Why Has GDP Growth Been So Slow to Recover?

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1. Introduction

From 2010q1 to 2016q2, US GDP grew at an annual average rate of 2.01%. In comparable stages of the previous three expansions, GDP growth averaged 3.75% annually. Over 2010-2016, this shortfall of 1.74 percentage points (pp) cumulates to a value of GDP 13.2% greater than it actually is.

Although there is widespread agreement that the recovery in GDP has been slow, there is less agreement on why it has been slow. We group explanations for the slow recovery of GDP into four broad categories. The first, slower trend growth, emphasizes changes in the economy and the labor force that have transpired over decadal time scales and which arguably have little to do with the dynamics of economic recovery. These evolving trends include, most prominently, the demographic shifts of the surge of women into the labor force in the 1970s-1990s and, more recently, the baby boom beginning to retire. They also include other long-term shifts such as the gradual decline in weekly hours and, more controversially and less well understood, the productivity malaise. The second group of explanations emphasizes chronic problems related to inadequate demand or policy failures: secular stagnation; retarded consumption growth because of growing inequality; hysteresis that manifests as slow growth of the labor force and employment; and failures of monetary and/or fiscal policy. The third group of explanations consists of one-off explanations: weak international demand as Europe struggled to recover and growth slowed in China; lingering effects of the financial crisis on both the housing sector and private fixed investment; fiscal headwinds because of the combined unwinding of fiscal stimulus from the American Reinvestment and Recovery Act (ARRA) and the sequester; fiscal policy uncertainty that postponed investment and consumption and thus depressed demand; and the potentially reduced ability of monetary policy to provide effective stimulus in the face of the zero lower bound on interest rates. The fourth group of explanations suggests that at least some of the slowdown in GDP growth (and in productivity) is not real but rather is an artifact of escalating difficulties with the measurement of real output and prices in some important sectors of the economy, such as information technology (IT).

This paper examines the slow recovery and its causes. An initial question one must answer when quantifying the slowdown is, slow compared to what? We answer this in two ways, which gives rise to two different but complementary slow-growth decompositions. The first

builds on the comparison in the opening paragraph, and decomposes the difference in the mean growth rate of GDP (and other variables) in the current recovery, minus the comparable stages of the previous three recoveries[1], into the sum of changes in long-term growth rates and changes in cyclical components. This decomposition allows us to evaluate the first category of explanations, that the slow growth in this recovery is at least in part due to underlying long-term shifts such as changing demographics. To implement this comparison we develop estimates of the long-term trends in various economic variables using a combination of time series methods and bottom-up analysis of some key series. In particular, we adopt the approach in the literature on the labor force participation rate in which we compute a pure aging trend for the LFPR.

Our second decomposition is aimed at assessing the final three groups of explanations. The benchmark for this decomposition is what one reasonably might have projected growth over the 2010-2016 period to be, standing in 2009q4 (with the benefit of fully revised economic data through 2009). Accordingly, this second decomposition expresses the actual growth of GDP (or other variables) over 2010q1-2016q2 as the sum of its trend component, a predicted cyclical component, and a prediction error. The predictions are computed using factors estimated using a 139-variable dynamic factor model (DFM), where the forecasting model parameters are estimated using values of the factors from 1984q1-2007q4. With 2009q4 as a jumping off point, the forecasting model is used to predict the variables from 2010q1-2016q2. Although this is not a true out-of-sample exercise, it does provide a way to quantify the arc of the recovery that would be consistent with correlations from the previous three business cycles. Thus departures from that predicted path represent either shocks that occurred over 2010-2016, new dynamics (breakdown of the forecasting model), or both.

We have several main findings. First, of the 1.74 pp of slow growth, we attribute 0.91pp to a slower long-term mean growth rate for GDP.[2] Most of this trend slowdown is attributable to demographic changes that affect the long-term supply of labor. Our estimates of current trend GDP growth are comparable to those of the Congressional Budget Office (CBO (2106)). Our estimate is sensitive to how much of the recent slowdown in productivity growth is permanent,

[1] The recession ended in 2009q2 according to the NBER, but the unemployment rate peak was in 2009q4 and measures of aggregate employment reached their trough in late 2009 or early 2010. By 2010q2, the unemployment rate nearly equals the CBO's estimate of the NAIRU. We compare 2010q1-2016q2 to the previous expansions from their third quarters until the unemployment rate falls to the CBO's NAIRU.

[2] Throughout, mean growth rates are reported to two decimal points to facilitate cross-referencing with tables and to reduce rounding confusion in growth rate addition.

which induces considerable uncertainty into the fraction of the decline is attributable to trend shifts. That said, our estimate of one-half to two-thirds of the slowdown (relative to the previous three recessions) is due to slower long-run trends is consistent with previous estimates made earlier in the recovery (CBO (2013), CEA (2013, ch. 2)).

Second, compared to the benchmark of our 2009q4 DFM forecasts, GDP growth averaged 0.52pp slower than would have been expected, given the severity of the Great Recession. We view this 0.52pp mean shortfall as the slow growth of GDP that is to be explained.

Third, many measures of economic activity grew essentially as predicted. Employment growth closely tracks its forecasted values, as does the growth rates of consumption and gross private domestic investment.

Fourth, a few key economic indicators recovered more slowly than predicted. Notably, the rate of long-term unemployment and the labor force participation rate fell short of their predicted values. In addition, government spending, especially at the state and local level, along with government employment, substantially underperformed relative to the DFM forecasts, as did the growth of exports.

Fifth, although the productivity malaise remains a puzzle, some of the slowdown in average growth over 2010-2016, 0.23pp by our estimates, is cyclical. (Our estimate of the cyclical component of productivity is the one part of our results that is sensitive to specification changes and other specifications yield substantially larger cyclical components, e.g. 0.6pp.) Even after adjusting for predicted cyclical movements in productivity and allowing for a modest trend productivity slowdown, we obtain a large estimate for the unexpectedly slow growth in productivity of 1.09pp. An important question going forward is how much, if any, of this discrepancy is likely to be permanent.

Taken together, we find evidence in favor of some of the explanations for the slow growth of GDP, after accounting for the slower long-term demographic trends. The unexpectedly slow growth of exports points to weak international demand as one restraint. According to our decompositions, a large fraction, roughly half, of the slowness in GDP growth is explained (in a GDP accounting sense) by unusually slow growth in government expenditures. At the federal level, the timing of this fiscal drag aligns with the unwinding of ARRA expenditures and the 2013 introduction of the sequester, while state and local spending and hiring was slow over the

entire recovery. We also find some circumstantial evidence that measurement problems could play a role in the measured growth slowdown, although that evidence is not restricted to the sector (IT) which has received the most attention in the measurement debate. In contrast, we find less support for many of the other proposed explanations. While services consumption was unexpectedly slow, total consumption growth makes only a small contribution to the unexpected part of the GDP growth slowdown, and the contribution of investment is even smaller. Business fixed investment, while slow in 2013-2014, was not abnormally slow on average over this period. Perhaps most surprisingly, the growth of housing investment over this period was slightly stronger than would have been expected standing in 2009q4 (note that this strong growth is from an extremely low starting point in 2009q4). And employment growth was stronger than would have been expected. The finding that consumption and investment largely tracked their predicted values poses a challenge for explanations that operate through a channel of weak private aggregate demand.

2. Growth Trends

The long-term growth rate of GDP has evolved over the past 70 years as a result of long-term supply-side changes in the economy. The most significant such change is demographic changes in the labor force. As seen in Figure 1, the labor force participation rate (LFPR) grew by 8pp from the mid-1960s to the late 1990s. In the late 2000s, the first wave of the baby boom reached Social Security early retirement age, and since the mid-2000s the retirement of baby boomers has contributed to the large decline in the LFPR. Women tend to work fewer hours than men, and the rise in the LFPR during the 1970s -1990s was associated with a decline in average weekly hours. Combined with the long-term evolution of population growth arising from shifts in fertility, the size of the child-bearing population, and immigration, these long-term demographic trends lead to changes in the long-term steady-state growth rate of economic activity. While some of these demographic changes might have endogenous links to long-term economic welfare, the aging of the baby boom does not and in any event these trends are on decadal time scales far longer than business cycle fluctuations. For the purpose of this paper, we treat these demographic trends as exogenous low frequency shifts in the growth rate of employment, GDP, and NIPA components.

We use different methods to estimate growth trends depending on their purpose. All series used to estimate the factors are, for that purpose, detrended using a time series smoother. For the purpose of comparing trends in the current recovery to those in the previous three, and for making the forecasts of GDP, employment, and other headline variables, we take a different approach to estimating the post-2007 trend based on a combination of demographic modeling, time series methods, and judgment. We discuss these two methods in turn.

2.1. Full-sample time series trends

Full-sample estimates of the trends are used to estimate the average trend in series *i* in the previous three expansions. Following Stock and Watson (2012, 2016), we estimate the low-frequency growth rate trend using a biweight filter with a truncation parameter (bandwidth) of 100 quarters, applied to the full data span available for a given series.[3] End points are handled by truncation and renormalization (not by prediction of the series and extrapolation). Relative to an equal-weighted moving average filter, the smooth weights eliminate jumps in the estimated trend. Relative to the Hodrick-Prescott (1997) filter, the pass band of this filter is much longer to reduce overlap with business cycle frequencies. For additional discussion comparisons to other filters, see Stock and Watson (2016, Section 6.1.1). In unreported robustness results, we also computed the trends using semiparametric cyclical adjustment (e.g. Stock (2014)) and the results away from the end points (i.e. pre-2007) were insensitive to this additional adjustment, so for simplicity we drop the cyclical adjustment step.

2.2 Post-2007 growth trends

For employment, GDP, GDI, and the primary NIPA aggregates, we estimate the post-2007 growth trends using a "bottom-up" approach. Using standard supply-side growth identities, the long term trend in employment and GDP is computed as the sum of long-term trends in the components. The component with the most and best-understood variability is the LFPR, for which the post-2007 growth trend is computed as a pure demographic shift (a pure "aging trend").

[3] The biweight filter $w(L)$ is two-sided with $w_j = c(1 - (j/B)^2)^2$ for $|j| \le B$ and = 0 otherwise, where B is the bandwidth and c is a normalization constant such that $w(1) = 1$.

