Journal of Monetary Economics 92 (2017) 78–95

Contents lists available at ScienceDirect

Journal of Monetary Economics

journal homepage: www.elsevier.com/locate/jmoneco

Is the intrinsic value of a macroeconomic news announcement related to its asset price impact?☆

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ARTICLE INFO

Article history:
Received 30 April 2015
Revised 8 September 2017
Accepted 8 September 2017
Available online 9 September 2017

JEL classification:
G14
E37
E44
E47
C53
D83

Keywords:
Macroeconomic announcements
Price discovery
Learning
Forecasting
Nowcasting

ABSTRACT

The literature documents a heterogeneous asset price response to macroeconomic news announcements. We relate this heterogeneity to a novel measure of the intrinsic value of an announcement—the announcement's ability to nowcast GDP growth, inflation, and the federal funds target rate—and find that differences across the intrinsic values of several U.S. macroeconomic announcements explain a significant fraction of the variation in the impact each of these announcements has on U.S. Treasury yields. We also decompose the intrinsic value into the announcement's relation to fundamentals, a timeliness premium, and a revision premium, and find that the former two characteristics are the most important ones in explaining the heterogeneous response.

Published by Elsevier B.V.

1. Introduction

An extensive literature has studied the response of U.S. Treasury yields to macroeconomic news announcements.[1] Some of these papers have highlighted the heterogeneous response: Some announcements have a strong impact on U.S. Treasury

☆ For comments and suggestions on an earlier and preliminary draft, we thank an anonymous referee, Torben Andersen, Tim Bollerslev, Dean Croushore, Eric Ghysels, Refet Gürkaynak (associate editor), Michael McCracken, Ricardo Reis (editor), Barbara Rossi, Jonathan Wright, the participants of the $(EC)^2$ Conference, the ECB Workshop on Forecasting Techniques, the Applied Econometrics and Forecasting in Macroeconomics and Finance Workshop at the St. Louis Fed, the Conference on Real-Time Data Analysis, Methods and Applications at Federal Reserve Bank of Philadelphia, the Conference on Computing in Economics and Finance, the Humboldt-Copenhagen Conference on Financial Econometrics, the HITS workshop on Advances in Economic Forecasting, and the seminar participants at the University of Nürnberg and the Ifo Institute. We thank Domenico Giannone, Lucrezia Reichlin, and David Small for sharing their computer code with us, and Margaret Walton for outstanding research assistance. Any views expressed represent those of the authors and not necessarily those of the European Central Bank, the Eurosystem, the Federal Reserve System, or the Board of Governors.

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[1] See, for example, Fleming and Remolona (1997, 1999), Balduzzi et al. (2001), Goldberg and Leonard (2003), Gürkaynak et al. (2005), Beechey and Wright (2009), and Swanson and Williams (2014).

http://dx.doi.org/10.1016/j.jmoneco.2017.09.008
0304-3932/Published by Elsevier B.V.

yields, but some do not. However, there are no papers that systematically investigate what causes this heterogeneous response. In this paper, we help fill the void by (i) estimating a novel empirical measure of an announcement's intrinsic value for 36 different U.S. macroeconomic announcements; (ii) decomposing each of these measures into three components that capture the announcement's relation to fundamentals, timing, and revisions; and (ii) relating differences across announcements' characteristics to differences in the responses of U.S. Treasury yields to each of these announcements.

First, motivated by economic theory, we define and estimate the intrinsic value of an announcement as its importance in nowcasting the following primitives or fundamentals: the U.S. Gross Domestic Product (GDP), the GDP price deflator, and the Federal Funds Target Rate (FFTR). More precisely, the intrinsic value is the nowcasting weight placed on the macroeconomic announcement at the time of its release.

Next, using the same nowcasting framework, we decompose this intrinsic value into three components that capture the announcement's relation to fundamentals, timing, and revisions. While the previous literature has discussed each of the last two characteristics in isolation, our contribution is to formally define all three announcement characteristics coherently within a single nowcasting framework. Our definition of the announcement's relation to fundamentals is its importance in nowcasting our three primitives independent of the announcement's release time and revisions. We define the announcement's timeliness premium as the change in its nowcasting weight due to its release time. Similarly, we define the announcement's revision premium as the change in its nowcasting weight due to its future revisions.

Finally, we relate an announcement's intrinsic value, timeliness premium, revision premium, and relation to fundamentals to the announcement's impact on U.S. Treasury yields. We find that using GDP as the nowcasting target is more useful in explaining the impact of announcement surprises on U.S. Treasury yields than using the GDP deflator or the FFTR. When using GDP as the nowcasting target, our intrinsic value measure explains between 12 and 19 percent of the variation in the heterogeneous response of U.S. Treasury yields to macroeconomic news announcements. When we estimate the importance of the three individual announcement characteristics separately, we find that our novel measures of timeliness and relation to fundamentals are the most important characteristics in explaining the announcement's impact. Notably, our novel measure of intrinsic value explains the heterogeneous response of U.S. Treasury yields to macroeconomic announcements better than other variables discussed in the previous literature, such as the reporting lag of the announcement and the magnitude of its revisions.

Since our focus is on understanding U.S. Treasury yields' response to macroeconomic news announcements, we choose nowcasting primitives that are consistent with this literature. In particular, Beechey and Wright (2009) group macroeconomic announcements into three broad categories: news about real output, news about prices, and news about monetary policy.[2] The primitives we choose, namely GDP, GDP price deflator, and the FFTR, are representative of each of these categories. When studying the response of other asset classes to macroeconomic announcements, researchers should consider other primitives: For example, in the case of foreign exchange markets, the primitives should include both domestic and foreign monetary policy rates.

Our paper contributes to the literature by showing that the asset price response to a particular type of announcement cannot be analyzed in isolation.[3] The effect that announcements have on asset prices crucially depends on the information environment. When studying the link between asset prices and macroeconomic fundamentals, researchers need to account not only for the surprise component of an announcement, but also for the announcement's intrinsic value, its relation to fundamentals, its timeliness, and its revisions, all relative to other announcements. For example, researchers analyzing the effect that final GDP announcements have on asset prices are likely to find that they have no impact, and may therefore wrongly conclude that there is a disconnect between asset prices and macroeconomic fundamentals. We show that U.S. Treasury yields do not react to final GDP announcements because, even though its relation to fundamentals is high, the timeliness of the GDP final release is poor, and, as a result, the impact of GDP final announcements on U.S. Treasury yields relative to other announcements is small.

Importantly, our analysis shows that the relationship between the intrinsic value of an announcement and its asset price impact is not perfect. In particular, we find that the release of nonfarm payroll has the biggest impact on Treasury yields, yet it is not the macroeconomic variable with the biggest intrinsic value. This raises the possibility that there may be an overreaction to certain announcements, such as nonfarm payroll, because of the coordination value of public information beyond its intrinsic value (e.g., Morris and Shin, 2002). Another possibility is that our definition of the intrinsic value of macroeconomic announcements needs to be further refined. For example, one could consider other primitives, like term premia. Furthermore, even though our method allows announcements to vary in their importance over time, one could impose more structure to better estimate this time-variation (e.g., Bacchetta and van Wincoop, 2013; Goldberg and Grisse, 2013). Another extension would be to control for regime switches driven by, for instance, Alan Greenspan's 2004 statement that nonfarm payroll numbers are more informative than the unemployment numbers.[4] We leave these extensions to future research.

[2] Since nominal Treasury prices embody inflation expectations and expected future real interest rates, news about prices, real output, and monetary policy are natural choices of primitives.

[3] Recent studies by Ehrmann and Sondermann (2012) and Lapp and Pearce (2012) further support this view.

[4] Gürkaynak and Wright (2013) show that Greenspan's statement shifted the market's attention to nonfarm payroll and away from the unemployment rate. This may be because investors became convinced that nonfarm payroll is indeed more informative about the state of the economy. Or it may be because investors learned what the Federal Reserve pays attention to it, allowing them to predict future policy actions.

Table 1
Characteristics of macroeconomic announcements.

n	Announcement	Unit	Release time	Obs.
	Quarterly announcements			
	Real activity			
1	GDP advance (first estimate)	% change	8:30	76
2	GDP preliminary (second estimate)	% change	8:30	76
3	GDP final (third estimate)	% change	8:30	76
	Prices			
4	GDP price deflator advance	% change	8:30	76
5	GDP price deflator preliminary	% change	8:30	76
6	GDP price deflator final	% change	8:30	76
	Monthly announcements			
	Real activity			
7	Unemployment rate	%	8:30	228
8	Nonfarm payroll employment	Change	8:30	228
9	Retail sales	% change	8:30	228
10	Retail sales less automobiles	% change	8:30	227
11	Industrial production	% change	9:15	228
12	Capacity utilization	%	9:15	228
13	Personal income	% change	8:30/10:00	228
14	Consumer credit	change	15:00	228
	Consumption			
15	Personal consumption expenditures	% change	8:30	228
16	New home sales	Level	10:00	227
	Investment			
17	Durable goods orders	% change	8:30/9:00/10:00	227
18	Construction spending	% change	10:00	227
19	Factory orders	% change	10:00	227
20	Business inventories	% change	8:30/10:00	228
	Government purchases			
21	Government budget deficit	Level	14:00	228
	Net exports			
22	Trade balance	Level	8:30	228
	Prices			
23	Average hourly earnings	% change	8:30	228
24	Producer price index (PPI)	% change	8:30	228
25	Core PPI	% change	8:30	228
26	Consumer price index (CPI)	% change	8:30	228
27	Core CPI	% change	8:30	228
	Forward looking			
28	U. Michigan (UM) consumer confidence preliminary	Index	9:55/10:00	200
29	Philadelphia Fed manufacturing index	Index	10:00	227
30	UM consumer confidence final	Index	9:55/10:00	200
31	Conference Board (CB) consumer confidence	index	10:00	228
32	(ISM-)Chicago Purchasing Managers Index (PMI)	index	10:00	226
33	ISM Manufacturing PMI	index	9:15/10:00	228
34	Housing starts	level	8:30	226
35	CB leading economic index	% change	8:30/10:00	228
	Weekly Announcements			
36	Initial jobless claims	level	8:30	992

Note: The table displays the 36 U.S. macroeconomic variables analyzed in the paper, along with the announcement unit used in both the agency reports and the market expectations, the time of the announcement release (Eastern Time), and the number of available data releases. The sample covers January 1997 to December 2015. ISM stands for Institute for Supply Management, formerly National Association of Purchasing Management (NAPM).

