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GDPNow: A Model for GDP "Nowcasting"

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Abstract: This paper documents GDPNow, a "nowcasting" model for gross domestic product (GDP) growth that synthesizes the "bridge equation" approach relating GDP subcomponents to monthly source data with the factor model approach used by Giannone, Reichlin, and Small (2008). The GDPNow model forecasts GDP growth by aggregating 13 subcomponents that make up GDP with the chain-weighting methodology used by the U.S. Bureau of Economic Analysis. Using current vintage data, out-of-sample GDPNow model forecasts are found to be more accurate than a number of statistical benchmarks since 2000. Using real-time data since the second-half of 2011, GDPNow model forecasts are found to be only slightly inferior to consensus near-term GDP forecasts from Blue Chip Economic Indicators. The forecast error variance of GDP growth for each of the GDPNow model, Blue Chip, and the Federal Reserve staff's Green Book is decomposed as the sum of the forecast error covariances for the contributions to growth of the subcomponents of GDP. The decompositions show that "net exports" and "change in private inventories" are particularly difficult subcomponents to nowcast.

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"*It is no longer true that academics are the people best informed about the evolution of next quarter's GDP as was the case even in the 1960s*."

[Lawrence Summers, "Economic specialization is a feature, not a bug"[1], July 26, 2011]

Section 1: Introduction

The view expressed by Lawrence Summers in the above quote is probably right. Perusing the June 2014 *Wall Street Journal Economic Forecasting Survey*[2], one sees that most of the panelists submitting forecasts of GDP growth and other economic indicators are mostly business economists[3]. As documented by Landefeld, Seskin and Fraumeni (2008), survey-based data available to the public account for about 70 percent of the expenditure share of the "advance" (or first) estimate of gross domestic product (GDP) released 25 to 30 days after the end of a quarter. Both business economists and Federal Reserve staff economists utilize much of this available data when making very short-run GDP forecasts. As former Fed staff economists Jon Faust and Jonathan Wright put it in their 2009 paper evaluating the historical accuracy of Fed staff forecasts, "by mirroring key elements of the data construction machinery of the Bureau of Economic Analysis, the Fed staff forms a relatively precise estimate of what BEA will announce for the previous quarter's GDP even before it is announced." And yet, this "bottom-up" approach of mimicking of the BEA's methods of translating publically available data into an estimate of GDP is less straightforward than it might seem. Much of recent literature on GDP "nowcasting" utilize fairly sophisticated econometric techniques in a "top-down" approach to directly forecast GDP without forecasting its subcomponents.

This paper describes a GDP "nowcasting" model called GDPNow that attempts to marry the econometrics used in the "top-down" approaches with the careful attention to the details of GDP data construction used in "bottom-up" approaches. After a brief summary of the GDP nowcasting literature in Section 2, we describe the GDPNow model in detail in Section 3. Section 4 evaluates the forecasting performance of the GDPNow model and Section 5 concludes. An appendix includes some technical details as well as tables documenting the data and sources used in the GDPNow model.

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[1] The article is available at http://blogs.reuters.com/lawrencesummers/2011/07/26/economic-specialization-is-a-feature-not-a-bug/

[2] Available at http://online.wsj.com/public/resources/documents/wsjecon0614.xls

[3] There are a few exceptions, for example, Edward Leamer of UCLA Anderson School of Management.

Section 2: Literature Review

There is a large literature on "nowcasting" U.S. GDP growth; we briefly review and classify the studies according to their approach. For a good technical treatment of the methods of this literature, see Foroni and Marcellino (2013).

1.) **Simple regression approaches**: Braun (1990) uses two simple regression models, one relating quarterly production workers hours growth to quarterly GNP[4] growth and a second using an Okun's law equation with the unemployment rate and model-based estimates of the natural rate of unemployment and potential GNP. Ingenito and Trehan (1996) use a simple regression model of real GDP growth on a constant, three lags, and both nonfarm payroll employment growth and real consumption growth for the current quarter. Both Braun (1990) and Ingenito and Trehan (1996) address how they forecast the missing values of the monthly series needed for their models. Similar one-equation regression based forecast models of GDP growth are used by Fitzgerald and Miller (1989) and Koenig and Dolomas (1997).
2.) **"Medium Data" or "Data-rich" Methods Without Component Forecasting:** Kitchen and Kitchen (2013) run 24 simple univariate regressions of quarterly GDP growth on contemporaneous and lagged values of one other regressor. They combine the forecasts of these models using normalized R-squares from the regressions as weights. Carriero, Clark, and Marcellino (2012) consider a number of statistical models including various mixed frequency models which relate GDP growth to up to 9 monthly indicators and lags of GDP growth. The lags of the monthly indicators imply up to 50 explanatory variables in their model. To avoid overfitting, the authors use Bayesian methods. Giannone, Reichlin and Small (2008) use a dynamic factor model to nowcast GDP. Their model, which includes roughly 200 monthly macroeconomic indicators, can handle the "jagged edge" nature of staggered data releases so that the forecaster need not throw away data when predicting GDP growth. Finally, Schorfheide and Song (2013) develop an 11-variable mixed-frequency Bayesian vector autoregression (BVAR) that combines monthly and quarterly data by using state-space and Monte Carlo methods to estimate the posterior distribution of unobserved monthly values for real GDP [and other quarterly series]. Beauchemin (2014) adapted the Schorfheide and Song (2013) approach for the Minneapolis Mixed Frequency Vector Autoregression (MF-VAR) model. Forecasts from the MF-VAR model are regularly posted on the Minneapolis Fed's website.
3.) **Bridge Equation Methods/Tracking Models**: This approach, pioneered by Nobel Laureate Lawrence R. Klein; is discussed in Klein and Sojo (1989). In short, one forecasts the major expenditure components of GDP using bridge equations that regress the growth rate of a component on one or more related monthly series[5]. Missing values of the monthly series in the quarter of interest are forecasted, generally by a univariate time series models like an ARIMA. The forecasts of the GDP components are then aggregated up to a GDP forecast using a national

[4] Prior to 1992, GNP was most often used to measure aggregate output.
[5] The monthly series are generally aggregated to a quarterly growth rate in the bridge equations.

income accounting identity. In today's jargon, bridge equation type models are often called "tracking models". There are a number of proprietary tracking forecasts currently in use such as the *Current Quarter Model* from Moody's Analytics [see Zeller and Sweet (2012)] and GDP tracking forecasts from Macroeconomic Advisers[6]. Other bridge equation based approaches for nowcasting U.S. GDP growth include Payne (2000) and Miller and Chin (1996). We will borrow heavily from Miller and Chin (1996) and say more about their paper as we describe our approach.

Section 3: The GDPNow model

GDPNow borrows heavily from Miller and Chin (1996) and Giannone, Reichlin and Small (2008). Since the model builds up its GDP forecast from a forecast of subcomponents, it is a "tracking model" according to the above classification.

In short, the model uses the following six steps:

(1) Forecast the high-level subcomponents of GDP – 13 of them – with a quarterly BVAR only using data through the last quarter. This step is used by Chin and Miller (1996).

(2) Use a variant of the nowcasting model of Giannone, Reichlin and Small (2008) with a large number of data series to extract an underlying factor of economic activity akin to the *Chicago Fed National Activity Index*.

(3) Following Stock and Watson (2002), include this factor in factor augmented autoregressions to forecast a large number of monthly data series. For each series, aggregate the actual available data and the monthly forecasts into a quarterly percent (log) change.

(4) For each of the investment and government spending GDP components in step (1), run two sets of "bridge equation" regressions. The first set regresses a "granular" subcomponent of an expenditure component on one or more of the monthly series aggregated to the quarterly frequency in Step 3 [e.g. manufactured homes investment growth is regressed on a measure of real mobile home shipments growth]. The forecasts of the "granular" subcomponents are aggregated up to a forecast for the quarterly series. This forecast and the BVAR forecast from step (1) are included in a second bridge equation.

(5) Construct forecasts of consumption, imports/exports, and inventory investment using slightly different approaches.

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[6] Occasionally, these tracking forecasts have been available on the Macroeconomic Advisers blog http://macroadvisers.net/blog/. For a brief description of GDP tracking by Ben Herzon of Macroeconomic Advisers, see Herzon (2013).

(6) Finally, combine the quarterly forecasts of the components into a GDP forecast with the same chain-weighting methodology that the Bureau of Economic Analysis (BEA) uses to estimate real GDP.

Detailed description

We assume that the BEA has released an estimate of GDP growth for quarter *T* and that we are interested in forming the nowcast for quarter *T+1*. We will need to mix quarterly and monthly data; for the monthly data let $x_{t,m}$ denote the value of x in the *m*th month (first, second or third) of quarter *t*. The quarterly average of x in quarter *t* is then $X_t = \frac{1}{3}(x_{t,1} + x_{t,2} + x_{t,3})$. Throughout this note, monthly variables will be lower case letters or words and quarterly variables will be upper-case letters or words.

Step 1: Compute the one-step ahead forecast of 13 real quantity components of GDP using a five lag Bayesian vector autoregression (BVAR) model. The components are listed in Table A1 and the implementation of the prior, which closely follows, Banbura, Giannone, and Reichlin (2008), is described in the appendix. The estimation sample is 1968-present.

Label the forecasted growth rate of the *i*th component of GDP as $\Delta \log \hat{X}_{T+1}^{i,BVAR}$ [7]. Additionally, obtain fitted values from the BVAR from an initial date T_0 (1985q1) through quarter *T* and collect these in the vector

$$\widehat{\boldsymbol{S}_1^i} = [\Delta \log \hat{X}_{T_0}^{i,BVAR}, \Delta \log \hat{X}_{T_0+1}^{i,BVAR}, \ldots, , \Delta \log \hat{X}_{T-1}^{i,BVAR}, \Delta \log \hat{X}_{T}^{i,BVAR}]'$$

We run a similar 5-lag BVAR with the implicit quarterly price deflators of the same 13 components.

Step 2a: Some of the monthly series are nominal and need to be deflated. In some instances the nominal series is released before the appropriate deflator is[8] and therefore we need to use a forecast of the deflator. We generate these forecasts with a twelve lag 34-variable BVAR starting in 1983. The variables in this BVAR (all prices) are listed in Table A2. We use the conditional forecasting techniques described by Waggoner and Zha (1999) that allows the forecast to handle the staggered release dates of the data.

Step 2b: Estimate a single common latent factor for a large number (currently 124) of monthly time series. There is considerable overlap between the data we use to construct the factor and the data used to construct the Chicago Fed National Activity Index[9] (CFNAI). As is done when computing the CFNAI, the data are first transformed to be stationary (i.e. nontrending) and then normalized to have mean 0 and standard deviation 1. The list of variables and their transformations is in Table A4. The data releases the series are taken from are in Table A3. Many of the series are taken directly from Haver

[7] The scaled real change in private inventories is not logged; in order to simplify the presentation we do not adjust the notation to reflect this.

[8] For example, when retail sales are released before the Consumer Price Index

[9] See Federal Reserve Bank of Chicago (2013) for a description of the methodology used to calculate CFNAI

Analytics; these series generally have an “@” appearing in the series name. Other series need to be modified somehow; like being deflated by a price and/or spliced with another series[10].

Denoting the *i*th pre-transformed series as $y_{t,h}^{i}$, and it's post-transformed standardized value as $z_{t,h}^{i}$, the estimated factor model is

$$(1) \quad f_{t,h} = \rho_1 f_{t,h-1} + \rho_2 f_{t,h-2} + \rho_3 f_{t,h-3} + u_{t,h}$$

$$(2) \quad z_{t,h}^{i} = \gamma_1^{i} f_{t,h} + \varepsilon_{t,h}^{i}$$

The latent factor is $f_{t,h}$. To keep the notation of mixing monthly and quarterly data consistent throughout the note we adopt the notational convention that if $1 \leq h \leq 3$, then

$$\ldots = x_{t-1,h+3} = x_{t,h} = x_{t+1,h-3} = \cdots$$

I.e., in our notation, the fourth month of quarter t-1 is also the first month of quarter t.

Doz, Giannone, and Reichlin (2006) show that the parameters and the variances of the error terms ($u_{t,h}$ and $\varepsilon_{t,h}^{i}$) in equations (1) and (2) can be consistently estimated by first estimating the latent factor(s) with simple principal components[11] and then estimating both (1) and (2) with OLS. The latent factor(s) can then be extracted with the Kalman filter and Kalman smoother. In an extension of the Doz, Giannone, and Reichlin (2006) model; Giannone, Reichlin, and Small (2008) show how a dynamic factor model of this type can be extended to handle non synchronous data releases where some series are released in a more timely fashion than others. We follow the Giannone, Reichlin, and Small (2008) approach to generate an estimate of the time series of the smoothed factors. We also forecast future values of the factor using equation (1) and the last [smoothed] estimates of the factors. I.e. if month *h-1* in quarter *t* is the last month where we have data on at least some of the series, then we have estimates of $f_{t,h-1}, f_{t,h-2}$, and $f_{t,h-3}$ but not $f_{t,h}$. We then use (1) to forecast $f_{t,h}, f_{t,h+1}, \ldots$. This follows the Giannone, Reichlin, and Small (2008)[12] approach.

Step 3: Forecast the monthly series of interest using a variant of the Stock and Watson (2002) approach. Suppose we are interested in forecasting values for the values $y_{t,h}^{i}, y_{t,h+1}^{i}, \ldots$ when we have the non-missing observations $\ldots, y_{t,h-2}^{i}, y_{t,h-1}^{i}$. Similar to Stock and Watson (2002), we run factor augmented auotregressions of the form

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[10] E.g. the NAICS based manufacturing and trade sales series need to be spliced with SIC based counterparts,

[11] Stock and Watson (2002) describe a method for estimating principal components when some series are missing at the beginning of the sample. In our application, an example of such a series is the ISM Nonmanufacturing Index which is only available starting July 1997. We implement Stock and Watson's method in our application.

[12] We do differ from Giannone, Reichlin, and Small (2008) in that we do *not* use month *h* data until we have the ISM Manufacturing Index for month *h*. This implies that series from the Reuters/University of Michigan and Conference Board consumer surveys as well as series from the Philly Fed Business Outlook Survey are not used until the ISM Manufacturing Index is released.

$$(3)\quad \Delta\log(y_{t,h}^{i}) = \alpha_i + \sum_{k=1}^{q} \gamma_k^i \Delta\log(y_{t,h-k}^{i}) + \sum_{j=0}^{r} \beta_j^i f_{t,h-j}$$

where the estimated factors $f_{t,h}$ from Step 2 are used. The number of lags of the dependent variable, *q*, and the number of lags of the factors, *r*, are selected with the Akaike Information Criterion (AIC) where we restrict $1 \leq q \leq 12$ and $0 \leq r \leq 3$. In the case of the consumption variables, we restrict $6 \leq q \leq 12$. Since we are able to forecast the factors as far out into the future as we'd like, we can recursively forecast $\Delta\log(y_{t,h}^{i})$, $\Delta\log(y_{t,h+1}^{i})$, … as well. This approach is different from Stock and Watson (2002) in the sense that they do not forecast future values of the factor and iteratively roll-over the one step ahead forecasts. Rather, they make *h*-step ahead projections directly with the available factors.

Step 4a: Run "bridge equation" regressions [investment and government spending components]. We explain this step for residential investment; the same method is also used for nonresidential structures investment, equipment investment, intellectual property products investment (IPP), federal government spending and state+local government spending.

The 13 GDP components used in our quarterly BVAR model are too coarse to be bridged directly with the monthly indicators in a manner that mimics the way BEA actually constructs GDP. For example, in the advance GDP estimate, monthly Census Bureau data on manufactured home shipments[13] are the primary source for the manufactured homes subcomponent of real residential investment. This monthly series is not used for the other components of residential investment. Not surprisingly, the quarterly growth rate of manufactured home shipments has a much higher correlation with real manufactured home investment growth [r = 0.82, 1990Q1-2012Q4] than with total real residential investment growth [r = 0.41]. Rather than including very small components like manufactured home investment in the quarterly BVAR, and run the risk of over-fitting, we proceed as follows:

Partition nominal and real residential investment into 7 subcomponents

BEA Residential Investment Subcomponent	2012Q4 Share of Residential Investment	Monthly Indicator
Permanent-site	41.3%	SplicedNewHousingConstruction
Manufactured homes	0.9%	MobileHomeVal
Dormitories	0.8%	NONE [Use AR(4)]
Improvements	39.2%	SplicedBuildingMaterials
Brokers' commissions on sale of structures	16.4%	valExHomeSales+ valNewHomeSales

[13] Available at http://www.census.gov/construction/mhs/mhsindex.html

Residential equipment	2.3%	RetSalesResEquip
Net purchases of used structures	-0.9%	NOT USED

The monthly indicators, which are price-deflated, are listed in Table A4. "Net purchases of used structures" is not used because it is negative and only available since 1995Q1

a.) For each of the monthly series, we use equation (3) to forecast the quarterly growth rate for the quarter of interest (*T+1*). For example, on the day before the quarter *T+1* advance GDP release $y_{T+1,3}^{\text{MobileHomeVal}}$ will not be available, but $y_{T+1,2}^{\text{MobileHomeVal}}$ will be. Therefore, we use (3) to obtain the forecast $\hat{y}_{T+1,3}^{\text{MobileHomeVal}}$ and construct

$$(4)\quad \Delta\log(\hat{Y}_{T+1}^{\text{MobileHomeVal}}) = \log\left(\frac{y_{T+1,1}^{\text{MobileHomeVal}} + y_{T+1,2}^{\text{MobileHomeVal}} + \hat{y}_{T+1,3}^{\text{MobileHomeVal}}}{y_{T,1}^{\text{MobileHomeVal}} + y_{T,2}^{\text{MobileHomeVal}} + y_{T,3}^{\text{MobileHomeVal}}}\right)$$

The forecasted value $\Delta\log(\hat{Y}_{T+1}^{\text{MobileHomeVal}})$ will have less predictive power for manufactured home investment than the actual unavailable value $\Delta\log(Y_{T+1}^{\text{MobileHomeVal}})$ due to the missing value for the last month. Therefore, we also use (3) to construct the fitted values

$$(5)\quad \Delta\log(\hat{Y}_{t}^{\text{MobileHomeVal}}) = \log\left(\frac{y_{t,1}^{\text{MobileHomeVal}} + y_{t,2}^{\text{MobileHomeVal}} + \hat{y}_{t,3}^{\text{MobileHomeVal}}}{y_{t-1,1}^{\text{MobileHomeVal}} + y_{t-1,2}^{\text{MobileHomeVal}} + y_{t-1,3}^{\text{MobileHomeVal}}}\right)$$

for $t < T+1$. If we are making our nowcast well before the advance GDP release, (4) and (5) will also incorporate forecasts for $y_{t,2}^{\text{MobileHomeVal}}$ and perhaps $y_{t,1}^{\text{MobileHomeVal}}$. This is the same method Chin and Miller (1996) use.

b.) For each subcomponent of real residential investment, $RealResInv_t^{\text{i}}$, and its n_i associated monthly indicator(s), we estimate the bridge equation regression

$$(6)\quad \Delta\log(REALRESINV_t^{\text{i}}) = \varphi_i + \sum_{k=1}^{n_i} \theta_k^i \Delta\log(\hat{Y}_t^{\text{i}})$$

and make the forecast $\Delta\log(\widehat{REALRESINV}_{T+1}^{\text{i}})$. The bridge equation is estimated with data since 1985:Q1. For dormitories investment growth – and any other subcomponents for which we do not have a related monthly series – we use an AR(4) forecast.

c.) For the first six components of the above residential investment list, we compute the time *T* spending shares $SH_T^{\text{j}} = \frac{NOMRESINV_T^{\text{j}}}{\sum_{k=1}^{6} NOMRESINV_T^{\text{k}}}$. The bridge model forecast of real residential investment is

$$(7)\quad \Delta\log(REAL\widehat{RES}INV_{T+1}^{\text{Bridge}}) = \sum_{i=1}^{6} SH_T^{\text{i}} \Delta\log(REAL\widehat{RES}INV_{T+1}^{\text{i}})$$

This weighting uses the fact that the growth rate of a Tornqvist index is a very good approximation of the growth rate of a Fisher index, even when time *T* expenditure weights are used instead of the average of the time *T* and time *T+1* spending weights. Using the time *t-1* spending shares SH_{t-1}^{i}, we go backwards in time to construct the fitted values $\Delta\log(REAL\widehat{RES}INV_t^{\text{Bridge}})$.

