The Effect of GNP Announcements on Fluctuations of GNP Growth*

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Abstract

This paper is an empirical study of the degree in which perceptions affect the evolution of the economy. We study the effects of the announcements that the government makes on GNP growth. These announcements are subject to a substantial degree of noise and its accuracy improves with time. A revised number is published several years after the first announcement was made public. We consider that the final revision is the "true" value of GNP growth. We show that once announcements are taken into account, the true value of GNP growth at time t has no predictive power in determining growth at any future time. All the predictive power lies in the announcements, and not in the true level of growth. Actually, we show that the variable that determines future growth is the unexpected part of the announcements. We also show that announcements affect growth via aggregate investment.

JEL Classification Codes: E01, E27, E32

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1 Introduction

In economic models agents are typically assumed to be fully and correctly informed about the entire past history of the economy. They are assumed to know precisely the realizations of all past variables that can be useful for the prediction of future events. The only uncertainty that they face being due to the existence of unforeseeable exogenous shocks that will occur *in the future.* The real world, however, is considerably more complex. Economic agents are uncertain not only about the events to be realized in the future, but also on the value of variables that were realized *in the past.* In particular the *true* level of past economic activity (such as the *true* level of real Gross National Product last quarter) is a variable that we nobody knows *with certainty.* Agents do not really *know* the complete history of the economy (not even the history that is relevant for prediction of future aggregate activity); they have *perceptions* about the past. They establish probability distributions on the realizations of the economic variables *in the past* based on their observations.

Thus, in order to forecast the future behavior of the economy it would seem useful to know both **(1)** the actual past performance of the economy and **(2)** the past performance of the economy *as perceived by the agents.* The reason is that agents take actions based upon their perceptions, and these actions determine the future path of the economy. Thus, the future course of the economy depends on the perceptions that agents may have on its past evolution. The perception that agents have today about the past performance of the economy is itself an important economic variable.

In this paper, we investigate and establish the importance of agent perceptions about past activity as a determinant of present and future activity. Our primary contribution is to document the influence of announcements of past growth rates of U.S. real GNP growth upon future real GNP growth. We do so by exploiting the well-documented fact (Mankiw and Shaphiro (1986), Runkle (1998), Young (1994)) that data on economic activity is subject to a large degree of measurement noise when it is announced for the first time. Data are revised, and well after the first announcement was made, a final version is published. The first announcement is the GNP growth that agents *perceived*, while the final one (unavailable at the time) is the "true" growth rate.

We find a striking result: in a regression explaining the growth rate of real GNP for quarter t, the true growth rate of the economy during quarter $t-1$ *does not matter* if the growth rate at $t-1$ *perceived* during quarter t is also included in the regression.

We also show, through examination of the components of real GNP, that the influence of beliefs works through aggregate investment. Our result also leads us to question the roots of autocorrelation in macroeconomic aggregates across time: if perceptions play a large role in this process, then other variables that induce autocorrelation must necessarily be less important than commonly thought.

Our work addresses a subject seldom explored in the empirical literature. The closest papers in spirit to ours are Oh and Waldman ((1990) and (2005)). In their 1990 paper, they study the effects of (false) announcements in the leading economic indicators upon future economic activity. Their primary result is that predictions of future growth do in fact influence its actual realization. Thus, if agents receive information which states that aggregate activity is likely to be high in the future (even if this information is based on incorrect data), the information has a positive effect on movements of future output. In their 2005 paper, they use forecasters' data to test directly if false announcements on the index of leading indicators have a direct effect on the forecasters' predictions, finding that they effectively do. Our approach, and the spirit of our results, is similar to their 1990 paper; but while they look at how beliefs about the *future* affect future output, we look at how beliefs about the *present* affect future output. By centering on the effects of announcements on *past* GNP (less prone to be interpreted as a prediction of future activity than the index of leading indicators), we can explore the time series properties of GNP when controlling by the announcements. It is difficult to think on any type of reverse causality inducing our results, as we use an informational variable that is an imperfect measurement of *past*, not future, events.

Our paper is also related to Matsusaka and Sbodorne (1995) who show that the movements of consumer confidence that are not be explained by fundamentals (at least with the data available to the econometrician) Granger-cause movements in output, explaining between 13 and 26 percent of the variance of GNP.

Runkle (1998) shows that revisions of economic data tend to be very large, and shows that to evaluate the performance of monetary policy and understanding its motivation it is necessary to use the announcements (to which policy reacts) and not the final value of the macroeconomic variables (unknown to the policy maker at the time of taking the decisions).

The very nature of the results connects our paper with the "animal spirits" view of the business cycle. Our results relate them with the literature on self-fulfilling expectations, multiple equilibria and strategic complementarities. Particularly with those papers in which uncertainty on past events helps to determine future outcomes; like Acemoglu (1993) who models the investment accelerator exploiting agent uncertainty about the level of past aggregate investment and Rodríguez Mora ((1994) and (1995)) who models the accuracy of people's perceptions about the past as an endogenous variable.

The rest of the paper is organized as follows. In Section 2, we describe our empirical approach. Section 3 presents our main results. We discuss them and conclude in section 4. In appendix A, we examine whether our results are evidence of "animal spirits".

2 GNP Announcements and Revisions

To measure the perceptions that agents have about the past is not straightforward. In contrast to the large literature that studies how agents generate expectations about the future, little attention has been devoted to studying how perceptions about the past are generated. Fortunately, the manner in which economic variables are measured and made public provides us with an adequate representation of agents' perceptions.