The supply-side identities are similar to ones used by Gordon (20XX, 2014), CEA (), and CBO. We write these first for employment as measured by the establishment survey, and second for GDP:[4]

$$\Delta \ln E_t^{Payroll} = \Delta \ln \left(\frac{E_t^{Payroll}}{E_t^{HH}} \right) + \Delta \ln e_t + \Delta \ln LFPR_t + \Delta \ln Popn_t \qquad (1)$$

$$\Delta \ln GDP_t = \Delta \ln \left(\frac{GDP_t}{Y_t^{NFB}} \right) + \Delta \ln \pi_t^{NFB} + \Delta \ln h_t^{NFB} + \Delta \ln \left(\frac{E_t^{NFB}}{E_t^{Payroll}} \right) + \Delta \ln E_t^{Payroll} \qquad (2)$$

where $E_t^{Payroll}$ = Total employment, establishment survey

E_t^{NFB} = Employment, nonfarm business, establishment survey

E_t^{HH} = Total employment, household survey (CPS)

e_t = Employment rate = 1 – unemployment rate (CPS)

$LFPR_t$ = labor force participation rate (CPS)

$Popn$ = civilian non-institutionalized population age 16+ (CPS)

Y_t^{NFB} = real output, nonfarm business

π_t^{NFB} = labor productivity, nonfarm business (output per hour)

h_t^{NFB} = weekly hours per worker, nonfarm business

The first term in (1) is the growth rate of the ratio of employment as measured by the Establishment Survey and the Household Survey. The second term is the growth rate of the employment rate, the third term is the growth rate of the LFPR, and the final term is the growth rate of the population. In (2), the first term is the negative growth rate of the share of NFB output in total output, the second term is the growth rate of NFB labor productivity, the third term is the

[4] The growth identities (1) and (2) derive from the identities $PayrollEmp = \frac{PayrollEmp}{HHEmp} \times \frac{HHEmp}{LF} \times \frac{LF}{Popn} \times Popn$ and $GDP = \frac{GDP}{NFBoutput} \times \frac{NFBoutput}{NFBHours} \times \frac{NFBHours}{NFBEmp} \times \frac{NFBEmp}{PayrollEmp} \times PayrollEmp$, using obvious abbreviations, and taking first differences of logarithms.

growth rate of NFB hours per employee, the fourth term is the growth rate of the share of NFB payroll employment in total payroll employment, and the final term is the growth rate of payroll employment. [5]

We now describe the methods used to compute the trends of each of the terms in (1) and (2).

Labor force participation rate. We use a standard approach (e.g. CEA (2014)) and estimate demographic component of the post-2007 trend in the LFPR. Specifically, using CPS microdata, we estimate participation rates for men and women separately at each age 16-80. These participation rates are estimated using 2005 and 2006 data to reflect participation at full employment (during the previous expansion, the unemployment rate first fell below the CBO estimate of the NAIRU in 2005q3). We then use actual CPS population shares to compute counterfactual changes in the LFPR that would arise solely from demographic shifts (the CPS shares are extended into 2016 using scaled Social Security Administration share projections). The result is a pure aging trend for the LFPR that reflects the effect of the aging baby boomers moving into normal retirement ages. The LFPR and this pure aging trend post-2007 are plotted in Figure 2, where the pure aging trend is benchmarked to the LFPR in 2007q4 for graphing purposes (this benchmarking is not necessary for the slow-growth decompositions because those are in growth rates).

Population. For this analysis, we condition on actual (CPS) population growth. An alternative approach that projects population to grow post-2007 at the trend growth rate of population as estimated using a biweight filter for 2007q4 yields essentially the same results.

Productivity growth. Although there appears to be a broad view that trend productivity growth has slowed after its surge in the late 1990s, the extent of the slowdown is far from settled. Figure 3 presents the real-time Survey of Professional Forecasters median forecast of nonfarm business productivity growth over the subsequent 10 years, along with the historical 10-year average growth rate of productivity (the latter is computed using the fully revised data available as of this writing). Since 2008, the SPF 10-year forecast has been below its 1960-2017 mean of 2.13%, hovering between 1.86% and 2.04% from 2008-2013 until dropping to 1.37% this year.

[5] An alternative approach is to use total GDP and total household employment. Doing so has the advantage of avoiding the payroll-household survey connection, however the productivity measure is for the entire economy which is well known to have substantial measurement limitations. The decomposition used here has the advantage of connecting with the broader literature on productivity, which focuses on NFB productivity.

Reflecting this broad pessimism, CBO is currently using projecting 10-year productivity growth to be 1.8% (CBO (2016)). Absent any consensus on this value, we adopt a post-2007 trend productivity growth rate of 1.9%, consistent with SPF values 2008-2013 and slightly above the current CBO value. This is the least certain of the components of our estimate of the post-2007 trend and we highlight results that are sensitive to this assumption in our discussion of results.

Employment rate. Following standard practice, the long-term trend growth rate of the employment rate is set to zero (full employment over the long run).

Remaining series. The remaining terms in (1) and (2) exhibit much smaller changes in their trend growth rates, at least since the mid-1990s, than do the LFPR and productivity growth (and, to a lesser extent, population). Our estimated growth trends for these remaining series are insensitive to the method used. To maintain consistency with the pre-2007 detrending, we therefore adopt as the trend growth rate for the remaining series the 2007q4 value of the biweight trend, computed using the full sample.

Values of estimated trends. Table 1 presents the values of the estimated trends for each year, 2010 through the first half of 2016. Our estimate of trend GDP growth declines over this period from 2.09% to 1.87%. Virtually all this decline is driven by the aging trend in the LFPR. The average trend growth rate of GDP 2010q1-2016q2 is 1.97%, the same as CBO's 2.0% estimate of the growth of potential GDP over 2016-2026.

3. Dynamic Factor Model for the Cyclical Components

The forecasts for a given variable y_{it} in 2009 is computed using contemporaneous values of 8 estimated factors $\hat{F}_t$, using data on (y_{it}, F_{it}) from 1984q1-2007q4.

To fix notation, we briefly summarize the dynamic factor model. A DFM represents the N time series X_t – here, the cyclical components of 139 variables – as a linear function of a small number r of unobserved factors F_t, which in turn evolve over time, plus an idiosyncratic component e_t which represents measurement error and series-specific dynamics. The factors give rise to the dynamic comovements of the observed series. We work with the static form of the DFM,

$$X_t = \Lambda F_t + e_t \tag{3}$$

$$F_t = \Phi(\mathrm{L})F_t + \eta_t, \tag{4}$$

where Λ is the $N \times r$ matrix of factor loadings, $\Phi(\mathrm{L})$ is are the vector autoregression lag polynomial for the factors, and η_t are the innovations to the factors. The term ΛF_t is referred to as the common component of X_t and e_t is the idiosyncratic component.

Estimation using detrended growth rates. The factors are estimated using the cyclical components of the 139 series (discussed below), where the cyclical components were computed as the residual after full-sample detrending of Section 2.1. Factors were then estimated by principal components, applied to these cyclical components, over the 1959q3-2009q4 period.[6] For the remainder of the analysis, these estimated factors are treated as data. Factors 5-8 explain substantial fractions of the variation in labor productivity, hourly compensation, the term spread, and exchange rates, so following Stock and Watson (2016) we adopt an 8-factor model.

Given these (full-sample) estimates of the factors, the factor loadings Λ and the factor VAR coefficients $\Phi(\mathrm{L})$ were estimated by least squares using data on X_{it} (the full-sample detrended data) and the factors $\hat{F}_t$, with an estimation period of 1984q1-2007q2.

Data for estimating the factors. The factors are estimated using the 139 series summarized in Table 2. All data are quarterly, with the full sample period 1959q1-2016q2. Real activity variables are seasonally adjusted. The series used to estimate the factors omit high-level aggregates to avoid aggregation identities and double-counting, for example GDP is omitted because its components are included, consumption of goods is omitted because durables and nondurables consumption are included separately, and total employment is omitted because its components are included. Series are transformed to be approximately stationary, for example real activity variables are transformed to growth rates (at an annual rate) and inflation is transformed to first differences. These transformed data are then detrended following Section 2.1 so that the cyclical growth components are used to estimate the DFM.

Table 3 provides two measures of model fit for selected series: the R^2 of the common component (the fraction of the variance of the one-quarter growth rate of the indicated cyclical component (X_{it}) explained by the estimated factors) and the root mean squared error of the

[6] As discussed in Stock and Watson (2016), even if there are structural breaks in the dynamic factor model coefficients it can be desirable to estimate the factors over the full sample, and this appears to be the case for this data set.

idiosyncratic component. The R^2s are large for the real activity variables, for example are 0.70 and 0.92 respectively for the quarterly growth rates of GDP and payroll employment (neither of which were used to estimate the factors). Interestingly, the RMSEs of the idiosyncratic components are quite similar in the in- and out- of sample periods for the listed series, consistent with stability of the pre-2007 DFM over the post-2009 period.

Forecasts. The forecasts are computed using DFM parameters estimated over 1984q1-2007q4, applied to the data through 2009q4. Specifically, the forecast of the cyclical component of the i^{th} variable is computed using the following steps. These steps apply both to the 139 variables used to estimate the factors and to those variables, like GDP, not used to estimate the factors.

(i) The cyclical component X_{it} is computed as described in Section 2.1.

(ii) The forecasting model for the i^{th} cyclical component is estimated by regressing X_{it} on $\hat{F}_t$ to estimate its factor loading $\hat{\Lambda}_i^{84-07}$. The residuals from this regression are the estimated idiosyncratic component, and an AR(2) is estimated for the idiosyncratic component over 1984q1-2007q4.

(iii) Using the VAR(3) coefficients $\hat{\Phi}(L)$ estimated over 1984q1-2007q4, the values of the factors over 2010-2016, $\hat{F}_{t|2009q4}$, are forecasted using $\{\hat{F}_t\}$ through 2009q4.

(iv) Using the factor forecasts $\{\hat{F}_{t|2009q4}\}$ from (iii), the factor loadings $\hat{\Lambda}_i^{84-07}$ from (ii), and the idiosyncratic AR(2) from (ii), forecasts of X_{it} are made over the period 2010q1-2009q4.

(v) Forecasts for the original series (not detrended) are computed by adding the post-2007 trend to the forecasts of X_{it}. For the series for which bottom-up trends described in Section 2.2 are available, those post-2007 trends are used. For the remaining series, the post-2007 trend is set to the value of the full-sample trend in 2007q4. For GDP decompositions, the individual-specific trends are estimated by least squares shrinkage of 2007q4 full-sample trend subject to the restriction that the share-weighted trends add to the mean trend in GDP from Section 2.2 (this final step typically results in second-decimal changes in the individual share-weighted trends).

4. The Slow Recovery: Empirical Results

As summarized in the introduction, the empirical work is organized around two decompositions. The first decomposes the growth gap between this recovery and the previous three into trend and cyclical contributions. The second decomposes growth over 2010-2016 into a predicted part using data through 2009q4 and subsequent unpredicted, or unexpected, developments. These decompositions are complementary and ask different questions.