For the three major categories of nonresidential fixed investment [equipment, IPP and structures] and for both major categories of government spending [federal and state+local] we also use the same weighted average of bridge equations approach. The subcomponents and related monthly series used in the bridge equations are provided in Tables A5a, A5b, A5c, A5d, A5e and A5f.

Step 4b: Combine "bridge equation" forecasts with BVAR forecasts [investment and government spending components].

As Chin and Miller (1996) note, bridge models only use a subset of the data that go into the BEA's estimate of GDP growth. Following the lead of these authors, we combine the bridge equation based forecast and the Step 1 BVAR forecast for six of the low-level GDP components. The regression combination equation for residential investment growth is

$$(8)\quad \Delta\log(REALRESINV_t) = \delta_{ResInv}\Delta\log\left(REAL\widehat{RES}INV_t^{\text{BVAR}}\right) + (1-\delta_{ResInv})\Delta\log\left(REAL\widehat{RES}INV_t^{\text{Bridge}}\right) + \text{E}_t$$

We estimate (8) with restricted least squares (RLS)[14] and omit a constant from the regression since both of the right hand side terms in (8) are already forecasts of the left hand side term. As we get more monthly housing data, $\Delta\log\left(REAL\widehat{RES}INV_t^{\text{Bridge}}\right)$ will become more accurate on average and δ_{ResInv} will get smaller. We use a similar approach for equipment, IPP, and nonresidential structures investment and for both federal and state+local government expenditures.

Step 5: Forecasting Real Net Exports. Forecasting net exports is tricky; Chin and Miller (1996), for example, forecast net exports as a residual by forecasting GDP directly[15], forecasting all of the other components of GDP, and backing out net exports. As they note, the net exports forecasts from this method are not very accurate. Our approach for forecasting net exports of goods[16] is the following:

[14] We constrain δ_{ResInv} to be between 0 and 1.
[15] Chin and Miller (1996) using a simple regression of GDP growth on 1.) a constant, 2.) their quarterly BVAR prediction of GDP, 3.) quarterly real consumption growth using monthly data extrapolated with predictions from their monthly BVAR model, 4.) quarterly production hours growth using monthly data extrapolated with predictions from their monthly BVAR model.
[16] An isomorphic approach is used for services.

a.) We construct monthly series on real goods imports and real goods exports using Census Bureau/BEA data on nominal goods imports/exports[17] and monthly BLS data on imports and exports prices. The (NSA) exports price index for all commodities is taken directly from the *U.S. Import and Export Price Indexes* release[18]. Goods import price inflation is constructed as a weighted average of 8 import price inflation rates from the same release[19]. The petroleum import price index is manually seasonally adjusted [using the default Haver settings] while the other series are not. The weights are the categories' nominal import shares from the prior quarter in NIPA table 4.2.5. The two-year lag in revision of the weights in the BLS import price index[20] causes some discrepancy between the BLS import price series for all commodities and the BEA import price series for goods from NIPA table 4.2.4.

b.) We then construct an estimate of the contribution of goods net exports to real monthly GDP growth using the formula

$$(9)\quad contgoodsnetexports_{T+1,h} = \frac{nomgoodsexports_{T+1,h-1}}{nomgdp_{T+1,h-1}} \Delta \log(realgoodsexp_{T+1,h}) - \frac{nomgoodsimports_{T+1,h-1}}{nomgdp_{T+1,h-1}} \Delta \log(realgoodsimp_{T+1,h})$$

Formula 9 is approximately the contribution to growth from a Tornqvist index; it is a very accurate approximation to the contribution to percent change used by the BEA. Monthly nominal GDP is a splice of the series constructed by Macroeconomic Advisers[21] and Stock and Watson[22].

c.) Next, we estimate a factor-augmented autoregression with $contgoodsnetexports_{T+1,h}$ exactly as we did in equation (3).

$$(10)\quad contgoodsnetexports_{t,h} = \sum_{k=1}^{q} \gamma_k^{NX} contgoodsnetexports_{t,h-k} + \sum_{j=0}^{r} \beta_j^{NX} f_{t,h-j}$$

Lag lengths are again selected using the AIC. We do not include a constant in the regression so that longer horizon forecasts of the net exports contribution converge to 0.

d.) We separately estimate factor augmented autoregressions for real goods exports growth and real goods imports growth [this time with a constant term included], and generate forecasts

[17] The series are on a balance of payments basis and are available from Exhibit 1 of the FT-900 Census Bureau/BEA *U.S. International Trade in Goods and Services* release at http://www.census.gov/foreign-trade/Press-Release/current_press_release/ft900.pdf.

[18] See http://www.bls.gov/news.release/ximpim.t02.htm.

[19] See http://www.bls.gov/news.release/ximpim.t01.htm.

[20] See http://www.bls.gov/news.release/ximpim.tn.htm.

[21] See http://www.macroadvisers.com/content/MA_Monthly_GDP_Index.xlsx. Since the series is released with a longer lag than the international trade data; we forecast using a constant 4.5% (SAAR) monthly growth rate where necessary.

[22] See http://www.princeton.edu/~mwatson/mgdp_gdi.html.

$\Delta\log(\widehat{realgoodsexports}_{T+1,h+1})$ and $\Delta\log(\widehat{realgoodsimports}_{T+1,h+1})$ where *h* is the last month we have trade data for.

The forecasts $\Delta\log(\widehat{realgoodsexports}_{T+1,h+1})$ and $\Delta\log(\widehat{realgoodsimports}_{T+1,h+1})$ will not, in general, be consistent with $\widehat{contgoodsnetexports}_{T+1,h+1}$; as (9) will not hold. Therefore we solve for the unique adjustment factor $\alpha^{NXadj}_{T+1,h+1}$ that imply the adjusted forecasts

$$\Delta\log(\widehat{realgoodsexp}^{NXadj}_{T+1,h+1}) = \Delta\log\left(\widehat{realgoodsexp}_{T+1,h+1}\right) + \alpha^{NXadj}_{T+1,h+1}$$

and

$$\Delta\log(\widehat{realgoodsimp}^{NXadj}_{T+1,h+1}) = \Delta\log\left(\widehat{realgoodsimp}_{T+1,h+1}\right) - \alpha^{NXadj}_{T+1,h+1}$$

are mutually consistent with equations (9) and (10). We repeat the forecast/adjustment process through the 3rd month of quarter *T+1*. Then, if *h* = 1 for example, the monthly model forecast for the (approximate) contribution of goods net exports to GDP growth in quarter *T+1* is:

$$(12)\quad \widehat{CONTGOODSNETEXPORTS}^{MonthlyModel}_{T+1} = \frac{BEANOMGOODSEXPORTS_T}{NOMGDP_T}\log\left(\frac{realgoodsexp_{T+1,1} + \widehat{realgoodsexp}^{NXadj}_{T+1,2} + \widehat{realgoodsexp}^{NXadj}_{T+1,3}}{realgoodsexp_{T,1} + realgoodsexp_{T,2} + realgoodsexp_{T,3}}\right) - \frac{BEANOMGOODSIMPORTS_T}{NOMGDP_T}\log\left(\frac{realgoodsimp_{T+1,1} + \widehat{realgoodsimp}^{NXadj}_{T+1,2} + \widehat{realgoodsimp}^{NXadj}_{T+1,3}}{realgoodsimp_{T,1} + realgoodsimp_{T,2} + realgoodsimp_{T,3}}\right)$$

Going backwards through time [and using in-sample forecasts for the same months where we don't have data], we generate the fitted values $\widehat{CONTGOODSNETEXPORTS}^{MonthlyModel}_{t}$ for *t* < *T+1*[23]. We generate alternative fitted values $\widehat{CONTGOODSNETEXPORTS}^{BVAR}_{t}$ by using the BVAR growth forecasts for real goods exports and real goods imports in place of the [log] growth rates in (12). We estimate the regression

$$(13)\quad CONTGOODSNETEXPORTS_t = \delta_{NXGoods}\widehat{CONTGOODSNETEXPORTS}^{BVAR}_{t} + (1-\delta_{NXGoods})\widehat{CONTGOODSNETEXPORTS}^{MonthlyModel}_{t} + \mathrm{E}_t$$

by RLS where $CONTGOODSNETEXPORTS_t$ is the share-weighted growth rate of real goods exports less the share-weighted growth rate of real goods imports [using time *t-1* expenditure shares]. The final forecast of real goods exports (imports) growth is a weighted average of the BVAR [weight $\delta_{NXGoods}$] and "monthly data model" [weight $1-\delta_{NXGoods}$] forecasts.

[23] We are assuming we have one month of international trade in quarter *T+1* and have to use forecasts for the last two months. Obviously, if the amount of available monthly data was different, then a different number of "hats".

The forecasts for imports and exports in services are generated using exactly the same approach[24].

Step 6: Forecast consumption directly. Since PCE consumption spending is already monthly, there is no need to use bridge equations. For the monthly consumption components that we use to partition total consumption, we still forecast the months that are not available with equation (3). The subcomponents of PCE consumption that we use are listed in Table A6. As described by Chapter 5 of the *NIPA Handbook: Concepts and Methods of the U.S. National Income and Product Accounts*, the BEA uses the "retail control" method to estimate consumption for many durable and nondurable goods[25]. For these goods, whenever retail sales from the U.S. Census Bureau is released (around the middle of the month), we use the latest growth rate in nominal sales for the "retail control" group – Retail Sales & Food Services Excluding Auto, Gas Stations & Building Materials –as a forecast of the growth rate in nominal consumption for the analogous PCE bundle[26]. We also assume that revisions in retail control sales will result in a proportional revision to the retail control basket in the PCE. The Consumer Price Index is also released around the middle of the month. Price measures for the PCE retail control subcomponents can (almost exactly) be mapped into CPI subcomponents. Whenever the Consumer Price Index is released we use the appropriate components to "nowcast" the inflation rate for the PCE retail control basket. Table A7 contains the mapping we use from CPI to PCE components.

The BEA does not use retail sales to estimate PCE new motor vehicle sales, but they do publish unit light-weight auto and truck sales about a week before retail sales are released[27]. The BEA also publishes data on the consumer share of auto and light truck sales[28]. We use all of this data to nowcast the real PCE new motor vehicle sales for the latest month whenever the BEA's unit vehicle sales data is released. For the other PCE components we do not exploit other monthly releases to predict the latest month's numbers, although one could certainly do so. As shown in Table A6, we partition goods into 4 subcomponents and services into 2 subcomponents. Assuming, for example, we have h=2 months of PCE data in quarter *T+1*, our forecast for real PCE goods consumption growth in quarter T+1 is

$$(14)\quad \Delta\log(\widehat{REALPCE}_{T+1}^{\text{Goods}})$$
$$=\sum_{k=1}^{4}\left\{\left(\frac{NOMGOODS_T^k}{\sum_{j=1}^{4}NOMGOODS_T^j}\right)log\left(\frac{realgoods_{T+1,1}^k+\ realgoods_{T+1,2}^k+\ \widehat{realgoods}_{T+1,3}^k}{realgoods_{T,1}^k+realgoods_{T,2}^k+realgoods_{T,3}^k}\right)\right\}$$

Notice that quarter *T* expenditure shares are used as weights in the forecast. Similarly, our forecast for real PCE services growth is

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[24] The monthly series for real service exports and imports are "SplicedServiceExports" and "SplicedServiceImports" shown in Table 4A.

[25] See http://www.bea.gov/national/pdf/chapter5.pdf

[26] Actually, we partition the retail control group into food services and non-food services and separately forecast their PCE analogs using the same technique. This allows us to construct separate "goods" and "services" forecasts of consumption growth.

[27] See table 6 of http://www.bea.gov/national/xls/gap_hist.xls

[28] See ASCPU@USNA and BusShareTrucks in Table A4. Since these series are released with a longer lag than unit auto sales, the latest months data on light auto/truck sales must be combined with the factor model forecasts of these variables.

$$(15)\quad \Delta \log(\widehat{REALPCE}_{T+1}^{\text{Svcs}}) = \sum_{k=1}^{2} \{ \left(\frac{NOMSVCS_T^k}{\sum_{j=1}^{2} NOMSVCS_T^j} \right) log \left(\frac{realsvcs_{T+1,1}^k + realsvcs_{T+1,2}^k + \widehat{realsvcs}_{T+1,3}^k}{realsvcs_{T,1}^k + realsvcs_{T,2}^k + realsvcs_{T,3}^k} \right) \}$$

Step 7: Forecast change in private inventories (CIPI) directly. We use a different approach for forecasting inventory investment. The BEA gives a very detailed description its methodology for estimating inventory stocks and investment in Chapter 7 of the *NIPA Handbook: Concepts and Methods of the U.S. National Income and Product Accounts*[29] (BEA 2014). The key identity is:

$$(16)\quad cipi_{t,h}^{i,BEA} = \Delta invent_{t,h}^{i,BEA-Book} + iva_{t,h}^{i,BEA}$$

This equation says that $cipi_{t,h}^{i,BEA}$ – the change in private inventories for industry *i* (durable goods manufacturers, merchant wholesalers, etc.) in month *h* of quarter *t* – is equal to the change in the book value of inventories for the industry plus an "inventory valuation adjustment". Series on the changes in the book values of inventories are published by both the Census Bureau and the BEA. There are some differences between the Census Bureau and BEA measures because of technical financial accounting reasons. However, the differences are generally very small and have much less of effect on tracking estimates of $CIPI_{t,h}^{i,BEA}$ than revisions to the book value data do. Therefore we will use the approximation:

$$(17)\quad cipi_{t,h}^{i,BEA} \cong \Delta invent_{t,h}^{i,Census-Book} + iva_{t,h}^{i,BEA}$$

Since the Census based book values are released before the BEA book values (and are the primary source data input for them), working with the Census book value obviates the problem of worrying how revisions to the Census book values would impact the BEA revisions. The "inventory valuation adjustment" (IVA) is the negative of the holding gain that occurs when inventory prices increase. The NIPA accounting principle motivating inclusion of this term is that "production should be recorded at the time it occurs", so, hypothetically, if firms neither produced nor sold any goods in a period, but the value of their inventories increased due to a price increase, then GDP should *not* mechanically increase because of the increase in the book value of their inventories.

The BEA provides end-of-quarter nominal inventory stocks by industry in NIPA table 5.7.5B, real inventory stocks in NIPA table 5.7.6B, and implicit deflators in table 5.7.9B. End-of-quarter nominal inventory stocks are related to CIPI by

[29] See http://www.bea.gov/national/pdf/NIPAhandbookch7.pdf

$$(18)\quad NOMINVSTOCK_t^{i,BEA} = NOMINVSTOCK_{t-1}^{i,BEA} + \frac{1}{12}\sum_{h=1}^{3} cipi_{t,h}^{i,BEA}$$

The $\frac{1}{12}$ factor is needed because BEA reports monthly CIPI at annual rates. We use the following partition of total private inventories by industry:

Industry	**Book-value inventory data available from Census Bureau before advance GDP release**	**Monthly inventory data available from BEA**
Durable manufacturing	Yes	Yes
Nondurable manufacturing	Yes	Yes
Merchant wholesale	Yes	Yes
Nonmerchant wholesale	No	Yes
Retail ex autos	Yes	Yes
Retail autos	No[30]	Yes
Farm	No	No
Construction+mining+utilities+other nonfarm	No	No[31]

By construction, the total stock of real inventories is the Fisher chain-weighted aggregate of the industry level real inventory stocks, and the total real private CIPI is the quarterly difference of the real inventory stock [multiplied by 4 to annualize]. We call industries in the above table with U.S. Census Bureau data on the book-value of inventories – durable manufacturing, nondurable manufacturing, merchant wholesalers, and retailers excluding auto dealers – "Census inventory industries". For these industries, we will use (17) to nowcast inventories. For the "non-Census inventory industries", we will not use (17) as there is no quarter *T+1* data on book-values before the advance GDP release.

Using (17) to "nowcast" the inventory contributions to GDP growth for "Census inventory industries" is still challenging because **NO** data on the IVAs for the quarter of interest (*T+1*) is provided until the advance GDP release. BEA (2014) gives a fairly detailed illustration of how they use BLS producer price indexes to estimate inventory valuation adjustments; we mimic their implementation as closely as possible [see e.) below]. Here is a sketch of our strategy for nowcasting inventory investment by industry – in short the method is "forecast IVAs whenever you have Census book-value data, otherwise forecast BEA's change in private inventories directly":

[30] Although the Census Bureau does publish data on retail auto inventories, the BEA does not use this data for the advance GDP estimate. Therefore, we do not use it.

[31] BEA does publish this data in their "underlying detail tables". For the most recent years, BEA simply assumes that monthly inventory changes for these industries within a particular quarter are constant. See NIPA tables 5.6.5BM1 and 5.6.6BM1. This assumption implies the monthly inventory data for these industries are not useful for our purposes.

a.) First estimate a monthly price BVAR and forecast, using Waggoner and Zha (1999) for months where some, but not all, of the data is available. Some of the forecasted prices will be used to deflate nominal values of sales or shipments in the BVAR estimated in step b.). Also, some of the forecasted prices are used in step e.) of the IVA derivation. We use the actual and forecasted values of monthly sales prices for the "Census inventory industries" to construct end-of-quarter *T+1* forecasts for the inventory implicit price deflators for these industries[32].

b.) Estimate a "core quantity" BVAR using 16 monthly series. The series, listed in Table A8a, include industry level data on employment, real sales and industrial production. The BVAR also includes the ISM composite manufacturing index and the inventories subcomponent of the index. The BVAR does **not** include any other inventory variables. The sales variables are deflated by one of the price variables used in a.); combining the real and price forecasts provides a forecast for nominal sales.

c.) Estimate 6 different "block" BVARs using a subset of variables from step b.) in the first block and one other industry inventory variable in the second block. The variables in the first block of each BVAR are also given in Table A8b. For the "Census inventory industries", the inventory variable is the sum of the two terms on right hand side of (17) [Census change in book-value plus BEA IVA] divided [or scaled] by nominal industry level sales lagged by 6-months. For nonmerchant wholesaler and retail automotive inventories, the scaled inventory variable is in Table A8b. By construction, contemporaneous and lagged values in the first block can impact values in the second block while values in the second block cannot effect values in the first [either lagged or contemporaneously]. The dynamics of the variables in the first block are determined using the variables and parameter estimates in the step b.) BVAR. For example, the ISM Manufacturing Index appears in only the durable and nondurable manufacturing inventory blocks. The block structuring ensures that 1.) The ISM Manufacturing Index forecasts [coming from b.)] are the same in both manufacturing block BVARs 2.) The ISM Manufacturing Index values and forecasts directly affect the durable/nondurable manufacturing inventory forecasts but not the other inventory forecasts. The choice of variables for the block BVARs is motivated by the fact that inventory investment has a fairly high correlation with the difference between IP growth and real goods final sales growth. As in step a.), we use the conditional forecasting technique described by Waggoner and Zha (1999) to constrain the forecasts to equal the actual data wherever it is available. We are able to combine the "core quantity" BVAR and all of the block BVARs into one large BVAR by putting 0s in the appropriate places for both the lag coefficient parameters and the error covariance matrix.

d.) For the "Census inventory industries", we use the nominal sales growth forecasts from a.) and b.), and the inventory forecasts [scaled by nominal sales] in c.) to back out a forecast for CIPI on the left hand side of (17). Wherever we have actual Census data on the book value of inventories, we can also use (17) to back out the implied IVA forecast that is consistent with both the CIPI forecast and the book value data. The log likelihood of a particular forecast for

[32] The quarterly inventory implicit price deflators are taken from NIPA table 5.7.9B. The forecasts are derived from the monthly sales price series using a Denton interpolation procedure which interpolates a lower frequency variable with a related higher frequency one.

quarters *T* and *T+1* data, conditional on monthly data through the end of quarter *T-1* [for which there will be no missing data] and the BVAR parameter estimates, is straightforward to calculate[33].

e.) Whenever we get Census book-value data on inventories in "Census inventory industry" *i*, we also use an alternative forecasting model of the IVA using the aforementioned BEA (2014) method of constructing IVAs with BLS PPI prices. The method requires combining "finished+work-in-progress" PPI goods prices with intermediate materials PPI prices. The raw sources we use for both types of prices are in Table A8c. The combined PPI prices need to be converted to "end-of-month prices" and then to "average monthly prices"; again see BEA (2014). All inventories are assumed to be "First in First Out" (FIFO) and the "turnover pattern" – the proportion of inventory stocks that sit on the shelves for exactly x-months[34] – that best fits the data[35] is used. The model implied IVAs do not exactly match the actual IVAs, and the autocorrelation of the "discrepancy errors" is positive. Therefore, we fit an AR(1) to these "discrepancy errors". For any given pattern of industry *i* IVAs beyond the last available month[36], and up until a terminal date for the PPI data [the 3rd month of quarter *T+1* padding with forecasts of the PPIs where necessary from a.)], we can calculate the likelihood of a forecasted path of IVAs using the AR(1) model and a standard likelihood formula for an AR(1)[37].

f.) We then use the log-likelihoods in the IVA/PPI models in e.) and the log-likelihood in the big BVAR in step d.) to estimate the values of the IVAs [for the months where we have Census book-values on inventories] that maximize the sum of the likelihoods. This maximization step assumes that the error terms from d.) are independent from the error terms from e.). [38]

g.) Once we have the most likely IVAs – for the months where we have Census book-values on inventories – we use (17) to back out the implied monthly CIPIs. We then use the large BVAR and the conditional forecasting algorithm from Waggoner and Zha (1999), to get forecasts of the CIPIs for industry-month pairs where we do not have Census book value data on inventories. This means we do not have to worry about forecasting IVAs for the months that we do not have Census book value data. The nominal CIPI forecasts and the forecasts of the associated price deflators are used to back out forecasts of the real inventory stocks. We use the same BVAR to get forecasts of CIPIs for retail auto dealer inventories and non-merchant wholesaler inventories, where no Census book value data is available.