We will exploit the fact that governments make announcements, which become common knowledge, about the past performance of the economy. These announcements are noisy measurements of the true realizations of economic variables. The accuracy of the measurements depends upon the amount of information available to the statistical agency at any point in time. Mankiw and Shapiro (1986) show that the noise in the revisions is due to the appearance of unforeseeable new information. Clearly, the longer the period of time the statistical agency has to formulate an estimate of an economic variable, the more accurate will be that measurement. Years after the first announcement was made, the statistical agency makes a final estimate of activity for that period. We assume this final estimate to be the "truth". It is this number that economists use when doing econometrics and that is widely available in digital format. The crucial point is that the first announcement and the final estimate (the truth) differ substantially. The announcements are composed of the truth and an error term. We will assume that the latest announcement reflects the state of opinion about the realizations of the economic variables at any given moment of time, an appropriate assumption given that the announcements receive much attention in the media. Our main objective is to study the usefulness of both announcements and truth in predicting future rates of growth of the economy and future growth rates of the components of real GNP.

Our work focuses upon announcements of real GNP in the United States.[1] As Mankiw and Shapiro write, "GNP is probably the most closely watched economic series. Almost all observers - economists, policy makers, and the press - consider it the primary measure of the health of the macroeconomy. Estimates of GNP, therefore, receive much attention". As it is well docu-

[1] We focus upon GNP rather than GDP because until 1991 the U.S. government used GNP as its primary measurement of aggregate activity.

mented, there is considerable noise in the measurement of past GNP. The first "advance" estimate,[2] based upon preliminary and incomplete source data, is released soon after the end of a quarter; we will denote the announcement made at the beginning of quarter t on the rate of growth *during* quarter $t-1$ by $\hat{g}_{t-1}^{t}$.

As additional data becomes available, "preliminary" and "final" estimates are released thirty and sixty days after that first announcement. Each month, the Commerce Department publishes its most recent estimates of real GNP growth for the previous six quarters. The final comprehensive benchmark revisions are published after five years. These latest estimates are based on new and revised source data and are influenced by updated seasonal factors, shifts in the base period and by definitional changes. In general, the initial estimate, based upon the roughest data, is subject to the most noise. We consider the final comprehensive estimate of quarterly GNP[3] as the "true" value of quarterly GNP. The "true" growth rate during period t is denoted g_t.

Our sample period ranges from January 1967 to July 1991. The first date was selected because before January 1967 the first estimate of monthly real GNP was announced two months after the end of a quarter, and we wanted a measure of perceptions consistent across time. The last date was chosen

[2] We do not make use of the "flash" estimate. This estimate was published fifteen days *before* the end of the quarter during the final years of the 1970's and the first years of the 1980's. It was originally intended for exclusive use by policy makers, and was not intended to be made public, due to the large amount of noise that it possessed. The flash estimate began to receive public attention inducing its discontinuation.

[3] In practice, we work with growth rates and not levels so we need not worry about periodic revisions to the national accounts which, by changing the base year of prices, changes systematically all past measurements of GNP.

because in October 1991, the Commerce Department ceased publishing initial estimates of real GNP and switched to a GDP based national accounting system. Additionally, it is necessary to have a long time lag between the last announcement in our sample and the present in order for the last observations of the true growth rate to be sufficiently updated.

Our data on the initial estimates of current dollar GNP were recorded from the Survey of Current Business. For the period January 1967 to October 1991, we recorded manually the monthly estimates of the previous five quarters of current dollar GNP for which estimates are available.[4]

Estimates published at any given month are in constant dollars, thus even if the price index changes with time the estimates on growth are consistent across time. Our regression results reported above concentrate upon the first estimate of real GNP growth for quarter $t-1$ available during quarter t. This information[5] is typically published (and widely disseminated) between fifteen days and one month after the end of quarter $t-1$. Our data on the true levels of real GNP and its breakdown into components is taken from the United States National Income and Product Accounts.

In figure A, we plot the "true" value versus the initial announcement. Clearly, they differ substantially. In Table 1, we present descriptive statistics of these variables. The existence of a difference between them, the noise in

[4] Our data was collected manually and refers directly and systematically to the *first* announcements made. Since we started the project an excellent data base on real time announcements has been available by Dean Croushore and Tom Stark (available in their homepage at the Philadelphia Federal Reserve Bank, references in Croushore and Stark (2001). We use the data that we collected because from their data it would be involved, even though possible, to extract the *first* announcement in GNP growth. Obviously it should be possible to replicate our results using announcements extracted from their data set.

[5] These data are available upon request to the corresponding author.

the first announcement, is a well-known fact that has attracted considerable attention. We will consider this noise[6] as measurement mistake, defined as:

$$\hat{m}_{t-1}^{t} \equiv g_{t-1} - \hat{g}_{t-1}^{t} \tag{1}$$

As it was pointed by Runkle (1998), it is noteworthy that the best linear estimator of the truth is *not* the first announcement, but a function of it. In table A we present the following regression:

$$g_t = \alpha_0 + \alpha_1 \hat{g}_t^{t+1} + e_t \tag{2}$$

We can reject the hypothesis that the constant is zero (at a 10 % confidence level). We can also reject the hypothesis that the parameter of $\hat{g}_t^{t+1}$ is one. Thus, we have to take into account the fact that the initial announcement is not an unbiased predictor of the final revision.[7]

To that end, we define the "best estimation" of true GNP growth at period $t-1$ available at t as

$$\hat{h}_{t-1}^{t} = \hat{\alpha}_0 + \hat{\alpha}_1 \hat{g}_{t-1}^{t} \tag{3}$$

In addition, we define *"innovation"* as the difference between the *"truth"*

[6]We tested the series $\hat{m}_{t-1}^{t}$ using a GARCH model to see whether the conditional variance of the announcements changed over time. We found that it did not.