4.1 Guide to tables and figures

The first decomposition is presented in Table 4 for GDP, employment, productivity, and selected other variables. As shown in the first row, GDP growth in the comparable stage of the previous three recoveries averaged 3.75%, fully 1.74pp above the 2.01% growth during 2010q1-2016q2. Of this 1.74pp growth gap, 0.91pp are attributable to the slowdown in the trend growth rate of GDP, while the remaining 0.82pp constitutes the gap in the cyclical performance.

Tables 5 and 6 present the second decomposition, which represents growth over the current expansion as the sum of a trend, a predicted cyclical component, and an unpredicted component (an unexplained prediction error). As seen in the first row of Table 5, over 2010q1 to 2016, GDP growth averaged 2.01%, 0.04pp above its 1.97% average trend growth. In contrast, the predicted growth of the cyclical component of GDP was 0.56pp, leaving an unexplained prediction error of -0.52. That is, adding the trend and the predicted cycle, GDP was predicted to grow and 2.53%, but in fact only grew at 2.01%, for a growth shortfall of 0.52pp.

Table 6 presents the same decomposition, applied to the components of GDP. For Table 6, the entries are percentage point contributions of the indicated entry to GDP growth. For example, the predicted mean contribution of personal consumption expenditures to GDP growth over 2010-2016 is 1.75pp, of which 1.54pp was the trend growth rate and 0.21pp was the predicted cyclical contribution; the actual contribution was 1.60pp, leading to a -0.15pp unpredicted contribution to GDP growth.

Figure 4 plots the predicted and actual paths of a number of variables. These charts provide insights into the timing of the departures of actual growth from predicted. Figure 4a presents results for GDP growth. Panel (a) presents the actual data (black 2009q4, blue

thereafter) and the trend growth rate. Panel (b) presents the predicted and actual values of the cyclical component on an expanded time scale.

4.2 Main findings

These empirical results suggest the following findings.

1. Changes in long-term trends, which are primarily driven by demographic changes in the labor force, account for slightly more than half (0.91pp of 1.74pp) of the slow growth in GDP, relative to the previous three recessions. We stress that there is considerable uncertainty about the trend component because of the uncertainty over the persistence of the slowdown in productivity growth. If trend productivity growth during the recovery remained at its 1960-2016 average of 2.13%, the decline in the trend component of GDP would be only 0.7pp; if trend productivity growth were 1.7% (which is less than CBO but higher than the recent SPF forecasts in Figure 3), then decline in the trend would account for 1.1pp, or roughly two-thirds of the total decline in GDP growth, relative to the previous three expansions. These estimates of the contribution of the slowdown are in line with previous estimates based on similar supply side decompositions, see CBO (2012) and CEA (2013). The surge of women into the labor force in the 1970s-1990s and the retirement of the baby boom more recently also has slowed the growth of the labor force and the trend growth of employment; in the case of payroll employment, trend growth fell by 0.74pp from 1.58% to 0.84%. An average annual growth rate of employment of 0.84% corresponds to monthly payroll job expansion of approximately 100,000 jobs per month.
2. Compared to what would have been expected based on the data through 2009q4, actual GDP growth has fallen short by 0.52pp. Because our method predicts the cyclical component, the total predicted value is sensitive to the value of the post-2007 trend which mechanically is added to the cyclical prediction; thus variations of ±0.2pp arising from variations in trend productivity growth would contribute a corresponding ±0.2pp to the cyclical shortfall in GDP. Our predicted cyclical component of GDP is robust to variations in the benchmark model, including shifting the jumping-off date to 2009q2 or 2009q3, using fewer factors, estimating the factors over the full sample period, or using a low-dimensional VAR. As can be seen in Figure 4(a), the actual cyclical component

tracks the prediction through mid-2012, then again from 2014-2016. Thus the shortfall in GDP growth, relative to the prediction, mainly occurs in 2012 and the first half of 2013: during 2012 and 2013, predicted GDP growth averaged 2.74%, but actual GDP growth averaged only 1.9%.

3. In contrast to GDP growth, growth of total employment and private employment has been stronger than predicted. The actual growth rate of establishment employment closely tracked the 2009q4 prediction through 2014, but the strong growth of employment persisted into 2015-2016 whereas forecasted employment growth reverts to its long-term mean by 2016q2. Total private payroll employment and nonfarm business payroll employment have patterns similar to total payroll employment, with actuals essentially matching predicted until 2015, when employment grew more strongly than predicted. The major discrepancy between predicted and actuals among employment series is government employment, for which the unpredicted cyclical component was large and negative (-0.87pp). Whereas government employment was forecasted to increase at 0.59% per year on average, it fell by 0.28% per year. Putting aside the large spikes due to Census hiring in 2010q21, the unexpectedly slow growth of government employment occurred throughout 2010 – 2014. Consistent with these aggregate employment measures recovering essentially as predicted, the unemployment rate largely tracked its predicted values. Unlike the major measures of employment (aside from government employment), the decline in the LFPR was more severe than predicted, even after accounting for the demographic trend. This observation is consistent with Figure 2, which shows that one-third of the decline in the LFPR since 2007q4 is not accounted for by the pure aging trend.
4. Productivity growth has been very slow by any standard. We estimate that some of that decline, -0.23pp, is a normal cyclical response to the Great Recession. Actual productivity growth over this period was 0.58%, or 1.55pp below the 1960-2007 mean growth of productivity. After adjustment for the cyclical estimate of -.23pp, the productivity shortfall is -1.22pp, relative to the 1960-2007 mean. We view this 1.22pp shortfall, relative to the 1960-2007 mean, as the as the productivity slowdown puzzle. Our judgmental trend for productivity assigns 0.23pp of this slowdown to a slower long-term growth, but in our view any estimate of current trend productivity growth (or

forecast over the next 10 years) is largely speculative. Turning to timing, the slow growth of productivity early in the recovery was largely consistent with the 2009q4 prediction, however starting in 2013 productivity growth started to flag, and is well below the predicted values in 2015-2016. This timing reflects the unexpected weakness in output in 2012-2013 and the unexpected strength in employment growth in 2015-2016.[7]

5. Consumption growth over the recovery was slightly weaker than predicted, and made a modest -0.15pp contribution to GDP growth. The weakest component of consumption was services, and the slow growth in services was largely focused in a few sectors: recreational goods and vehicles, financial services and insurance, other services, and nonprofit institutions serving households.
6. Private fixed investment made a small negative contribution to the unexplained cyclical shortfall in GDP. This aggregate combines offsetting effects of unpredicted slow growth of nonresidential investment and unpredicted strong growth of residential investment. The strong growth of residential investment might initially seem counterintuitive, however recall that forecasts as of 2009q4 were starting from an exceptionally low level of residential investment, so the growth (which is what matters for the GDP growth accounting used here) from this very low base was strong, even though the level of residential investment was, and remains, low by historical standards.
7. The unexpected decline in the petroleum component of U.S. imports is consistent with the sharp increase in domestic U.S. oil production since the late 2000s. This decline in net oil imports made a modest contribution of +0.09pp to GDP through the unexpected decline in imports.[8]

[7] This discussion needs a caveat. Aside from NFB hours, employment, and productivity, the rest of the decompositions in Tables 5 and 6 are robust to changes in specification including estimation dates, detrending methods, factor estimation variants, and using smaller VAR models. However, the estimates of the predicted cyclical component of NFB hours, employment, and productivity are sensitive to changes, and in particular other specifications (and VARs) produce larger estimates of the cyclical component, for example estimating the factors using data through 2016q2 increases the predicted cyclical component to 0.61 so that a larger fraction of the slowdown is attributed to normal cyclical movements. This sensitivity further underscores the need for more research on productivity growth over this periods.

[8] Because we do not undertake to identify macroeconomic shocks, we are not able to trace through the full effect on economic activity of the oil price boom and the more recent decline in oil prices. The recent study by Baumeister and Kilian (2016) suggests that the oil price decline since mid-2014 had a negligible net effect on economic activity (a modest increase in consumption offset by a decrease in private fixed investment).

8. From a GDP accounting perspective, the components that made the largest negative contributions to the unpredicted shortfall of GDP growth were government spending and exports. The unexpectedly slow growth of state and local government spending occurred from 2010 to 2014, while the unexpectedly slow growth of federal government spending occurred mainly in 2013. The unexpectedly slow growth of exports occurred during 2013 and since 2015. The timing of these unexpectedly slow contributions, along with the slow growth of services, more than accounts for the main period of unexpectedly slow GDP growth, 2012-2013 (in a GDP accounting sense).

5. Interpretation and Caveats

Because we do not identify a structural DFM, we cannot identify the structural shocks that led to the 0.46pp of slow GDP growth over this period. Still, by applying the decompositions described above to multiple series, we are able to shed light on many of the explanations for the slow recovery.

Many of the explanations seem to have limited empirical support. Explanations in which aggregate demand is held back by unusually retarded growth of consumption – be it by increasing inequality, policy uncertainty, or consumer deleveraging – do not square with the fact that contribution of consumption growth to the unpredicted shortfall in GDP growth was only -0.15pp; rather, consumption growth largely tracked its predicted path over the recovery. Although the components of consumption experienced unexpected shifts, from services to durable goods (and especially in 2012 and 2013), that does not seem to align with any particular explanation that focuses on aggregate demand.

Similarly, there is little evidence to support theories that operate through unduly slow investment. Residential investment growth was, in fact, unexpectedly strong, perhaps a consequence of starting from such a low level at the end of 2009. Nonresidential business fixed investment growth largely tracked its predicted path, except for a slow spell in 2013 and more recently in 2015-16.

The fact that, together, the growth of consumption and investment largely tracked pre-2007 patterns suggests that unusual features of the current recession that held back the normal cyclical growth of aggregate demand are not key drivers of the slow recovery. Moreover, one

would expect slow aggregate demand to be reflected in sluggish revival of employment and the unemployment rate, but that is evidently not the case since employment grew faster than, and the unemployment rate fell in line with, the 2009 prediction. One nonstandard explanation that has circumstantial support is that there has been hysteresis in the labor market, with an unusually prolonged recovery of the long-term unemployment rate and the shortfall of the LFPR exceeding the combined predicted effects of the baby boom retiring and normal cyclical patterns.

Based on this evidence, we find two (perhaps three) explanations for the slow recovery to be the most compelling. First, the weakness of government spending, both fiscal and state and local, and of government employment, combined with its timing, suggests that the unwinding of ARRA spending combined with the sequester provided substantial headwinds to the recovery, contributing an estimated 0.25pp of reduction in mean growth over this period, relative to the predicted path (this calculation implicitly sets the government spending multiplier to 1).