2. Macroeconomic and financial data

We collect data on 36 U.S. macroeconomic series, listed in Table 1, covering a broad set of real activity, prices, consumption, and investment variables. For each of these, we have announcement dates and times, (median) market expectations, initial (actual) released values, and final (revised) values. Each announcement $a^n_{p,t}$ is uniquely identified by the index number n of the announcement series in Table 1, by the date and time t of its release, and by its reference period p. Nonfarm payroll released in early February, for example, has January as its reference period. Table 1 also provides the announcement unit used in both the agency reports and the market expectations, the time(s) of the announcements, and the number of observations for each quarterly, monthly or weekly variable.

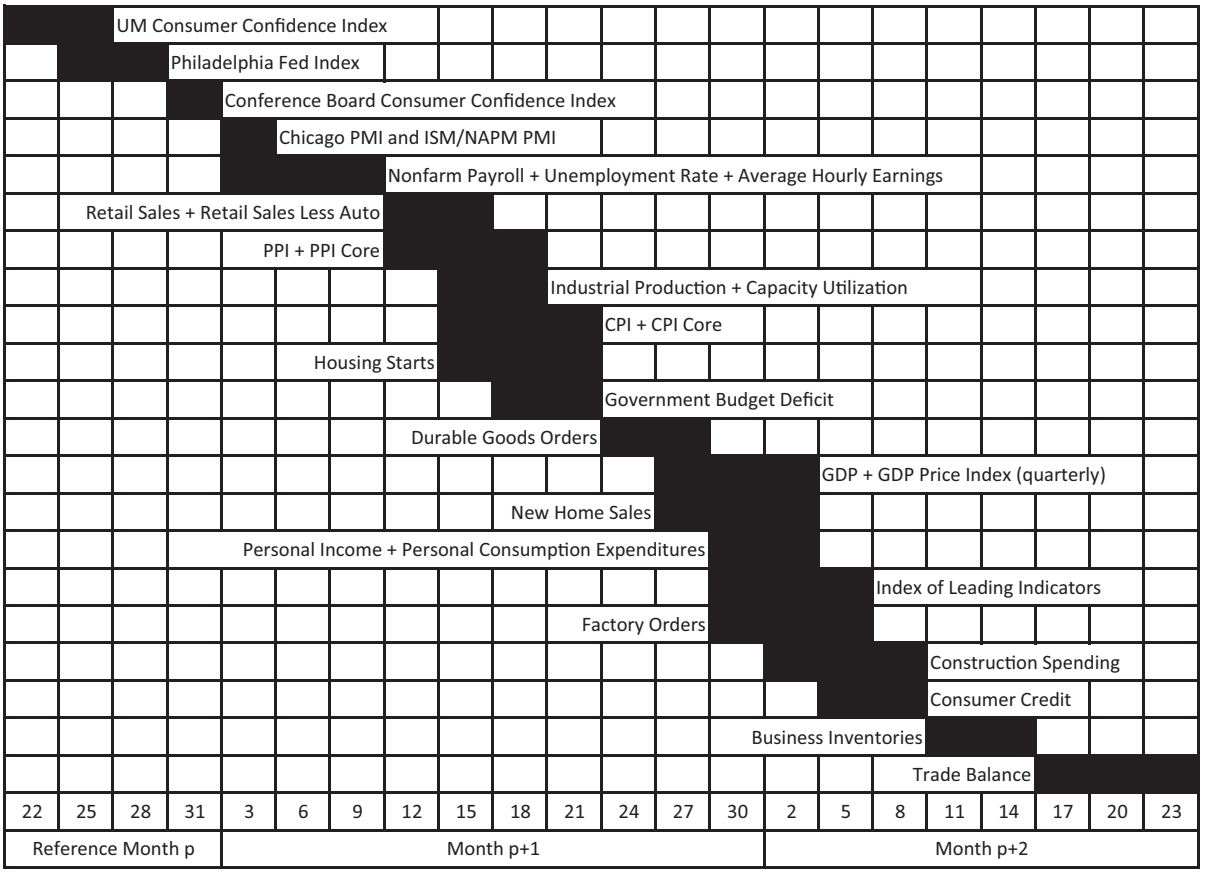

Fig. 1. Macroeconomic announcement calendar. *Note:* this figure shows the usual calendar timing of U.S. macroeconomic announcements across the month. The reference month is labeled as p with most variables released in the subsequent month and some released up to six weeks later. Each GDP series (advance, preliminary, or final) is released on a quarterly basis. Not represented in the figure is the initial jobless claims announcement, which is released weekly on Thursday for the previous week. The University of Michigan releases a final version (not shown) of their consumer confidence index two weeks after their preliminary release.

For a given reference month p, the release of macroeconomic information follows a relatively stable and predictable schedule. Fig. 1 shows, for instance, that the University of Michigan (UM) consumer confidence index is almost always released first, and nonfarm payroll is always released on the first Friday of month $p+1$ at 8:30 am ET. Following Andersen et al. (2003), the variables in Table 1 are presented in the order of their release date within each group (real activity, forward looking, etc.).

Most of our macroeconomic data derives from Bloomberg, including announcement dates, times, reference periods, market expectations, final revised values, and actual released values. The Bloomberg data covers the sample from January 1997 to the present. We augment this with historical data from Money Market Services (MMS). The variables in the MMS dataset, however, start at different times. Many variables go back to the 1980's, but initial jobless claims, consumer confidence, and GDP price deflator first start in 1991, while core CPI and core PPI start in 1992. The University of Michigan consumer confidence index, the Chicago PMI, and the Philadelphia Fed manufacturing index are not part of the MMS data. The final (revised) numbers, covering the period from 1990 to 2015 for all variables, were collected in May 2016 from Bloomberg, the various statistical agencies (BLS, BEA, etc.), and the FRED database.

Because actual release dates, times, expectations, and values for *all* variables are only available from January 1997 onwards, we begin nowcasting in that month and analogously use January 1997 through December 2015 as our sample in the event study. This choice ensures consistency between the construction of the announcement characteristics and the asset price impacts we aim to explain. But because actual announcements or final values (or both) for all macroeconomic variables are available as early as 1990, we utilize the 1990–1996 sample to estimate the transition matrices required in the nowcasting exercise. The Federal Funds Target Rate (FFTR) data and its release dates over the same sample period are also from Bloomberg.

The financial data consist of daily changes in yields for the constant maturities 6-month and 1-year U.S. Treasury bills as well as the constant maturities 2-year and 5-year U.S. Treasury notes[5] and come from the Federal Reserve Board. We focus on the U.S. Treasury bond market as opposed to the equity or foreign exchange markets because, as shown by the previous literature, e.g., Andersen et al. (2007), the link between U.S. Treasury yield movements and macroeconomic news announcements is theoretically simpler and empirically stronger.

3. Asset price response to macroeconomic announcements

In this section, we discuss the relationship between an announcement's price impact and its intrinsic value, timeliness, revisions, and relation to fundamentals within the context of a noisy rational expectations model. The heterogeneous response of Treasury yields to 36 major macroeconomic announcements from 1997 to 2015 is also documented here.

3.1. Theoretical framework

To provide a framework for defining an announcement's price impact, its intrinsic value, and the effect of its underlying characteristics, we briefly discuss a stylized noisy rational expectations model of price reactions to public signals (Kim and Verrecchia, 1991a; 1991b). The details of this suggestive model are in the Online Appendix. Every period, the equilibrium price of a traded asset is a function of the representative investor's expectation of the asset's final payoff. When a noisy public signal about this final payoff is received, the investor updates her expectation in a Bayesian manner. As a result, the price change is equal to the surprise component of the signal times a constant. This constant reflects the *price impact* of the announcement because it is the coefficient one obtains when regressing price changes on the surprise component of the announcement. We can also label this constant as the *intrinsic value* of the announcement because, in the model, it is equal to the weight placed by the investor on the signal when she is updating her belief about the asset's payoff.

In the empirical analysis that follows, the intrinsic value of an announcement is allowed to differ from its price impact. To estimate the intrinsic value of the announcement, we assume that the asset's payoff is related to the state of the economy, as proxied by GDP, GDP price deflator, or the FFTR. Assuming further that the investor uses a Kalman filter to nowcast the state of the economy, the intrinsic value of the announcement can be defined as the weight the investor puts on the announcement when nowcasting the state of the economy.

Following previous studies (e.g., Fleming and Remolona, 1997; 1999; Balduzzi et al., 2001; Goldberg and Leonard, 2003; Gürkaynak et al., 2005; Beechey and Wright, 2009; Swanson and Williams, 2014), in the next sub-section, the price impact of the announcement is estimated by regressing daily Treasury yield changes on macroeconomic news surprises. The first main objective of our paper is to relate the intrinsic value of the announcement, that is the weight the investor puts on the announcement when nowcasting the state of the economy, to the price impact of the announcement.[6]

The model makes several intuitive predictions about the effect of an announcement's characteristic—either its relation to fundamentals, timeliness, or revisions—on its intrinsic value and thus on its price impact (see the Online Appendix for details): a more timely announcement, an announcement that is more highly correlated with the payoff of the risky asset, or an announcement that undergoes smaller revisions, has a higher intrinsic value and therefore has a higher price impact. To ensure consistency with our novel measure of the intrinsic value of the announcement, we define and estimate these characteristics within the nowcasting framework as well. The second main objective of our paper is to assess which characteristic is most highly related to the price impact of the announcement.