[7]Introducing lags (g_{t-1}^{t}, etc.) does not improve the estimation. The values of our estimation are slightly different from the ones reported by Runkle, the difference being accounted for by his use of data ranging from 1961 to 1996 (thus including different measurement strategies and the fact that he uses annualized values of growth (which changes the intercept). His estimated value for α_0 ranges between 0.0066 and 0.0092, his value of α_1 in between 0.7358 and 0.7947.

and the *"best estimation"* (the residual in equation 2).

$$\hat{e}^t_{t-1} = g_{t-1} - \hat{h}^t_{t-1} \tag{4}$$

Our objective for the rest of the paper is to predict the behavior of true GNP growth (g_t), using as explanatory variables true past GNP growth (g_{t-1}) *and the perceptions that people had at the beginning of t on growth during* $t-1$. As measures of perceptions we will use either $\hat{g}^t_{t-1}$ or $\hat{h}^t_{t-1}$. Our results do not depend at all on using one or the other. Thus, we have no interest in entering in a debate on whether the announcements could be improved upon. In order to check the robustness of our results we will present them using both announcements and mistakes ($\hat{g}^t_{t-1}$ and $\hat{m}^t_{t-1}$) or "best estimations" and "innovations" ($\hat{h}^t_{t-1}$ and $\hat{e}^t_{t-1}$).

3 Results for U.S. Real GNP

One of the well-known macroeconomic facts is that past rates of growth of real GNP have predictive power for future real GNP growth. The time series of real GNP growth exhibits persistence. A high rate of growth last quarter is typically associated with a high rate of growth next quarter. The traditional explanation of this basic fact of the business cycle lies on existence of physical state variables (such as investment or capital stock) which induce correlation in the first derivative of real GNP over time.

In this section, we show that once perceptions are taken into account this basic stylized fact is untrue. Once announcements are controlled for, the *true* past rate of real GNP growth no longer has predictive power for future real GNP. Instead, all the predictive power lies on the rate of real GNP growth that agents observed (i.e. government announcements). Then in Section 3.2, we demonstrate that perceptions influence real GNP through aggregate investment.

To examine the effect of government announcements upon real GNP growth presupposes an econometric model that explains real GNP growth. We take a reduced form approach and model growth as an ARMA process. Then the effects of adding announcements to the model are studied.

Our final estimation[8] of the ARMA model on the time series of the (true) growth rate of real GNP[9] is:

$$g_t = \alpha_0 + \alpha_1 g_{t-1} + \epsilon_t. \tag{5}$$

Where g_t is the true rate of growth of real GNP, α_0 and α_1 are parameters to be estimated and ϵ_t is an error term. Table 3 contains all the regressions we run in this section. Its first column shows the result of estimating equation 5. As expected, the coefficient on past growth is significant and greater than zero.

To examine the importance of the announcements of real GNP we add the first announcement of real GNP growth for period $t-1$, $(\hat{g}^t_{t-1})$, announced at the beginning period t:[10]

[8]We report only the final results for the ARMA processes that we studied. These are the simplest regressions that generated white noise error terms.

[9]Note that the g_t is $\ln(y_t/y_{t-1})$, where y_t is real GNP during quarter t. Thus the average level of g_t over the period $1960-1991$ is .0061 implying an annual growth rate of 2.4% over this period.

[10]We concentrate upon the first announcement of real GNP growth for period $t-1$ that

$$g_t = \alpha_0 + \alpha_1 g_{t-1} + \alpha_2 \hat{g}^t_{t-1} + \epsilon_t. \tag{6}$$

The result of this regression (second column of Table 3) illustrates the main point of the paper. Once the announcements are taken into account, the past true rate of growth looses all predictive power. What matters to determine growth during period t is not the growth rate during $t-1$, but the *perception* that agents taking decisions at t had on the rate of growth during $t-1$. The remaining columns of Table 3 should reassure the reader that the previous argumentation is sound. [11]

As we have seen in Table A, the announcement is not the best prediction of past growth. In the third column of the Table, we have substituted the announcement by the "best estimation" of the true rate of growth during $t-1$ available at the beginning of t (as defined in 3). Perhaps not surprisingly the results do not change.

A potentially more serious problem with equation 6 is that g_{t-1} and $\hat{g}^t_{t-1}$ are highly correlated, which might lead to multicollinearity problems. The rule of thumb (according to Greene (1990) is that we should be concerned about multicollinearity problems if the R^2 of a regressing the RHS variables into themselves is larger than the R^2 of the equation. In Table A, we can see

is announced one month into period t. The addition of other announcements does not change the results.

[11] Both the announcements and the "truth" are deseasonalized series. We do not think that this affects our results.

When the "true" series is deseasonalized, the values of GNP used are that of the revised ("true") series, *not* the announcements. In the event that there exists autocorrelation in the deseasonalized series due to the method of seasonal correction and not due to economic factors, that autocorrelation should appear in equation (6) independent of the inclusion of the announcements.

that this is the case.

In order to deal with this problem we make two exercises. **(1)** First, we see that multicollinearity is not an issue when we regress g_t on the true past rate of growth and the measurement mistake ($\hat{m}_{t-1}^t$, defined in 1) instead of the announcement. We cannot reject the hypothesis that the parameters for g_{t-1} and $\hat{m}_{t-1}^t$ are equal but of different sign (Table 3, Column 4). The implication is identical to the one we obtained before: the truth does not matter; only the announcement does. The advantage of this regression is that the correlation of between g_{t-1} and $\hat{m}_{t-1}^t$ should be smaller than between g_{t-1} and $\hat{g}_{t-1}^t$. We check that multicollinearity is not worrisome in this equation by noticing that the R^2 of running a regression of the RHS variables into themselves (in Table 4) is smaller than the R^2 of the equation.

(2) A further test consists in running a regression of growth at t on both the announcement and the mistake.[12] Here references to the true growth at $t-1$ are included only through the mistakes. If the truth were the only variable that mattered, then the estimated parameter of the mistake should be equal to the estimated parameter of the truth. If, on the other extreme, only the announcement mattered, then the parameter of the mistake would not be significantly different from zero. In Column 5 of Table 3, we run this regression. We cannot reject that the mistakes have no effect, indicating that the announcements (and not the truth) are all that matters. The correlation between announcements and mistakes is small, and so multicollinearity is not an issue in this equation either: the R^2 of the regression of the RHS variables

[12] We thank one of the referees for suggesting this regression. It is similar in approach to Oh and Waldman (1990)

into themselves is lower that the R^2 of the equation.