Second, exports were considerably weaker than expected, suggesting that stagnant international demand also played a substantial role.

Third, we find some room for explanations associated with poor or missed measurement of real output, although it mainly comes from unexpected sources. In particular, the unexpected decline in services consumption in 2013 is largely attributable (in a GDP accounting sense) to declines in some of the most poorly measured sectors of consumption: financial services and insurance, recreational goods and vehicles (which includes personal consumption of computers), other services (which includes professional services), and nonprofit institutions serving households (services provided by nonprofits which are not sold and for which there is no market price). This said, Byrne, Fernald, and Reinsdorf (2016) make a carefully argued case that measurement issues can explain at most a small fraction of the observed productivity slowdown, yet the prominence of these poorly measured sectors in the decline in services consumption is intriguing. Additional investigation of these measurement issues are warranted.

We end with some caveats. Because we are working with a linear model that does not have identified shocks, we are unable to speak to concerns that monetary policy was less effective in this recovery than would have been expected had interest rates not hit the zero lower bound. Indeed, our predictions build in most of the policies that aimed to reverse the recession, since our forecasts are made using data through 2009q4. Had less aggressive monetary and fiscal policies been pursued in late 2008 and 2009, the 2009 factors used for our forecast would have

been different and we would have projected a different, possibly slower, growth path over the recovery.

Stepping back, our main finding is that the recovery has not been as slow as is often asserted. This is not to say that the pace of recovery was desirable: it was not, and faster growth of incomes and employment would have benefited American workers. But more than half the slow growth, compared to the previous three recoveries, derives from slower long-term trend growth, which in turn is mainly a consequence of changing demographic features of the labor force that have nothing to do with the Great Recession. Compared to what would have been expected in 2009q4 using cyclical correlations from 1984-2007, there remains a shortfall. That shortfall seems largely associated with the one-off factors of weak international demand and slower than expected growth of government expenditures.

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Table 1. Benchmark post-2007 long-term growth rates for employment, GDP, and their supply-side components (percent per year)

		GDP identity					Payroll employment identity		
	GDP_t	$\frac{GDP_t}{Y_t^{NFB}}$	π_t^{NFB}	h_t^{NFB}	$\frac{E_t^{NFB}}{E_t^{Payroll}}$	$E_t^{Payroll}$	$\frac{E_t^{NFB}}{E_t^{Payroll}}$	$LFPR_t$	$Popn_t$
2010	2.09	-0.40	1.90	-0.19	-0.18	0.95	0.08	-0.27	1.13
2011	2.04	-0.40	1.90	-0.19	-0.18	0.91	0.08	-0.31	1.13
2012	1.98	-0.40	1.90	-0.19	-0.18	0.85	0.08	-0.36	1.13
2013	1.95	-0.40	1.90	-0.19	-0.18	0.82	0.08	-0.39	1.12
2014	1.92	-0.40	1.90	-0.19	-0.18	0.79	0.08	-0.41	1.12
2015	1.89	-0.40	1.90	-0.19	-0.18	0.76	0.08	-0.43	1.11
2016	1.87	-0.40	1.90	-0.19	-0.18	0.74	0.08	-0.45	1.11

Notes: 2016 is the first half.

Table 2. Categories of quarterly time series used to estimate the factors

	Category	Number of series
(1)	NIPA	12
(2)	Industrial Production	7
(3)	Employment and Unemployment	30
(4)	Orders, Inventories, and Sales	9
(5)	Housing Starts and Permits	6
(6)	Prices	24
(7)	Productivity and Labor Earnings	5
(8)	Interest Rates	10
(9)	Money and Credit	6
(10)	International	9
(11)	Asset Prices, Wealth, Household Balance Sheets	10
(12)	Other	2
(13)	Oil Market Variables	9
	Total	139

Notes: The series used to estimate the factors do not include both aggregates and their components when all the components are available, for example consumption of durables and consumption of nondurables are included so goods consumption is not; similarly GDP and total payroll employment are not included. For the full list of series, data transformations, and additional discussion, see Stock and Watson (2016).

Table 3. Measures of fit of the DFM, in- and out- of sample, for selected series

	R^2 of common component	RMSE of idiosyncratic component	
	1984-2007	1984-2007	2010-2016
GDP	0.70	1.16	1.32
NFB output	0.71	1.47	1.90
NFB total hours	0.69	1.38	0.94
NFB employment	0.81	0.82	0.71
Total employment (payroll)	0.92	0.41	0.49
Total employment (CPS)	0.56	0.97	0.94
Labor force (CPS)	0.15	0.99	1.03
NFB productivity	0.47	1.88	2.01
LFPR	0.15	0.77	0.98
Consumption (PCE)	0.52	1.40	1.66
Investment (GPDI)	0.49	7.85	7.70
NFB avg. weekly hours	0.25	1.03	0.69

Notes: Summary statistics are for the 8-factor DFM, with the factors estimating using 139 variables over the estimation sample 1984q1-2007q4 as described in the text.

Table 4. Slow growth decomposition #1: Annual average percent growth rates in the current recovery vs. past three recoveries, trend and cycle components

	Expansions 1981-2007 while u > CBO NAIRU			**2010q1-2016q2**			**Growth Rate Gap**		
	Mean	Trend	Cycle	Mean	Trend	Cycle	Mean	Trend	Cycle
GDP	3.75	2.89	0.86	2.01	1.97	0.04	-1.74	-0.91	-0.82
NFB output	4.29	3.17	1.12	2.53	2.37	0.16	-1.76	-0.80	-0.96
NFB total hours	2.18	1.25	0.93	1.95	0.47	1.48	-0.23	-0.78	0.55
NFB employment	2.10	1.45	0.65	1.73	0.66	1.07	-0.37	-0.79	0.42
Total employment (payroll)	1.99	1.58	0.40	1.58	0.84	0.74	-0.41	-0.74	0.34
Total employment (CPS)	1.85	1.40	0.44	1.35	0.76	0.59	-0.50	-0.65	0.15
Labor force (CPS)	1.36	1.38	-0.02	0.51	0.76	-0.25	-0.85	-0.63	-0.23
Population (CPS)	1.14	1.26	-0.12	1.03	1.12	-0.09	-0.11	-0.14	0.03
NFB productivity	2.12	1.92	0.19	0.58	1.90	-1.32	-1.54	-0.02	-1.51
LFPR	0.22	0.12	0.10	-0.52	-0.37	-0.15	-0.74	-0.49	-0.25
Consumption (PCE)	3.81	3.14	0.66	2.34	1.97	0.37	-1.47	-1.17	-0.30
Investment (GPDI)	7.41	3.58	3.84	5.42	1.97	3.45	-1.99	-1.60	-0.39
NFB avg. weekly hours	0.07	-0.20	0.27	0.22	-0.19	0.41	0.15	0.01	0.14

Notes: For all series in this table, the post-2007 trends are computed using the "bottom-up" method of Section 2.2.

Table 5. Slow growth decomposition #2: Cyclical components 2010q1-2016q2, actual, predicted, and unexplained

	Mean growth rates, 2010q1-2016q2				
	Actual	Post-2007 trend	Cycle: Actual	Cycle: Forecast	Unexplained
A. Production					
GDP	2.01	1.97	0.04	0.56	-0.52
NFB output	2.53	2.37	0.16	0.73	-0.57
NFB total hours	1.95	0.47	1.48	0.98	0.50
NFB employment	1.73	0.66	1.07	0.67	0.40
Total employment (payroll)	1.58	0.84	0.74	0.54	0.20
Total employment (CPS)	1.35	0.76	0.59	0.44	0.15
Labor force (CPS)	0.51	0.76	-0.25	0.10	-0.35
Population (CPS)	1.03	1.12	-0.09	-0.04	-0.05
NFB productivity	0.58	1.90	-1.32	-0.23	-1.09
LFPR	-0.52	-0.37	-0.15	0.14	-0.29
NFB avg. weekly hours	0.22	-0.19	0.41	0.30	0.11
B. Misc. additional series					
Industrial production	2.12	1.59	0.53	1.69	-1.16
Employment: government	-0.28	0.69	-0.97	-0.10	-0.87
Employment: private	1.94	1.06	0.88	0.65	0.23

Notes: For the series in panel A, the post-2007 trends are computed using the "bottom-up" method of Section 2.2. The post-2007 trends in panel B are computed as the 2007q4 value estimated by the full-sample biweight filter.

Table 6. Slow growth decomposition #2 for contributions to GDP: Cyclical components 2010q1-2016q2, actual, predicted, and unexplained

	Mean growth rates, 2010q1-2016q2				
	Actual	Post-2007 trend	Cycle: Actual	Cycle: Forecast	Unexplained
GDP	2.01	1.97	0.04	0.56	-0.52
Consumption	1.60	1.54	0.25	0.21	-0.16
PCE-goods	0.79	0.69	0.05	0.10	0.00
PCE-durable goods	0.47	0.38	0.09	0.06	0.03
PCE-nondurable goods	0.33	0.31	-0.01	0.05	-0.04
PCE-services	0.81	0.86	-0.26	0.10	-0.15
Investment (GDPI)	0.85	0.40	0.54	0.52	-0.07
Fixed private investment	0.77	0.40	0.37	0.30	0.07
FPI-nonresidential	0.58	0.39	0.15	0.28	-0.08
FPI-residential	0.18	0.01	0.17	0.05	0.12
Government	-0.20	0.20	-0.42	-0.15	-0.25
G-Federal	-0.12	0.09	-0.21	-0.14	-0.07
G-State&local	-0.09	0.11	-0.21	0.00	-0.19
Net exports	-0.19	-0.18	-0.04	-0.16	0.15
Exports	0.45	0.59	-0.15	0.29	-0.43
Imports	-0.65	-0.77	0.11	-0.45	0.58
Imports ex. petroleum	-0.71	-0.76	0.02	-0.42	0.47
Petroleum imports	0.03	-0.02	0.04	-0.05	0.09

Notes: All entries (including trends) are percentage point contributions to GDP, computed by forecasting the growth rate of the component using data through 2009q4, then scaled by mean GDP share weights over the 2010-2016 period. Components do not add to totals because of rounding and the approximation that the growth rate of the sum is the sum of the share-weighted growth rates. For GDP the 2007 trend is the "bottom-up" trend for GDP from Section 2.2. For all other series, the post-2007 trends are the least squares fit to the 2007q4 biweight trend values estimated, subject to the constraint their share weighted averages sum to the trend for GDP. Because imports subtract from GDP, their contributions enter here with a negative sign.