3.2. Price impact of announcements

Following the literature, we define the surprise component of a macroeconomic announcement as the difference between its actual realization $a^n_{p,t}$ and its corresponding market expectation $\mu^n_{p,t}$ based on the information available before its release. The realization $a^n_{p,t}$ is the value of the macroeconomic variable n referring to period p, which is released at time t. Market expectations are measured as the median expectation across the set of Bloomberg/MMS forecasts. Also following the literature, surprises are standardized by dividing each of them by their sample standard deviation in order to make the units of measurement comparable across macroeconomic variables. The standardized news surprise associated with the release of macroeconomic variable n with reference period p at time t is therefore:

$$s^n_{p,t} = \frac{a^n_{p,t} - \mu^n_{p,t}}{\sigma^n_s}, \tag{1}$$

[5] We use daily changes instead of changes from a shorter time window around the announcement time (e.g., 5 minutes) to account for the price drifts ahead of several macroeconomic announcements documented in Kurov et al. (2016). Nevertheless, our conclusions are similar if we relate announcements' characteristics to 5 min price impacts.

[6] We are implicitly assuming that the expectations hypothesis holds. For this reason, we focus on short-term bills and notes (6-month, 1-, 2- and 5-year maturities). In fact, we observe that our measure of intrinsic value, which does not take into account the impact of macroeconomic news announcements on the term premia, explains a higher fraction of the variation in price impact for these shorter maturities than for the 10-year notes and 30-year bonds (not tabulated in the paper).

Table 2
Effect of macroeconomic announcement surprises on U.S. treasury yields.

		6-month bills		1-year bills		2-year notes		5-year notes	
n	Announcement	β_n	R^2	β_n	R^2	β_n	R^2	β_n	R^2
1	GDP advance	0.767**	0.054	0.941*	0.049	1.631**	0.068	1.028	0.018
2	GDP preliminary	0.298	0.012	−0.039	0.000	0.000	0.000	0.028	0.000
3	GDP final	−0.131	0.002	0.227	0.003	0.097	0.000	−0.183	0.001
4	GDP price deflator advance	0.221	0.004	0.288	0.005	0.867	0.019	0.867	0.013
5	GDP price deflator preliminary	−0.056	0.000	0.405	0.014	0.651	0.016	1.545**	0.061
6	GDP price deflator final	0.497	0.022	0.670	0.028	0.082	0.000	−0.342	0.004
7	Unemployment rate	−0.775***	0.032	−0.759**	0.020	−1.055**	0.017	−0.344	0.002
8	Nonfarm payroll employment	1.845***	0.183	2.734***	0.255	4.218***	0.271	3.687***	0.210
9	Retail sales	0.757***	0.068	1.132***	0.097	2.085***	0.125	2.334***	0.113
10	Retail sales less automobiles	0.530***	0.033	0.906***	0.062	1.701***	0.083	2.022***	0.084
11	Industrial production	−0.015	0.000	0.400	0.006	1.231***	0.041	0.652*	0.012
12	Capacity utilization	0.199	0.002	0.757**	0.022	1.606***	0.069	1.082***	0.034
13	Personal income	0.025	0.000	−0.109	0.001	−0.182	0.001	−0.110	0.000
14	Consumer credit	0.054	0.000	−0.082	0.000	−0.355	0.003	−0.388	0.003
15	Personal consumption expenditures	0.287	0.005	0.531*	0.016	0.354	0.004	0.381	0.004
16	New home sales	0.353	0.009	0.287	0.005	0.414	0.006	0.787**	0.019
17	Durable goods orders	0.335	0.008	0.384	0.008	0.460	0.006	0.633	0.011
18	Construction spending	0.266	0.003	0.064	0.000	0.460	0.007	0.321	0.003
19	Factory orders	0.163	0.002	0.127	0.001	0.170	0.001	0.313	0.003
20	Business inventories	−0.011	0.000	0.048	0.000	0.016	0.000	0.198	0.001
21	Government budget deficit	−0.454*	0.015	−0.433*	0.014	−0.581*	0.014	−0.486	0.008
22	Trade balance	−0.094	0.001	−0.042	0.000	0.203	0.002	0.707*	0.016
23	Average hourly earnings	0.335	0.006	0.714**	0.017	1.260**	0.024	1.840***	0.052
24	PPI	0.213	0.004	0.189	0.003	0.248	0.002	0.555	0.009
25	Core PPI	0.248	0.006	0.461*	0.015	0.534	0.009	0.994***	0.030
26	CPI	0.316	0.004	0.528	0.012	0.697*	0.014	0.543	0.006
27	Core CPI	0.480	0.010	0.773**	0.025	1.13***	0.037	0.926**	0.018
28	UM consumer confidence preliminary	0.577*	0.016	0.679*	0.018	1.015**	0.024	1.346***	0.038
29	Philadelphia Fed index	0.255	0.003	0.769***	0.032	1.575***	0.073	1.784***	0.080
30	UM consumer confidence final	−0.080	0.001	−0.011	0.000	0.050	0.000	0.208	0.001
31	CB consumer confidence index	0.666***	0.039	0.726***	0.033	0.876**	0.024	1.003**	0.027
32	Chicago PMI	0.704***	0.035	1.033***	0.062	1.645***	0.082	1.822***	0.092
33	ISM PMI	1.082***	0.052	1.669***	0.131	2.566***	0.174	2.836***	0.164
34	Housing starts	0.086	0.000	0.112	0.001	0.152	0.001	0.201	0.001
35	CB leading economic index	0.757**	0.022	0.270	0.004	0.075	0.000	0.502	0.007
36	Initial jobless claims	−0.558***	0.019	−0 0.763***	0.03	−1.152***	0.039	−1.036***	0.027

Note: The table reports the results of individual event study regressions of daily Treasury yield changes on standardized macroeconomic announcement surprises (2): $\Delta y_t = \alpha_n + \beta_n s^n_{p,t} + \epsilon^n_t$. The sample covers the period from January 1997 to December 2015. White standard errors are used, and ***, **, and * represent a 1, 5, and 10% level of significance, respectively.

where σ^n_s is the sample standard deviation of $a^n_{p,t} - \mu^n_{p,t}$ based on all (initial) release times of the respective macroeconomic variable n.

We estimate the impact of a given macroeconomic announcement n on asset prices by estimating the following equation:

$$\Delta y_t = \alpha_n + \beta_n s^n_{p,t} + \epsilon^n_t, \tag{2}$$

where Δy_t is the daily change in Treasury yields (in basis points) and the intercept α_n is a time-invariant, variable-specific announcement return.[7] Since σ^n_s is constant for any variable n, the standardization in Eq. (1) has no impact on the statistical significance of the response estimates or on the fit of Eq. (2).[8]

Table 2 reports the results of Eq. (2) for each of the 36 macroeconomic variables across the four different Treasury maturities for the 1997–2015 sample period. Our measures of each variable's *price impact* are the slope coefficient β_n on the standardized surprise, which represents basis points per standard deviation of surprise, and the corresponding R^2 of the regression.

[7] Gürkaynak and Wright (2013) review the literature on event studies, including its caveats and limitations.

[8] By using identification through censoring, Rigobon and Sack (2008) estimate the share of the survey-based surprise due to noise. We choose not to follow their procedure because we allow the impact of news to vary with its noise. If we purged the noise from the announcement, we would underestimate the effect of noise on the price impact.

Consistent with the prior literature, we find large differences in slope coefficients and R^2 across announcements. For instance, while the releases of nonfarm payroll and the Institute for Supply Management (ISM) PMI have large and significant price impacts, the releases of housing starts, durable goods orders, and the PPI have insignificant price impacts. It is this wide heterogeneity in asset price impact that we aim to explain in this paper.[9]

Consistent with the above model and the findings in Fleming and Remolona (1997), Andersen et al. (2003), and Hess (2004) among others, we find that, within a general category of macroeconomic indicators, announcements released earlier tend to have greater impact than those released later. An obvious example is that of GDP, where the advance (first) release has the highest price impact. Similarly, the preliminary announcement of the University of Michigan's (UM) consumer confidence index (released around the middle of the reference month) has a bigger effect on asset prices than the final announcement (released just before the end of the reference month).

Other studies highlight the importance of the timeliness of an announcement. Hess and Niessen (2010) show that the price impact of the German *ifo* Business Climate Index diminished substantially after the creation of the German ZEW Indicator of Economic Sentiment, precisely because the ZEW index is released before the *ifo* index. Andersson et al. (2007) show that the reason for the small reaction of German bond prices to the aggregate German Consumer Price Index (CPI) announcement lies in the earlier release of CPI data for the individual German states. In a similar spirit, Ehrmann et al. (2011) show that there is no significant market reaction to Euro area macroeconomic announcements because all individual country releases are already known (money supply being the only counter-example since it is only measured at the Euro area level).

However, the results in Table 2 make it clear that timeliness is not the only characteristic related to the price impact of an announcement. For instance, even though the unemployment rate and nonfarm payroll are released simultaneously and early, surprises in nonfarm payroll have a much larger price impact than surprises in the unemployment rate (more than 20% R^2 versus 2% R^2). Similarly, core CPI has a higher price impact than headline CPI. In light of the model above, it may be that nonfarm payroll and core CPI have a bigger price impact because they either undergo smaller revisions after their initial release or because they are more "useful" to investors in forecasting a fundamental variable of interest, such as GDP, GDP deflator, or the FFTR. In the following section, we define our novel measures of announcement characteristics and investigate how these characteristics help explain the heterogeneity in price impact of macroeconomic announcements.

4. Measuring and decomposing the intrinsic value of announcements

In this section we describe the methodology for consistently measuring an announcement's intrinsic value and its components: timeliness, revisions, and relation to fundamentals. We start by setting up a nowcasting framework, which we subsequently use to define these four characteristics.