In the sixth column, we use as RHS variables the "best prediction" and the measurement mistake. The results are analogous to the ones obtained in Column 4.

Columns 7, 8 and 9 do the same exercise, but we use as RHS variable the "innovation" in the announcement process (the residual of regressing equation 2) instead of the measurement mistake. The results do not change, the parameter of $\hat{e}_{t-1}^{t}$ is equal but of reverse sign than the parameter of g_{t-1} in column (7), but looses all predictive power when the true growth at $t-1$ is substituted by a measure of the perceptions on it that agents had during t (eight and ninth columns). In Table 4, we run regressions of the RHS variables into themselves. The R^2 of these regressions are always lower than the ones in columns (4-9) of Table 3.

Summarizing: it is perceptions what matter, not the truth. The perception that we have today on what was GNP growth last quarter affects crucially GNP growth this quarter, but last quarter's GNP growth does not seem to affect it.

The fact that the perceptions and the truth are highly correlated does not affect our results. When we run alternative regressions where multicollinearity is not an issue, we get the same result. A final set of regressions, from which the truth (g_{t-1}) is omitted, are reported in the remaining columns of Table 3.

Another way of seeing our point is the following. Imagine that an economist is assigned with the task of predicting real GNP growth for the current quarter. The economist knows that the published measurements of the past performance are noisy. Assume further that our economist is truly fortunate; he is fully informed about the *true* rate of growth during the previous quarters, information available only to him. Our results indicate that in this circumstance the economist would not use the additional information to forecast future growth, for forecasting purposes he can do no better than using the announcements.

Thus, **(1)** if announcement data are not used then true past growth helps to predict future growth. Additionally, **(2)** the announcement (in absence of the true past growth) helps to predict future growth. It would be wrong to think that **(2)** happens because the announcement is a good estimation of the truth, while **(1)** is a somewhat "structural" relationship. Our point is that **(1)** happens because the truth is a "good instrumental variable" of the announcement, while **(2)** is a "structural" relationship.

This does not deny that other factors such as capital accumulation or total factor productivity induce correlation in output levels; they obviously do. Nevertheless our finding suggests that persistence of real GNP *growth*, and thus of business cycles fluctuations, lies fundamentally on *beliefs* on past events, not on the events themselves. It suggests that business cycles fluctuations may be driven more by whims and misperceptions than by real events.

3.1 Surprises

We find more evidence for our hypothesis by conducting an additional exercise. Not all the information contained in an announcement is new information. Agents have expectations on the rate of growth during quarter $t-1$ before the announcement is made. These expectations are based on their knowledge on growth during $t-2$. Agents know that, after all, real GNP *is* serially correlated, and before the announcement on g_{t-1} is made all that they know is the value of $\hat{g}_{t-2}^{t-1}$. Once the announcement is made there will be a difference between this number ($\hat{g}_{t-1}^{t}$) and their expectations. This difference determines how surprised they are by the announcement. This surprise is the new information revealed by the announcement. We will now show that the "surprise" is the component of the announcement that has predictive power.

Before the "advance" estimate of real GNP growth during $t-1$ agents could forecast its value based upon the announcements made the previous quarter on the GNP growth during $t-2$. Define s_{t-1}^{t}, the unexpected part of the announcement made at t about growth at $t-1$, as the error term in the following regression equation:

$$\hat{g}_{t-1}^{t} = \beta_0 + \beta_1 \ \hat{g}_{t-2}^{t-1} + s_{t-1}^{t}. \tag{7}$$

Where $\hat{\beta}_0 + \hat{\beta}_1 \ \hat{g}_{t-2}^{t-1}$ is the best linear prediction, at time $t-1$, of the announcement at time t of the rate of growth of the economy at $t-1$; we will call it the expected part of the announcement and denote it by $E\left(\hat{g}_{t-1}^{t}\right)$. As should be expected, s_{t-1}^{t} is white noise (the Box Pierce statistic is 16.49).[13]

In Table 5 we show the results of running a regression of the true rate of growth on its past values, the "expected announcement" and past values of

[13]For comparative purposes with the other variables, its standard deviation is 0.00867.

the "surprise", i.e.:

$$g_t = \alpha_0 + \alpha_1 \; g_{t-1} + \alpha_2 \; E\left(\hat{g}^t_{t-1}\right) + \alpha_3 \; s^t_{t-1} + \epsilon_t \tag{8}$$

Noticing that the announcement is the summation of the expectation and the surprise:

$$\hat{g}^t_{t-1} = E\left(\hat{g}^t_{t-1}\right) + s^t_{t-1} \tag{9}$$

In the first column of the table, we observe again that controlling for the announcement the effect of the truth is not statistically different from zero. In addition, we find two new results. First, the effect of the expected part of the announcement is not significantly different from zero even at a 10 % confidence level (the P-value is 0.173). Second, the surprise (the unexpected part of the announcement) has a positive and significant effect.

In the second column, we drop the past true growth and we observe again that the surprise has the bulk of the predictive power. We cannot reject that the expected part has no effect at the 5% confidence level and only marginally at the 10% level. The surprise appears always as significantly different from zero.

In the third column, we do not include the expected part of the announcement. The truth is not significant, while the surprise it is.

In the fourth column, we report the results of the regression of the unexpected component of the announcement on past values of itself and true growth. None of them explains this part of the announcement. This insures that the result is not due to the way in which data are collected. Our final equation, omitting the insignificant variables, is presented in the last column.

3.2 Through Which Components Do Perceptions Matter?

The regressions results presented above demonstrate that agents' perceptions matter as economic variables in their own right. In this subsection, we investigate through which component of real GNP do perceptions matter. Intuition suggests that perceptions should matter through investment, a forward-looking variable and an especially volatile component of GNP.

