best case scenario for an information shock in a three variable system with output, E5Y, and non-durable consumption. The shock is identified as that shock explaining the most of the forecast error variance of output at a horizon of eight years among all shocks contemporaneously orthogonal to output. The actual series is given by the more lightly shaded line while the simulated is given by the darker line.
Figure 10 (continued)
Historical Simulations

(B) Contribution of Transitory Shock: Historical Simulations

Note: The above simulation is from the identification of a shock satisfying the best case scenario for a transitory shock in a three variable system with output, E5Y, and non-durable consumption. The shock is identified as that shock explaining the most of the forecast error variance of output at a horizon of one year among all shocks which have a transitory effect on output. The actual series is given by the more lightly shaded line while the simulated is given by the darker line.
Figure 11
Spike Plots of Responses in News Heard Categories: Favorable Employment, Unfavorable Employment, Unfavorable Energy Crisis, Unfavorable Prices, and Favorable Stocks
Figure 12
Inflation and E5Y Across Time
Figure 13
Impulse Responses with ordering: \( Y \rightarrow \text{Inflation} \rightarrow E5Y \rightarrow C \)
Figure 14
Impulse Responses with ordering:  Y→E5Y→Inflation→C

Response to Cholesky One S.D. Innovations ± 2 S.E.
Figure 15

Historical Simulations in Four Variable Case
Included Variables: Output, inflation, E5Y, and non-durable consumption

(A) Contribution of Information Shock: Historical Simulations

Note: The above simulation is from the identification of a shock satisfying the best case scenario for an information shock in a four variable system with output, consumer price inflation, E5Y, and non-durable consumption. The shock is identified as that shock explaining the most of the forecast error variance of output at a horizon of eight years among all shocks contemporaneously orthogonal to output. The actual series is given by the more lightly shaded line while the simulated is given by the darker line.
Figure 13 (continued)

Historical Simulations in Four Variable Case
Included Variables: Output, inflation, E5Y, and non-durable consumption

(B) Contribution of Transitory Shock: Historical Simulations

Note: The above simulation is from the identification of a shock satisfying the best case scenario for a transitory shock in a four variable system with output, consumer price inflation, E5Y, and non-durable consumption. The shock is identified as that shock explaining the most of the forecast error variance of output at a horizon of one year among all shocks which have a transitory effect on output. The actual series is given by the more lightly shaded line while the simulated is given by the darker line.
Figure 16
S & P 500 and E5Y Across Time
Figure 17
Impulse Responses with ordering: Y→S & P 500→E5Y→C
Figure 18
Impulse Responses with ordering: $Y \rightarrow \text{Inflation} \rightarrow \text{S} \ & \ P \ 500 \rightarrow \text{E5Y} \rightarrow C$
Figure 19
E5Y and the First Principal Component of Inflation and the Stock Market
Figure 20 (A)
Bivariate VAR
Labor Productivity and Inflation
Response to Cholesky One S.D. Innovations ± 2 S.E.

Figure 20 (B)
Bivariate VAR
Labor Productivity and S & P 500
Response to Cholesky One S.D. Innovations ± 2 S.E.
Figure 21
Unemployment and E5Y Across Time
Figure 22
Impulse Responses with Ordering Y → Unemployment → E5Y → C
Figure 23
Impulse Responses with Unemployment and Inflation Ordered Prior to E5Y