Figure 1. U.S. labor force participation rate (LFPR) and weekly hours in manufacturing, 1960-2016

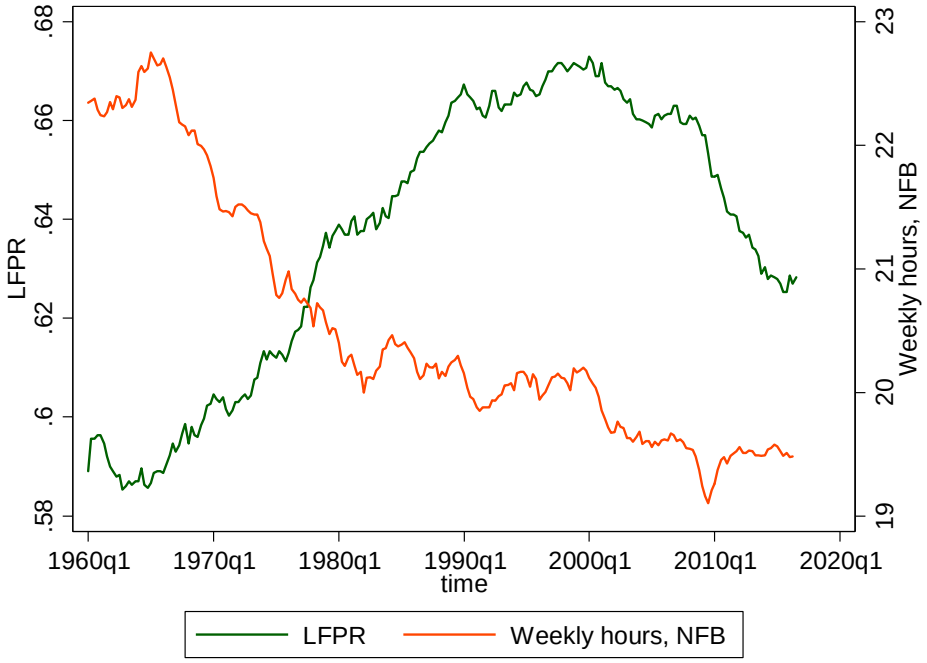


Figure 2. U.S. labor force participation rate and constructed pure aging trend, 2007q4-2016q3

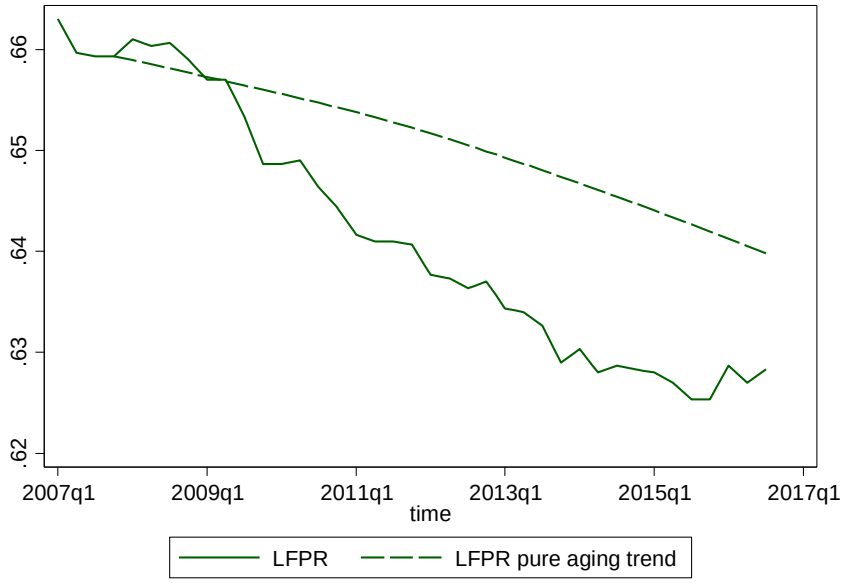


Figure 3. Real-time professional estimates of prospective ten-year growth of labor productivity in nonfarm business

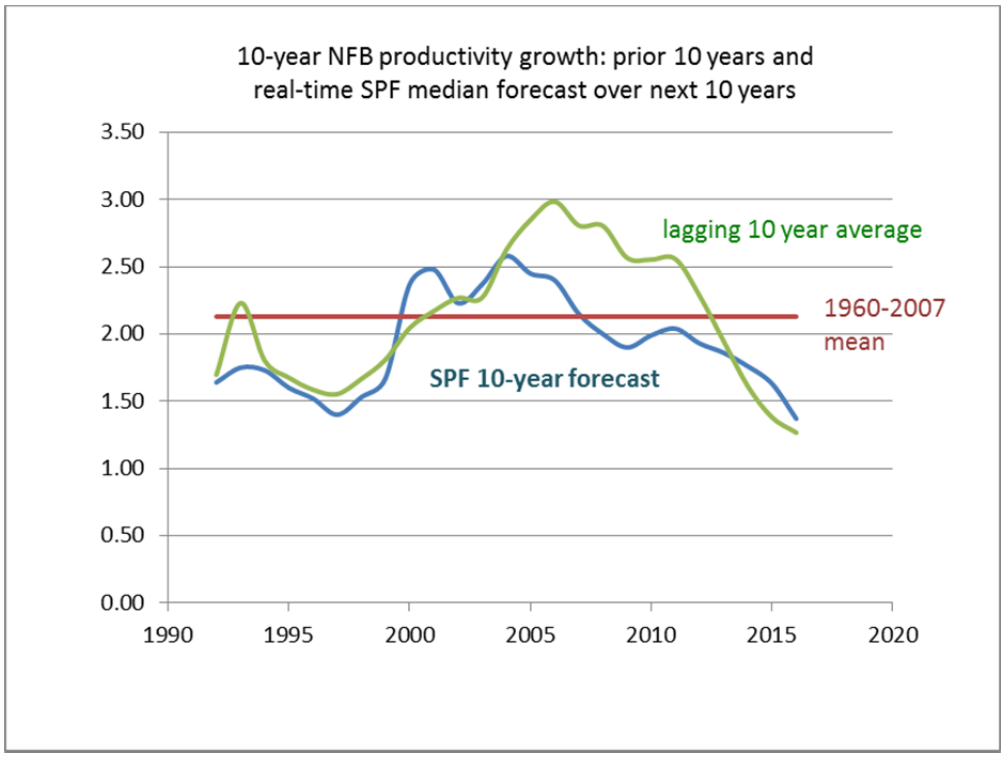
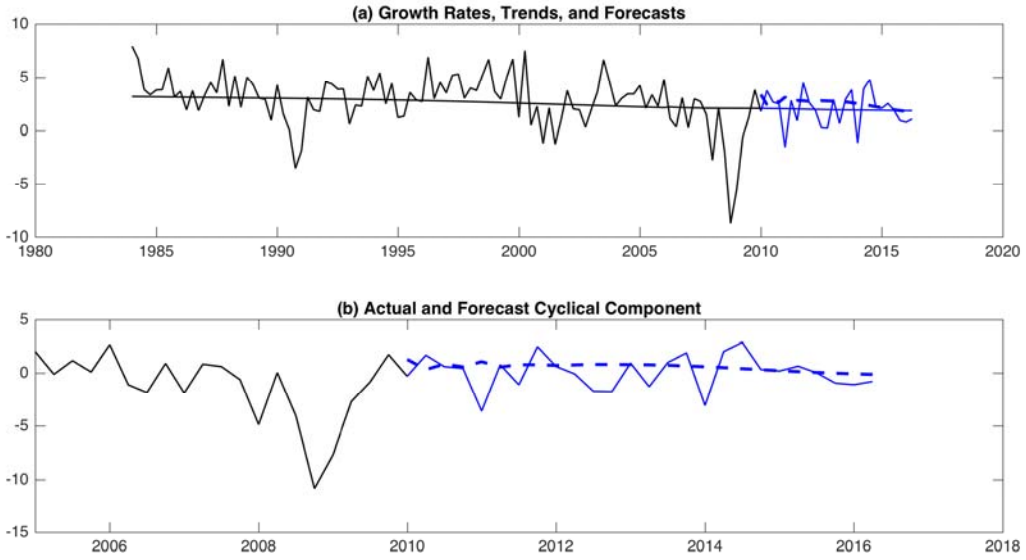
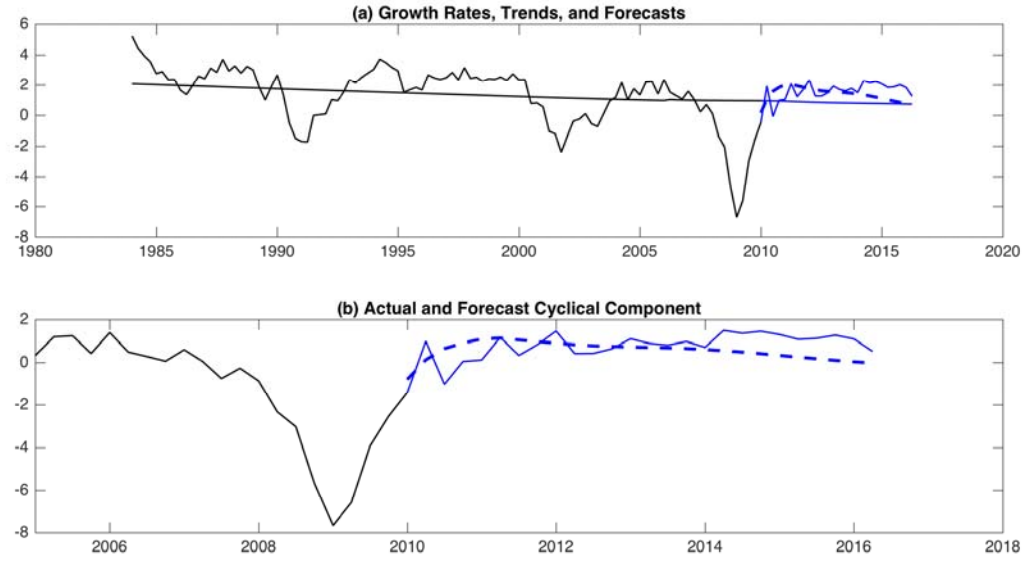


Figure 4. Historical values, trends (smooth lines), and predicted values (dashed) for various series