To explore the effect of measurement mistakes upon the components of real GNP, we use ARMA models to explain the growth rates of the major components of real GNP: consumption, investment and government spending. For each of the components i ($i = \{$consumption, investment, government expending$\}$) we estimate the following regressions:

$$c^i_t = \gamma^i_0 + \gamma^i_1 \, c^i_{t-1} + \gamma^i_2 \, \hat{m}^t_{t-1} + \epsilon^i_t. \tag{10}$$

$$c^i_t = \gamma^i_0 + \gamma^i_1 \, c^i_{t-1} + \gamma^i_2 \, g_{t-1} + \gamma^i_3 \, \hat{g}^t_{t-1} + \epsilon^i_t. \tag{11}$$

Where c^i_t is the growth rate of component i at time t, $\{\gamma^i_0, \gamma^i_1, \gamma^i_2, \gamma^i_3\}$ are parameters to be estimated, $\{g_{t-1}, \hat{g}^t_{t-1}, \hat{m}^t_{t-1}\}$ are (as before) the true growth, the announcement and the mistake; ϵ^i_t is a white noise error term.

The results of the estimation of (10) and (11) are in Table 6. The results for consumption (Personal Consumption Expenditure) are in columns (1) and (2); for investment (Gross Domestic Private Investment) in columns

(3) and (4); and for government expenditure (Government consumption expenditures and gross investment) in columns (5) and (6). It is clear that announcements matter because they affect investment. They do not affect the other components of GNP.

When predicting investment growth, it is useful to know the announcement, but the true level of growth has a non significant effect on investment (column 4). On the other hand, the announcements do not help predict neither consumption nor government expenditure growth (columns 2 and 6).

We also run regressions with the mistakes in the right hand side (columns 1,3,5). Not surprisingly, the mistakes only help predicting investment growth.

Notice that in the estimations of the investment equation (columns 3-4) the point estimate of the influence of the perceptions variable is much higher than in the equation using the growth rate of real GNP. This was to be expected; an aggregate shock that works only through investment should have a much larger influence upon the growth rate of aggregate investment than upon the growth rate of the economy as a whole. The perceptions variable does not help explain the growth rates of aggregate consumption and government expenditure suggesting that these variables are much less sensitive to perceptions than investment is.

4 Discussion

This paper documents the importance of agents' *perceptions* about past economic variables. For real GNP growth in the U.S., we show that the perception that economic agents have about its past realization is a much more important determinant of current growth than the *true* growth in previous quarters. Our primary result is that in a linear regression the true rate of growth at $t-1$ does not help to explain true real GNP growth during quarter t if we control for the announcement made at the beginning of t of the rate of growth *during* $t-1$. The beliefs of agents (expressed in the announcement, their available information) determine the future path of the economy much more than the true events that the announcement measures. When we decompose the announcement in a part that should have been expected and a "surprise", only the latter influences GNP growth. Finally, we also show that the announcement affects aggregate investment (it does not affect either consumption or government expenditure).

Thus, our main point of the paper is to show that announcements (even if they are mistaken) of GNP growth have much more predictive power on future GNP growth than the true past growth rates. This result might seem surprising, so some discussion is on demand.

Let us start by noting that we talk about growth, not about levels. Clearly, capital matters. Its accumulation is a slow process that is bound to generate correlation in the levels. We do not say the opposite. Notice also that we are not explaining a whole lot of the business cycle, only about a 12% of the variance of GNP growth.[14]

The surprising result is not that the announcements explain so much of the business cycle, but that the truth explains so little. Announcements

[14] Nevertheless, it is remarkable that we are only looking at one type of "mistakes" here. Oh and Waldman explain about 10% of growth fluctuations with mistakes in the announcements on leading indicators, which together with our 12% would amount to more than the 20% of the variance, which starts to seem a large number.

should be expected to have a distinctive effect whenever people find them useful to determine their investment levels. We can think of two reasons for this to be so.[15] Each of these readings of our results maps into a view of the Business Cycle.

The first view is held by the mainstream of the literature. Business Cycles are to a large measure the response to fluctuations of total factor productivity. If productivity has persistence, high productivity the previous quarter predicts high productivity next one. Consequently, if you believe that productivity was high last period, you would be more tempted to invest/produce next period because you expect productivity to remain relatively high. Thus, under this view of the business cycle announcements on past GNP growth predict true GNP growth because they are correlated with true past GNP growth; which in itself is correlated with productivity; which is correlated across time.

This "Real Business Cycle" explanation faces several caveats. To start with, it is unclear why agents should care about the announcements on *aggregate* productivity. They are likely to be much more interested in forecasting to have very good information on productivity on their own specific activities. It does not seem reasonable to believe that agents that have first hand experience on the evolution of a specific sector would change their views on the evolution *of this specific sector* just by the announcements of *aggregate* productivity growth.

More interestingly to us, this explanation of why announcements matter

[15]It is also possible to find interpretations with non rational agents. For instance, the effect that we find in the "surprises" would be easily explained if agents were prone to over-react to news.

is not compatible with the fact that the truth does not matter. There are two reasons for this.

(1) In order to estimate the past realizations of the variables agents would make use not only of the announcements but also of their private information. The private information that agents have about past events has to aggregate in the true past events, and not in the announcement. Thus, in the law of motion of aggregate variables (investment, output) we should observe an effect due to the truth beyond any effects due to the announcement.

(2) If productivity were correlated across time the true level of growth should be expected to have *some* incidence even if we believe that aggregate announcements are the only thing that matters to determine investment levels.

The summary is that, while not impossible, it appears difficult to conciliate our results with a "real" business cycle. This is so specially (but not only) because we find such a small response to the true past growth.

The second view of the business cycle (and of why announcements should matter) is substantially different: agents react to the announcement not because of its information about past events, but because it is a coordination device. The announcement would be a sunspot. It would have informative content about the future not through past growth, but via a direct channel. The announcements about GNP growth during $t-1$ are used not because they have information about GNP growth during $t-1$ but because they have information about growth at t. The announcements on growth during $t-1$ affect directly the expectations of growth during t. Insofar I want to invest only if I expect high growth (this is the assumption), announcements on past growth could act as a coordination device, a sunspot. Expectations would be self-fulfilling.