4.1. Nowcasting GDP growth, inflation, and the federal funds target rate

We propose and estimate a novel empirical measure of an announcement's intrinsic value and its components. We define the intrinsic value of an announcement as its importance in nowcasting three primitives: GDP advance, GDP price deflator advance, and the FFTR.[10] We generate nowcasts based on a dynamic factor model because this class of models parsimoniously captures the evolution of the high-dimensional vector of macroeconomic announcements. When new information arrives, the Kalman filter provides an estimate (nowcast) of the current state vector, which we then use to forecast the current level of the primitive of interest. Repeating this procedure every time new information arrives generates a time-series of Kalman gains and regression coefficients, which forms the basis of our measures of intrinsic value, timeliness premium, revision premium, and relation to fundamentals.[11]

Our approach to nowcasting is similar to Evans (2005) and Giannone et al. (2008). We assume that the state vector of the economy $\Phi_{p,t}$ follows a VAR(1) process, captured at time t by the state equation

$$\Phi_{p,t} = B_t \Phi_{p-1,t} + C_t \nu_{p,t}, \tag{3}$$

where $\nu_{p,t} \sim WN(0, I_{2\times 2})$. Note that there are two time subscripts, p and t. The state of the economy evolves at a monthly frequency, indexed by the reference period p. The subscript t governs how much information is available about the current and the past state vectors, and identifies specific times within the month. This setup naturally maps the ever-evolving

[9] In the Online Appendix, we present results for the sample period excluding the Federal Reserve's zero lower bound, starting in December 2008. Consistent with the findings of Swanson and Williams (2014), the asset price impacts are somewhat stronger prior to the zero lower bound period, in particular for the shorter maturity bills.

[10] Our primary reason for following the Kalman filter-based nowcasting approach is that its data structure lends itself to traceable counterfactual exercises. Macroeconomic forecasting with mixed-frequency data has received considerable attention in recent years (e.g., Andreou et al., 2010). Nevertheless, the Kalman filter remains the method of choice in terms of accuracy, at the cost of being computationally more demanding than, for instance, mixed data sampling (MIDAS) regressions (Bai et al., 2013).

[11] The Online Appendix provides extensive details on data management, timing conventions, and the nowcasting procedure.

information set—with its missing values, revisions, and irregular announcement dates—into our data structure. Because the dataset changes with each data release, the state space model is re-estimated at each data release time t.

The corresponding observation equation for a given information set t is

$$A_{p,t} = D_t \Phi_{p,t} + \varepsilon_{p,t}, \tag{4}$$

where $\varepsilon_{p,t} \sim WN(0, V_{p,t})$, and $A_{p,t} = \left[a^1_{p,t}, \ldots, a^N_{p,t}\right]'$ is the monthly vector of N macroeconomic variables containing the values $a^n_{p,t}$ available at time t. The variable $a^n_{p,t}$ contains only values announced on or before time t for the macroeconomic announcement n.

The 36 macroeconomic announcements listed in Table 1 and the FFTR series, which are assumed to jointly capture the state of the U.S. economy, are used in the nowcasting exercise, either in their original reporting units or transformed in order to approximate a linear relationship with the forecasting object. For variables reported in percent or percent changes, the original reporting unit is used, while variables reported in levels are transformed into percent changes. For example, the retail sales series, reported as a percent change, is not transformed, while the new home sales series is transformed from levels to percent change. For indexes, we use the original reporting unit.[12]

We estimate the state space representation given by Eqs. (3) and (4) with the two-step procedure of Giannone et al. (2008).[13] The estimation proceeds in four steps, which we repeat for each announcement release time t. We use an expanding window from January 1990 until time t, starting with the window ending on t = January 1, 1997.

First, we consolidate variables that are released piece by piece, namely GDP (advance, preliminary, final), GDP price deflator (advance, preliminary, final), and the University of Michigan consumer confidence index (preliminary, final) into one series, respectively. Thus we have $N = 32$ consolidated macroeconomic time series. However, in determining the intrinsic value, we keep track of each observation's original designation (advance, preliminary, or final). Given t, each time-series is standardized to zero mean and unit standard deviation.

Second, we define a five-dimensional state vector based on five principal components $\Phi_{p,t}$ extracted from the balanced part of the sample. Two principal components are based on all announcement series. Three further principal components are based on the subsets of real, nominal, and forward-looking announcement series, respectively. The matrix C_t collects the five eigenvectors, linking the factors $\Phi_{p,t}$ with the announcements $A_{p,t}$.[14]

Third, the Kalman filter is estimated given information available up until time t and the Kalman gains assigned to the announcements at the end of the sample are retrieved. Specifically, to construct the time-series of the intrinsic value of announcement n, only the gains k^n_t at the time of a new release of macroeconomic variable n are used.

Fourth, given the information at time t, we (Kalman-)smooth the latent factors. Then we use these factors to fit a forecasting model for the nowcasting target variables, analogously to Eq. (4). For the nowcasting targets GDP and the GDP price deflator, a linear model at quarterly frequency is used, whereas for the FFTR an ordered probit specification at monthly frequency is employed. For each forecasting target, indexed by j, we estimate coefficients (marginal effects for the FFTR) $\tilde{D}^j_t$ on the latent factors at each point in time. The absolute value of the product $w(j)^n_t = |\tilde{D}^j_t k^n_t|$ of this coefficient (row) vector with the respective column of the Kalman gain matrix is the *weight* on announcement n at time t for nowcasting the variable j.[15]

When these weights are derived from *actual* data released according to the *actual* release schedule, we refer to them as $w_A(j)^n_t$. In order to estimate the effect of timeliness and revisions, we create counterfactual datasets and apply the same nowcasting procedure on these new datasets. These datasets differ from the original one in terms of release timing, revision status, or both. We modify the respective property of only one macro announcement series n per nowcasting exercise.

To control for release timing, we counterfactually reorder the data. To do so, we identify the earliest announcement for each reference period and set the counterfactual announcement time of the variable of interest to one second before this previously earliest announcement. Applying the nowcasting procedure to these *reordered actual* datasets yields the weight series $w_{RA}(j)^n_t$.

To control for revision status, we counterfactually replace all releases of the variable of interest by the final revised values. By subjecting the original data to both this counterfactual replacement with final values and the counterfactual time reordering, the nowcasting procedure with this counterfactual dataset of *reordered final* announcements yields the weight series $w_{RF}(j)^n_t$.

[12] More details on the original reporting units and possible transformation of each macroeconomic variable are reported in the Online Appendix.

[13] Such "partial" models, specifying the target variable separately from the model of the predictors, are widely used in policy institutions (Bańbura et al., 2013). For our sample, this two-step procedure outperformed the one-step procedure in nowcasting GDP in terms of RMSFE. Further, the two-step approach allows us to tailor the second step to the forecasting target, which we exploit when replacing Eq. (4) for the FFTR with an ordered probit specification.

[14] We extract two factors from all announcements because for GDP such a model performs notably better at nowcasting and at forecasting 1-month-ahead GDP than one factor. For GDP deflator and FFTR, the performance is similar across different numbers of factors.

[15] We take absolute values to capture the direction-free impact of an announcement. Because we determine this weight by a two-step procedure, it differs from the weights implicitly assigned to observations within the Kalman filter as in, e.g., Koopman and Harvey (2003) and Bańbura and Rünstler (2011). In contrast, in our paper, the weight combines the gains determined by the Kalman filter with the coefficients from a separate forecasting regression, and captures the empirical relevance of only the most recent announcement release.

4.2. Intrinsic value and its decomposition

We define the intrinsic value $I(j)_t^n$ of macroeconomic variable n with respect to target variable j (GDP, GDP deflator, or FFTR) as the natural logarithm of the nowcasting weight put on macroeconomic variable n at the time t of its announcement, $I(j)_t^n \equiv \log\left[w_A(j)_t^n\right]$. The intrinsic value can therefore be thought of as the importance placed on the announcement when nowcasting the state of the economy.

Columns 1, 5, and 9 of Table 3 report the time-series average of our novel measure of intrinsic value of each macroeconomic variable for the three nowcasting targets. Note that because the weights $w_A(j)_t^n$ turn out to be between zero and one, the intrinsic value—the logarithm of the weight—is negative. This means that an announcement with a small negative number has large intrinsic value, and an announcement with a large negative number has very little intrinsic value. Based on this metric, Table 3 indicates that forward-looking announcements such as the consumer confidence indices and the PMI indices have large intrinsic values (small negative numbers) when nowcasting GDP and the FFTR. Similarly, price variables such as CPI and PPI appear to have large intrinsic value when nowcasting the GDP price deflator.

We decompose the intrinsic value $I(j)_t^n$ of each macroeconomic variable n for a given target variable j into the announcement's relation to fundamentals $F(j)_t^n$, a timeliness premium $T(j)_t^n$, and a revision premium $R(j)_t^n$:

$$I(j)_t^n \equiv F(j)_t^n + T(j)_t^n + R(j)_t^n, \tag{5}$$

where each component is defined using the nowcasting weights defined in the previous sub-section:[16]

$$log[w_A(j)_t^n] \equiv \log[w_{RF}(j)_t^n] + \log\left[\frac{w_A(j)_t^n}{w_{RA}(j)_t^n}\right] + \log\left[\frac{w_{RA}(j)_t^n}{w_{RF}(j)_t^n}\right]. \tag{6}$$

Each term in Eq. (6) reflects one of the announcement characteristics in Eq. (5). The *intrinsic value*, $I(j)_t^n \equiv \log\left[w_A(j)_t^n\right]$, is the nowcasting weight placed on the actual macroeconomic announcement at the time of its release. The *relation to fundamentals*, $F(j)_t^n \equiv \log\left[w_{RF}(j)_t^n\right]$, is the nowcasting weight placed on the macroeconomic announcement independent of its timing and its revisions. The *timeliness premium*, $T(j)_t^n = \log\left[w_A(j)_t^n\right] - \log\left[w_{RA}(j)_t^n\right]$, is the difference between the nowcasting weight placed on the actual macroeconomic announcement at the time of its release and the nowcasting weight placed on the actual announcement when it is reordered to be the first release in each forecasting period. The *revision premium*, $R(j)_t^n \equiv \log\left[w_{RA}(j)_t^n\right] - log\left[w_{RF}(j)_t^n\right]$, is the difference between the nowcasting weight placed on the actual announcement when it is reordered to be the first release in each forecasting period and the nowcasting weight placed on the announcement when it is reordered and replaced by its final revised value. We now discuss each component of the intrinsic value, as presented in Table 3, and compare them with some alternative naïve measures.