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[33] See, for example Chapter 11 of Hamilton (1994), page 293 11.1.10. If Ω is the covariance matrix of the errors, and $\boldsymbol{e}_t$ are the forecasted residuals in the BVAR, then the conditional log-likelihood we are referring to is $\log\mathrm{L}\left(\boldsymbol{y}_{T,1},\ldots,\boldsymbol{y}_{T,6}\middle|\Omega\right) \propto -\frac{1}{2}\sum_{h=1}^{6}\boldsymbol{e}'_{T,h}\Omega^{-1}\boldsymbol{e}_{T,h}$.

[34] We assume $x \leq 5$.

[35] In terms of minimizing the scaled sum of squared differences between the BEA's reported IVA and the model implied IVA. The scaling factor, which is "average monthly prices", is used so that recent IVAs do not get much larger weights than older IVAs [due to inflation]. The "turnover pattern" weights are restricted to be nonnegative and sum to 1.0.

[36] This will always be the 3rd month of quarter *T*.

[37] See Hamilton 1994 (pages 118-119) for this likelihood.

[38] It also assumes that the error terms from one IVA/PPI model, e.g. durable manufacturing, are independent from the error terms of a different IVA/PPI model, e.g. merchant wholesalers.

h.) For "farm" inventories and "construction+mining+utilities+other nonfarm" inventories, where no monthly data is available, we use an AR(4) with the quarterly series to generate forecasts for end of quarter *T+1*[39].

i.) We aggregate the forecasts of the [real] inventory stocks and their associated price deflators into the total real private inventory stock at the end of quarter *T+1* using the same Fisher chain-weighting of inventory stocks that BEA (2014) uses.

Finally, we generate in-sample forecasts of the real change in private inventories for quarters T, T-1, T-2, … 1983q2, 1983q1 by repeating steps a.) – i.) and maintaining the same BVAR and IVA model parameter estimates. Before the "final" [3rd] estimate of GDP growth in quarter *T*, we replace the BEA's "change in private inventories" with the estimate from the model. We do this because the model can account for revisions to Census data on the book-value of inventories that the BEA has not yet incorporated into their latest GDP estimate for quarter *T*.

We call the change in private inventories from the monthly model $\widehat{CIPI}_t^{MonthlyDataModel}$. The quarterly BVAR in Step 1 gives us the alternative forecast $\widehat{CIPI}_t^{QtrlyBVAR}$. We combine these forecasts by solving for the value of $\delta_{QtrlyBVAR}$ in (19) that minimizes the in-sample sum of squared differences between the predicted contribution of inventories to real GDP growth and the actual contribution of inventories to real GDP.

$$(19) \quad \widehat{CIPI}_t^{CombinedModel} = (1-\delta_{QtrlyBVAR})\widehat{CIPI}_t^{MonthlyDataModel} + \delta_{QtrlyBVAR}\widehat{CIPI}_t^{QtrlyBVAR}$$

The formula for the contribution to percent change is provided in the appendix; for the non-inventory components we use the actual price and quantity components rather than the forecasted values.

Step 8: Calculate real GDP growth with a Fisher chain weighting formula the price and quantity indexes forecasted in the previous steps.

See the appendix. In this step, one has to be careful to enter both goods and services imports into the formula with a minus sign. Also, the implicit price deflator for inventories is end-of-quarter. To convert this price index to a quarterly average, the average of the current end-of-quarter and previous end-of-quarter prices is used.

Section 4: Horse Races:

Before we assess the forecasting performance of our model, we make a digression on the quality of the consensus (average) forecast from *Blue Chip Economic Indicators*. We are interested in answering the question "Which components of GDP are most responsible for forecast errors of GDP growth?". *Blue Chip Economic Indicators* includes forecasts of the following GDP components: 1.) Real PCE

[39] We use a 12-quarter moving average as the forecasts of the implicit price deflators.

Consumption; 2.) Real Net Exports; and 3.) Real Change In Private Inventories. They do not include quarterly forecasts of fixed investment or government expenditures so we will have to treat those components as a residual. Using the formulas derived in the appendix, we can decompose annualized quarterly GDP growth as the sum of the contributions from the various components:

$$(20) REALGDP\%\Delta_t = CONT\%\Delta_{PCE,t} + CONT\%\Delta_{NX,t} + CONT\%\Delta_{CIPI,t} + CONT\%\Delta_{Other,t}$$

Using the fact that the variance of a sum is the sum of the entries of the covariance matrix for the terms in the sum, we can decompose the variance of quarterly GDP growth as in Table 1:

Table 1: Covariance matrix of contributions to percent change in annualized GDP growth: 1998-2013

	PCE	Net Exports	Inventories	"Other"	
PCE spending	2.00	-0.59	-0.15	1.43	
Net Exports	-0.59	0.92	-0.32	-0.61	
Change in private inventories	-0.15	-0.32	2.15	0.28	
"Other"	1.43	-0.61	0.28	2.00	
	PCE	Net Exports	Inventories	"Other"	Total Variance Of GDP Growth
Variance of contribution	2.00	0.92	2.15	2.00	
Sum of cross covariances	0.69	-1.52	-0.19	1.10	
Combined	2.69	-0.60	1.96	3.10	7.15

We see that the variance of the contribution of change in private inventories – 2.15 squared percentage points – is the largest of the four components. For the combined variance and covariance contributions, PCE and "Other" are the two largest contributors. We can do a similar variance decomposition for the *Blue Chip* forecast error of GDP growth if we are willing to make some assumptions about the *Blue Chip* price forecasts. We assume perfect foresight of the component price deflators; although this is obviously unrealistic it should be a relatively innocuous assumption since quarterly price changes have a minor effect on quarterly GDP growth[40]. We decompose the *Blue Chip* forecast errors for GDP growth as

$$(21) REALGDP\%\Delta_t - \widehat{REALGDP}\Delta_t^{BlueChip} = \sum_{i=1}^{4} (CONT\%\Delta_{i,t} - \widehat{CONT}\%\Delta_{i,t}^{\text{BlueChip}})$$

[40] We also have to assume that the forecast of the "other" component – fixed investment + government spending – implied by the *Blue Chip* forecasts of GDP and the remaining 3 components is what the *Blue Chip* panelists would actual use for their forecast of "other". It could be the case that the forecasters are not using a model where the forecast for GDP is consistent with the forecasts for the subcomponents. Backing out the "other" component as a residual may still be useful; in fact the *Blue Chip Econometric Detail* quarterly supplement to *Blue Chip Economic Indicators* is essentially designed for this very purpose.

We use the final *Blue Chip* forecast made about three weeks before the advance GDP release[41]. These forecasts are made after the "first final" GDP estimates for the previous quarter, so we don't have to worry about revisions to the previous quarter's net exports or CIPI estimates. The actual GDP growth rate and contributions in (21) use real-time data from the "advance" GDP release. We do not include advance GDP releases that are part of a benchmark or comprehensive revision to the NIPA since we don't know how much of the revisions to net exports and CIPI the *Blue Chip* forecasters are anticipating. If we square both sides of (21) and average the *N* forecasts across time we can decompose the average squared *Blue Chip* forecast error of GDP growth as[42]:

$$(22)\frac{1}{N}\sum_{t=1998Q1}^{2014Q1}(REALGDP\%\Delta_t - \widehat{REALGD}P\Delta_t^{BlueChip})^2$$
$$=\sum_{i=1}^{4}\{\frac{1}{N}\sum_{t=1998Q1}^{2014Q1}(CONT\%\Delta_{i,t} - \widehat{CONT}\%\Delta_{i,t}^{\text{BlueChip}})^2\}$$
$$+\sum_{i=1}^{4}\{\frac{1}{N}\sum_{t=1998Q1}^{2014Q1}\sum_{j\neq i}[(CONT\%\Delta_{i,t} - \widehat{CONT}\%\Delta_{i,t}^{\text{BlueChip}})(CONT\%\Delta_{j,t}$$
$$- \widehat{CONT}\%\Delta_{j,t}^{\text{BlueChip}})]\}$$

We call each of the first four summands in curly braces on the right hand side of (22) "the average squared forecast error of component i's contribution to GDP growth" and the last four summands in curly braces "the average sum of cross products for contribution *i*". Table 2 has both of these terms for each of the four subcomponents of GDP; it also has the full 4x4 cross product matrix of the average product of the forecast errors[43].

[41] Also, we construct the contributions to percentage change – both for the *Blue Chip* forecasts and for the actuals – using the chain-weighting formulas described in the appendix. This insures that if the component forecasts were all exactly right then the forecasted contributions would match the actual contributions. This wouldn't be the case if we used the BEA's published contributions to percent changes for several technical reasons [e.g. the BEA contributions are calculated using 1000+ components].

[42] Since there are 15 benchmark/comprehensive revision quarters for GDP over the 1998Q1-2014Q1 period, N=46. To simplify notation, we do not adjust the $t = 1998Q1$to $2014Q1$ notation in (22).

[43] The (i,j) entry in this matrix is $\frac{1}{N}\sum_{t=1998Q1}^{2012Q4}(CONT\%\Delta_{i,t} - \widehat{REALGD}P\Delta_{i,t}^{BlueChip})\ (CONT\%\Delta_{j,t} - \widehat{CONT}\Delta_{j,t}^{BlueChip})$

Table 2: Product matrix of average Blue Chip forecast errors for contributions to growth: 1998q1-2014q1

	PCE	Net Exports	CIPI	"Other"
PCE spending	0.40	-0.04	-0.14	-0.02
Net Exports	-0.04	0.72	-0.27	-0.16
Change in private inventories	-0.14	-0.27	0.78	-0.24
"Other"	-0.02	-0.16	-0.24	1.05

	PCE	Net Exports	CIPI	"Other"	MSE Of GDP growth forecast
Average squared forecast error of the contribution to GDP growth	0.40	0.72	0.78	1.05	2.94
Sum of cross products	-0.21	-0.48	-0.66	-0.43	-1.77
Combined	0.19	0.24	0.12	0.62	1.17
				RMSE	1.08

In Table 2, we see that the PCE contribution forecasts are more accurate than the other three components. This is perhaps not surprising since most of the consumption data for the quarter is directly available to the forecasters. However, for both net exports and CIPI, the cross-interactions of the forecast error with the other forecast errors cancel out much of their contribution to the total mean squared forecast error. Laurence Meyer, of Macroeconomic Advisers, noted this cancellation of forecast errors for GDP components in a speech he made while he was a Federal Reserve Governor:

> *My colleague at Washington University, Murray Weidenbaum, has suggested that forecast errors are often offsetting, reflecting the work of a saint who watches over forecasters. Her name is St. Offset. Her work is often observed when a forecaster gets a forecast for GDP in a particular quarter almost perfect, but misses by a wide amount on nearly every component of GDP!*[44]

It appears that "St. Offset" is indeed assisting the *Blue Chip* panelists. It also appears that the "other" component is responsible for much of their GDP forecast error. One should perhaps not read too much into this as "other" could also be picking up the unobserved discrepancy between the panelists GDP forecasts and their forecasts of the components.

As an alternative, we repeat the same exercise with the last Greenbook[45] "nowcast" of the contributions to real GDP growth. One advantage of the Greenbook "nowcasts" is that they contain a much more

[44] Speech available at http://www.federalreserve.gov/boarddocs/speeches/1998/19980108.htm. This reference was originally cited by Payne (2000).
[45] The Federal Reserve's Bluebook and Greenbook were combined into one document now called the Tealbook.

detailed component breakdown of GDP. They also contain the contributions themselves. The sum of the forecasted contributions equals GDP forecast apart from a negligible rounding error[46]. A disadvantage with using the Greenbook forecasts is that they are released with a lag of 5 to 6 years.

We use "advance release" BEA published contributions to change – available since the advance 1999Q3 release – since there is no need to construct the Greenbook contributions. The production date of the last Greenbook was anywhere from 1 day to 44 days before the advance GDP release over the 1999Q3-2008Q3 period. On average it was published 24 days before the release[47]. Table 3 contains the same component breakdown as the *Blue Chip* survey[48]:

Table 3: Product matrix of average Greenbook forecast errors for contributions to real GDP growth: 1999Q3-2008Q3

	PCE	Net Exports	CIPI	"Other"	
PCE spending	0.24	0.00	-0.06	0.08	
Net Exports	0.00	0.24	-0.11	-0.08	
Change in private inventories	-0.06	-0.11	0.32	-0.04	
"Other"	0.08	-0.08	-0.04	0.26	
	PCE	Net Exports	CIPI	"Other"	MSE Of GDP growth forecasts
Average squared forecast error of the contribution to GDP growth	0.24	0.24	0.32	0.26	1.06
Average sum of cross products	0.02	-0.19	-0.21	-0.05	-0.43
Combined	0.26	0.05	0.11	0.22	0.64
				RMSE	0.80

Again, "St. Offset" is reducing the impact of the forecast errors of net exports and CIPI. This is also apparent for a more conventional breakdown of the GDP components shown in Table 4:

[46] The Greenbook forecasts are rounded to the nearest tenth of a percentage point.
[47] The last Blue Chip survey is generally taken a little over 3 weeks before the advance GDP release.
[48] "Other" is calculated as the residual between the GDP nowcast and the sum of the other 3 contributions.

Table 4: Product matrix of average Greenbook forecast errors for contributions to real GDP growth: 1999Q3-2008Q3

	PCE	Structures	Equip+Soft	Residential	CIPI	Net Exports	Govt	Rounding Error
PCE	0.24	0.00	0.03	0.03	-0.06	0.00	0.03	0.00
Structures	0.00	0.03	0.01	0.00	-0.01	-0.01	-0.01	0.00
Equip+Soft	0.03	0.01	0.09	0.00	-0.05	-0.04	0.01	0.00
Residential	0.03	0.00	0.00	0.04	0.02	-0.02	0.00	0.00
CIPI	-0.06	-0.01	-0.05	0.02	0.32	-0.11	0.01	-0.01
Net Exports	0.00	-0.01	-0.04	-0.02	-0.11	0.24	-0.01	0.00
Govt	0.03	-0.01	0.01	0.00	0.01	-0.01	0.08	0.00
Rounding Error	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.01

	PCE	Structures	Equip+Soft	Residential	CIPI	Net Exports	Govt	Rounding Error	MSE Of GDP growth forecasts
Average squared forecast error of the contribution to GDP	0.24	0.03	0.09	0.04	0.32	0.24	0.08	0.01	1.04
Average sum of cross products	0.02	-0.03	-0.04	0.02	-0.21	-0.19	0.03	-0.02	-0.40
Combined	0.26	0.01	0.05	0.06	0.11	0.05	0.11	-0.01	0.63
								RMSE	0.80

We now turn to the horse races. Unfortunately, due to the data intensive nature of the GDPNow model[49], it is not feasible to use real-time data for a long sample. Therefore we conduct what Stock and Watson (2007) call a "pseudo-out-of-sample" forecasting exercising. We implement this as follows:

Algorithm for evaluating root mean square forecast error (RMSFE)

1.) Take a snapshot of all of the data on the day before the advance 2014:Q1 GDP release (April 30, 2014).
2.) For each of the monthly data series, toss out the last h observations of the series that were available through April 29, 2014 [where h is divisible by 3]. For each of the quarterly series, toss out the last h/3 available observations available through April 29, 2014. Use the truncated dataset to estimate the model and forecast GDP growth [for the April 29, 2014 vintage of data] for the quarter that was h/3 quarters before 2014:Q1. This is essentially the forecasting exercise that Giannone, Reichlin, and Small (2008) use[50].

Repeating step 2.) for h = 3, 6, … , 165, 168 generates out of sample forecasts for 2000:Q1 – 2013:Q4. Some of the alternative benchmark models "cheat" to give them an advantage over the GDPNow model. The models are:

1.) **Rolling-window AR(2)**: The model is

$$(22)\Delta\log(RealGDP_t) = \alpha_0 + \alpha_1\Delta\log(RealGDP_{t-1}) + \alpha_2\Delta\log(RealGDP_{t-2}) + u_t$$

At each time t0, (22) is estimated with OLS by using the last h* observations of $\Delta\log(RealGDP_t)$ through t0 $[\Delta\log(RealGDP_{t0-\mathrm{h}*+1}), \Delta\log(RealGDP_{t0-\mathrm{h}*+2}), \dots, \Delta\log(RealGDP_{t0})]$ and the forecast for $\Delta\log(RealGDP_{t0+1})$ is made. h* = 108 quarters is chosen to minimize the out-of-sample root mean square forecast error (RMSFE) for 2000:Q1 – 2013:Q4. Obviously, a forecaster would not know h* a priori. The rolling AR(2) performed slightly better than the AR(1) or AR(4).

2.) **Rolling-window factor augmented AR(2):** Let $f_{t,m}^{CFNAI}$ denote the Chicago Fed National Activity Index (CFNAI) in month *m* of quarter *t*. Since $f_{t,m}^{CFNAI}$ is analogous to a 1-month (log) growth rate, we relate it to quarterly GDP growth using the following moving average:

$$(23)F_t^{CFNAI} = \frac{1}{9}[f_{t,3}^{CFNAI} + 2f_{t,2}^{CFNAI} + 3f_{t,1}^{CFNAI} + 2f_{t-1,3}^{CFNAI} + f_{t-1,2}^{CFNAI}]$$

[49] We use well over 200 different time series.

[50] Like these authors, we are using what they call a "stylized calendar" where one pretends that the timing of the data releases is always the same. Of course, the staggering of the data releases does in fact change slightly from quarter to quarter. Like these authors, we are ignoring this in our exercise.

Equation (23) approximately transforms the CFNAI into a quarterly growth rate; Koenig (2002) uses this same weighted average of the ISM manufacturing index to nowcast GDP growth. The forecasting equation is:

$$(24)\Delta\log(RealGDP_t) = \alpha_0 + \alpha_1\Delta\log(RealGDP_{t-1}) + \alpha_2\Delta\log(RealGDP_{t-2}) + \alpha_3 F_t^{CFNAI} + \alpha_4 F_{t-1}^{CFNAI} + u_t$$

As before, rolling-window regressions of length h*quarters are used to forecast GDP growth, where h*=68 quarters is chosen to minimize the RMSFE. The model "cheats" by not choosing h* a priori. It also "cheats" because the forecaster would not see $f_{t,3}^{CFNAI}$ in real-time[51] and because the CFNAI is estimated using the entire data set. Alternative lag-lengths of the CFNAI and GDP growth had slightly higher RMSFEs.