This view of the role of announcements is implicit in the literature on multiple equilibria, coordination failures and sunspots. Under its light, a mistake in the announcements would have the same effect than a shock on the expectations. Actually, *it would be* a shock on the expectations. Cooper and John (1988) show that strategic complementarities may result in multiplicity of equilibria.[16] Many authors have constructed models that present strategic complementarities, allowing for multiplicity and sunspots. To name but a few: Azariadis (1981), Azariadis and Guesnerie (1984), Bryant (1983), Diamond (1982), and Woodford ((1986) and (1990)).

There are theoretical models in which agents use noisy measurements of past output directly in order to coordinate their actions.[17] These models would fit quite well with this interpretation of our results: announcements are in fact a sunspot that coordinates the expectations on future output. As sunspots go, this one does not strike as absurd. It would certainly look as crazy to disregard the information on past GNP growth in order to form our expectations on future one.

Under this view, our results are very much in line with Oh and Waldman's ((1990) and (2005)) discovery that mistakes in the announcements of the index of leading indicators have real effects on future output. They are also

[16]Strategic complementarity is not a necessary condition of multiplicity, as show in Vives (1999), but is the simplest, most popular and perhaps the best understood way of getting multiplicity. In any case what is truly important for us are not the reasons of multiplicity, but its existence.

[17]See Rodríguez Mora (1994) for a model in which agents use perceptions of past events as a coordination device and Bru and Vives (2002) for a model in which the accuracy of the information is endogenous

related to Matsusaka and Sbodorne (1995) who find that output is Granger-caused by the movements in the Consumer Confidence Index *that cannot be explained by macroeconomic variables.*

Overall, our results are no proof of either view of the business cycle, but they seem to fit more comfortably with the second than with the first.[18] As such, they can be interpreted as additional evidence of the powerful and direct role that expectations and "expectational shocks" might have in *leading* the business cycle.

[18]Nevertheless, we have no hard proof of it. In appendix A we do a test with inconclusive results.

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A Animal Spirits?

One could be tempted to interpret our results as support for the belief that "animal spirits" are important determinants of economic fluctuations. This could be so, but our results do not demonstrate by themselves the existence of such "animal spirits".

Announcements on past GNP growth could affect future GNP growth in two ways:

1. Knowing that real growth is serially correlated, agents may use the past level of growth in order to forecast current or future growth. Their knowledge of the past is limited, but they can use the announcement in order to estimate what *happened* and from there forecast what *will happen* in the future.
2. Agents might use the announcements independently of their informational content about *past* economic activity. They might use the announcement as something different from an estimation of the past.

   Anything that falls in this category could loosely be interpreted as "animal spirits". In particular, agents could use the announcements as an extraneous coordination device, a sunspot.[19]

The fact that announcements are used *a lot*, does not imply that they are used *"too much"*. In order to show the existence of "animal spirits" we would need to demonstrate that announcements are used for more than simply knowledge of what *happened*. In this section we will try to test exactly that. Our results will be found to be inconclusive. We are unable to say with certainty if announcements are used beyond their usefulness for estimating the past. Nevertheless, we consider it an interesting exercise and a first attempt to study a critical question.

We examine a simple model in which agents should make most use of the announcement in order to estimate the past. In the context of this model, we test whether agents are using the announcements for more than mere estimation of past events. If, in this model, agents were to use the announcement "too much" (i.e., for anything different from an estimation of past growth), then we believe this would be evidence that "animal spirits" indeed exist.

Components of the model

(1) We will assume that agents work in different sectors. The value of the aggregate is just the summation of the values across all the sectors. Nevertheless, we assume that the only thing that affects an agent's decision is *aggregate* GNP growth during the last period. They do not care about the growth rate of the specific sector where they toil. They do not care about their economic surroundings. They only care about aggregate growth.

This is of course a crude assumption. However, it ensures that agents have maximum incentive to estimate past real GNP growth using all the information available to them. Whatever the "true" model of the world is, in it the agents would make *less* use of the announcement on aggregate activity than in our model.

If the null hypothesis that agents use the announcement for more than for estimation of the past is not rejected in this model, then it would not be rejected either in the "true" model of the world.

(2) We also assume that agents have private information on the evolution of the specific sector where they toil. This information is based on their experience. Thus, their private

[19] See Rodríguez Mora (1994) for a model with these characteristics.

information correlates with the true value aggregate activity and *does not* correlates with the measurement mistakes made in the announcements.

The announcements (and not the truth) would be the only relevant RHS variable if agents had no alternative source of information. If they could react only to the announcement, then their actions would be a function of the announcement (and not of the truth). Thus, the aggregate behavior of the economy would depend upon announcements and not upon real events. Nevertheless, this is obvious and uninteresting. We make our hypothesis in order to insure that the truth have a decent chance of being significant.

We assume that agents have accurate information about the level of activity in their specific sector. We will assume further that activity is correlated at the sector level and aggregate levels. Thus, even if agents care only about the aggregate they will use their information on their specific sector in order to infer the aggregate activity.

To summarize agents have two pieces of information:

1. They know what happened in their sector, so an agent in sector i ($i = \{1, 2, ..., K\}$) knows the rate of growth in sector i during $t-1 : x^i_{t-1}$. Additionally, we posit that:

$$x^i_{t-1} = g_{t-1} + \epsilon^i_{t-1}. \tag{12}$$

   Where $\epsilon^i_{t-1} \sim N(0, \sigma^2_\epsilon)$.

2. In addition, all agents receive an announcement of the economy's growth rate last quarter:

$$\hat{g}^t_{t-1} = g_{t-1} + \hat{m}^t_{t-1}. \tag{13}$$

   Where we assume $\hat{m}^t_{t-1} \sim N(0, \sigma^2_m)$.