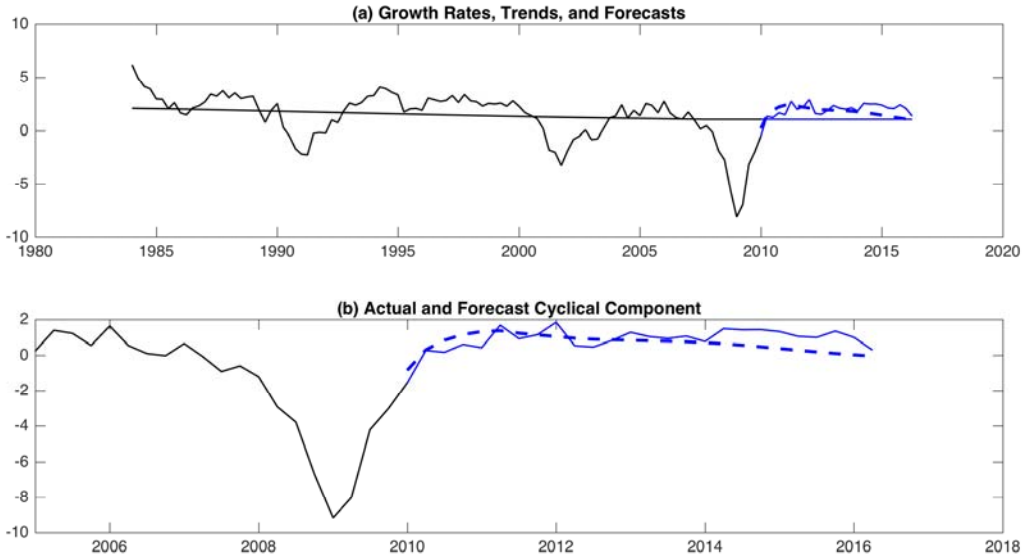
(a) GDP



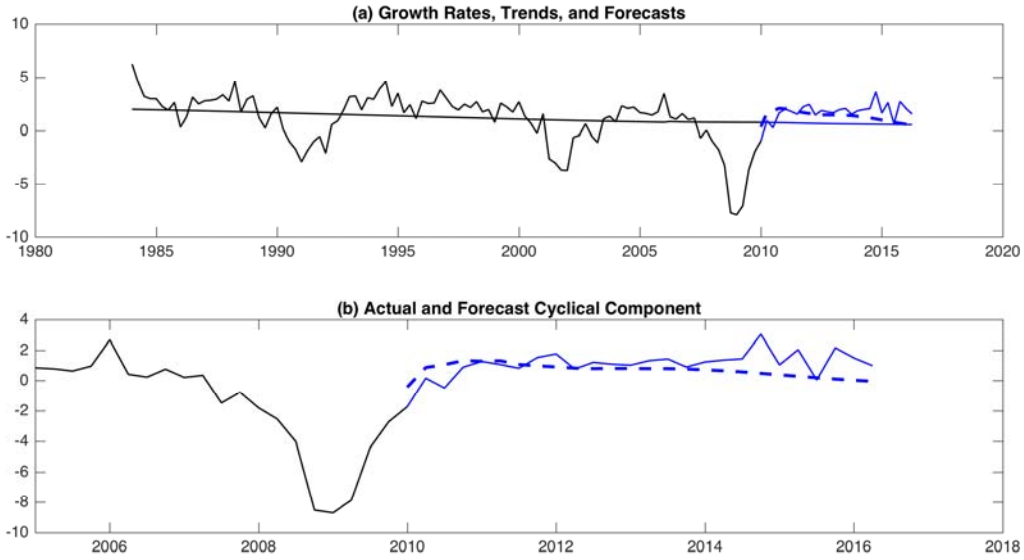
(b) Establishment employment (growth rate)



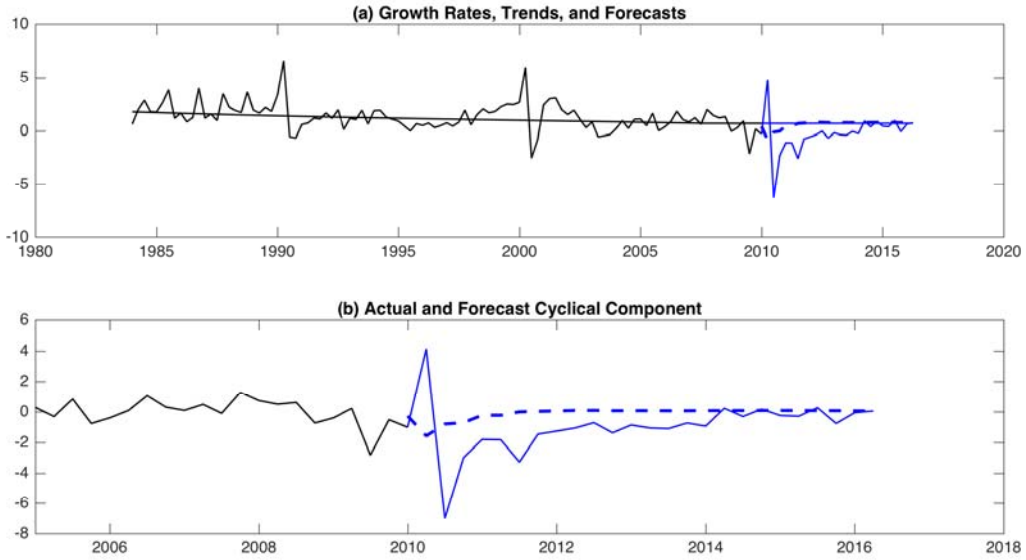
(c) Establishment employment: private



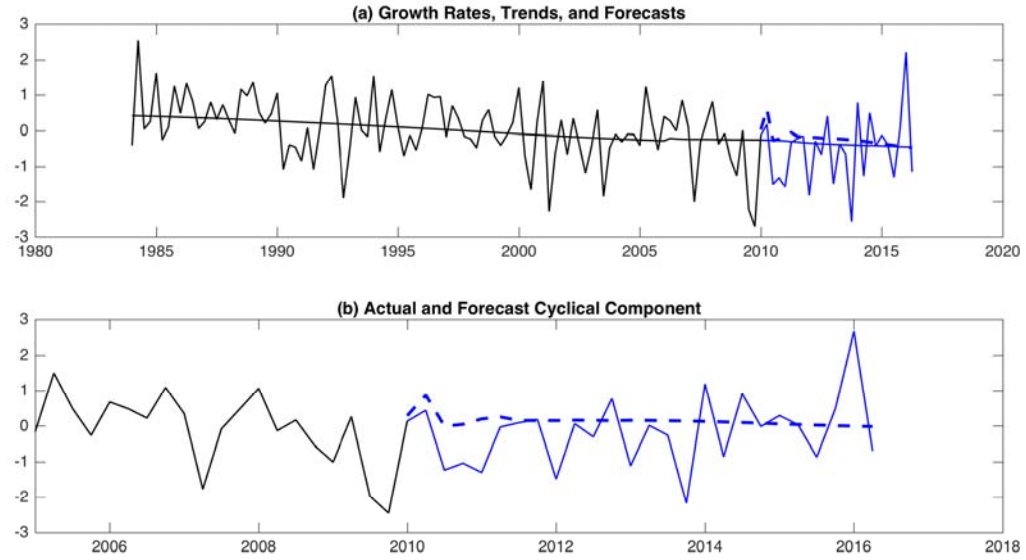
(d) Establishment employment: nonfarm business



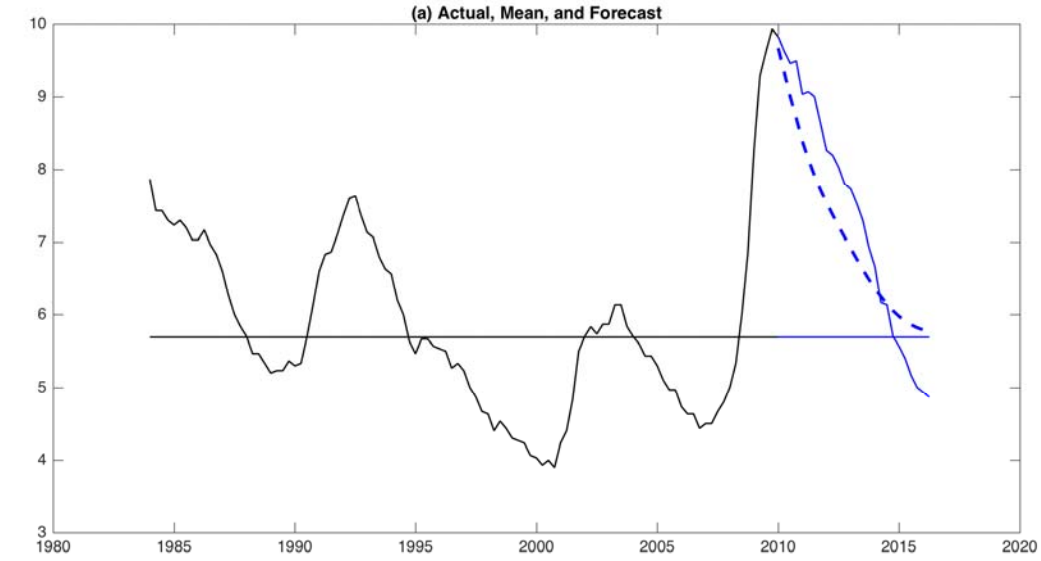
(e) Establishment employment: government (big growth spikes are the decennial Census)



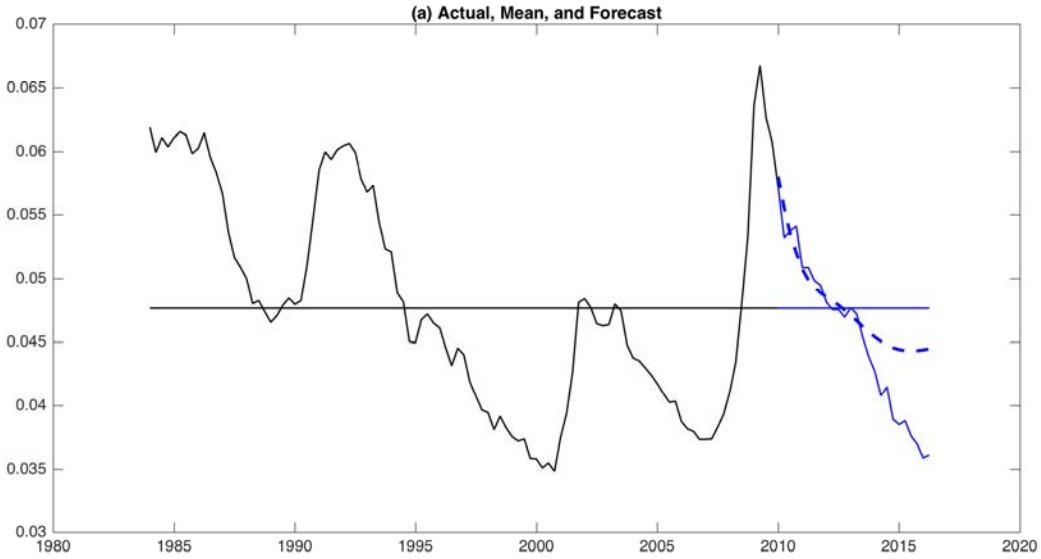
(f) Labor force participation rate (growth rates)