3.) **Mixed Frequency BVAR**: This model, adapted from Schorfheide and Song (2013), is described in the appendix. We use a 7-lag monthly BVAR with the following 7 variables: real consumption, nonfarm payroll employment, industrial production, the ISM Manufacturing Index, housing starts growth multiplied by residential investment's share of GDP, real capital goods shipments, and real GDP. As in Schorfheide and Song (2013), real GDP is a latent monthly variable estimated by the Kalman smoother. Rather than use the Monte Carlo Markov Chain (MCMC) algorithm developed by Schorfheide and Song (2013), we use the Expectation-maximization (EM) algorithm. In quarter *t*, we assume that we have all 3 months of data for the non-latent variables except real PCE. For real PCE, we need to forecast data for the third month of quarter t as that data point would not be available until after the "advance" GDP release.

4.) **Quarterly BVAR**: We use the same 5-lag quarterly BVAR with the quantity components of GDP that we used in step 1 as well as the same 5-lag quarterly BVAR with the implicit deflators. The growth forecasted is then computed using the chain-weighting formula A3 in the appendix.

5.) **Tracking model – monthly series only**: In the GDPNow model, each of the non-consumption component forecasts is a weighted average of the monthly indicator based forecast and the quarterly BVAR forecast. Here we set the weight on the BVAR forecasts to 0.

6.) **Full tracking model (GDPNow):** This is the Atlanta Fed GDPNow model.

[51] This is not entirely accurate because $f_{t,3}^{CFNAI}$ is released before the advance estimate of $RealGDP_t$. However, about a third of the monthly series used to compute $f_{t,3}^{CFNAI}$ are missing at the time of the release, so projected values are used in their place. See Federal Reserve Bank of Chicago (2013).

In Table 5 below, RMSFEs are calculated using annualized percent changes, not log-differences[52], since users are typically interested in the former. The Diebold-Mariano (1995) test statistics use the log-difference based forecast errors.

Table 5: Out of sample forecast performance on day before advance GDP release: 2000Q1 - 2013Q4

	RMSFE	Diebold Mariano Test Statistic For Forecasts Compared To Model 5.)	p-value
1.) Rolling AR(2)*	2.43	2.59	0.0095
2.) Rolling Factor Augmented AR(2)*	1.95	3.45	0.0006
3.) Mixed Frequency BVAR*	1.73	3.40	0.0007
4.) Quarterly BVAR*	2.28	2.65	0.0079
5.) Tracking model: Monthly version	1.22	0.68	0.4952
6.) GDPNow model	1.15		

*Accuracy of forecast is different from Model 6.) at 1% signficance level

We see that the full tracking model – GDPNow – has the lowest RMSFE and is significantly better than the first four models at the 1% significance level. Since the last 3 model forecasts are built up from component level forecasts, we can trace the source of the forecast errors in Tables 6a – 6c as we did with the Blue Chip and Greenbook forecasts:

[52] I.e we compute the mean-squared error of $100(\exp(\Delta\log(RealGDP_t))^4 - \exp(\Delta\log(\widehat{RealGDP_t}))^4)$.

Table 6a: Decomposition of MSFE of GDP forecast of Quarterly BVAR from forecast errors of component contributions to GDP growth: 2000-2013

	PCE	Equipment	IPP	Structures	Residential	Govt	CIPI	Net Exports	MSE Of GDP forecasts
Average squared forecast error of the contribution to GDP growth	1.26	0.36	0.03	0.13	0.24	0.39	1.05	0.86	4.31
Average sum of cross products	0.38	0.52	0.12	0.04	0.17	-0.22	-0.10	-0.01	0.89
Combined	1.63	0.88	0.15	0.16	0.41	0.17	0.95	0.85	5.20
RMSFE of contribution	1.12	0.60	0.16	0.36	0.49	0.62	1.02	0.93	
								RMSFE	2.28

Table 6b: Decomposition of MSFE of GDP forecast of Monthly Model from forecast errors of component contributions to GDP growth: 2000-2013

	PCE	Equipment	IPP	Structures	Residential	Govt	CIPI	Net Exports	MSE Of GDP forecasts
Average squared forecast error of the contribution to GDP growth	0.06	0.09	0.03	0.03	0.01	0.22	0.59	0.28	1.32
Average sum of cross products	0.00	0.00	-0.02	0.01	0.04	0.11	0.05	-0.04	0.16
Combined	0.06	0.09	0.01	0.04	0.05	0.33	0.65	0.25	1.48
RMSFE of contribution	0.25	0.29	0.17	0.16	0.12	0.47	0.77	0.53	
								RMSFE	1.22

Table 6c: Decomposition of MSFE of GDP forecast of *GDPNow* Model from forecast errors of component contributions to GDP growth: 2000-2013

	PCE	Equipment	IPP	Structures	Residential	Govt	CIPI	Net Exports	MSE Of GDP forecasts
Average squared forecast error of the contribution to GDP growth	0.06	0.12	0.03	0.03	0.01	0.23	0.51	0.30	1.28
Average sum of cross products	-0.01	0.00	0.00	0.01	0.04	0.07	0.02	-0.08	0.03
Combined	0.05	0.11	0.02	0.03	0.06	0.30	0.53	0.21	1.32
RMSFE of contribution	0.25	0.34	0.16	0.16	0.12	0.48	0.71	0.55	
								RMSFE	1.15

We see that the RMSFEs from Tables 6a – 6c do in fact match the RMSFEs from Table 5. The other conclusions we make from Tables 6a – 6c are:

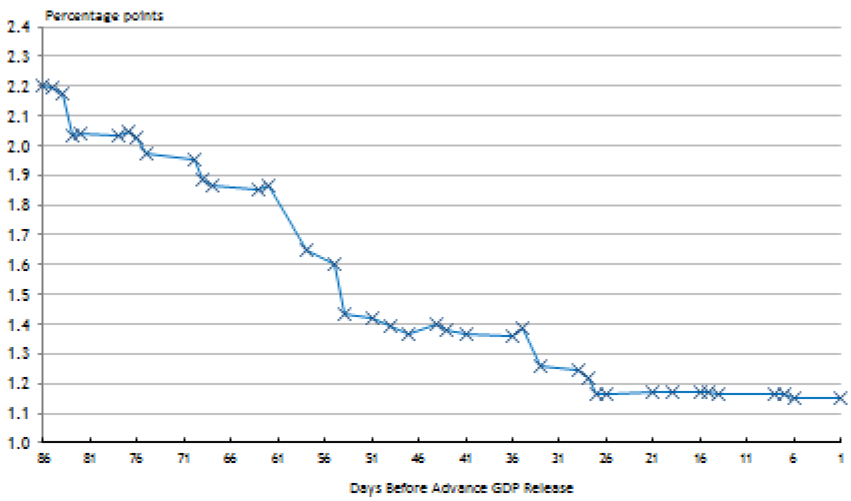
1.) The tracking model forecasts of the components are superior to the quarterly BVAR forecasts for all of the components except "Intellectual Property Products" investment (IPP).
2.) Most of the improvement from the monthly data only tracking model to the full GDPNow model comes from the change in private inventories component.
3.) Comparing Table 6c.) and Table 4.), we see that the tracking model forecasts of CIPI and government spending are inferior to the Greenbook forecasts of these components [in spite of the tracking model's informational advantage].
4.) Unfortunately, "St. Offset" does **not** help the tracking model forecasts as much as it does with the *Greenbook* and *Blue Chip* forecasts.

Conclusion 3.) is perhaps not surprising given the framework of our model in which one component of GDP is forecasted somewhat independently from another. As we saw in Table 1, when net exports has a below average contribution to GDP growth, this tends to be more than offset by positive contributions in the other components. A more unified modeling approach would perhaps be able to better capture the relationships between the components. For example, past Greenbooks have cited the Federal Reserve Board staff's "flow-of-goods" system used to keep track of inventory movements[53]. We leave these improvements to the model to further research.

Finally, we test if our tracking model's forecast accuracy improves as we get closer to the advance GDP release date. We do this by replacing April 29, 2014 in the "Algorithm for testing RMSFE" with the date that was *k* days before the 2014:Q1 release (on April 30, 2014). We take a snapshot of the data on this date and repeat the steps of the algorithm. Since 2014:Q1 growth was revised several times in the second quarter of 2014, we restrict the out-of-sample period to 2000:Q1 – 2013:Q4. The evolution of the RMSFE for 40 different snapshot dates is shown in the picture below.

[53] See, e.g., http://www.federalreserve.gov/monetarypolicy/files/FOMC20071031gbpt220071024.pdf

Root Mean Square Forecast Error of GDP Growth (SAAR) For *GDPNow* Model: 2000:Q1 – 2013:Q4



Interestingly, the nowcasts stop improving about four weeks before the advance GDP release. This forecast exercise does not use real time data, and it may be the case that the short-run nowcasts improve as they incorporate data revisions. Even 85 days before the advance GDP release, the forecasts are slightly more accurate than the BVAR and AR(2) forecasts shown in Table 5.

We have been regularly updating our GDPNow model since the second half of 2011 thereby establishing a short track record which we reproduce in Table 7 below.

Table 7: Real-time forecasting performance of GDPNow Model			
Quarter being forecasted	BEA's Advance Estimate (SAAR)	GDPNow Forecast Right Before BEA's Advance Estimate	Blue Chip Consensus Forecast 3 weeks before BEA's advance estimate
2011q3	2.5	3.2	1.9
2011q4	2.8	5.2	3.1
2012q1	2.2	3.0	2.2
2012q2	1.5	0.2	1.8
2012q3	2.0	1.8	1.7
2012q4	-0.1	0.1	1.4
2013q1	2.5	2.9	2.9
2013q2	1.7	1.3	1.7
2013q3	2.8	2.2	2.0
2013q4	3.2	3.1	2.4
2014q1	0.1	0.3	1.7
	Average absolute error	0.68	0.62
	Root-mean squared error	0.94	0.81

We see that over its short history, the GDPNow model has been slightly less accurate than the consensus forecast from *Blue Chip Economic Indicators* in spite of its informational advantage. Improvements have been made in the GDPNow model over time[54] and, since 2011, the GDPNow forecasts have been slightly more accurate than the *Blue Chip* consensus. We certainly don't want to read too much into this (yet!).

Section 5: Conclusions and extensions

It will be difficult to compare the GDPNow model 's performance to "professional" or "expert" forecasts until we establish a longer track record with real-time data. Nevertheless, it is probably safe to say that the GDPNow model forecasts are not as accurate as the best judgmental forecasts. The GDPNow model can still be useful since as it can be updated after virtually every major macroeconomic data release. Apart from improving the forecast performance of the GDPNow model, there are a number of possible extensions of this work. One would be cataloging with real-time data which releases are responsible for the largest increases in forecast accuracy. Giannone, Reichlin and Small (2008) found that the *Business Outlook Survey* release from the Federal Reserve Bank of Philadelphia led to a larger predictive improvement than many of the other releases. Since data from this survey are not used to

[54] The *GDPNow* forecasts in Table 7 were made in real-time. Subsequent improvements to the model have not been used to rerun past forecasts using updated versions of the model with real-time vintages of the data.

construct GDP, the Philly Fed Survey may be less important for our model. A second extension would be to exploit higher frequency – weekly or daily – data. For instance, Andreou, Ghysles and Kourtellos (2013) used mixed data sampling (MIDAS) regressions to nowcast GDP growth with daily financial data. This approach might be particularly useful around business cycle turning points. A third extension would be to adapt the model to backcast revisions to GDP growth. Following certain key data releases of GDP source data, business economists often make projections of how they expect the BEA to revise the most recent GDP estimate in lieu of the new information. However, the academic literature has not addressed this topic using a "bottom-up" approach. The topic could be particularly relevant for Federal Reserve policymakers who make projections of fourth quarter over fourth quarter real GDP growth rates that, for the current year, are impacted by BEA revisions. A fourth extension would be incorporating the model's forecasts into a DSGE model. Del Negro and Schorfheide (2012) provide evidence that conditioning Smets-Wouters (2007) DSGE forecasts on external *Blue Chip Economic Indicators* forecasts improves the short-run DSGE forecasts. Since *Blue Chip Economic Indicators* does not include a quarterly forecast for investment[55], it would be interesting to see if incorporating it further improved the DSGE forecasts. Finally, the model could be extended to "nowcast" the GDP Deflator or other price deflators like the PCE price index. The Federal Reserve Bank of Cleveland has done recent work on this topic that they've made available to the public on their "Inflation Nowcasting" webpage[56].

[55] Many DSGE models exclude consumer durables from consumption, such as the Federal Reserve Bank of Philadelphia's PRISM model: http://www.phil.frb.org/research-and-data/real-time-center/PRISM/ It would be fairly straightforward to decompose goods as "durables" and "nondurables" inside our model.

[56] Knotek II and Zaman (2014) have developed their own model for nowcasting inflation that performs as well or better than expert forecasters. Daily updates of the model are available at http://www.clevelandfed.org/research/data/us-inflation/nowcasting/.

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Appendix: Implementing the BVARs:

We use the BVAR formulas described in Banbura, Giannone, and Reichlin (2008). This involves augmenting the data of an ordinary BVAR with so-called "dummy observations". The hyperparameters used to construct the dummy observations are described in Banbura, Giannone, and Reichlin (2008) as well. Briefly, each variable in the BVAR is associated with a parameter δ_i that reflects the prior belief that the variable is either a random walk or displays mean reversion. For variables entered in the BVARs in log-levels, the random walk prior is used and $\delta_i = 1$. For variables entered in the BVARs in levels, first differences, or log differences, the mean reversion prior is used and $\delta_i = 0$ is used. The hyperparameter λ controls the overall tightness of the prior; setting $\lambda = 0$ means the data are ignored and the estimation only uses prior information. Setting $\lambda = \infty$ means prior information is not used at all and the BVAR is simply a VAR estimated by OLS. For $0 < \lambda < \infty$, small values of λ put a heavy weight on the prior information and large values of λ put little weight on the prior information. We follow Banbura, Giannone, and Reichlin (2008) in choosing λ so that the one step ahead forecast RMSE for three key variables in the BVAR is roughly the same as it would be with a 3-variable VAR with three key variables only. This keeps the BVAR from "overfitting" the data resulting in poor forecasts. The values of λ for the different BVARs are: GDP quantity component BVAR, $\lambda = 0.15$; GDP price component BVAR, $\lambda = 0.12$; monthly price inflation BVAR, $\lambda = 0.05$; core-quantity inventory BVAR, $\lambda = 0.07$. Finally for the all but the monthly price inflation BVAR, where the data are not entered in (log) levels, we include the prior on the sum of coefficients setting $\tau = 10\lambda$ as in Banbura, Giannone, and Reichlin (2008).

For the 7-lag mixed frequency BVAR (MF-BVAR) used in the horse races, logarithms of all of the variables are used except the ISM Manufacturing Index and housing starts growth multiplied by (the lag of) residential investment's share of GDP. Logged variables use the random walk prior $\delta_i = 1$; the other two variables use the mean reversion prior $\delta_i = 0$. The overall tightness prior $\lambda = 0.10$ was used since it was found to have the best forecasting performance among the values 0.05, 0.10, 0.15, 0.20, and 0.25. The implementation of the EM algorithm for estimating the MF-BVAR is fairly straightforward.

Step 1.) Splice together Macroadvisers' estimate of monthly real GDP starting in April 1992 with Stock and Watson's estimate of month real GDP starting in January 1959. Interpolate log quarterly real GDP with the log of the spliced monthly series[57] and use this series to initialize the estimate of monthly real GDP.

Step 2.) Estimate the BVAR with the six available monthly series and the estimate of (log) monthly real GDP.

Step 3.) Using the coefficient and error covariance matrix estimates from Step 2.), cast the BVAR into state space form. The observer equation includes the actual monthly series and (log) quarterly real GDP which is missing except for the third month of each quarter. The latent (log) monthly real GDP series is related to the observed quarterly series by:

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[57] The interpolation is done so that the average value of (log) monthly real GDP is equal to the published value of (log) real GDP.

$$(A0)\ \log(GDP_t^Q) = \log(GDP_{t,1}^M) + \log(GDP_{t,2}^M) + \log(GDP_{t,3}^M)$$

Equation (A0) uses the same log-linear approximation to an arithmetic average used by Schorfheide and Song (2013). The latent monthly series $\log(GDP_{t,h}^M)$ is estimated with the Kalman filter and smoother. In the final quarter *T*, $\log(GDP_T^Q)$ is missing. All of the other monthly series are available in quarter *T* except $\log(RealPCE_{T,3})$.

Step 4.) Repeat step 2 after replacing the previously estimated values of $\log(GDP_{t,h}^M)$ with their current estimate from the Kalman smoother. Repeat steps 2.) and 3.) until the time series $\log(GDP_{t,h}^M)$ converges. Annualized quarter *T* real GDP (logarithmic) growth is taken as $400\sum_{h=1}^{3}(\log(GDP_{T,h}^M) - \log(GDP_{T-1,h}^M))$.

Constructing price deflator for monthly private nonresidential construction spending

The Census Bureau's *Value of Construction Put in Place Survey* release includes nominal private nonresidential spending on structures [CPVD@USECON in Haver]. The series currently accounts for about 70% of nonresidential structures investment[58].

Table 6.A in BEA (2014) provides the detailed monthly price series – primarily PPIs – used to construct price deflators for the subcomponents of nonresidential structures investment. Table A9 has our mapping of the monthly source data to the structures deflators. There are a number of issues with the data.

1.) **PPIs are often only available starting in mid-2000s.** We "backcast" the PPIs before their start date using the associated investment price deflator interpolated to a monthly frequency[59]. For example, PPI for warehouses [R236221@PPIR] starts in December 2004. This series is used to construct the "multimerchandise shopping" structures deflator [JFNSSM@USNA]. For the "multimerchandise shopping" subcomponent, we backcast R236221@PPIR with the interpolated JFNSSM@USNA.
2.) **Source data is unavailable and/or quarterly.** E.g. Communication structures, which are constructed using the proprietary McGraw-Hill *Engineering News Record* construction cost index. For these series which do not have a monthly analog, we create one by using a modified Atkeson-Ohanian (2001) forecast[60]. The Atkeson-Ohanian [AO] forecast is simply the most recent 4-quarter inflation rate. For each month *h* in quarter *t*, we use the quarter *t-1* over quarter *t-5* inflation rate for the price deflator as the forecast for the annualized monthly rate of inflation in month *h*. We do not interpolate the quarterly series with Denton or Chow-Lin interpolation since we only want to use data that a forecaster would have available to her. We

[58] Petroleum and natural gas wells and mining investment have other source data.
[59] First difference proportional Denton interpolation of the quarterly series with a monthly series of constant ones is used.
[60] A number of papers have shown this can be a tough benchmark to beat.

call the interpolation method "Atkeson-Ohanian interpolation" and use it for a number of series in the model.

3.) **Some components use more than one series as source data.** For example "health care" uses an average of the Census Bureau price index for new-one family homes and the Turner Construction Cost Index[61]. In cases like this we split the subcomponent in half assigning the two price indexes to the halves.

The log change in the price index for monthly nonresidential construction spending [value-put-in-place] in month *h* of quarter *t* is constructed as:

$$(A1)\quad \Delta \log(pricevpip_{t,h}) = \sum_{j=1}^{25} SH_{t-1}^{\mathrm{j}} \Delta \log(monthlyprice_{t,h}^{\mathrm{j}})$$

where SH_{t-1}^{j} is the expenditure share of the nonresidential structures component *j* in quarter *t-1*[62], and $monthlyprice_{t,h}^{\mathrm{j}}$ is the associated monthly price deflator [often a PPI].