Agent i with information set $I^i_t \equiv [\hat{g}^t_{t-1}, x^i_{t-1}]$ faces a signal extraction problem in order to calculate her expectation of last period's real GNP growth. Application of Bayes rule yields:

$$E[g_{t-1}[I^i_t] = (1-\zeta)\hat{g}^t_{t-1} + \zeta x^i_{t-1}. \tag{14}$$

Where $\zeta = \frac{\sigma^2_m}{\sigma^2_\epsilon + \sigma^2_m}$.

We assume that agents make their decision based on their beliefs on g_{t-1} at time t:

$$x^i_t = E\left[F\left(g_{t-1}\right)\right]. \tag{15}$$

Assuming that F is linear, (15) becomes:

$$x^i_t = \upsilon + \gamma \quad \left((1-\zeta)\ \hat{g}^t_{t-1} + \zeta\ x^i_{t-1}\right) \tag{16}$$

Summation across agents yields equation (6):

$$g_t = \alpha_0 + \alpha_1\ g_{t-1} + \alpha_2\ \hat{g}^t_{t-1} \tag{17}$$

with

$$\begin{aligned} \alpha_0 &= \upsilon, \\ \alpha_1 &= \gamma\ \zeta, \\ \alpha_2 &= \gamma\ \left(1-\zeta\right). \end{aligned} \tag{18}$$

If announcements are only used to predict the past level of aggregate growth then it should be true that

$$\frac{\alpha_2}{\alpha_1} = \frac{(1-\zeta)}{\zeta} = \frac{\sigma^2_\epsilon}{\sigma^2_m}. \tag{19}$$

Alternatively, agents use the announcement for more than mere estimation of the past. (For example, the past announcement is an extraneous variable upon which agents coordinate.) In this case, the following equation holds:

$$x_t^i = \upsilon + \gamma \; E[g_{t-1}[I_t^i] + \delta \; \hat{g}_{t-1}^t. \tag{20}$$

From which aggregate GNP growth would again follow equation (6), with

$$\begin{aligned} \alpha_0 &= \upsilon, \\ \alpha_1 &= \gamma \; \zeta, \\ \alpha_2 &= \gamma \; (1-\zeta) + \delta. \end{aligned} \tag{21}$$

Assuming $\delta > 0$,

$$\frac{\alpha_2}{\alpha_1} = \frac{(1-\zeta)}{\zeta} + \frac{\delta}{\gamma \; \zeta} > \frac{\sigma_\epsilon^2}{\sigma_m^2}. \tag{22}$$

Thus, a test of whether agents in the economy use announcements today for more than mere knowledge of what happened last quarter is a test of whether $\frac{\alpha_2}{\alpha_1} > \frac{\sigma_\epsilon^2}{\sigma_m^2}$.

From Table 3 we obtain our estimates for α_1 and α_2 . From the descriptive statistics reported in Table 1, σ_m^2 is estimated to be 2.90×10^{-5}.

We can calculate σ_ϵ^2 using data from the Productivity Database of Wayne B. Gray. This dataset is a panel of 450 four digit SIC sectors containing extensive annual data from 1958 to 1989, including estimates of value added and a price deflator for each sector. From this source, we extract series on current dollar value added in each sector and deflate these series to construct real value added in each sector. The sector growth rates are then constructed by forming the differences of the natural logarithms. Taking σ_ϵ^2 to be the average of the variances each year, we obtain an estimate of σ_ϵ^2 to be $\hat{\sigma}_\epsilon^2 = .0195$.

Alternatively, we may estimate σ_ϵ^2 disaggregating the economy into fewer sectors. From Citibase, we obtained sectorial data classifying the economy into 14 sectors.

Calculating growth rates for each of these sectors and the aggregate (using quarterly data from 1946.1 to 1992.4) we can obtain an estimate of σ_ϵ^2 from the estimation of a seemingly unrelated regression (SUR) system. The j^{th} equation has the growth rate of sector j ($j = 1, ..., 14$) at time t as the endogenous variable and a constant and the aggregate growth rate at time t in the right hand side. This allows some sectors to grow systematically above or below that of the aggregate. The disturbances across time and equations are assumed uncorrelated and drawn from the same Normal distribution with mean zero and variance σ_ϵ^2. The sample estimate of σ_ϵ^2 using this method[20] was .00554.

Clearly, the sector-idiosyncratic noise is orders of magnitude larger than the measurement noise. This induces us to reject the null hypothesis that "animal spirits" exists *versus* the alternative that the model is true. We reject the null hypothesis, but the alternative hypothesis would also be rejected by the data (agents should care for something different from the aggregate). Our test is admittedly very simple, it does not proof or disprove the existence of "animal spirits". It is included here only because we do not want our results to be misinterpreted as showing something that they actually do not.

[20]The careful econometrician will observe that in practice we estimate the SUR system as 14 separate equations using least squares and estimate σ_ϵ^2 as the average across equations of the average of the estimates of the disturbance term variance. This is equivalent to SUR when each equation has the same set of right hand side variables.

	$\hat{g}_{t-1}^{t}$ Fisrt Announcement	g_{t-1} True Lagged Growth	$\hat{m}_{t-1}^{t}$ Measurement Mistake
Mean	0.006264	0.007088	-0.00013
Standard Deviation	0.009610	0.009379	0.006404
Number of Observations	100	127	100

Table 1: Descriptive Statistics

Parameter	Dependent variable: g_t True Growth
Constant	0.001314 (0.000722)
$\hat{g}_t^{t+1}$ First Announcement	0.769474* (0.063154)
Sample Size	100
R^2	0.602358
Adjusted R^2	0.598300
Durbin-Watson	2.270539

Table 2: The initial announcement as predictor of the revised one. Standard deviations in parentheses. Starred coefficients are significant at the 5% confidence level.