4.3. Relation to fundamentals

In the noisy rational expectations model, market participants put more weight on announcements that are more closely related to fundamentals. The above definition, $F(j)_t^n \equiv \log\left[w_{RF}(j)_t^n\right]$, captures this idea since it is the nowcasting weight placed on the announcement that has been replaced with its final revised value (to remove the impact of revisions) and reordered so that it is the first release in each reference cycle (to remove the impact of timing).

The times-series average of this novel measure of relation to fundamentals is reported in columns 2, 6, and 10 of Table 3 for each macroeconomic variable. As for the intrinsic value, an announcement with a small negative number has a large relation to fundamentals, and an announcement with a large negative number has a small relation to fundamentals. Intuitively, GDP announcements are closely related to fundamentals when nowcasting GDP, as well as nonfarm payroll and forward looking indicators. GDP deflator announcements, as well as CPI and PPI announcements, are most closely related to fundamentals when nowcasting the GDP price deflator. A mix of real activity and inflation announcements have a high relation to fundamentals when nowcasting the FFTR.

Alternatively, one could measure the relation to fundamentals by looking at the correlation of each announcement with GDP, the GDP price deflator, and FFTR. These correlations are reported in columns 13–15 of Table 3. Note that the correlations between our novel measures and these alternative measures are 0.7, 0.6, and 0.5 when nowcasting GDP, the GDP price deflator, and FFTR, respectively.

4.4. Timeliness premium

In the noisy rational expectations model, market participants put more weight on announcements that are more timely. The definition of this premium, $T(j)_t^n = \log\left[w_A(j)_t^n\right] - \log\left[w_{RA}(j)_t^n\right]$, captures this idea because it is the difference between the actual nowcasting weight and the reordered nowcasting weight. This difference should be negative and small for timely announcements, but large and negative for announcements that are released late and whose re-ordering improves their nowcasting ability.

[16] Starting with the factorization $w_A(j)_t^n \equiv w_{RF}(j)_t^n \frac{w_A(j)_t^n}{w_{RA}(j)_t^n} \frac{w_{RA}(j)_t^n}{w_{RF}(j)_t^n}$, we obtain Eq. (6) by taking the natural logarithm of this identity.

Table 3
Nowcasting characteristics of macroeconomic announcements.

		GDP (adv)				GDP price deflator (adv)				FFTR				Correlation with			Reporting	Revision
n	Announcement	I (1)	F (2)	T (3)	R (4)	I (5)	F (6)	T (7)	R (8)	I (9)	F (10)	T (11)	R (12)	GDP (13)	Def. (14)	FFTR (15)	Lag (16)	Magnitude (17)
	Real Activity																	
1	GDP advance	−3.25	−1.56	−1.42	−0.28	−6.36	−5.29	−1.06	0.00	−5.39	−3.97	−1.42	0.00	1.00	0.00	0.22	29	1.26
2	GDP preliminary	−3.37	−1.84	−1.53	0.00	−6.47	−5.29	−1.18	0.00	−5.50	−3.97	−1.53	0.00	0.96	0.02	0.21	58	1.31
3	GDP final	−3.37	−2.15	−1.54	0.31	−6.49	−5.52	−1.18	0.21	−5.52	−3.98	−1.55	0.01	0.94	0.02	0.14	87	1.30
	Prices																	
4	GDP price deflator advance	−5.52	−3.96	−1.57	0.00	−4.49	−3.94	−1.21	0.66	−6.19	−5.37	−0.85	0.02	0.00	1.00	0.02	29	1.21
5	GDP price deflator preliminary	−5.56	−4.00	−1.61	0.04	−4.50	−3.30	−1.21	0.00	−6.16	−5.38	−0.80	0.03	0.02	0.98	0.01	58	1.24
6	GDP price deflator final	−5.58	−3.89	−1.62	−0.06	−4.51	−3.47	−1.22	0.18	−6.17	−5.33	−0.82	−0.02	0.01	0.97	0.13	87	1.11
	Real Activity																	
7	Unemployment rate	−3.77	−2.03	−1.69	−0.05	−4.79	−4.59	−0.19	0.00	−5.18	−3.97	−1.19	−0.02	0.20	0.25	0.06	5	0.81
8	Nonfarm payroll employment	−3.04	−1.95	−1.14	0.05	−6.19	−5.23	−0.80	−0.17	−5.12	−4.02	−1.15	0.05	0.60	0.11	0.31	5	1.14
9	Retail sales	−3.81	−2.29	−1.67	0.15	−6.47	−5.74	−1.05	0.32	−6.15	−4.46	−1.81	0.12	0.49	0.01	0.19	13	1.26
10	Retail sales less automobiles	−3.56	−2.38	−1.52	0.34	−6.56	−5.76	−1.10	0.30	−5.87	−4.42	−1.69	0.24	0.52	0.27	0.28	13	1.22
11	Industrial production	−3.87	−2.14	−1.75	0.02	−7.07	−5.48	−1.55	−0.05	−6.05	−4.36	−1.82	0.14	0.66	0.07	0.27	16	1.28
12	Capacity utilization	−4.10	−2.07	−1.91	−0.12	−5.96	−5.03	−0.90	−0.04	−5.74	−4.06	−1.61	−0.07	0.30	0.27	0.02	16	1.80
13	Personal income	−4.98	−2.78	−2.21	0.01	−7.69	−6.39	−1.33	0.02	−7.02	−4.86	−2.18	0.02	0.24	0.09	0.01	29	0.81
14	Consumer credit	−4.50	−2.35	−2.17	0.01	−7.11	−5.97	−1.18	0.04	−6.41	−4.40	−2.02	0.01	0.33	0.03	0.00	37	1.23
	Consumption																	
15	Personal consumption expenditures	−4.39	−2.36	−2.02	0.00	−7.18	−5.47	−1.46	−0.25	−6.67	−4.57	−2.16	0.05	0.48	0.16	0.14	29	1.23
16	New home sales	−6.09	−3.77	−2.25	−0.07	−8.54	−6.47	−1.79	−0.29	−8.63	−6.13	−2.43	−0.08	0.11	0.11	0.13	27	1.12
	Investment																	
17	Durable goods orders	−4.56	−2.59	−2.04	0.07	−7.29	−5.78	−1.63	0.11	−6.87	−4.74	−2.18	0.06	0.17	0.15	0.10	26	1.06
18	Construction spending	−4.87	−2.53	−2.20	−0.15	−7.79	−5.84	−1.74	−0.21	−7.08	−4.72	−2.26	−0.10	0.42	0.03	0.15	32	1.24
19	Factory orders	−4.38	−2.55	−2.06	0.22	−7.15	−5.68	−1.64	0.18	−6.60	−4.66	−2.13	0.19	0.35	0.03	0.14	34	1.09
20	Business inventories	−5.54	−2.48	−2.12	−0.93	−7.56	−5.73	−1.32	−0.51	−7.17	−4.39	−1.95	−0.82	0.44	0.33	0.13	44	1.23
	Government Purchases																	
21	Government budget deficit	−6.82	−4.89	−2.02	0.10	−8.05	−7.04	−0.99	−0.03	−8.61	−6.88	−1.88	0.15	0.30	0.17	0.01	15	0.17
	Net Exports																	
22	Trade balance	−7.03	−3.63	−2.43	−0.98	−9.36	−7.16	−1.72	−0.47	−9.29	−5.71	−2.33	−1.25	0.10	0.43	0.03	43	1.13
	Prices																	
23	Average hourly earnings	−5.80	−4.13	−2.01	0.33	−6.10	−4.60	−0.35	−1.15	−7.87	−6.41	−1.67	0.22	0.04	0.21	0.12	5	0.89
24	PPI	−4.29	−3.43	−0.84	−0.02	−3.56	−3.26	−0.29	−0.01	−4.88	−4.66	−0.41	0.20	0.28	0.38	0.15	15	0.98
25	Core PPI	−5.63	−4.34	−1.53	0.24	−4.26	−3.62	−0.75	0.10	−5.80	−6.00	−0.55	0.74	0.11	0.40	0.01	15	0.92
26	CPI	−4.51	−3.31	−1.19	0.00	−3.67	−3.24	−0.52	0.09	−5.01	−4.61	−0.55	0.15	0.34	0.55	0.19	17	1.38
27	Core CPI	−5.69	−3.85	−1.64	−0.20	−4.43	−3.42	−1.08	0.08	−6.33	−5.91	−0.84	0.41	0.03	0.33	0.09	17	1.27
	Forward Looking																	
28	UM consumer confidence preliminary	−1.95	−1.68	−0.27	0.00	−4.87	−4.61	−0.27	0.00	−3.87	−3.63	−0.24	0.00	0.48	0.05	0.21	−17	1.20
29	Philadelphia Fed index	−2.21	−1.81	−0.38	−0.02	−5.09	−4.70	−0.41	0.02	−4.50	−3.99	−0.53	0.02	0.61	0.00	0.55	−12	1.23
30	UM consumer confidence final	−2.71	−1.68	−1.03	0.00	−5.43	−4.60	−0.83	0.00	−4.50	−3.63	−0.86	0.00	0.49	0.04	0.19	−3	0.11
31	CB consumer confidence index	−3.41	−2.13	−1.28	0.00	−4.93	−4.70	−0.21	−0.02	−4.84	−4.05	−0.80	0.01	0.43	0.13	0.11	−3	0.88
32	Chicago PMI	−2.93	−1.93	−0.99	−0.01	−5.81	−4.79	−0.98	−0.04	−5.20	−4.10	−1.15	0.05	0.53	0.13	0.42	−1	1.29
33	ISM PMI	−2.80	−1.79	−1.02	0.00	−5.65	−4.75	−0.98	0.08	−5.14	−3.92	−1.24	0.02	0.61	0.10	0.50	2	1.20
34	Housing starts	−5.12	−3.10	−2.11	0.09	−7.64	−6.13	−1.59	0.08	−7.63	−5.52	−2.29	0.17	0.26	0.05	0.11	18	1.03
35	CB leading economic index	−4.71	−1.89	−2.12	−0.70	−7.29	−5.06	−1.79	−0.44	−7.17	−4.19	−2.20	−0.78	0.18	0.43	0.14	23	0.89
36	Initial jobless claims	−2.45	−2.35	−0.05	−0.05	−5.50	−5.62	0.10	0.02	−4.47	−4.31	−0.06	−0.11	0.38	0.17	0.18	6	1.01

Note: For each macroeconomic variable, the table displays the time-series average of the variable's intrinsic value (I) and its components: the relation to fundamentals (F), the timeliness premium (T), and the revision premium (R). These characteristics are based on nowcasting GDP, the GDP price deflator, or the FFTR, and are computed as described in Section 4. The numbers in columns 1–12 are natural logarithms, hence the negative signs. Columns 13–17 report alternative measures of the three components, namely the correlation with the nowcasting target, the reporting lag, and the revision magnitude, as defined in Section 4. The data sample is from January 1997 to December 2015.