Algorithm for updating new housing value-put-place spending with housing starts data

Although value put-in-place (VPIP) C30 construction spending data are the source data for BEA's advance estimate of permanent site residential investment, the C30 data on residential construction VPIP is based largely on housing starts data and average sales price data from the new home sales data release. Since these series are released one to two weeks prior to C30, we can largely anticipate the VPIP data once the housing starts and new home sales data are released[63]. Census Bureau (2013) describes how housing starts and sales price data are mapped into VPIP; we largely follow their procedure. In short, if we have data on single-family starts and average sales prices through month *h* of quarter T+1 while we only have VPIP through month *h-1*, we forecast single-family VPIP for month *h* as

$$(A2)\quad \widehat{vpip}_{T+1,h} = \sum_{k=0}^{11} \alpha_k (starts_{T+1,h-k}^{\text{single-fam}})(avgsalesprice_{T+1,h-k}^{\text{single-fam}})$$

where $\alpha_0, \alpha_1, \dots, \alpha_{11}$ are constants from Table 1 of Census Bureau (2013)[64]. If $starts_{T+1,h}^{\text{single-fam}}$ is available but $avgsalesprice_{T+1,h}^{\text{single-fam}}$ is not, we use a forecast $\widehat{avgsalesprice}_{T+1,h}^{\text{single-fam}}$ in (A2) that

[61] Avaliable here: http://www.turnerconstruction.com/cost-index. Since this price index is quarterly and not available in Haver Analytics we do not utilize it.
[62] Available in NIPA table 5.4.5U.
[63] We also use revisions to housing starts to anticipate revisions to value-put-in-place.
[64] The α_k terms actually depend on what calendar month *h* is in; in the program we incorporate this feature.

comes from the monthly price BVAR. Multi-family VPIP are built up from multi-family starts by Census using a more complicated scheme; therefore we use a simple two variable BVAR with multi-family starts and multi-family VPIP to forecast the latter in month *h* when starts are available for this month but VPIP is not.

Chain weighting formulas

Fisher Chain-Weighting: This is directly from BEA (2014) and Whelan (2000).

$$(A3)\ REALGDP\%\Delta_t = \sqrt{\frac{\sum_{i=1}^{13} Q_t^{\mathrm{i}} P_{t-1}^{\mathrm{i}}}{\sum_{i=1}^{13} Q_{t-1}^{\mathrm{i}} P_{t-1}^{\mathrm{i}}} \frac{\sum_{i=1}^{13} Q_t^{\mathrm{i}} P_t^{\mathrm{i}}}{\sum_{i=1}^{13} Q_{t-1}^{\mathrm{i}} P_t^{\mathrm{i}}}} - 1$$

P_t^{i} is the price of component i in period t; and Q_t^{i} is the quantity of component i[65] in period t. This growth rate isn't annualized but can easily made so. The negatives of real services imports and real goods imports must be entered into (A3). Also, we use implicit prices for the price components. The formula for GDP deflator inflation rate is exactly the same as (A3) except the P's and Q's get switched.

Contributions to percentage change: We use the formula for constructing the contributions to percent change of the components in BEA (2014) and Whelan (2000)[66]. That formula is for the contributions to the percent change at a quarterly rate, not an annual rate. In NIPA table 1.1.2, BEA reports the contribution to the annualized percent change in Real GDP. We modify the BEA (2012) and Whelan (2000) formula to an annualized contribution by using a multinomial expansion.

$$(A4)\ \ 1 + REALGDP\%\Delta_t = 1 + \sum_{i=1}^{13} CONT\%\Delta_{i,t}$$

$(A4)$ is real GDP growth as the sum of its contributions [not annualized], so it follows that

[65] We are using 13 subcomponents, obviously the number terms in the summands in A3 will change for a different number of subcomponents.

[66] The formula from BEA (2014) for the contribution to percent change is

$$CONT\%\Delta_{i,t} = \frac{\left(\frac{P_t^{\mathrm{i}}}{P_t^F} + P_{t-1}^{\mathrm{i}}\right)\left(Q_t^{\mathrm{i}} - Q_{t-1}^{\mathrm{i}}\right)}{\sum_{j=1}^{N}\left(\frac{P_t^{\mathrm{j}}}{P_t^F} + P_{t-1}^{\mathrm{j}}\right) Q_{t-1}^{\mathrm{j}}}$$

where P_t^F is the Fisher price index for the aggregate in period t relative to period t-1[the gross inflation rate].

$$(A5)\ (1 + REALGDP\%\Delta_t)^4 = (1 + \sum_{i=1}^{13} CONT\%\Delta_t^{\mathrm{i}})^4$$

$$= 1 + 4\sum_{i=1}^{13} CONT\%\Delta_t^{\mathrm{i}} + 6\sum_{i=1}^{13}\sum_{j=1}^{13} CONT\%\Delta_t^{\mathrm{i}}\, CONT\%\Delta_t^{j}$$

$$+ 4\sum_{i=1}^{13}\sum_{j=1}^{13}\sum_{k=1}^{13} CONT\%\Delta_t^{\mathrm{i}} CONT\%\Delta_t^{j}\, CONT\%\Delta_t^{k}$$

$$+ \sum_{i=1}^{13}\sum_{j=1}^{13}\sum_{k=1}^{13}\sum_{l=1}^{13} CONT\%\Delta_t^{\mathrm{i}} CONT\%\Delta_t^{j} CONT\%\Delta_t^{k} CONT\%\Delta_t^{l}$$

We divide the two-way interactions between components *i* and *j* evenly and, similarly, divide the 3-way interactions by 3 and the 4-way interactions by 4.

Fisher subtraction: This is needed when we have chain-weighted data for an aggregate and one or more subcomponents, but not for the aggregate excluding the subcomponents. For example, there is no series for "real nonresidential structures investment excluding mining exploration, shafts, and wells"[67]. For series like these we need to use "Fisher subtraction". We implement this using formula 5.16 from Liu, Hamalainen, and Wong (2003).

[67] Both the aggregate and the subcomponent are in NIPA Table 5.4.6.

Table A1: Variables used in quarterly GDP component BVAR

CTGZ@USNA	Personal Consumption Expenditures: Goods (SAAR, Mil.Chn.2009.$)	LogLevel
CSZ@USNA	Personal Consumption Expenditures: Services (SAAR, Mil.Chn.2009.$)	LogLevel
FNEZ@USNA	Real Private Nonresidential Investment: Equipment (SAAR, Mil.Chn.2009$)	LogLevel
FNPZ@USNA	Real Private Nonresidential Investment: Intellectual Propert Products (SAAR, Mil.Chn.2009$)	LogLevel
FNSZ@USNA	Real Private Nonresidential Investment: Structures (SAAR, Mil.Chn.2009$)	LogLevel
FRZ@USNA	Real Private Residential Investment (SAAR, Mil.Chn.2009$)	LogLevel
XMZ@USNA	Real Exports of Goods (SAAR, Mil.Chn.2009$)	LogLevel
XSZ@USNA	Real Exports of Services (SAAR, Mil.Chn.2009$)	LogLevel
MMZ@USNA	Real Imports of Goods (SAAR, Mil.Chn.2009$)	LogLevel
MSZ@USNA	Real Imports of Services (SAAR, Mil.Chn.2009$)	LogLevel
GFZ@USNA	Real Federal Government Consumption & Gross Investment (SAAR, Mil.Chn.2009$)	LogLevel
GSZ@USNA	Real State & Local Govt Consumption & Gross Investment (SAAR, Mil.Chn.2009$)	LogLevel
VZtoGDP	"VZ@USNA" Real Change in Private Inventories (SAAR, Mil.Chn.2009$) divided by the one period lag of "Real Gross Domestic Product (SAAR, Mil.Chn.2009$)" [GDPZ@USNA].	Level

Note: All of these components are available from NIPA table 1.5.6.

Table A2: Variables used in monthly price BVAR

Variable Name	Variable Descrption	Transformation
PCU@USECON	CPI-U: All Items (SA, 1982-84=100)	LogDiff
PCUSLFE@USECON	CPI-U: All Items Less Food and Energy (SA, 1982-84=100)	LogDiff
PCUSND@USECON	CPI-U: Nondurables (SA, 1982-84=100)	LogDiff
PCUSSLE@USECON	CPI-U: Services Less Energy Services (SA, 1982-84=100)	LogDiff
UH@CPIDATA	CPI-U: Housing (SA, 1982-84=100)	LogDiff
SP2620@PPI	PPI: Nonmanufacturing Industries (SA, 1982=100)	LogDiff
SP3000@USECON	PPI: Finished Goods (SA, 1982=100)	LogDiff
SP2900@PPI	PPI: Intermediate Materials Less Food and Energy (SA, 1982=100)	LogDiff
sa(RMFG@PPIR)	PPI: Manufacturing (Dec-84=100) - Seasonal Adjustment, All	LogDiff
PZALL@USECON	KR-CRB Spot Commodity Price Index: All Commodities (1967=100)	LogDiff
PZTEXP@USECON	Spot Oil Price: West Texas Intermediate [Prior'82=Posted Price] ($/Barrel)	LogDiff
NAPMPI@USECON	ISM: Mfg: Prices Index (NSA, 50+ = Econ Expand)	Lev
SpliceRetailTradeDeflator	Sales Price Deflator: Retail Trade (SA, 2005=100) "DTSR@USNA", spliced together with SIC based equivalent DTSR1@USNA before 1997.	LogDiff
SpliceWholesaleTradeDeflator	Sales Price Deflator: Merchant Wholesale Trade Industries (SA, 2005=100) "DTSWM@USNA", spliced together with SIC based equivalent DTSW1@USNA before 1997.	LogDiff
SpliceManTradeDeflator	Sales Price Deflator: Manufacturing Industries (SA, 2005=100), "DTSM@USNA" spliced together with SIC based equivalent "DTSM1@USNA" before 1997.	LogDiff
SplicedMedian	FRB Cleveland Median CPI (SAAR, %chg) "CLEVFED@USECON" spliced together with discontinued median before 1983 CLEVM@USECON.	LogDiff
SplicedTrim	FRB Cleveland 16% Trimmed-Mean CPI (SAAR, %chg) "CLEVCPI@USECON" spliced together with discontinued trim before 1983 CLEVT@USECON.	LogDiff
GOODSIMPORTPRICEsplice	Log difference is weighted average of log differences of detailed import price indexes from BLS. The weights are the previous quarter's import shares of these detailed components from NIPA Table 4.2.5. See text for a more detailed description.	LogDiff

PXEA_USECONsplice	Where available use PXEA@USECON "Export Price Index: All Imports (NSA, 2000=100) ". However from 1982-1988 the index is not available each month and therefore it is interpolated with a combination of the quarterly Export price index in the NIPA accounts and the PPI for finished goods [SP3000@PPI]. Uses proportional Denton method for interpolation.	LogDiff
ImpSvcDefmthA1	Constructed deflator for services imports. Constructed by regressing quarterly log change in NIPA services imports implicit price deflator on 3 terms. 1.) GOODSIMPORTPRICEsplice. 2.) The previous quarter's 4-quarter log change in this same implicit price deflator. 3.) A constant.	LogDiff
ExpSvcDefmthA1	Constructed deflator for services exports. Constructed by regressing quarterly log change in NIPA services exports implicit price deflator on 3 terms. 1.) PXEA_USECONsplice 2.) The previous quarter's 4-quarter log change in this same implicit price deflator. 3.) A constant.	LogDiff
CoreRealRetailPCEDefExFoodSvc	This is a constructed Fisher price index of the PCE components that have counterparts in the "retail sales control" ex food services group. The Haver tickers for nominal expenditure categories are [CDMTM@USNA CDFDM@USNA CDOM@USNA CDRGM@USNA CSFPM@USNA CNLM@USNA CNOOM@USNA] and the tickers for the real expenditure categories are [CDMTHM@USNA CDFDHM@USNA CDOHM@USNA CDRGHM@USNA CSFPHM@USNA CNLHM@USNA CNOOHM@USNA]. Prices are defined implicitly. When the Consumer Price Index release comes out, the index is updated by linking the detailed "retail control" PCE price components to their counterparts in the CPI. See Table A7.	LogDiff
HerzonServicesExFoodDef	Constructed Fisher price index for nonfood services	LogDiff
CSFPMDef	Implicit PCE price deflator for food services	LogDiff
CDMVUMDef	Implicit PCE price deflator for net purchases of used motor vehicles	LogDiff
CDMVNMDef	Implicit price deflator for Personal Consumption Expenditures: New Motor Vehicles	LogDiff
CNEMDef	Implicit price deflator for Personal Consumption Expenditures: Gasoline and Other Energy Goods	LogDiff

TornPriceNonResStrMth	Constructed deflator for private nonresidential construction put-in-place. See appendix for description.	LogDiff
CCIHD@USECON	Houses under Construction: Price Deflator (NSA, 2005=100)	LogDiff
ESComputerDefqtrInterpSplice	Quarterly investment price deflator for computers interpolated/extrapolated to a monthly frequency using combination of "PPI: Electronic Computers and Computer Equipment (NSA, Dec-98=100) - Seasonal Adjustment, All" [sa(P115@PPI)] and "PCE: Personal Computers & Peripheral Equip Price Index (SA, 2005=100)" [JCDFCPM@USNA]. Uses proportional Denton method for interpolation.	LogDiff
SP3200@PPI	PPI: Capital Equipment (SA, 1982=100)	LogDiff
R5312101_PPIRInterp	PPI: Real Estate Agts, Nonresid Prop Sales/Brokerage Fees/Commiss. Starts in 1995, so backcasted before then with the implicit price deflator for brokers' commissions on residential structures [interpolated to monthly frequency]	LogDiff
RBMRS_PPIRback	PPI: Net Material Inputs: Resid Maintnce/Repair Construction. Starts in 1986, so backcasted before then with the implicit price deflator for residential improvements [interpolated to monthly frequency].	LogDiff
CPIMajappSplice	CPI-U: Major Appliances (SA, Dec-97=100). Starts in 1997, so backcasted before then with PCE: Major Household Appliances Price Index.	LogDiff

Table A3: Data releases used for GDP nowcast

Primary data release	Source	GDP components forecasted directly from release
Reuters/University of Michigan Index of Consumer Sentiment	Reuters/University of Michigan	None**, ***
Philly Fed Business Outlook Survey	Federal Reserve Bank of Philadelphia	None**, ***
Conference Board Consumer Confidence	The Conference Board	None**, ***
Chicago Fed Midwest Manufacturing Index	Federal Reserve Bank of Chicago	None**
ISM Manufacturing Index	Institute for Supply Management	Change in private inventories
ISM Nonmanufacturing Index	Institute for Supply Management	None**, ***
BEA Unit Auto sales	Bureau of Economic Analysis	Real PCE New Motor Vehicles, Change in private inventories
Initital Unemployment Insurance Claims	Bureau of Labor Statistics	None**
Employment situation	Bureau of Labor Statistics	Nonresidential software investment, Government spending, Change in private inventories
Wholesale Trade	U.S. Census Bureau	Change in private inventories
International Trade (FT900)	U.S. Census Bureau	Net exports, Equipment investment, Change in private inventories
U.S. Import and Export Price Indexes	Bureau of Labor Statistics	Net exports
Monthly Treasury Statement	U.S. Treasury	Government spending
Retail trade and inventories	U.S. Census Bureau	Real PCE (retail control) spending, Change in private inventories
Producer Price Index	Bureau of Labor Statistics	Equipment investment, Change in private inventories
Industrial Production	Federal Reserve	Change in private inventories, Government spending
Consumer Price Index	Bureau of Labor Statistics	Real PCE (retail control) spending, Change in private inventories
New residential construction C20 (Housing Starts)	U.S. Census Bureau	Residential investment
Existing Home Sales	U.S. Census Bureau	Residential investment

Advance Durable Goods Report	U.S. Census Bureau	Equipment investment, Change in private inventories
New Home Sales	U.S. Census Bureau	Residential investment
Manufacturers' Shipments, Inventories, and Orders	U.S. Census Bureau	Equipment investment, Change in private inventories
Construction spending (C30)	U.S. Census Bureau	Residential investment and nonresidential structures investment
Manufactured Homes Survey	U.S. Census Bureau	Residential investment
Personal income and outlays	Bureau of Economic Analysis	Real PCE
S&P 500 Index	Standard and Poors	None**

** Although not used to directly forecast any of the GDP components, it is used to estimate a latent factor (similar to the Chicago Fed National Activity Index) that is used to indirectly forecast many of the GDP components.

*** The most recent value of the series is not used to update the latent factor until the ISM Manufacturing Index is released

Table A4: Monthly indicators used in factor model

Variable Name	Variable description and/or construction description.	Transformation	Primary data release	Name of Deflator
ADS@USECON	Domestic Retail Auto Sales (SAAR, Mil.Units)	LogDiff	Auto sales	
FRBC@SURVEYS	Chicago Fed Midwest Manufacturing Index (SA, 2007=100)	DiffLev	Chicago Fed Survey	
WeeklyClaims	Unemployment Insurance: Initial Claims, 4-Week Moving Average	LogDiff	Claims	
CPG@USECON	Value of Public Construction Put in Place (SAAR, Mil.$). Deflated by Consumer Price Index (PCU@USECON).	LogDiff	Construction PIP	PCU@USECON
CPGF@USECON	Value of Total Federal Construction Put in Place (SAAR, Mil.$)	LogDiff	Construction PIP	TornPriceNonResStrMth
CPGS@USECON	Value of State and Local Construction Put in Place (SAAR, Mil.$)	LogDiff	Construction PIP	TornPriceNonResStrMth
CPVD@USECON	Private Construction: Nonresidential (SAAR, Mil.$) -- Deflated by TornPriceNonResStrMth.	LogDiff	Construction PIP	TornPriceNonResStrMth
SplicedNewHousingConstruction	Private Construction: Residential: New Housing Units (SAAR, Mil.$) [CPVRH@USECON] deflated by "Houses under Construction: Price Deflator (NSA, 2005=100) " (CCIHD@USECON).	LogDiff	Construction PIP	CCIHD@USECON
CCIEN@USECON	Conference Board: Consumer Expectations (SA, 1985=100)	DiffLev	Consumer Confidence	
CCIN@USECON	Conference Board: Consumer Confidence (SA, 1985=100)	DiffLev	Consumer Confidence	

CCIPSN@USECON	Conference Board: Consumer Confidence Present Situation (SA, 1985=100)	DiffLev	Consumer Confidence	
SplicedMichCur	University of Michigan: Current Economic Conditions (NSA, Q1-66=100) -- CCOND@USECON. Pre 1978 survey was updated lower than monthly frequency; these observations are linearly interpolated.	DiffLev	Consumer Sentiment	
SplicedMichExp	University of Michigan: Consumer Expectations (NSA, Q1-66=100) -- CEXP@USECON. Pre 1978 survey was updated lower than monthly frequency; these observations are linearly interpolated.	DiffLev	Consumer Sentiment	
SplicedMichSent	University of Michigan: Consumer Sentiment (NSA, Q1-66=100) -- CSENT@USECON. Pre 1978 survey was updated lower than monthly frequency; these observations are linearly interpolated.	DiffLev	Consumer Sentiment	
LACONSA@USECON	All Employees: Construction (SA, Thous)	LogDiff	Employme nt	
LAD61A@USECON	All Employees: Construction of Residential Buildings (SA, Thous)	LogDiff	Employme nt	
LADURGA@USECON	All Employees: Durable Goods Manufacturing (SA, Thous)	LogDiff	Employme nt	
LAEDUHA@USECON	All Employees: Education & Health Services (SA, Thous)	LogDiff	Employme nt	
LAFGDA@LABOR	All Employees: Department of Defense (SA, Thous)	LogDiff	Employme nt	
LAFGOVA@USECON	All Employees: Federal Government (SA, Thous)	LogDiff	Employme nt	
LAFIREA@USECON	All Employees: Financial Activities (SA, Thous)	LogDiff	Employme nt	
LAGOODA@USECON	All Employees: Goods-producing Industries (SA, Thous)	LogDiff	Employme nt	
LALEIHA@USECON	All Employees: Leisure & Hospitality (SA, Thous)	LogDiff	Employme nt	