RHS: true growth (g_t)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Constant	.00486* (.000997)	.00372* (.00108)	.0031* .0012	.00372* (.00108)	.00372* (.00108)	.003* (.0012)	.0031* (.00116)	.00374* (.00106)	.0031* (.0012)	.00374* (.00106)	.0031* (.0012)
g_{t-1} True Lagged Growth	.323* (.0847)	.0176 (.1491)	.0176 (.1491)	.3802* (.0994)			.4888* (.1212)				
$\hat{g}^t_{t-1}$ Measurement on $g_t - 1$		.3626* (.1478)			.3802* (.0994)			.3761* (.0932)		.3761* (.0928)	
$\hat{h}^t_{t-1}$ Best Linear Guess on g_{t-1}			.4712* (.1921)			.494* (.1291)			.4888* (.1212)		.4888* (.1205)
$\hat{m}^t_{t-1}$ Measurement Mistake				$-$.3626* (.1478)	.0176 (.1491)	.0176 (.1491)					
$\hat{e}^t_{t-1}$ "Innovation"							$-$.4712* (.1921)	.0176 (.1491)	.0176 (.1492)		
Sample Size	126	100	100	100	100	100	100	100	100	100	100
Adjusted R^2	.098	.126	.126	.126	.126	.126	.126	.126	.126	.135	.135
Durbin -Watson	2.10	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.98	1.97

Table 3: Regression Results. Standard deviations in parentheses. Starred coefficients are significant at the 5% confidence level.

Dependent Variable	g_{t-1} True Lagged growth	$\hat{g}^t_{t-1}$ Announcement	$\hat{g}^t_{t-1}$ Announcement	$\hat{h}^t_{t-1}$ Best Linear Guess
Constant	0.006197 (0.000906)	0.006197 (0.000906)	0.006264 (0.000966)	0.006082 (0.000697)
m^t_{t-1} Measurement Mistake	0.480803 (0.142236)	-0.519197 (0.142236)		-0.399508 (0.109447)
e^t_{t-1} "Innovation"			$-2.04E-16$ (0.161575)	
R^2	0.104422	0.119689	0.000000	0.119689
Adjusted R^2	0.095283	0.110706	-0.010204	0.110706

Table 4: Regression of RHS variables of table 3 into themselves

Endogenous variable	(1) g_t True Growth	(2) g_t True Growth	(3) g_t True Growth	(4) s_t^{t+1} Surprise	(5) g_t True Growth
Constant	0.003851* (0.001618)	0.003865* (0.001605)	0.005335* (0.001210)	-.000838 (.00117)	.00610* (.000909)
g_{t-1} True Lagged Growth	0.016998 (0.151288)		0.124413 (0.130100)	.149 (.125)	
$E\left(\hat{g}_{t-1}^{t}\right)$ Expected Announcement	0.344485 (0.250824)	0.359054 (0.213600)			
s_{t-1}^{t} Surprise	0.368328* (0.154633)	0.381089* (0.104397)	0.287689* (0.143711)	-.115 (.138)	.381* (.105)
Sample Size	99	99	99	98	99
Adjusted R^2	0.117097	0.126177	0.108946	.00870	.110
Durbin-Watson	1.999915	1.982446	2.100025	2.01	1.96

Table 5: Regression Results using Unexpected Component of Announcements. Standard deviations in parentheses. Starred coefficients are significant at the 5% confidence level.

	(1)	(2)	(3)	(4)	(5)	(6)
c_t=	Consumption	Consumption	Investment	Investment	Government Spending	Government Spending
Constant	0.005376* (.001)	.00538 (.001)	0.003314 (.00487)	−0.016648* (0.006987)	0.002855* (.001004)	0.002664* (0.001178)
c_{t-1} Lagged value	0.253819* (0.0986)	.2602 (.1387)	0.268973* (.0998)	−0.308609* (0.179379)	0.218530* (0.101420)	0.216373* (0.102127)
$\hat{m}^t_{t-1}$ Measurement Mistake	−0.007869 (0.110545)		−1.568859* (0.782714)		−0.101533 (0.146249)	
g_{t-1} True Lagged Growth		−.0115 (.1240)		1.403720 (1.076585)		−0.084255 (0.156960)
$\hat{g}^t_{t-1}$ Measurement on $g_t - 1$		.004209 (.1241)		2.260088* (0.756659)		0.116375 (0.154396)
Sample Size	100	100	100	100	100	100
Adjusted R^2	0.044783	0.034877	.0676	0.180150	0.026767	0.017632
Durbin-Watson	2.07	2.07	1.92	1.974258	2.00	1.996834

Table 6: Regression Results for Components of Real GNP. Standard deviations in parentheses. Starred coefficients are significant at the 5% confidence level

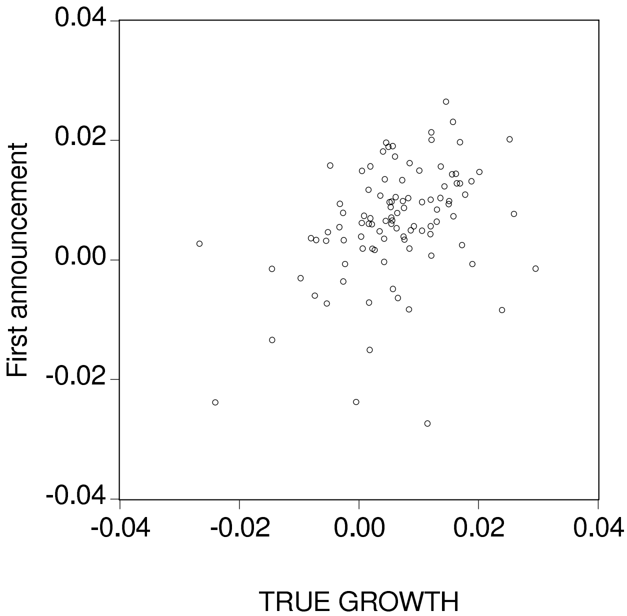

Figure 1: Initial announcement versus final value ("true") growth rate of GNP