The time-series average of this novel measure of timeliness is reported in columns 3, 7, and 11 of Table 3. Looking at GDP announcements, our timing premium is higher (smaller negative number) for the timelier variable, GDP advance, than for GDP final. Forward looking variables that are released early, such as the confidence indices, have very high timeliness premia.

The previous literature (e.g., Fleming and Remolona, 1997) uses the reporting lag as a measure of timing discount, which is the difference between the announcement date and the end of the reference period.[17] The time-series average of each variable's reporting lag (measured in days) is shown in column 16 of Table 3. We call reporting lag a timing discount because the larger the number, the worse the timing of the announcement. Thus, the correlation between our timing premium and reporting lag should be negative. Indeed, we find the correlations to be −0.47, −0.52, and −0.37 when the target variables are GDP, GDP price deflator, and the FFTR, respectively.

One drawback of the announcement's reporting lag as a measure of timeliness is that it is a linear function of time, so an improvement in timeliness of, say, six days is the same for an early and a late announcement. However, we expect a 7-day reporting lag announcement to gain more from moving up its release date six days than a 21-day reporting lag announcement moving up six days. This is because the 7-day reporting lag announcement will now be the first announcement, while the 21-day reporting lag announcement will still remain a latecomer about which earlier releases will likely have already conveyed sufficient information. The novel measure we propose explicitly takes into account the position of the announcement when computing the nowcasting gain in timeliness. This is the reason why two announcements released at the same time, like the unemployment rate and nonfarm payroll, can have different timeliness premia.

4.5. Revision premium

In the noisy rational expectations model, market participants put more weight on announcements that undergo smaller revisions. The above definition of this premium, $R(j)_t^n \equiv \log\left[w_{RA}(j)_t^n\right] - log\left[w_{RF}(j)_t^n\right]$, captures this idea since it is the difference between the nowcasting weight of the actual announcement minus the weight of its final revised value, both independent of the timing of the announcement (reordered). This number should be negative and small for announcements that are not heavily revised, but large and negative for announcements that are heavily revised and whose revisions improve their nowcasting ability.

The time-series average of this novel measure of revisions is reported in columns 4, 8, and 12 of Table 3. Overall, there is significantly less variation in revision premium across announcements compared to the other characteristics. Many numbers are even positive, indicating that the final revised values do worse in nowcasting the given primitive than the actual releases. This is consistent with the findings in Orphanides (2001), who shows that a Taylor rule with real-time macroeconomic announcements performs better than a Taylor rule with final revised numbers.

The previous literature (e.g., Gilbert, 2011) uses an alternative measure of revision noise, namely the absolute value of the difference between the final revised value and the initial release. This measure captures the magnitude of the revisions that an announcement undergoes.[18] This definition includes both sample and benchmark revisions, and assumes that the last available value reflects the "true" situation.[19] In the last column of Table 3, we report the time-series average of this measure of revision magnitude.

The correlation between our novel measure of revision premium and the alternative revision magnitude (discount) measure is, on average, −0.10 for the three nowcasting targets (GDP, GDP deflator, and FFTR). This occurs because the revision magnitude does not take into account the possibility that the revised (final) number is less useful in nowcasting target variables than the original (first-released) number. This measure only captures the magnitude of the revision but not the relevance of a revision, which our nowcasting measure does capture. For example, the UM consumer confidence index is heavily revised, and hence its preliminary release has a big revision magnitude shown in the last column of Table 3. However, we find that the preliminary release has a revision premium of zero when nowcasting the FFTR, which suggests that the final revised value does no better than the initial released value.

5. Relating the price impact to the announcements' characteristics

In this section, we relate our novel measure of the announcements' intrinsic value, as well as its components (relation to fundamentals, timeliness premium, and revision premium) to their price impact. We first examine whether our measures

[17] There is a difference between the end of the reference period and the end of the survey period. For instance, at the Bureau of Labor Statistics, "employment data refer to persons on establishment payrolls who received pay for any part of the pay period that includes the 12th of the month" (http://www.bls.gov/web/cestn1.htm). This means that taking the end of the month as the end of the reference period is not exact, because the surveying stopped much earlier in the month.

[18] In order to normalize the unit of measurement across macroeconomic series, we normalize this alternative measure of revision magnitude:

$$\frac{\left|a_{p,\infty}^n - a_{p,t}^n\right|}{\sigma_{\left|a_{p,\infty}^n - a_{p,t}^n\right|}},$$

where t is the time of the initial release of $a_{p,t}^n$ and $a_{p,\infty}^n$ is the final revised value.

[19] As a robustness check, we also use the first-available sample revisions for the variables available in the Federal Reserve Bank of Philadelphia's Real-Time Data Set and Bloomberg. The results are qualitatively similar.

affect the impact of announcement surprises on asset prices using the full sample. Then we investigate whether our measures explain the cross-section of price impact. All results are presented for the full sample period, and qualitatively similar results using the period excluding the Federal Reserve's zero lower bound period are presented in the Online Appendix.

5.1. Direct impact on asset returns

To assess the importance of the announcements' characteristics, the event study exercise from Section 3 is repeated with the intrinsic value, relation to fundamentals, timeliness premium, and revision premium added into the regressions. However, rather than estimating the price impact separately for each announcement (as we do in Eq. (2) and Table 2), we estimate an average price impact $\beta(j)$ across announcements, and only allow this price impact to vary across announcements according to the announcements' characteristics $X(j)_{p,t}$. More precisely, we estimate the following equation separately for each target variable j:

$$\Delta y_t = \beta_0(j) + \beta(j)s_{p,t} + \beta_x(j)s_{p,t}X(j)_{p,t} + \epsilon(j)_t, \tag{7}$$

where Δy_t are the daily changes in Treasury yields in basis points around the macroeconomic releases and $s_{p,t}$ are the surprise components of all the macroeconomic announcements pooled together, defined as in Eq. (1).[20] The interaction term $s_{p,t}X(j)_{p,t}$ allows the price impact of the announcement to vary across the announcements' characteristics, which are either the intrinsic value (I), relation to fundamentals (F), timeliness premium (T), revision premium (R), or a vector with all three characteristics.[21]

We standardize and smooth our measure of intrinsic value of the announcement. Specifically, we divide each characteristic by its standard deviation estimated across all announcements and all times. This eases the interpretation of the coefficient estimates. In addition, we smooth the weights by taking a 12-month backward-looking moving average. The assumption is that, in calculating the importance of an announcement, investors take the average importance over the past year.

There is one table of results per nowcasted primitive j: Table 4 for GDP, Table 5 for the GDP price deflator, and Table 6 for the FFTR. Columns 2 to 5 in all three tables show the results with each different characteristic included in the regression in isolation, and column 6 shows all three characteristics competing against each other.

Column 2 indicates that, for all nowcasting targets, the intrinsic value of an announcement has an economically and statistically significant effect on the asset price impact of that announcement. The sign of the coefficient is consistent with theory: the bigger the intrinsic value of the announcement is, the bigger is its price impact. For example, a one-standard deviation surprise in an announcement with an average intrinsic value of zero increases the 6-month Treasury yields by about 1 basis point when the nowcasting target is GDP (Table 4, column 2). If we increase the intrinsic value of this announcement by one standard deviation, a surprise on this announcement will increase 6-month yields by about 1.2 basis point (1.022+0.216), which is a 20-percent increase in the impact on yields. Repeating this calculation, we see that the increase in price impact due to intrinsic value is about 15 percent across maturities when the nowcasting target is the GDP price deflator or the FFTR.

Columns 3 through 6 suggest that, across forecasting targets, the relation to fundamentals and timeliness premium are the most relevant announcement characteristics; revision noise is, most of the time, statistically insignificant. Column 6 suggests that increasing the timing of an announcement by one standard deviation increases the impact of the surprise by about 10 to 20 percent when the nowcasting variable is GDP, while increasing the relation to fundamentals by one standard deviation increases the impact of the surprise by about 20 to 30%. The sign of these effects is consistent with the theoretical model summarized in Section 3.1.

The importance of the timeliness premium suggests that the rate at which financial markets update their forecasts towards fundamentals decreases with the amount of information already available. Imprecise, but early, information can be as useful from a nowcasting perspective as precise, but late news.