LAMANUA@USECON	All Employees: Manufacturing (SA, Thous)	LogDiff	Employment	
LAMINGA@USECON	All Employees: Mining (SA, Thous)	LogDiff	Employment	
LANAGRA@USECON	All Employees: Total Nonfarm (SA, Thous)	LogDiff	Employment	
LANDURA@USECON	All Employees: Nondurable Goods Manufacturing (SA, Thous)	LogDiff	Employment	
LAP15A@USECON	All Employees: Computer Systems Design & Related Services (SA, Thous)	LogDiff	Employment	
LAPBSVA@USECON	All Employees: Professional & Business Services (SA, Thous)	LogDiff	Employment	
LAPTSVA@USECON	All Employees: Professional & Technical Services (SA, Thous)	LogDiff	Employment	
LAPRIVA@USECON	All Employees: Total Private Industries (SA, Thous)	LogDiff	Employment	
LAPSRVA@USECON	All Employees: Private Service-providing Industries (SA, Thous)	LogDiff	Employment	
LARTRDA@USECON	All Employees: Retail Trade (SA, Thous)	LogDiff	Employment	
LASRVOA@USECON	All Employees: Other Services (SA, Thous)	LogDiff	Employment	
LAWTRDA@USECON	All Employees: Wholesale Trade (SA, Thous)	LogDiff	Employment	
LE@USECON	Civilian Employment: Sixteen Years & Over (SA, Thous)	LogDiff	Employment	
LENA@USECON	Civilian Employment: Nonagricultural Industries: 16 yr + (SA, Thous)	LogDiff	Employment	
LFPRUnround	Civilian Labor Force: 16 yr + (SA, Thous) -- LF@USECON, series is divided by size of population.	LogDiff	Employment	
LOMANUA@USECON	Average Weekly Hours: Prod & Nonsupervisory: Overtime: Manufacturing (SA, Hrs)	DiffLev	Employment	
LoserOnLayoff	Civilians Unemployed: Job Losers On Layoff (SA, Thous.) -- LUJLL@USECON, series is divided by size of labor force.	DiffLev	Employment	

LRM25@USECON	Civilian Unemployment Rate: Men, 25-54 Years (SA, %)	DiffLev	Employment	
LRMANUA@USECON	Average Weekly Hours: Prod & Nonsupervisory: Manufacturing (SA, Hrs)	DiffLev	Employment	
LRPRIVA@USECON	Average Weekly Hours: Prod & Nonsupervisory: Private Industries (SA, Hrs)	LogDiff	Employment	
LUMD@USECON	Median Duration of Unemployment (SA, Weeks)	DiffLev	Employment	
StateLocalEmp	Sum of LASGOVA@USECON "All Employees: State Government (SA, Thous) " and LALGOVA@USECON "All Employees: Local Government (SA, Thous) ".	LogDiff	Employment	
URUnround	Unemployed, 16 Years & Over: 16 yr + (SA, Thous) -- LTU@USECON, series is divided by size of labor force.	DiffLev	Employment	
YPWGM@USNA	Wage and Salary Disbursements: Government (SAAR, Bil.$) -- Deflated by Consumer Price Index (PCU@USECON).	LogDiff	Employment	PCU@USECON
US05SAU@USECON	Break-Adjusted Existing Single-Family Home Sales, United States (SAAR, Thous).	LogDiff	Existing Home Sales	

valExHomeSales	Nominal value is "existing single-family home sales" from National Association of Realtors (NAR) times the median sales price of existing single-family homes also from the NAR. The sales prices are NSA, so we seasonally adjust them with Haver's default settings. This constructed nominal sales value is deflated by the industry PPI for "PPI: Real Estate Agents: Residential Property Sales, Brokerage Fees, and Commissions" [NAICS code 5312101] from the Table 5 of the PPI release.	LogDiff	Existing Home Sales	R5312101@PPIRInterp
HPT@USECON	New Pvt Housing Units Authorized by Building Permit (SAAR, Thous.Units)	DiffLev	Housing Starts	
HST@USECON	Housing Starts (SAAR, Thous.Units)	DiffLev	Housing Starts	
HST1@USECON	Housing Starts: 1 Unit (SAAR, Thous.Units)	DiffLev	Housing Starts	
HSTM@USECON	Housing Starts: Total Multifamily (SAAR, Thous.Units)	DiffLev	Housing Starts	
HSTMW@USECON	Housing Starts: Midwest (SAAR, Thous.Units)	DiffLev	Housing Starts	
HSTNE@USECON	Housing Starts: Northeast (SAAR, Thous.Units)	DiffLev	Housing Starts	
HSTS@USECON	Housing Starts: South (SAAR, Thous.Units)	DiffLev	Housing Starts	
HSTW@USECON	Housing Starts: West (SAAR, Thous.Units)	DiffLev	Housing Starts	

NomSingleStarts	Housing Starts: 1 Unit (HST1@USECON) multiplied by "New 1-Family Houses: Average Sales Price (Dollars) - Seasonal Adjustment, All" (sa(HN1PA@USECON)). Series is then deflated by "Houses under Construction: Price Deflator (NSA, 2005=100)" (CCIHD@USECON).	LogDiff	Housing Starts	CCIHD@USECON
CoreCapGoodsExports	Exports: Capital Goods, except Automotive (SA, Mil.$) TXG2@USINT. Then exports for other noncore categories are subtracted. (TX21300@USINT,TX21301@USINT,TX22000@USINT,TX22010@USINT,TX22020@USINT,TX22220@USINT,TX21320@USINT,TX21100@USINT, and TX20005@USINT) Series is then deflated by PPI: Capital Equipment (SA, 1982=100) [SP3200@PPI].	LogDiff	International Trade	SP3200@PPI
CoreCapGoodsImports	Imports: Capital Goods, except Automotive (SA, Mil.$) TMG2@USINT. Then exports for other noncore categories are subtracted. (TM21300@USINT,TM21301@USINT,TM22000@USINT,TM22010@USINT,TM22020@USINT,TM22220@USINT,TM21320@USINT,TM21100@USINT, and TM20005@USINT) Series is then deflated by PPI: Capital Equipment (SA, 1982=100) [SP3200@PPI].	LogDiff	International Trade	SP3200@PPI

SplicedExportsComputersAndRelated	Nominal series is sum of exports of "computers" and "computer accessories" from from Exhibit 7 of Census international trade release (FT900). Nominal series is deflated by "Atkeson-Ohanian" extrapolator of quarterly price deflator for comupters and peripherals investment. See text for description of the extrapolation method.	LogDiff	International Trade	ESComputerDefmthAO ["Atkeson-Ohanian" extrapolator of quarterly price deflator for comupters and peripherals investment. See text for description of the extrapolation.]
SplicedGoodsExports	Exports of goods on BOP basis from Census FT900 International Trade Release. FRED ticker BOPGEXP. Series not available before 1992, so backcast with "Exports, f.a.s.: Total Goods, Census Basis -- TMXA@USINT"	LogDiff	International Trade	PXEA@USECONsplice
SplicedGoodsImports	Imports of goods on BOP basis from Census FT900 International Trade Release. FRED ticker BOPGIMP. Series not available before 1992, so backcast with "Imports, f.a.s.: Total Goods, Census Basis -- TMMA@USINT"	LogDiff	International Trade	PMEA@USECONsplice
SplicedImportsComputersAndRelated	Nominal series is sum of exports of "computers" and "computer accessories" from from Exhibit 7 of Census international trade release (FT900). Nominal series is deflated by ESComputerDefmthAO	LogDiff	International Trade	ESComputerDefmthAO ["Atkeson-Ohanian" extrapolator of quarterly price deflator for comupters and peripherals investment. See appendix for description of the extrapolation.]
SplicedServiceExports	Exports of services on BOP basis from Census FT900 International Trade Release. FRED ticker BOPSEXP. Haver ticker BPXSVM@USECON	LogDiff	International Trade	ExpSvcDefmthA1

SplicedServiceImports	Exports of services on BOP basis from Census FT900 International Trade Release. FRED ticker BOPSIMP. Haver ticker BPXSVX@USECON	LogDiff	International Trade	ImpSvcDefmthA1
CUMFG@IP	Capacity Utilization: Manufacturing [SIC] (SA, % of Capacity)	LogDiff	IP	
CUT@IP	Capacity Utilization: Total Index (SA, % of Capacity)	LogDiff	IP	
IP@IP	IP: Total Index (SA, 2007=100)	LogDiff	IP	
IP51@IP	IP: Consumer Goods (SA, 2007=100)	LogDiff	IP	
IP511@IP	IP: Durable Consumer Goods (SA, 2007=100)	LogDiff	IP	
IP512@IP	IP: Nondurable Consumer Goods (SA, 2007=100)	LogDiff	IP	
IP521@IP	IP: Business Equipment (SA, 2007=100)	LogDiff	IP	
IP53@IP	IP: Materials (SA, 2007=100)	LogDiff	IP	
IP54@IP	IP: Nonindustrial Supplies (SA, 2007=100)	LogDiff	IP	
IPB31@IP	IP: Drilling Oil and Gas Wells (SA, 2007=100)	LogDiff	IP	
IPFP@IP	IP: Final Products {Mkt Group} (SA, 2007=100)	LogDiff	IP	
IPMFG@IP	IP: Manufacturing (SIC) (SA, 2007=100)	LogDiff	IP	
IPTP@IP	IP: Final Products and Nonindustrial Supplies (SA, 2007=100)	LogDiff	IP	
NAPMC@USECON	ISM Mfg: PMI Composite Index (SA, 50+ = Econ Expand)	Lev	ISM Manuf	
NAPMEI@USECON	ISM Mfg: Employment Index (SA, 50+ = Econ Expand)	Lev	ISM Manuf	
NAPMII@USECON	ISM Mfg: Inventories Index (SA, 50+ = Econ Expand)	Lev	ISM Manuf	
NAPMNI@USECON	ISM Mfg: New Orders Index (SA, 50+ = Econ Expand)	Lev	ISM Manuf	

NAPMOI@USECON	ISM Mfg: Production Index (SA, 50+ = Econ Expand)	Lev	ISM Manuf	
NAPMVDI@USECON	ISM Mfg: Supplier Deliveries Index (SA, 50+ = Slower)	Lev	ISM Manuf	
NMFC@SURVEYS	ISM Nonmanufacturing: NMI Composite Index (SA, 50+=Increasing)	Lev	ISM NonManuf	
ASTOT@USECON	Domestic plus Imported Retail Auto Sales (SAAR, Mil.Units)	LogDiff	Light Weight Vehicle Sales	
TLTSAR@USECON	Total Truck Sales: Light, 0-14,000 Lbs GVW (SAAR, Mil.Units)	LogDiff	Light Weight Vehicle Sales	
BusShareTrucks	Business share of unit truck sales; constructed variable. Total unit light weight truck sales [business plus consumers] is from BEA [http://www.bea.gov/national/xls/gap_hist.xls] with FRED ticker LTRUCKSA. Consumer unit light weight truck sales is from NIPA table 7.2.5S. Share is 1 minus ratio of unit sales to consumer to total unit sales	DiffLev	Light Weight Vehicle Sales + NIPA Underlying Detail 7.2.5S	
CoreCapGoodsShipments	Mfrs' Shipments: Nondefense Capital Goods ex Aircraft (SA, Mil.$) minus computer shipments (NMSG41A@USECON, NMSG41B@USECON and NMSG41C@USECON). Series is then deflated by Series is then deflated by PPI: Capital Equipment (SA, 1982=100) [SP3200@PPI].	LogDiff	M3/Shipm ents	SP3200@PPI
DefenseShipments	"Manufacturers' Shipments: Defense Capital Goods (SA, Mil.$) " [MSCD@USECON] deflated by Consumer Price Index [PCU@USECON].	LogDiff	M3/Shipm ents	PCU@USECON

HSM@USECON	Manufacturers' Shipments of Mobile Homes (SAAR, Thous.Units)	DiffLev	M3/Shipments	
ManInvShipRatio	Manuf I/S ratio. NMI@USECON/NMS@USECON. Mfrs' Inventories: All Manufacturing Industries (EOP, SA, Mil.$) divided by Mfrs' Shipments: All Manufacturing Industries (SA, Mil.$)	LogDiff	M3/Shipments	
NMS@USECON	Mfrs' Shipments: All Manufacturing Industries (SA, Mil.$). Converted to real by dividing by SpliceManTradeDeflator	LogDiff	M3/Shipments	SpliceManTradeDeflator
RealCapitalShipments	Mfrs' Shipments: Nondefense Capital Goods ex Aircraft (SA, Mil.$) deflated by PPI: Capital Equipment (SA, 1982=100) (NMSCNX@USECON/SP3200@PPI)	LogDiff	M3/Shipments	
SplicedComputersShipments	Nominal series is sum of "Electronic Computers", "Computer Storage Devices", and "Other Computer Peripheral Eqpt" from Table 1 of full Census M3-2 report. These series are not included in the advance durable goods report (M3-1); in between M3-1 and M3-2 the latest month's values are extrapolated by "Computers & Electronic Products" shipments from the M3-1. Nominal series is deflated by "Atkeson-Ohanian" extrapolator of quarterly price deflator for comupters and peripherals investment. See appendix for description of the extrapolation.	LogDiff	M3/Shipments	ESComputerDefmthAO ["Atkeson-Ohanian" extrapolator of quarterly price deflator for comupters and peripherals investment. See text for description of the extrapolation.]

SplicedDurableGoodsOrders	Constructed (Real) Manufacturers' New Orders: Durable Goods (SA, Mil.$). NAICS based nominal series is NMODG@USECON deflated by SP3200@PPI.	LogDiff	M3/Shipments	SP3200@PPI
NondefenseAircraftNetShipments	Constructed variable. Nominal shipments are "Mfrs' Shipments: Nondefense Aircraft & Parts" [From Census M3 Report -- FRED ticker ANAPVS] excluding shipments of "Electronic Computers", "Computer Storage Devices", and "Other Computer Peripheral Eqpt" from same M3 report. Net shipments subtract exports of Civilian Aircraft, Civilian Aircraft: Parts, Civilian Aircraft: Engines from Exhibit 7 of FT900 and add imports of these same categories.	LogDiff	M3/Shipments + International Trade	S142102@PPIextrap
MobileHomeVal	Nominal value is unit shipments of manufactured homes from the Census Bureau Manufactured Homes Survey (see http://www.census.gov/construction/mhs/mhsindex.html) times average sales price of manufactured homes from same survey. The sales price data are NSA, so we seasonally adjust them with Haver's default settings. Nominal mobile home shipments are deflated by the PPI for mobile homes [in Table 6 of PPI release].	LogDiff	Manufactured Homes Survey	P155@PPI
HN1MT@USECON	New 1-Family Houses For Sale: Months Supply (SA, Ratio)	LogDiff	New Home Sales	
HN1SUS@USECON	New 1-Family Houses For Sale: United States (SA, Thous)	DiffLev	New Home Sales	
HN1US@USECON	New 1-Family Houses Sold: United States (SAAR, Thous)	DiffLev	New Home Sales	

valNewHomeSales	Nominal value is "New 1-Family Houses Sold" from the Census New Home Sales release [FRED ticker HSN1F] times the average sales price from table 1 of the same release. The sales price series is NSA, so we seasonally adjust it with Haver's default settings. This constructed nominal sales value is deflated by the industry PPI for "PPI: Real Estate Agents: Residential Property Sales, Brokerage Fees, and Commissions" [NAICS code 5312101] from the Table 5 of the release	LogDiff	New Home Sales	R5312101@PPIRInterp
ASCPU@USNA	Autos: Consumer Dollars as a Percent of Final Sales (SA, %)	DiffLev	NIPA Underlying Detail 7.2.5S	
TSHSU@USNA	Total Heavy Truck Sales [Over 14,000 lbs GVW] (SAAR, Mil.Units)	LogDiff	NIPA Underlying Detail 7.2.5S	
CBHM@USECON	Real Personal Consumption Expenditures (SAAR, Bil.Chn.2005$)	LogDiff	PCE/Personal Income	
CDBHM@USECON	Real Personal Consumption Expenditures: Durable Goods (SAAR, Bil.Chn.2005$)	LogDiff	PCE/Personal Income	
CNBHM@USECON	Real Personal Consumption Expenditures: Nondurable Goods (SAAR, Bil.Chn.2005$)	LogDiff	PCE/Personal Income	
CSBHM@USECON	Real Personal Consumption Expenditures: Services (SAAR, Bil.Chn.2005$)	LogDiff	PCE/Personal Income	
YPDHM@USECON	Real Disposable Personal Income (SAAR, Bil.Chn.2005$)	LogDiff	PCE/Personal Income	
YPLTPMH@USECON	Real Personal Income Less Transfer Payments (SAAR, Bil.Chn.2005$)	LogDiff	PCE/Personal Income	

BOFGX@SURVEYS	Philadelphia Fed Business Outlook Survey: Future Activity Index (SA, %Bal)	Lev	Philly Fed Survey	
BOISM@SURVEYS	Philly Fed Bus Outlook: Current Activity Diffusion Index, ISM-Adj (SA, >50=Inc)	Lev	Philly Fed Survey	
CoreRetailSales	Constructed (Real) Retail Sales & Food Serv Excl Auto, Gas Stations & Building Materials(SA, Mil.$). Nominal NAICS based series is NRSXMI47@USECON. Deflated by constructed Core Retail PCE Deflator.	LogDiff	Retail trade	CoreRealRetailPCEDef
NRST@USECON	Retail Sales & Food Services (SA, Mil.$) deflated by constructed retail trade deflator	LogDiff	Retail trade	SpliceRetailTradeDeflator
RetailInvSalesRatio	Inventory to sales ratio for retail: Total Excl Motor Vehicle & Parts Dealers NRIXM@USECON/NRSXM@USECON	LogDiff	Retail trade	
RetSalesResEquip	Nominal values from monthly retail trade relase [NAICS code 442 and NAICS codes 44311+44313]. Appliance T.V. and camera store sales are released with a 1-month lag, so they are extraplated with electronics and appliance store sales [NAICS code 443]. Nominal series deflated by CPI for major appliances.	LogDiff	Retail trade	CPIMajappSplice
SplicedBuildingMaterials	Retail Sales: Building Materials, Garden Equipment & Supply Dealers (SA, Mil.$) -- (NRSI4@USECON).	LogDiff	Retail trade	ImprovementsDef**
SDY5COMM@USECON	S&P: Composite 500, Dividend Yield (%)	DiffLev	S&P 500	
SP500@USECON	Stock Price Index: Standard & Poor's 500 Composite (1941-43=10)	LogDiff	S&P 500	PCU@USECON

saFTO@USECON	Federal Outlays (Mil.$) - Seasonal Adjustment, All	LogDiff	Treasury	PCU@USECON
saFTOD@USECON	Federal Outlays: National Defense (Mil.$) - Seasonal Adjustment, All	LogDiff	Treasury	PCU@USECON
NWSH@USECON	Merchant Wholesalers: Sales: Total (SA, Mil.$). Deflated by Wholesale Trade Deflator.	LogDiff	Wholesale	SpliceWholesaleTradeDeflator
WholeSaleInvSalesRatio	Merchant Wholesalers: Inventory to sales ratio.	LogDiff	Wholesale	

**ImprovementsDef is geometric mean of 3 series: 1.) Census price index for "New Single-Family Houses Under Construction" CCIHD@USECON. 2.) Industry PPI [Table 9] for Net Material Inputs: Residential Maintenance&Repair Construction RBMRS@PPIR 3.) Price index constructed with "Atkeson-Ohanian" extrapolation of 4-quarter percen change in Employment Cost Index for Construction. LSPIGC@USECON

Table A5a: Monthly indicators used in bridge equations for nonresidential structures investment subcomponents

Component Ticker	Description	NIPA Table	Monthly Indicator(s)
NResStructExMineWellQuant	Total excluding mining and wells: Constructed for model by "Fisher subtraction". See Liu, Hamalainen, and Wong (2003) http://publications.gc.ca/collections/collection_2009/fin/F21-8-2003-13E.pdf for a description	Constructed	"Real" private nonresidential construction put-in-place (C30) [CPVD@USECON deflated by TornPriceNonResStrMth]
FNSMPZ@USNA	Petroleum and natural gas wells	Table 5.4.6	IP: Oil and gas well drilling [IPB31@IP]
FNSMIZ@USNA	Mining	Table 5.4.6	AR(4)

Note: AR(4) means an AR(4) is used and no monthly data is used in model

Table A5b: Monthly indicators used in bridge equations for residential investment subcomponents