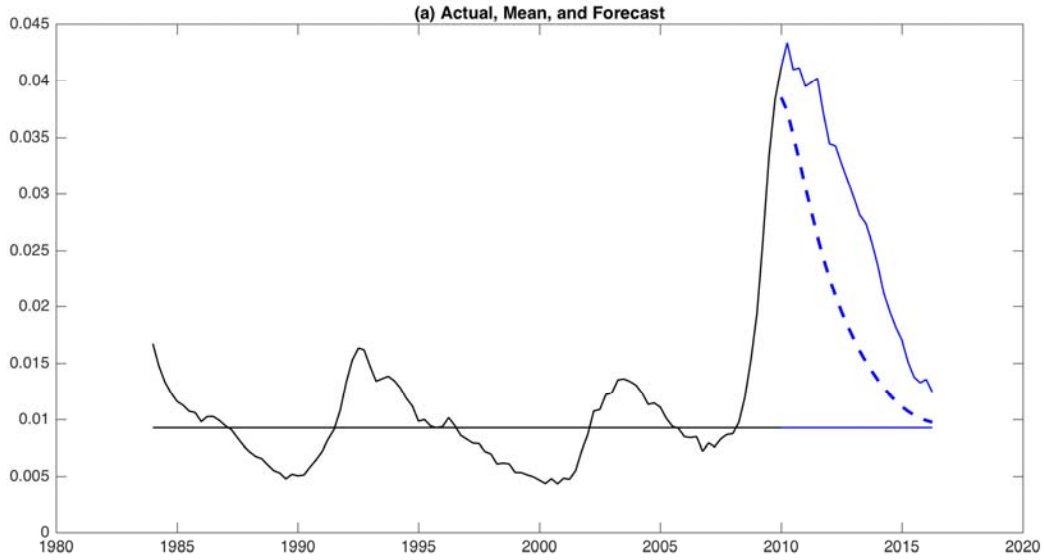
(g) Unemployment rate



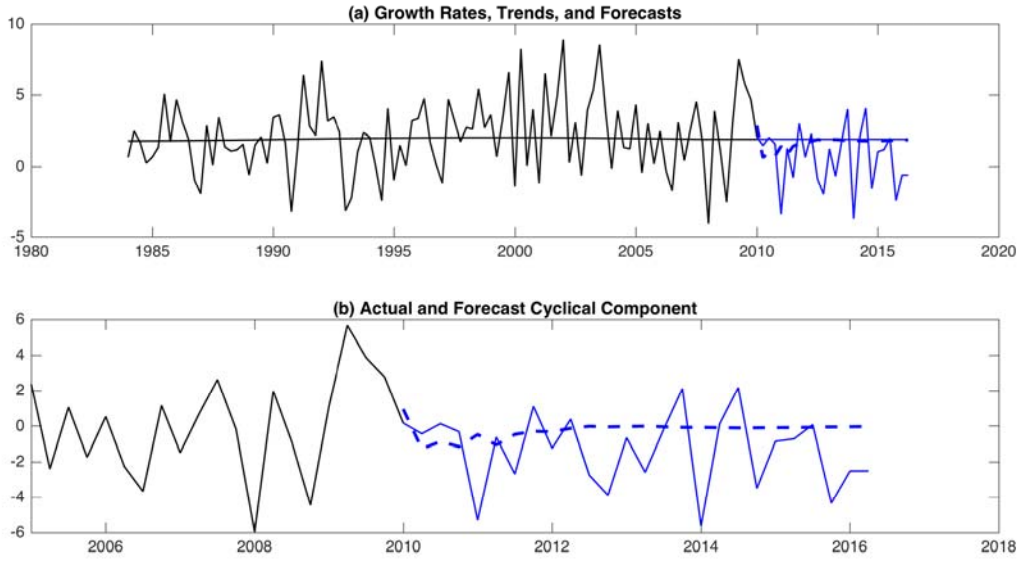
(h) Short-term unemployment rate (<27 weeks)



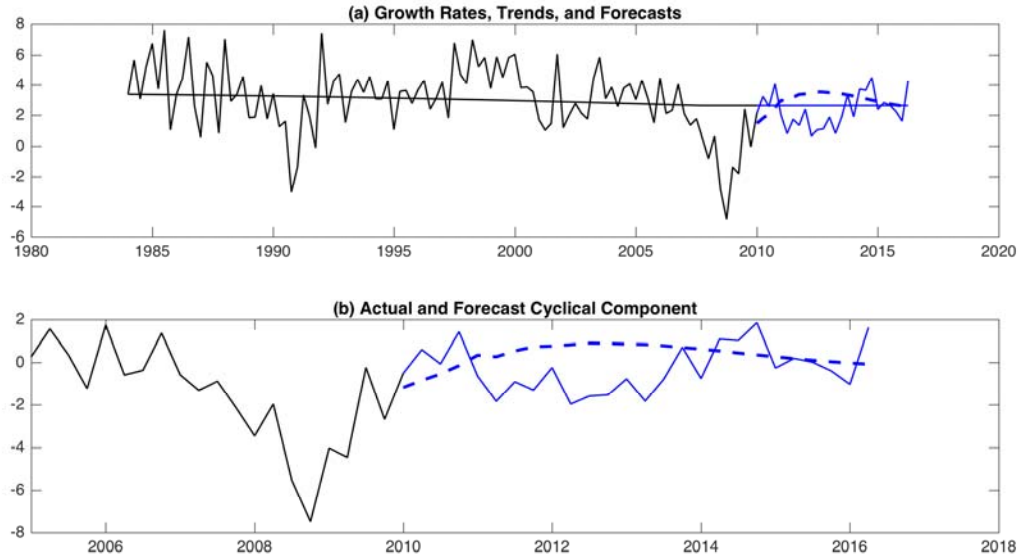
(i) Long-term unemployment rate (27+ weeks)



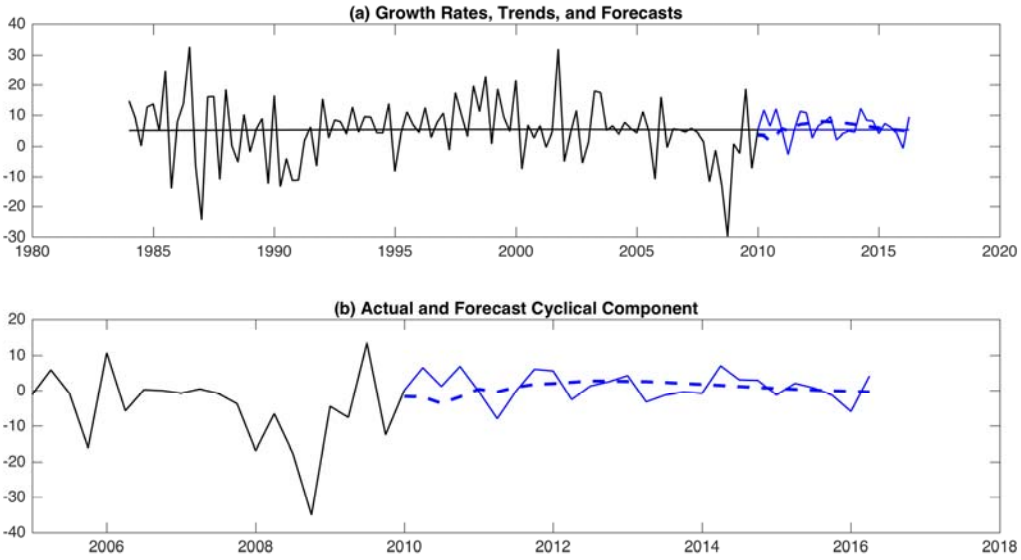
(j) NFB Labor Productivity (growth rate)