5.2. Determinants of average surprise impact

In the previous sub-section, we examined whether our novel measures affect the impact of announcement surprises on asset prices using the full sample. We now investigate whether our measures explain the cross-section of price impact and how they compare with the alternative announcement characteristics previously used in the literature, such as reporting lag. In this cross-sectional analysis, we take our estimates of the asset price impact, namely the R^2 from Eq. (2) and Table 2, and estimate the equation:

$$R^2_n(j) = \alpha_0(j) + \alpha_x(j)X_n(j) + \epsilon_n(j), \tag{8}$$

[20] We change the sign of the surprise of two announcements, the unemployment rate and initial jobless claims, so that positive surprises are associated with either higher economic activity or higher inflation than expected.

[21] We do not include a main effect for the announcement characteristic because the noisy rational expectations model predicts that the announcement characteristic only affects the price impact and does not affect the yield change. Consistent with this view, when we include a main effect for the announcement, the main effect is not statistically significant and our results are qualitatively similar.

Table 4
GDP channel results.

	6-month treasury bills						1-year treasury bills					
Coefficient on	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
S	0.379***	1.022***	0.993***	0.575***	0.379***	1.117***	0.539***	1.478***	1.280***	0.851***	0.548***	1.524***
	(0.057)	(0.193)	(0.189)	(0.096)	(0.064)	(0.210)	(0.060)	(0.189)	(0.201)	(0.105)	(0.057)	(0.206)
S × Intrinsic value		0.216***						0.315***				
		(0.059)						(0.054)				
S × Relation to fundamentals			0.211***			0.200***			0.255***			0.245***
			(0.053)			(0.051)			(0.065)			(0.054)
S × Timeliness premium				0.120**		0.0928**				0.191***		0.158***
				(0.050)		(0.044)				(0.055)		(0.056)
S × Revision premium					−0.003	0.022					0.080	0.110*
					(0.055)	(0.046)					(0.049)	(0.065)
Constant	−0.371***	−0.366***	−0.369***	−0.368***	−0.371***	−0.367***	−0.318***	−0.310***	−0.316***	−0.313***	−0.316***	−0.310***
	(0.050)	(0.045)	(0.038)	(0.044)	(0.040)	(0.051)	(0.050)	(0.048)	(0.059)	(0.061)	(0.050)	(0.049)
R^2	0.009	0.012	0.012	0.010	0.009	0.012	0.015	0.020	0.018	0.017	0.015	0.020
	2-year treasury notes						**5-year treasury notes**					
Coefficient on	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
S	0.841***	2.249***	1.893***	1.298***	0.863***	2.278***	0.975***	2.296***	1.925***	1.406***	0.998***	2.301***
	(0.065)	(0.243)	(0.233)	(0.131)	(0.084)	(0.269)	(0.101)	(0.230)	(0.275)	(0.159)	(0.098)	(0.256)
S × Intrinsic value		0.472***						0.443***				
		(0.074)						(0.074)				
S × Relation to fundamentals			0.361***			0.354***			0.326***			0.322***
			(0.073)			(0.073)			(0.086)			(0.077)
S × Timeliness premium				0.279***		0.231***				0.264***		0.220***
				(0.064)		(0.080)				(0.079)		(0.071)
S × Revision premium					0.183***	0.226***					0.196**	0.236***
					(0.067)	(0.069)					(0.090)	(0.084)
Constant	−0.282***	−0.271***	−0.279***	−0.276***	−0.278***	−0.270***	−0.207***	−0.196**	−0.205***	−0.201***	−0.203**	−0.196***
	(0.070)	(0.072)	(0.056)	(0.078)	(0.075)	(0.075)	(0.076)	(0.078)	(0.072)	(0.066)	(0.080)	(0.067)
R^2	0.020	0.026	0.023	0.022	0.021	0.026	0.020	0.025	0.023	0.022	0.021	0.025

Note: The table displays results of regressing daily Treasury yield changes on macro surprises (column 1), on macro surprises and surprises interacted with our announcement characteristics separately (columns 2, 3, 4, and 5), and on macro surprises and surprises interacted with announcement characteristics all at once (column 6). Characteristics are derived from the nowcasting exercise for GDP. The data sample runs from January 1997 to December 2015, and each regression is based on 7595 observations. Bootstrapped standard errors are used, and ***, **, and * represent a 1, 5, and 10% level of significance, respectively.

Table 5
GDP price deflator channel results.

	6-month treasury bills						1-year treasury bills					
Coefficient on	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
S	0.379***	0.907***	1.072***	0.396***	0.375***	1.108***	0.539***	1.439***	1.467***	0.614***	0.537***	1.604***
	(0.052)	(0.231)	(0.221)	(0.058)	(0.048)	(0.189)	(0.051)	(0.260)	(0.202)	(0.089)	(0.052)	(0.221)
S × Intrinsic value		0.133**						0.226***				
		(0.054)						(0.060)				
S × Relation to fundamentals			0.160***			0.163***			0.215***			0.225***
			(0.051)			(0.039)			(0.042)			(0.051)
S × Timeliness premium				0.020		0.033				0.088		0.110*
				(0.043)		(0.050)				(0.063)		(0.059)
S × Revision premium					−0.034	−0.029					−0.014	0.0014
					(0.042)	(0.046)					(0.060)	(0.058)
Constant	−0.371***	−0.369***	−0.371***	−0.370***	−0.371***	−0.370***	−0.318***	−0.314***	−0.318***	−0.315***	−0.318***	−0.315***
	(0.047)	(0.046)	(0.045)	(0.054)	(0.046)	(0.044)	(0.054)	(0.050)	(0.058)	(0.049)	(0.055)	(0.046)
R^2	0.009	0.010	0.010	0.009	0.009	0.011	0.015	0.018	0.018	0.015	0.015	0.018
	2-year treasury notes						**5-year treasury notes**					
Coefficient on	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
S	0.841***	2.017***	1.902***	0.983***	0.838***	2.138***	0.975***	1.972***	1.724***	1.147***	0.967***	1.986***
	(0.081)	(0.328)	(0.308)	(0.105)	(0.081)	(0.314)	(0.098)	(0.355)	(0.417)	(0.119)	(0.069)	(0.394)
S × Intrinsic value		0.295***						0.250***				
		(0.080)						(0.081)				
S × Relation to fundamentals			0.246***			0.263***			0.173*			0.193**
			(0.069)			(0.066)			(0.094)			(0.085)
S × Timeliness premium				0.166***		0.190***				0.201**		0.215***
				(0.058)		(0.064)				(0.085)		(0.077)
S × Revision premium					−0.033	−0.009					−0.065	−0.039
					(0.082)	(0.077)					(0.086)	(0.077)
Constant	−0.282***	−0.277***	−0.282***	−0.277***	−0.282***	−0.277***	−0.207***	−0.203**	−0.207**	−0.201**	−0.207***	−0.201***
	(0.075)	(0.063)	(0.072)	(0.068)	(0.062)	(0.080)	(0.063)	(0.081)	(0.086)	(0.086)	(0.072)	(0.077)
R^2	0.020	0.022	0.021	0.020	0.020	0.022	0.020	0.022	0.021	0.021	0.021	0.022

Note: The table displays results of regressing daily Treasury yield changes on macro surprises (column 1), on macro surprises and surprises interacted with our announcement characteristics separately (columns 2, 3, 4, and 5), and on macro surprises and surprises interacted with announcement characteristics all at once (column 6). Characteristics are derived from the nowcasting exercise for GDP price deflator. The data sample runs from January 1997 to December 2015, and each regression is based on 7595 observations. Bootstrapped standard errors are used, and ***, **, and * represent a 1, 5, and 10% level of significance, respectively.

Table 6
FFTR channel results.

	6-month treasury bills						1-year treasury bills					
Coefficient on	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
S	0.379***	1.026***	1.039***	0.550***	0.378***	1.093***	0.539***	1.494***	1.334***	0.804***	0.540***	1.470***
	(0.061)	(0.220)	(0.269)	(0.103)	(0.063)	(0.295)	(0.066)	(0.241)	(0.215)	(0.113)	(0.0553)	(0.334)
S × Intrinsic value		0.157***						0.232***				
		(0.051)						(0.053)				
S × Relation to fundamentals			0.135***			0.117**			0.163***			0.144**
			(0.052)			(0.059)			(0.046)			(0.061)
S × Timeliness premium				0.123*		0.100*				0.189***		0.163***
				(0.065)		(0.060)				(0.060)		(0.054)
S × Revision premium					−0.018	0.00726					0.028	0.059
					(0.056)	(0.050)					(0.055)	(0.053)
Constant	−0.371***	−0.368***	−0.370***	−0.369***	−0.371***	−0.368***	−0.318***	−0.313***	−0.316***	−0.315***	−0.317***	−0.313***
	(0.050)	(0.051)	(0.051)	(0.044)	(0.048)	(0.048)	(0.050)	(0.053)	(0.047)	(0.050)	(0.062)	(0.057)
R^2	0.009	0.010	0.010	0.010	0.009	0.010	0.015	0.018	0.016	0.017	0.015	0.018
	2-year treasury notes						**5-year treasury notes**					
Coefficient on	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
S	0.841***	2.151***	1.976***	1.158***	0.845***	2.198***	0.975***	2.127***	1.978***	1.222***	0.980***	2.206***
	(0.060)	(0.311)	(0.345)	(0.128)	(0.080)	(0.385)	(0.080)	(0.321)	(0.378)	(0.108)	(0.094)	(0.370)
S × Intrinsic value		0.319***						0.280***				
		(0.071)						(0.077)				
S × Relation to fundamentals			0.233***			0.224***			0.206***			0.211***
			(0.069)			(0.075)			(0.078)			(0.073)
S × Timeliness premium				0.226***		0.185**				0.177**		0.139
				(0.073)		(0.073)				(0.083)		(0.094)
S × Revision premium					0.085	0.133					0.115	0.159*
					(0.072)	(0.082)					(0.099)	(0.083)
Constant	−0.282***	−0.276***	−0.280***	−0.279***	−0.281***	−0.275***	−0.207***	−0.202**	−0.205**	−0.205**	−0.205***	−0.201**
	(0.065)	(0.065)	(0.077)	(0.062)	(0.079)	(0.066)	(0.074)	(0.087)	(0.085)	(0.083)	(0.065)	(0.084)
R^2	0.020	0.023	0.021	0.021	0.020	0.023	0.020	0.022	0.021	0.021	0.021	0.022

Note: The table displays results of regressing daily Treasury yield changes on macro surprises (column 1), on macro surprises and surprises interacted with our announcement characteristics separately (columns 2, 3, 4, and 5), and on macro surprises and surprises interacted with announcement characteristics all at once (column 6). Characteristics are derived from the nowcasting exercise for the Federal Funds Target Rate. The data sample runs from January 1997 to December 2015, and each regression is based on 7595 observations. Bootstrapped standard errors are used, and ***, **, and * represent a 1, 5, and 10% level of significance, respectively.