Component Ticker	Description	NIPA Table	Monthly Indicator(s)
FRSPZ@USNA	Permanent-site	Table 5.3.6	"Real" private new housing construction (VPIP) [SplicedNewHousingConstruction/CCHID@USECON]: Nominal series is sum of spending on new single family and new multifamily housing construction from Table 2 Census C30 release. In the interim period between the "New Residential Construction" housing starts release and the C30 value put in place release, we update this series in the model using the method described in the appendix.
FRSHMZ@USNA	Manufactured homes	Table 5.4.6U	"Real" value of mobile home shipments [MobileHomeVal/P155@PPI]
FRSHDZ@USNA	Dormitories	Table 5.4.6U	AR(4)
FRSBKZ@USNA	Brokerage commissions	Table 5.4.6U	"Real" value of new and existing home sales [valExHomeSales + valNewHomeSales]/R5312101_PPIRInterp

FRSINZ@USNA	Improvements	Table 5.4.6U	"Real" Retail Sales: Building Materials, Garden Equipment & Supply Dealers [SplicedBuildingMaterials deflated by geometric mean of 3 series deflated by geometric mean of 3 series: 1.) Census price index for "New Single-Family Houses Under Construction" CCIHD@USECON. 2.) Industry PPI [Table 9] for Net Material Inputs: Residential Maintenance&Repair Construction RBMRS@PPIR 3.) Price index constructed with "Atkeson-Ohanian" extrapolation of 4-quarter percen change in Employment Cost Index for Construction. LSPIGC@USECON]
FREZ@USNA	Residential equipment	Table 5.3.6	"Real" Retail Sales: Appliance, Television, and Camera Stores + Furniture & Home Furniture Stores [RetSalesResEquip/CPIMajappSplice]

Note: AR(4) means an AR(4) is used and no monthly data is used in model

Table A5c: Monthly indicators used in bridge equations for equipment investment subcomponents

Component Ticker	Description	NIPA Table	Monthly Indicator(s)
HerzonCoreEQty	"Core" equipment -- Constructed for model by "Fisher subtraction" of other E&S subcomponents listed below from total real E&S investment. See Liu, Hamalainen, and Wong (2003) http://publications.gc.ca/collections/collection_2009/fin/F21-8-2003-13E.pdf for a description.	Constructed	Net "core" capital goods shipments: CoreCapGoodsShipments - CoreCapGoodsImports + CoreCapGoodsShipments
FNENPZ@USNA	Computers and peripherals	Table 1.5.6	Net computer shipments: SplicedComputersShipments - SplicedExportsComputersAndRelated + SplicedImportsComputersAndRelated
TIZ@USNA	New trucks	Table 7.2.6B	Constructed real business truck sales: Quarterly log growth rate is weighted average of log growth rates of "Heavy truck sales" [TSHSU@USNA] and "Light truck sales to businesses" [BusShareTrucks*TSHSU@USNA]. Weights are previous quarter's expenditure shares of light and heavy truck sales to businesses from NIPA Table 5.5.5U

AINZ@USNA	New autos	Table 7.2.6B	Constructed monthly real business auto sales. Product of total retail unit auto sales [ASTOT@USECON] and share of auto sales ($) sold to consumers [ASCPU@USNA].
MVIUTZ@USNA	Net purchases of used light MVs	Table 7.2.6B	AR(4)
FNETPZ@USNA	Aircraft	Table 5.5.6U	Real "net" aircraft shipments [NondefenseAircraftNetShipments]

Table A5d: Monthly indicators used in bridge equations for federal government expenditures subcomponents

Component Ticker	Description	NIPA Table(s)	Monthly Indicator(s)
GFZ@USNA	Federal government spending		
	National Defense		
GFDESLZ@USNA	Real Compensation of Employees: Military	Table 3.11.6	AR(4)
GFDESVZ@USNA	Real Compensation of Employees: Civilian	Table 3.11.6	Payroll Employment: Department of Defense (Civilian) [LAFGDA@LABOR]
GFDSFZ@USNA	Real Consumption of Govt Fixed Capital	Table 3.11.6	AR(4)
NatDefenseTreasCatsQty	(Intermediate Durables+Svcs) + (Total Investment): Constructed chain-weighted aggregate.	Table 3.11.6+3.9.6	Treasury statement: National Defense Outlays (SA, Deflate by CPI) [saFTOD@USECON/PCU@USECON]
GFDENZ@USNA	Intermediate Nondurables	Table 3.11.6	AR(4)
GDOAIZ@USNA	(-)Own account investment	Table 3.11.6	AR(4)
GDOSSZ@USNA	(-)Sales to other sectors	Table 3.11.6	AR(4)
	Nondefense		
GGNESZ@USNA	Real Compensation of Employees	Table 3.10.6	Nondefense payroll federal govt employment [LAFGOVA@USECON - LAFGDA@USECON]
GFNSFZ@USNA	Real Consumption of Govt Fixed Capital	Table 3.10.6	AR(4)
GFNEDZ@USNA	Intermediate Durables	Table 3.10.6	Treasury statement: Total Outlays (SA, Deflate by CPI) [saFTO@USECON/PCU@USECON]

GFNENZ@USNA	Intermediate Nondurables	Table 3.10.6	Treasury statement: Total Outlays (SA, Deflate by CPI) [saFTO@USECON/PCU@USECON]
GFNESZ@USNA	Intermediate Services	Table 3.10.6	AR(4)
GNOAIZ@USNA	(-)Own account investment	Table 3.10.6	AR(4)
GNOSSZ@USNA	(-)Sales to other sectors	Table 3.10.6	AR(4)
GFNISZ@USNA	Structures investment	Table 3.9.6	"Real" Value of Federal Construction Put in Place [CPGF@USECON/TornPriceNonResStrMth]
GFNIEZ@USNA	Equipment+Software investment	Table 3.9.6	AR(4)

Note: AR(4) means an AR(4) is used and no monthly data is used in model

Table A5e: Monthly indicators used in bridge equations for state+local govt expenditures subcomponents

Component Ticker	Description	NIPA Table(s)	Monthly Indicator(s)
GGSESZ@USNA	Real compensation of general govt. employees	Table 3.10.6	Payroll employment: state+local [StateLocalEmp = LASGOVA@USECON + LALGOVA@USECON]
GSESFZ@USNA	Consumption of fixed capital	Table 3.10.6	AR(4)
GSEPIZ@USNA	Intermediate goods and svcs purchased	Table 3.10.6	AR(4)
GSOAIZ@USNA	(-)Own account investment	Table 3.10.6	AR(4)
GSOSSZ@USNA	(-)Sales to other sectors	Table 3.10.6	AR(4)
GSISZ@USNA	Investment: Structures	Table 3.9.6	"Real" State and Local Construction Put in Place [CPGS@USECON deflated by TornPriceNonResStrMth]
GSIEZ@USNA	Investment: Equipment+Software	Table 3.9.6	Industrial Production (Total) [IP@IP]

Note: AR(4) means an AR(4) is used and no monthly data is used in model

Table A5f: Monthly indicators used in bridge equations for intellectual proprty products investment subcomponents

Component Ticker	Description	NIPA Table	Monthly Indicator(s)
FNPSZ@USNA	Software	Table 1.5.6	Prof. + bus. svcs employment [LAPBSVA@USECON]
FNPRZ@USNA	Research and development	Table 1.5.6	Prof. + technical svcs employment [LAPTSVA@USECON]
FNPEZ@USNA	Entertainment, literary, and artistic originals	Table 1.5.6	AR(4)

Note: AR(4) means an AR(4) is used and no monthly data is used in model

Table A6: Component breakdown used to forecast consumption

Consumption Variable Name	Consumption Variable Description	Method for "nowcasting" latest month
GOODS		
CDMVNHM@USNA	Personal Consumption Expenditures: New Motor Vehicles (SAAR, Mil.Chn.2005.$)	Latest number predicted with growth in share weighted average growth rates of unit auto sales to consumers [derived from ASTOT@USECON and ASCPU@USNA] and unit truck sales to consumers [derived from TLTSAR@USECON and BusShareTrucks].
CDMVUHM@USNA	Real PCE: Net Purchases of Used Motor Vehicles	No other monthly indicator used.
CoreRealRetailPCEQtyExFoodSvc	Personal Consumption Expenditures: Components that map into retail control basket less food services [retail trade series is NRSXMI47@USECON - NRSV2@USECON in Haver]	Latest number predicted with "Retail Sales & Food Serv Excl Auto, Gas Stations & Building Materials(SA, Mil.$) " less food services -- NRSXMI47@USECON - NRSV2@USECON --when available. NRSXMI47@USECON - NRSV2@USECON series is deflated by appropriate average of appropriate CPI components when available. Otherwise the deflator is forecast.
CNEHM@USNA	PCE: Gasoline & Other Energy Gds (SAAR, Mil.Chn.2005.$)	No other monthly indicator used.
SERVICES		

CSFPHM@USNA	Real PCE: Purchased Meals & Beverages	Latest number predicted with "Retail sales food services & drinking places" -- NRSV2@USECON -- when available. NRSV2@USECON series is deflated by appropriate average of appropriate CPI components when available. Otherwise the deflator is forecast.
HerzonServicesLessFoodQty	Constructed for model by "Fisher subtraction" of food services from total PCE services. Source data from NIPA tables 2.4.5U and 2.4.6U. See Liu, Hamalainen, and Wong (2003) http://publications.gc.ca/collections/collection_2009/fin/F21-8-2003-13E.pdf for a description of Fisher subtraction.	No other monthly indicator used.

Table A7: CPI to PCE retail correspondence

CPI Price Component	CPI Price Description	PCE Price Component	PCE Price Description
UTCT@CPIDATA	CPI-U: Tires (SA, 1982-84=100)	JCDMTTM@USNA	Personal Consumption Expenditures: Tires Price Index (SA, 2009=100)
UTCOON@CPIDATA	CPI-U: Vehicle Parts & Eqpt ex Tires (NSA, 1982-84=100)	JCDMTVM@USNA	Personal Consumption Expenditures: Accessories & Parts Price Index(SA, 2009=100)

UHHF@CPIDATA	CPI-U: Household Furniture & Bedding (SA, 1982-84=100)	JCDFUM@USNA	Personal Consumption Expenditures: Furniture Price Index (SA, 2009=100)
UHHQCN@CPIDATA	CPI-U: Clocks, Lamps and Decorator Items (NSA, 1982-84=100)	JCDFOLM@USNA	PCE: Clock/Lamp/Lighting Fixture/Othr HH Decorative Item Price Idx(SA, 2009=100)
UHHWFN@CPIDATA	CPI-U: Floor Coverings (NSA, Dec-97=100)	JCDFOFM@USNA	PCE: Carpets & Other Floor Coverings Price Index (SA, 2009=100)
UHHWW@CPIDATA	CPI-U: Window Coverings (SA, Dec1997=100)	JCDFOTM@USNA	Personal Consumption Expenditures: Window Coverings Price Index (SA, 2009=100)
UHHPM@CPIDATA	CPI-U: Major appliances(SA, Dec-97=100)	JCDFKKM@USNA	PCE: Major Household Appliances Price Index (SA, 2009=100)
UHHPO@CPIDATA	CPI-U: Other Household Appliances (SA, Dec-97=100)	JCDFKSM@USNA	PCE: Small Elec Household Appliances Price Index (SA, 2009=100)
UHHQDN@CPIDATA	CPI-U: Dishes and Flatware (NSA, Dec-97=100)	JCDFGDM@USNA	Personal Consumption Expenditures: Dishes and Flatware Price Index(SA, 2009=100)
UHHQK@CPIDATA	CPI-U: Nonelectric Cookware and Tableware (SA, Dec1997=100)	JCDFGKM@USNA	PCE: Nonelectric Cookware & Tableware Price Index (SA, 2009=100)
UHHTTN@CPIDATA	CPI-U: Tools, Hardware and Supplies (NSA, Dec-97=100)	JCDFSTM@USNA	PCE: Tools, Hardware & Supplies Price Index (SA, 2009=100)
UHHTQ@CPIDATA	CPI-U: Outdoor Equipment and Supplies (SA, Dec-97=100)	JCDFSLM@USNA	PCE: Outdoor Equip & Supplies Price Index (SA, 2009=100)
UEVT@CPIDATA	CPI-U: Televisions (SA, 1982-84=100)	JCDFTVM@USNA	Personal Consumption Expenditures: Televisions Price Index (SA, 2009=100)
UEVQ@CPIDATA	CPI-U: Other Video Equipment (SA, Dec-97=100)	JCDFTOM@USNA	Personal Consumption Expenditures: Other Video Equip Price Index (SA, 2009=100)
UEVAN@CPIDATA	CPI-U: Audio Equipment (NSA, 1982-84=100)	JCDFTUM@USNA	Personal Consumption Expenditures: Audio Equipment Price Index (SA, 2009=100)
UEVADN@CPIDATA	CPI-U: Audio Discs, Tapes & Other Media (NSA, Dec-97=100)	JCDFTPM@USNA	PCE: Prerec/Blank Audio Disc/Tape/Digital Files/Download Price Idx(SA, 2009=100)

UEVDBN@CPIDATA	CPI-U: Video Cassettes & Discs, Blank & Prerecorded (NSA, Dec-97=100,	JCDFTCM@USNA	PCE: Video Cassettes & Discs, Blank & Prerecorded Price Index (SA, 2009=100)
UETPQ@CPIDATA	CPI-U: Photographic Equipment (SA, Dec-97=100)	JCDOWPM@USNA	Personal Consumption Expenditures: Photographic Equip Price Index (SA, 2009=100)
UDIIP@CPIDATA	CPI-U: Personal Computers and Peripheral Equipment (SA, Dec-07=100)	JCDFCPM@USNA	PCE: Personal Computers & Peripheral Equip Price Index (SA, 2009=100)
UDIISN@CPIDATA	CPI-U: Computer Software and Accessories (NSA, Dec 1997=100)	JCDFCSM@USNA	PCE: Computer Software & Acc Price Index (SA, 2009=100)
UDIION@CPIDATA	CPI-U: Telephone Hardware/Calculators/Other Cons Info Items (NSA, Dec 1997=100)	JCDFCOM@USNA	PCE: Calculators/Typewriters/Othr Info Processing Eqpt Price Idx(SA, 2009=100)
UEEON@CPIDATA	CPI-U: Sports Equipment (NSA, 1982-84=100)	JCDRSM@USNA	PCE: Sporting Equip, Supplies, Guns & Ammunition Price Index (SA, 2009=100)
UEES@CPIDATA	CPI-U: Sport Vehicles including Bicycles (SA, 1982-84=100)	JCDOWLM@USNA	Personal Consumption Expenditures: Motorcycles Price Index (SA, 2009=100)
UEES@CPIDATA	CPI-U: Sport Vehicles including Bicycles (SA, 1982-84=100)	JCDOWBM@USNA	Personal Consumption Expenditures: Bicycles & Acc Price Index (SA, 2009=100)
UEES@CPIDATA	CPI-U: Sport Vehicles including Bicycles (SA, 1982-84=100)	JCDBBBM@USNA	Personal Consumption Expenditures: Pleasure Boats Price Index (SA, 2009=100)
UEES@CPIDATA	CPI-U: Sport Vehicles including Bicycles (SA, 1982-84=100)	JCDBBPM@USNA	Personal Consumption Expenditures: Pleasure Aircraft Price Index (SA, 2009=100)
UEES@CPIDATA	CPI-U: Sport Vehicles including Bicycles (SA, 1982-84=100)	JCDBBOM@USNA	PCE: Other Recreational Vehicles Price Index (SA, 2009=100)
UERMN@CPIDATA	CPI-U: Recreational Books (NSA, Dec-97=100)	JCDRBM@USNA	Personal Consumption Expenditures: Recreational Books Price Index (SA, 2009=100)
UEGM@CPIDATA	CPI-U: Music Instruments and Accessories (SA, Dec-97=100)	JCDFTIM@USNA	Personal Consumption Expenditures: Musical Instruments Price Index(SA, 2009=100)

UAOWJ@CPIDATA	CPI-U: Jewelry (SA, Dec-86=100)	JCDOJJM@USNA	Personal Consumption Expenditures: Jewelry Price Index (SA, 2009=100)
UAOWW@CPIDATA	CPI-U: Watches (SA, Dec-86=100)	JCDOJWM@USNA	Personal Consumption Expenditures: Watches Price Index (SA, 2009=100)
UMQN@CPIDATA	CPI-U: Medical Equipment and Supplies (NSA, Dec-09=100)	JCDOOTM@USNA	PCE: Therapeutic Medical Equip Price Index (SA, 2009=100)
UMSPE@CPIDATA	CPI-U: Eyeglasses & Eye Care (SA, Dec-86=100)	JCDOOEM@USNA	PCE: Corrective Eyeglasses & Contact Lenses Price Index (SA, 2009=100)
UDES@CPIDATA	CPI-U: Educational Books & Supplies (SA, 1982-84=100)	JCDEBM@USNA	Personal Consumption Expenditures: Educational Books Price Index (SA, 2009=100)
P0441@PPI	PPI: Luggage and Small Leather Goods (NSA, 1982=100)	JCDOLM@USNA	PCE: Luggage & Similar Personal Items Price Index (SA, 2009=100)
UDIION@CPIDATA	CPI-U: Telephone Hardware/Calculators/Other Cons Info Items (NSA, Dec 1997=100)	JCDOTM@USNA	PCE: Telephone & Facsimile Equip Price Index (SA, 2009=100)
UFCC@CPIDATA	CPI-U: Cereals & Cereal Products (SA, 1982-84=100)	JCNFOFGM@USNA	Personal Consumption Expenditures: Cereals Price Index (SA, 2009=100)
UFCB@CPIDATA	CPI-U: Bakery Products (SA, 1982-84=100)	JCNFOFKM@USNA	Personal Consumption Expenditures: Bakery Products Price Index (SA, 2009=100)
UFMB@CPIDATA	CPI-U: Beef & Veal (SA, 1982-84=100)	JCNFOFBM@USNA	Personal Consumption Expenditures: Beef and Veal Price Index (SA, 2009=100)
UFMP@CPIDATA	CPI-U: Pork (SA, 1982-84=100)	JCNFOFPM@USNA	Personal Consumption Expenditures: Pork Price Index (SA, 2009=100)
UFMO@CPIDATA	CPI-U: Other Meats (SA, 1982-84=100)	JCNFOFRM@USNA	Personal Consumption Expenditures: Other Meats Price Index (SA, 2009=100)
UFMPP@CPIDATA	CPI-U: Poultry (SA, 1982-84=100)	JCNFOFJM@USNA	Personal Consumption Expenditures: Poultry Price Index (SA, 2009=100)
UFMS@CPIDATA	CPI-U: Fish & Seafood (SA, 1982-84=100)	JCNFOFLM@USNA	Personal Consumption Expenditures: Fish and Seafood Price Index (SA, 2009=100)