Table 7
Price impact and intrinsic value.

6-month treasury bills				**1-year treasury bills**			
	Nowcasting target				Nowcasting target		
Coefficient on	GDP (1)	GDP Deflator (2)	FFTR (3)	Coefficient on	GDP (1)	GDP Deflator (2)	FFTR (3)
Intrinsic value	0.0123**	0.0024	0.0099*	Intrinsic value	0.0196**	0.0060	0.0163**
	(0.0060)	(0.0027)	(0.0051)		(0.0088)	(0.0040)	(0.0075)
Constant	0.0570**	0.0281**	0.0602**	Constant	0.0884**	0.0516***	0.0961**
	(0.0235)	(0.0124)	(0.0263)		(0.0341)	(0.0185)	(0.0384)
R^2	0.117	0.004	0.067	R^2	0.139	0.013	0.086
2-year treasury notes				**5-year treasury notes**			
	Nowcasting target				Nowcasting target		
Coefficient on	GDP (1)	GDP Deflator (2)	FFTR (3)	Coefficient on	GDP (1)	GDP Deflator (2)	FFTR (3)
Intrinsic value	0.0266**	0.0064	0.0209**	Intrinsic value	0.0248**	0.0070	0.0191**
	(0.0099)	(0.0055)	(0.0086)		(0.0094)	(0.0052)	(0.0083)
Constant	0.1180***	0.0605**	0.1230***	Constant	0.1120***	0.0625**	0.1150**
	(0.0383)	(0.0250)	(0.0439)		(0.0362)	(0.0244)	(0.0421)
R^2	0.187	0.011	0.103	R^2	0.178	0.014	0.094

Note: The table displays results of regressing the estimated R^2coefficients in Eq. (2) on the announcement's intrinsic value derived from nowcasting GDP advance, the GDP price deflator advance, and the Federal Funds Target Rate. The sample covers the period from January 1997 to December 2015, and each regression is based on 36 observations. White standard errors are used, and ***, **, and * represent a 1, 5, and 10% level of significance, respectively.

where X_n is the time-series average of our announcement characteristics. Table 7 shows the results where X_n is the announcement's intrinsic value for all three nowcasting targets j, namely GDP, GDP price deflator, and FFTR. Table 8 shows the results for GDP only, but where X_n is the announcement's relation to fundamentals, timeliness premium, revision premium, as well as the alternative measures of these components used by the previous literature: correlation with GDP, reporting lag, and revision magnitude. We include each of these characteristics separately because our sample is small with only 36 observations (one estimate of price impact per announcement).

Looking across columns 1 through 3 in Table 7, we find that our intrinsic value measure, when using GDP or FFTR as our nowcasting targets, explains 6 to 18% of the variation in the price impact of announcement surprises, as measured by the R^2.[22] In contrast, using GDP deflator as the nowcasting target is not useful at all. This finding may be an artifact of the sample period we analyze, during which inflation was relatively low and inflation expectations may not have played a sizeable role in nominal Treasury prices.[23] Using GDP as the nowcasting target is also more useful in explaining the variation than using the FFTR. This may not be surprising because the impact of news about the FFTR on nominal Treasury securities includes offsetting effects on real and inflation components, as shown by Beechey and Wright (2009).

Columns 2 through 4 of Table 8 further confirm that an announcement's relation to fundamentals and timeliness premium are more important in explaining the asset price impact of macroeconomic news announcements than the revision premium. Timeliness explains from 6 to 14% of the variation in asset price impact coefficients, and relation to fundamentals explains 8 to 12% of the variation in asset price impact coefficients. However, the revision characteristic explains only 0.8 to 4% of this variation. Overall, column 1 shows that our novel measure of intrinsic value explains the largest fraction of the variation in price impact when compared to its three components and their alternative measures.

Amongst the alternative measures in columns 5 through 7, correlation with GDP is mostly insignificant, but reporting lag is significant and explains a sizeable fraction of the variation in asset price impact. Interestingly, revision magnitude is statistically significant, but the sign is the opposite of what our theoretical model would predict: announcements that undergo larger revisions have a higher price impact. The counter-intuitive sign suggests that one should not consider the magnitude of the revisions in isolation; instead, one should consider both the magnitude of the revision and the relevance of the revision, which our nowcasting framework does.

[22] We obtain qualitatively similar results if we use the slope coefficients β_n as measure of price impact.

[23] Indeed we find that, prior to the "Zero Lower Bound" period, the GDP deflator target is much more relevant—similar in magnitude to the FFTR. The Online Appendix reports these results.

Table 8
Price impact and macroeconomic announcement characteristics.

6-month treasury bills							
	Nowcast measures of				Alternative measures		
	Intrinsic Value (1)	Relation to Fundamentals (2)	Timeliness Premium (3)	Revision Premium (4)	Correlation with GDP (5)	Reporting Lag (6)	Revision Magnitude (7)
Coefficient	0.0123**	0.0100**	0.0122	0.00453	0.0363*	−0.00626*	0.00383
	(0.0060)	(0.0048)	(0.0073)	(0.0044)	(0.0206)	(0.0036)	(0.0085)
Constant	0.0570**	0.0483**	0.0408**	0.0191***	0.00510	0.0265***	0.0145
	(0.0235)	(0.0188)	(0.0179)	(0.0059)	(0.0043)	(0.0092)	(0.0089)
R^2	0.117	0.089	0.060	0.008	0.083	0.059	0.001
1-year treasury bills							
	Nowcast measures of				Alternative measures		
	Intrinsic Value (1)	Relation to Fundamentals (2)	Timeliness Premium (3)	Revision Premium (4)	Correlation with GDP (5)	Reporting Lag (6)	Revision Magnitude (7)
Coefficient	0.0196**	0.0135*	0.0227**	0.0120**	0.0500	−0.0111**	0.0206**
	(0.0088)	(0.0070)	(0.0111)	(0.0055)	(0.0312)	(0.0054)	(0.0098)
Constant	0.0884**	0.0673**	0.0686**	0.0287***	0.00879	0.0413***	0.00484
	(0.0341)	(0.0276)	(0.0268)	(0.0085)	(0.0065)	(0.0134)	(0.0088)
R^2	0.139	0.076	0.098	0.026	0.074	0.087	0.016
2-year treasury notes							
	Nowcast measures of				Alternative measures		
	Intrinsic value (1)	Relation to fundamentals (2)	Timeliness premium (3)	Revision premium (4)	Correlation with GDP (5)	Reporting lag (6)	Revision magnitude (7)
Coefficient	0.0266**	0.0195**	0.0293**	0.0138*	0.0703*	−0.0168***	0.0427***
	(0.0099)	(0.0080)	(0.0128)	(0.0070)	(0.0376)	(0.0058)	(0.0122)
Constant	0.118***	0.0922***	0.0880***	0.0363***	0.00863	0.0558***	−0.0120
	(0.0383)	(0.0315)	(0.0306)	(0.0099)	(0.0087)	(0.0151)	(0.0112)
R^2	0.187	0.115	0.120	0.025	0.107	0.146	0.052
5-year treasury notes							
	Nowcast measures of				Alternative measures		
	Intrinsic value (1)	Relation to fundamentals (2)	Timeliness premium (3)	Revision premium (4)	Correlation with GDP (5)	Reporting lag (6)	Revision magnitude (7)
Coefficient	0.0248**	0.0162**	0.0302**	0.0159**	0.0547	−0.0168***	0.0388***
	(0.0094)	(0.0077)	(0.0126)	(0.0063)	(0.0361)	(0.0058)	(0.0115)
Constant	0.1120***	0.0824**	0.0894***	0.0362***	0.0142	0.0556***	−0.00797
	(0.0362)	(0.0305)	(0.0297)	(0.0095)	(0.0084)	(0.0144)	(0.0097)
R^2	0.178	0.088	0.139	0.036	0.071	0.162	0.047

Note: The table displays results of regressions of the R^2 from Eq. (2) in Table 2 on the macroeconomic announcement's intrinsic value and its components (relation to fundamentals, timeliness premium, and revision premium) derived from nowcasting GDP advance. The table also displays the results of similar regressions using alternative measures for the three components, namely correlation with GDP, reporting lag, and revision magnitude. The data sample is from January 1997 to December 2015, and each regression is based on 36 observations. White standard errors are used, and ***, **, and * represent a 1, 5, and 10% level of significance, respectively.

6. Conclusion

In this paper, we propose and estimate a novel measure of the intrinsic value of macroeconomic announcements. Our definition is based on the announcement's ability to nowcast GDP growth, the GDP price deflator, and the FFTR. We decompose this intrinsic value into three separate announcement characteristics: relation to fundamentals, timeliness, and revisions. We find that timeliness and relation to fundamentals are the most significant characteristics in explaining the variation in the response of U.S. Treasury yields to macroeconomic news announcements.

Our study offers two additional takeaways for policy makers and future research. First, the price response to a particular type of announcements cannot be analyzed in isolation. Indeed, the effect that announcements have on asset prices crucially depends on the information environment. Second, our analysis shows that the relationship between the intrinsic value of

an announcement and its asset price impact is not perfect. In particular, we find that while nonfarm payroll has the biggest impact on U.S. Treasury yields, it is not the announcement with the biggest intrinsic value.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at 10.1016/j.jmoneco.2017.09.008.

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