UFYF@CPIDATA	CPI-U: Milk (SA, Dec-97=100)	JCNFOFIM@USNA	Personal Consumption Expenditures: Fresh Milk Price Index (SA, 2009=100)
UFYPC@CPIDATA	CPI-U: Cheese and Related Products (SA, 1982-84=100)	JCNFOFDM@USNA	PCE: Processed Dairy Products Price Index (SA, 2009=100)
UFME@CPIDATA	CPI-U: Eggs (SA, 1982-84=100)	JCNFOFEM@USNA	Personal Consumption Expenditures: Eggs Price Index (SA, 2009=100)
UFOT@CPIDATA	CPI-U: Fats and Oils (SA, 1982-84=100)	JCNFOFWM@USNA	Personal Consumption Expenditures: Fats and Oils Price Index (SA, 2009=100)
UFFFF@CPIDATA	CPI-U: Fresh Fruits (SA, 1982-84=100)	JCNFOFFM@USNA	Personal Consumption Expenditures: Fresh Fruit Price Index (SA, 2009=100)
UFFVF@CPIDATA	CPI-U: Fresh Vegetables (SA, 1982-84=100)	JCNFOFVM@USNA	Personal Consumption Expenditures: Fresh Vegetables Price Index (SA, 2009=100)
UFFP@CPIDATA	CPI-U: Processed Fruits & Vegetables (SA, Dec-97=100)	JCNFOFTM@USNA	PCE: Processed Fruits & Vegetables Price Index (SA, 2009=100)
UFOS@CPIDATA	CPI-U: Sugar and Sweets (SA, 1982-84=100)	JCNFOFSM@USNA	Personal Consumption Expenditures: Sugar and Sweets Price Index (SA, 2009=100)
UFH@CPIDATA	CPI-U: Food At Home (SA, 1982-84=100)	JCNFOFOM@USNA	PCE: Food Products, Not Elsewhere Classified Price Index (SA, 2009=100)
UFBVM@CPIDATA	CPI-U: Beverage Materials Incl Coffee & Tea (SA, Dec-97=100)	JCNFOFCM@USNA	PCE: Coffee, Tea & Other Beverage Mtls Price Index (SA, 2009=100)
UFBVJ@CPIDATA	CPI-U: Juices & Nonalcoholic Drinks (SA, Dec-97=100)	JCNFOFNM@USNA	PCE: Mineral Waters, Soft Drinks & Vegetable Juices Price Index (SA, 2009=100)
UABHD@CPIDATA	CPI-U: Distilled Spirits At Home (SA, 1982-84=100)	JCNFOLDM@USNA	Personal Consumption Expenditures: Spirits Price Index (SA, 2009=100)
UABHW@CPIDATA	CPI-U: Wine At Home (SA, 1982-84=100)	JCNFOLEM@USNA	Personal Consumption Expenditures: Wine Price Index (SA, 2009=100)
UABHB@CPIDATA	CPI-U: Beer, Ale and Malt Beverages At Home (SA, 1982-84=100)	JCNFOLBM@USNA	Personal Consumption Expenditures: Beer Price Index (SA, 2009=100)
UFH@CPIDATA	CPI-U: Food At Home (SA, 1982-84=100)	JCNFEFM@USNA	PCE: Food Produced & Consumed on Farms Price Index (SA, 2009=100)

UAW@CPIDATA	CPI-U: Women's & Girls' Apparel (SA, 1982-84=100)	JCNLFFM@USNA	PCE: Women's & Girls' Clothing Price Index (SA, 2009=100)
UAM@CPIDATA	CPI-U: Men's & Boys' Apparel (SA, 1982-84=100)	JCNLMFM@USNA	PCE: Men's & Boys' Clothing Price Index (SA, 2009=100)
UAI@CPIDATA	CPI-U: Infants' & Toddlers' Apparel (SA, 1982-84=100)	JCNLFIM@USNA	PCE: Children's & Infants' Clothing Price Index (SA, 2009=100)
UEGW@CPIDATA	CPI-U: Sewing Machines, Fabric and Supplies (SA, Dec1997=100)	JCNLOLM@USNA	Personal Consumption Expenditures: Clothing Materials Price Index (SA, 2009=100)
UAMM@CPIDATA	CPI-U: Men's Apparel (SA, 1982-84=100)	JCNLXIM@USNA	PCE: Standard Clothing Issued to Military Personnel Price Index (SA, 2009=100)
UAF@CPIDATA	CPI-U: Footwear (SA, 1982-84=100)	JCNLSM@USNA	PCE: Shoes & Other Footwear Price Index (SA, 2009=100)
UMP@CPIDATA	CPI-U: Prescription Drugs & Medical Supplies (SA, 1982-84=100)	JCNODPM@USNA	Personal Consumption Expenditures: Prescription Drugs Price Index (SA, 2009=100)
UMGNN@CPIDATA	CPI-U: Nonprescription Drugs (NSA, Dec-09=100)	JCNODNM@USNA	PCE: Nonprescription Drugs Price Index (SA, 2009=100)
UMQN@CPIDATA	CPI-U: Medical Equipment and Supplies (NSA, Dec-09=100)	JCNODOM@USNA	PCE: Other Medical Products Price Index (SA, 2009=100)
UET@CPIDATA	CPI-U: Toys (SA, 1982-84=100)	JCNOGTM@USNA	PCE: Games, Toys & Hobbies Price Index (SA, 2009=100)
UEPTP@CPIDATA	CPI-U: Pets and Pet Products (SA, 82-84=100)	JCNRPM@USNA	PCE: Pets & Related Products Price Index (SA, 2009=100)
UHHQI@CPIDATA	CPI-U: Indoor Plants and Flowers (SA, Dec-90=100)	JCNGARM@USNA	PCE: Flowers, Seeds & Potted Plants Price Index (SA, 2009=100)
UETPFN@CPIDATA	CPI-U: Film and Photographic Supplies (NSA, Dec-97=100)	JCNOGFM@USNA	PCE: Film & Photographic Supplies Price Index (SA, 2009=100)
UHHKCN@CPIDATA	CPI-U: Household Cleaning Products (NSA, Dec-97=100)	JCNOLPM@USNA	PCE: Household Cleaning Products Price Index (SA, 2009=100)
UHHKRN@CPIDATA	CPI-U: Household Paper Products (NSA, Dec-97=100)	JCNOLFM@USNA	PCE: Household Paper Products Price Index (SA, 2009=100)

UHHWLN@CPIDATA	CPI-U: Other Household Linens (NSA, Dec-97=100)	JCNOLNM@USNA	Personal Consumption Expenditures: Household Linens Price Index (SA, 2009=100)
UEGW@CPIDATA	CPI-U: Sewing Machines, Fabric and Supplies (SA, Dec1997=100)	JCNOLSM@USNA	Personal Consumption Expenditures: Sewing Items Price Index (SA, 2009=100)
UHHKM@CPIDATA	CPI-U: Miscellaneous Household Products (SA, Dec-97=100)	JCNOLOM@USNA	PCE: Misc Household Products Price Index (SA, 2009=100)
UOPPMN@CPIDATA	CPI-U:Hair/Dental/Shaving/Misc Personal Care Prdcts (NSA, Dec-97=100)	JCNOPPM@USNA	PCE: Hair/Dental/Shave/Misc Pers Care Prods ex Elec Prod Price Idx(SA, 2009=100)
UOPPCN@CPIDATA	CPI-U: Cosmetics/Perfumes/Bath/Nail Preps & Impls(NSA, 1982-84=100)	JCNOPCM@USNA	PCE: Cosmetic/Perfumes/Bath/Nail Preparatns & Implements Price Idx(SA, 2009=100)
UOPPMN@CPIDATA	CPI-U:Hair/Dental/Shaving/Misc Personal Care Prdcts (NSA, Dec-97=100)	JCNOPEM@USNA	PCE: Elec Appliances for Personal Care Price Index (SA, 2009=100)
UOT@CPIDATA	CPI-U: Tobacco & Smoking Products (SA, 1982-84=100)	JCNOTM@USNA	Personal Consumption Expenditures: Tobacco Price Index (SA, 2009=100)
UERPN@CPIDATA	CPI-U: Newspapers and Magazines (NSA, Dec-97=100)	JCNMGM@USNA	PCE: Newspapers & Periodicals Price Index (SA, 2009=100)
UOEES@CPIDATA	CPI-U: Stationery/Stationery Supplies/Gift Wrap (SA, 1982-84=100)	JCNONM@USNA	PCE: Stationery & Misc Printed Mtls Price Index (SA, 2009=100)
PCUSLFE@USECON	CPI-U: All Items Less Food and Energy (SA, 1982-84=100)	JCNOVGM@USNA**	PCE: Govt Employees' Expenditures Abroad Price Index (SA, 2009=100)
PCUSLFE@USECON	CPI-U: All Items Less Food and Energy (SA, 1982-84=100)	JCNOVNM@USNA**	PCE: Pvt Employees' Expenditures Abroad Price Index (SA, 2009=100)
PCUSLFE@USECON	CPI-U: All Items Less Food and Energy (SA, 1982-84=100)	JCNOVRM@USNA**	PCE: Less: Personal Remittances in Kind to Nonresidents Price Idx (SA, 2009=100)
UFAHE@CPIDATA	CPI-U: Food at Employee Sites & Schools (SA, Dec-97=100)	JCSFPGM@USNA	PCE: Elementary & Secondary School Lunches Price Index (SA, 2009=100)

UFAHE@CPIDATA	CPI-U: Food at Employee Sites & Schools (SA, Dec-97=100)	JCSFPUM@USNA	PCE: Higher Education School Lunches Price Index (SA, 2009=100)
UFAHLN@CPIDATA	CPI-U: Limited Service Meals and Snacks (NSA, Dec-97=100)	JCSFPLM@USNA	PCE: Meals at Limited Service Eating Places Price Index (SA, 2009=100)
UFAHF@CPIDATA	CPI-U: Full Service Meals & Snacks (SA, Dec-97=100)	JCSFPEM@USNA	PCE: Meals at Other Eating Places Price Index (SA, 2009=100)
UFAHF@CPIDATA	CPI-U: Full Service Meals & Snacks (SA, Dec-97=100)	JCSFPDM@USNA	PCE: Meals at Drinking Places Price Index (SA, 2009=100)
UABE@CPIDATA	CPI-U: Alcoholic Beverages Away From Home (SA, 1982-84=100)	JCSFPBM@USNA	PCE: Alcohol in Purchased Meals Price Index (SA, 2009=100)

**No match can be determined, so use Core CPI as forecast for component

Table A8a: Core quantity variables in inventory BVAR

Variable Name	Variable Descrption	Transformation
IPMDG@IP	IP: Durable Manufacturing [NAICS] (SA, 2007=100)	LogDifference
LADURGA@USECON	All Employees: Durable Goods Manufacturing	LogDifference
RealNMSDG@USECON	Manufacturers' Shipments: Durable Goods (SA, Mil.$) -- deflated by Implicit price deflator for durable manufacturing sales [DTSMD@USNA, from NIPA table 2BUI]	LogDifference
NAPMII@USECON	ISM Mfg: Inventories Index (SA, 50+ = Econ Expand)	Level
NAPMC@USECON	ISM Mfg: PMI Composite Index (SA, 50+ = Econ Expand)	Level
IPMND@IP	IP: Nondurable Manufacturing [NAICS] (SA, 2007=100)	LogDifference
LANDURA@USECON	All Employees: Nondurable Goods Manufacturing (SA, Thous)	LogDifference
RealNMSNG@USECON	Mfrs' Shipments: Nondurable Goods Industries (SA, Mil.$) -- deflated by Implicit price deflator for nondurable manufacturing sales [DTSMN@USNA, from NIPA table 2BUI]	LogDifference
IPMFG@IP	IP: Manufacturing (SIC) (SA, 2007=100)	LogDifference
LAWTRDA@USECON	All Employees: Wholesale Trade (SA, Thous)	LogDifference
RealNWSH@USECON	Merchant Wholesalers: Sales: Total (SA, Mil.$)	LogDifference
IP51@IP	IP: Consumer Goods (SA, 2007=100)	LogDifference
LARTRDA@USECON	All Employees: Retail Trade (SA, Thous)	LogDifference
RealNRSXM@USECON	Retail Sales: Total Excl Motor Vehicle & Parts Dealers (SA, Mil.$) -- deflated by constructed price deflator for retail sales ex-autos	LogDifference
IAU@IP	IP: Motor Vehicle Assemblies (SAAR, Mil.Units)	LogDifference

TotalDomForAutoSales	Sum of light auto and light truck sales from foreign and domestic producers [ADS@USECON+AFS@USECON+TLSAR@USECON+TMSAR@USECON]	LogDifference

Note: BVAR includes 6 lags and data since January 1983.

Table A8b: Variables in second blocks of inventory BVARs

Variable Name	Variable Descrption [without sales scaling factor]	Sales scaling factor	Variables from core quantity BVAR in first Block
dBeaNMIDG_USECONscale	Change in Manufacturers' Inventories: Durable Goods [NMIDG@USECON] + Inventory Valuation Adj: Mfg: Durable Goods [VNMDIM@USNA].	Six month lag of Manufacturers' Shipments: Durable Goods [NMSDG@USECON].	dlIPMDG_IP, dlLADURGA_USECON, dlRealNMSDG_USECON, NAPMII_USECON, NAPMC_USECON
dBeaNMING_USECONscale	Change in Mfrs' Inventories: Nondurable Goods Industries [NMING@USECON] + Inventory Valuation Adj: Mfg: Nondurable Goods [VNMNIM@USNA]	Six month lag of Mfrs' Shipments: Nondurable Goods Industries [NMSNG@USECON].	dlIPMND_IP, dlLANDURA_USECON, dlRealNMSNG_USECON, NAPMII_USECON, NAPMC_USECON
dBeaNWIH_USECONscale	Change in Merchant Wholesalers: Inventories: Total [NWIH@USECON] + Inventory Valuation Adj: Merchant	Six month lag of Merchant Wholesalers: Sales: Total [NWSH@USECON]	dlIPMFG_IP, dlLAWTRDA_USECON, dlRealNWSH_USECON

	Wholesalers [VNWLMIM@USNA]		
dBeaNRIXM_USECONscale	Change in Retail Inventories: Total Excl Motor Vehicle & Parts Dealers [NRIXM@USECON] + Inventory Valuation Adj: Retail Trade excl Motor Vehicle & Parts Dealers [VNRIM@USNA - VNRDVIM@USNA].	Six month lag of Retail Sales: Total Excl Motor Vehicle & Parts Dealers [NRIXM@USECON]	dlIP51_IP, dlLARTRDA_USECON, dlRealNRSXM_USECON
VNRDVHM_USNAtoSalesB	Real Inventory Change: Retail: Motor Vehicle Dealers [NAICS](SAAR, Mil.Ch.2005$) [VNRDVHM@USNA]	Sum of light auto and light truck sales from foreign and domestic producers [ADS@USECON+AFS@USECON+TLSAR@USECON+TMSAR@USECON]	dlIAU_IP, dlTotalDomForAutoSales

dRealNonMerchWSInvToLagRealInv	Real Inventory Change: Nonmerchant Wholesalers [NAICS] (SAAR,Mil.Chn.2005$)	Lagged 1-quarter value of Nonmerchant Wholesalers Inventories (EOP, SAQT, Mil.Chn.2005$) [SNWWZ@USNA], interpolated to monthly frequency	dlIPMFG_IP, dlLAWTRDA_USECON, dlRealNMSDG_USECON, dlRealNMSNG_USECON, dlRealNWSH_USECON, dlRealNRSXM_USECON

Note: BVAR includes 6 lags and data since January 1983.

Table A8c: Prices used for inventory valuation adjustments (IVAs)

Finished goods + work in progress prices variable	Finished goods + work in progress prices description	Material goods prices variable	Material goods prices description
DurManufPricesWtSplicePPI	Weighted average of PPI inflation rates for the net output of major durable manufacturing industries [R321@PPIR, R327@PPIR, R331@PPIR, R332@PPIR, R333@PPIR, R334@PPIR, R335@PPIR, R336@PPIR, R337@PPIR, R339@PPIR]. NSA Data at http://www.bls.gov/news.release/ppi.t04.htm . SA Series taken from Haver Analytics using their seasonal adjustment settings. Weights using work in progress and finished goods inventories levels from Census Bureau M3 report [see http://www.census.gov/manufacturing/m3/prel/pdf/table6p.pdf]	SP2130@PPI	PPI: Materials for Durable Manufacturing

NonDurManufPricesWtPPISplice	Weighted average of PPI inflation rates for the net output of major nondurable manufacturing industries [R311@PPIR, R312@PPIR, R313@PPIR, R314@PPIR, R315@PPIR, R316@PPIR, R322@PPIR, R323@PPIR, R324@PPIR, R325@PPIR, R326@PPIR]. NSA Data at http://www.bls.gov/news.release/ppi.t04.htm . SA Series taken from Haver Analytics using their seasonal adjustment settings. Weights using work in progress and finished goods inventories levels from Census Bureau M3 report [see http://www.census.gov/manufacturing/m3/prel/pdf/table6p.pdf]	SP2120@PPI	PPI: Materials for Nondurable Manufacturing

WholeInvPPI	Weighted average of PPI inflation rates [durable -- R3361@PPIR, R337@PPIR, R321@PPIR, UDIIN@CPIDATA, R331@PPIR, R3351@PPIR, R3325@PPIR, R333@PPIR, SP2130@PPI] and [nondurable R322@PPIR, S063@PPI, R315@PPIR, SP3110@PPI, SP1100@PPI, R325@PPIR, R324@PPIR, S0261@PPI, SP3120@PPI] primarily net-output of manufacturing PPIs from Table 4 [http://www.bls.gov/news.release/ppi.t04.htm] and Table 5 [http://www.bls.gov/news.release/ppi.t05.htm] of PPI release. NSA data are seasonally adjusted using Haver seasonal adjustment. Weights derived from real chained-dollar and price series for merchant wholesale industry level sales from BEA NIPA tables 2BU [http://www.bea.gov/iTable/iTable.cfm?ReqID=12&step=1#reqid=12&step=3&isuri=1&1203=59] and 2BUI [http://www.bea.gov/iTable/iTable.cfm?ReqID=12&step=1#reqid=12&step=3&isuri=1&1203=60].	SP2000@PPI	PPI: All Intermediate Materials,Supplies and Components
WtMthRetExAutoInvPrices	Weighted average of retail sales inflation rates for BEA retail and food service sales from NIPA Table 7U [http://www.bea.gov/iTable/iTable.cfm?ReqID=12&step=1#reqid=12&step=3&isuri=1&1203=11]. Weights using interpolated and extrapolated inventory stocks from annual retail trade survey -- available at http://www2.census.gov/retail/releases/current/arts/invent.xls.	SP2000@PPI	PPI: All Intermediate Materials,Supplies and Components

Table A9: Producer price index mapping to nonresidential structures

Investment Component	Price index	Monthly Indicator 1	Start of PPI series	Monthly Indicator 2	Description of Monthly Series
Office building	JFNSCO@USNA	R236223@PPIR	Jun-06		PPI for Office Building
Health Care	JFNSCH@USNA	CCIHD@USECON	-	AO Forecast	Average of Census Bureau price index for new-one family homes [CCIHD@USECON] and unavailable Turner Construction Co building cost index
Warehouse	JFNSW@USNA	R236221@PPIR	Dec-04		PPI for Warehouses
Food and Beverage Establishments	JFNSSF@USNA	R236221@PPIR	Dec-04		PPI for Warehouses
Multimerchandise shopping	JFNSSM@USNA	R236221@PPIR	Dec-04		PPI for Warehouses
Other commercial	JFNSOC@USNA	R236221@PPIR	Dec-04		PPI for Warehouses and PPI for Mobile Structures [not used].
Manufacturing	JFNSMG@USNA	R236211@PPIR	Jun-07		PPI for industrial buildings
Electric power	JFNSPE@USNA	AO Forecast			Unavailable Bureau of Reclamation Quarterly construction cost index (BRCT@USECON)
Other power	JFNSPO@USNA	S101706@PPI	Jan-04	AO Forecast	Steel pipes and tube PPI is half of the index S101706@PPI, Unavailable Quarterly Bureau of Reclamation Cost index is the other [BRCT@USECON]
Communictation	JFNSTT@USNA	AO Forecast			not available
Religious	JFNSR@USNA	CCIHD@USECON			See Note 1
Educational and vocational	JFNSE@USNA	R236221@PPIR	Dec-04		Educational and vocational
Lodging	JFNSL@USNA	CCIHD@USECON	-	AO Forecast	See Note 1
Amusement and recreation	JFNSAM@USNA	CCIHD@USECON	-	AO Forecast	See Note 1
Air transportation	JFNSTA@USNA	CCIHD@USECON	-	AO Forecast	See Note 1
Farm	JFNSF@USNA	CCIHD@USECON	-	AO Forecast	See Note 1

Brokers' commissions on sales of structures	JFNSBK@USNA	R5312101@PPIR	Dec-95	R5312103@PPIR	For 2006 present: PPI for Real Estate Agts, Res prop sales, Brokerage fees, Commiss [R5312101@PPIR]. For 1996 to 2005, PPI for nonresidential property sales, brokerage fees, and commissions [R5312103@PPIR]

Note 1: Average of Census Bureau price index for new-one family homes [CCIHD@USECON] and unavailable Turner Construction Co building cost index