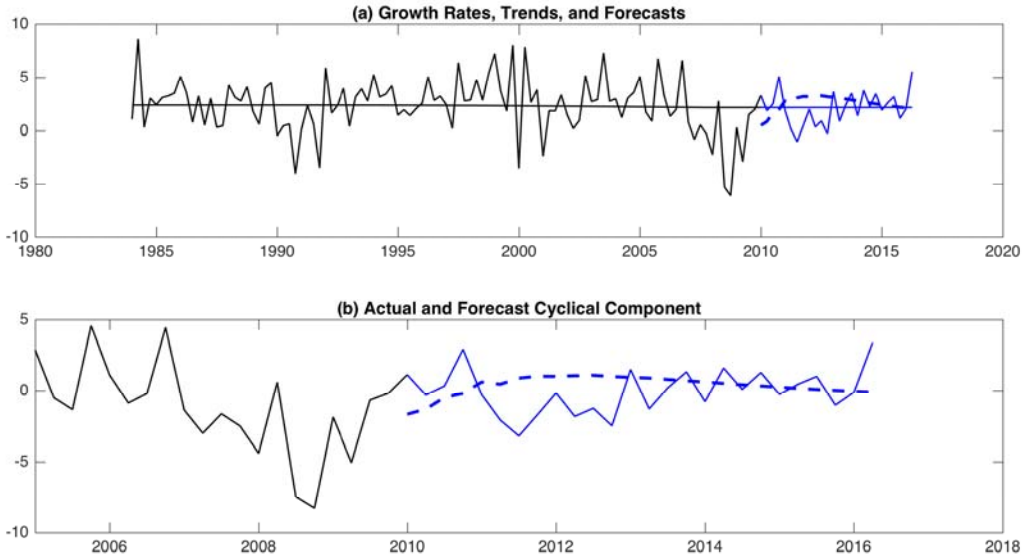
(k) Personal consumption expenditures



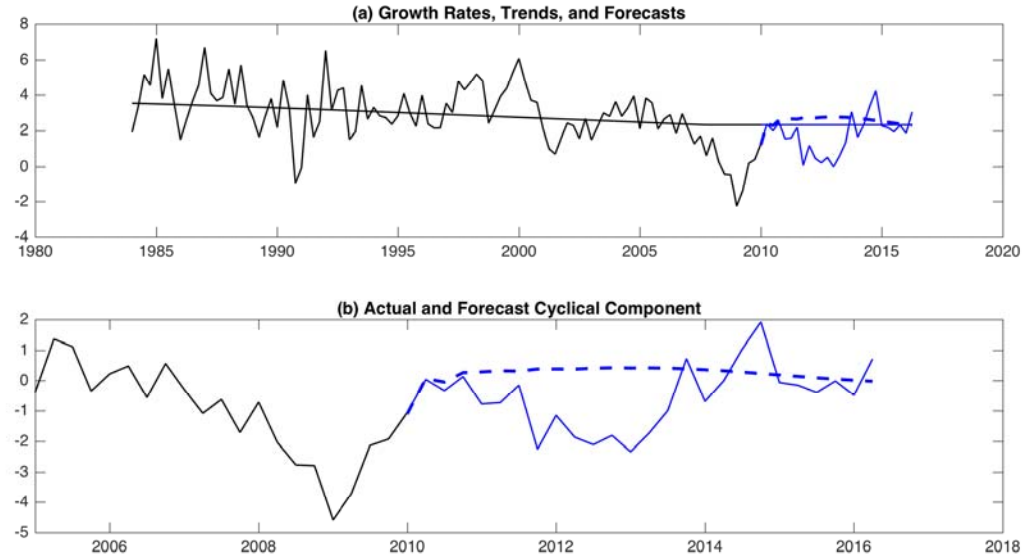
(l) PCE: durable goods



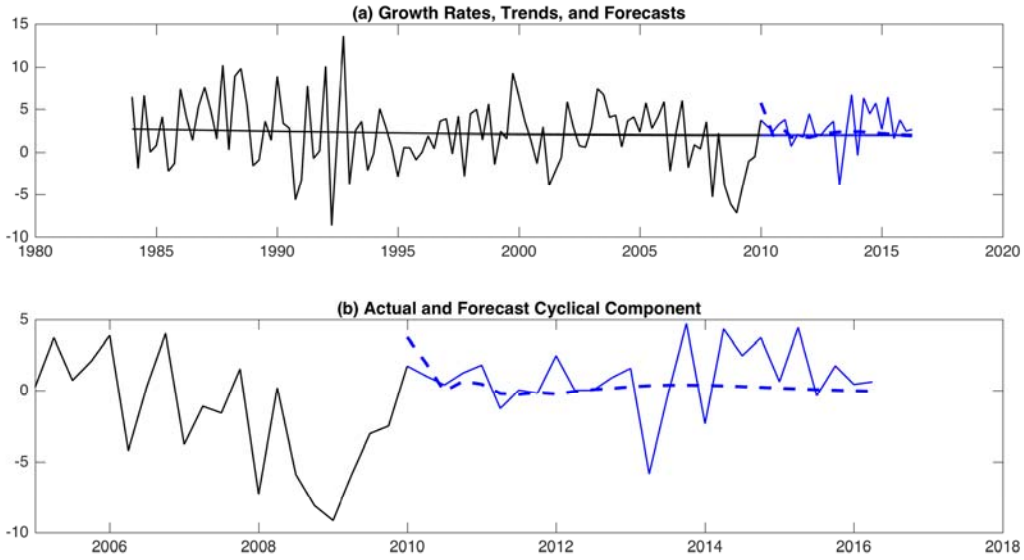
(m) PCE: nondurable goods



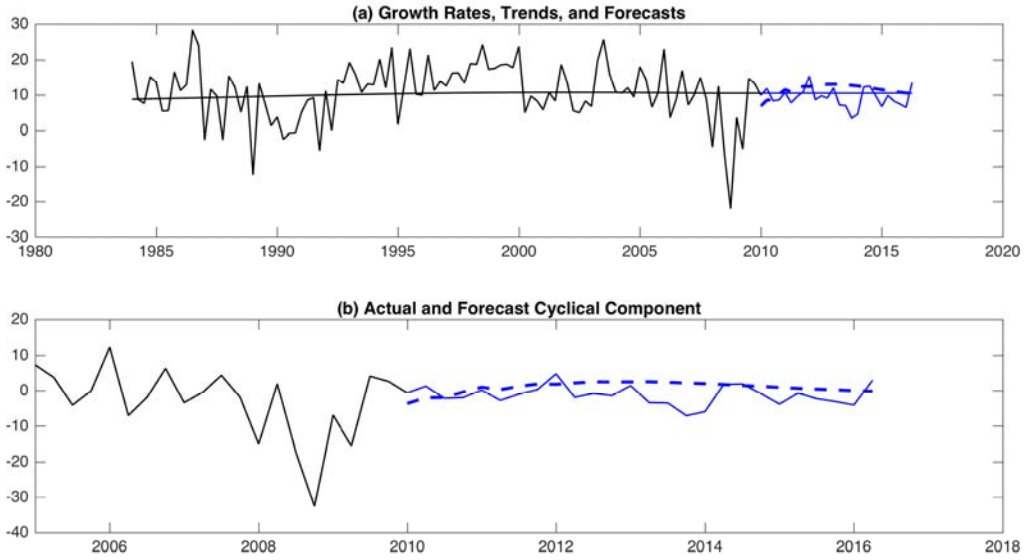
(n) PCE: services



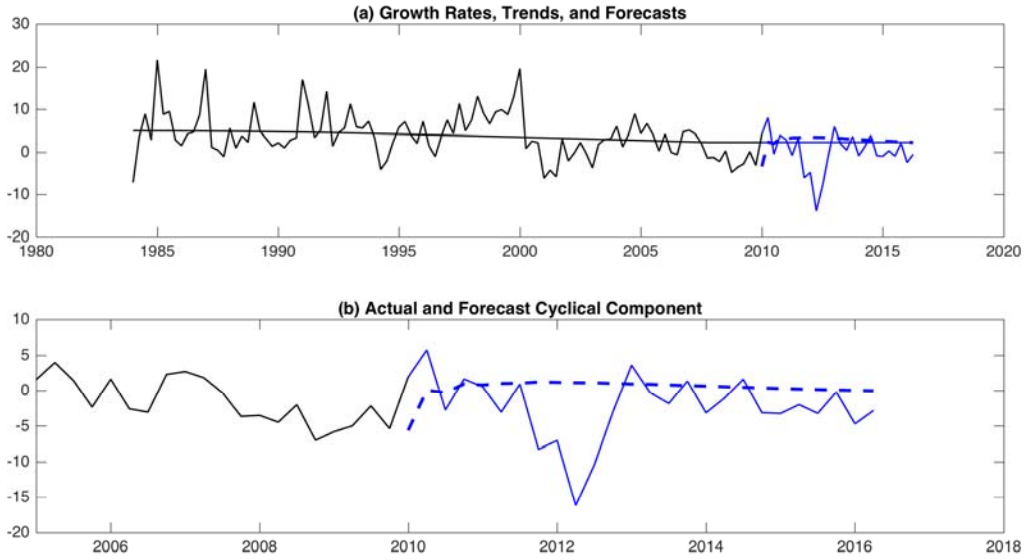
(o) PCE: food services and accommodations



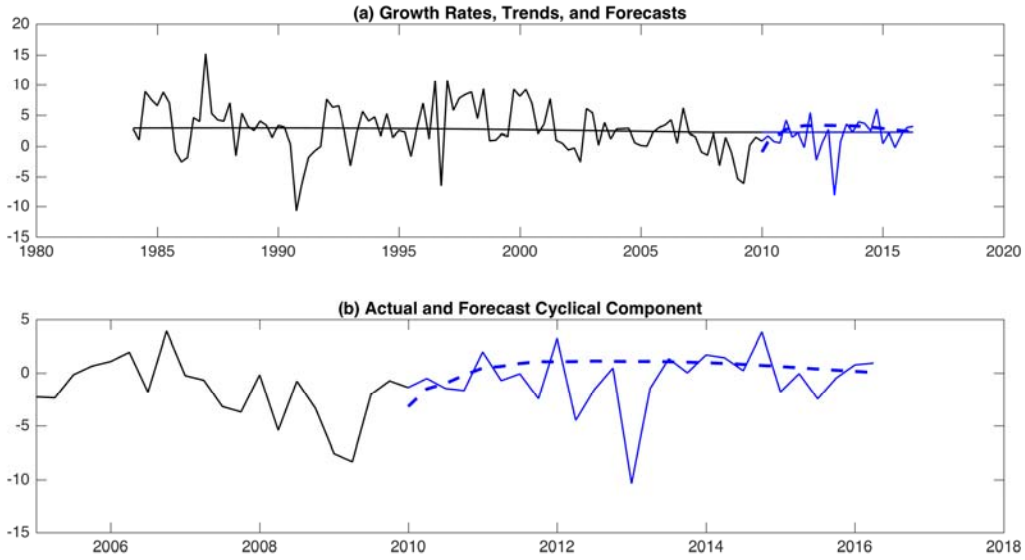
(p) PCE: recreational goods and vehicles



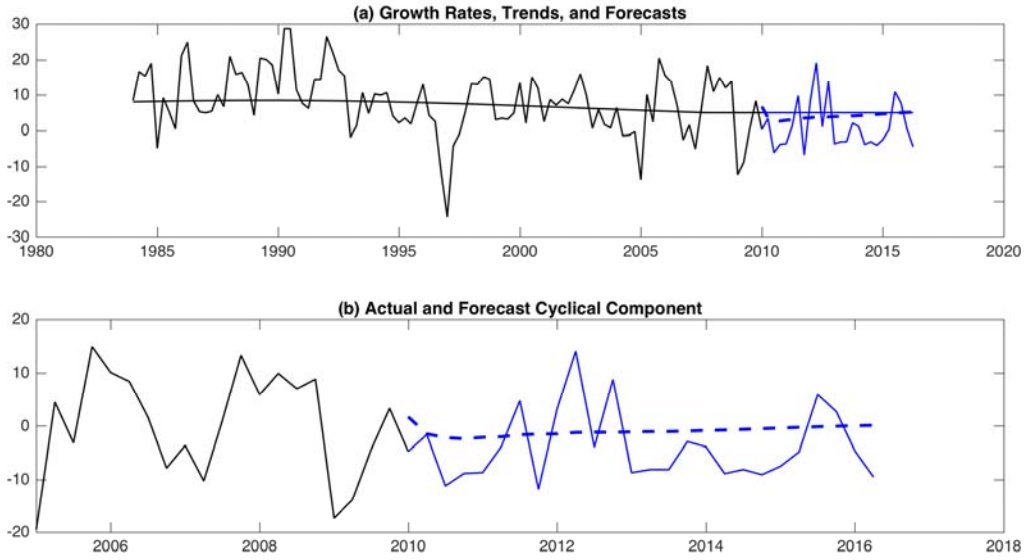
(q) PCE: financial services and insurance



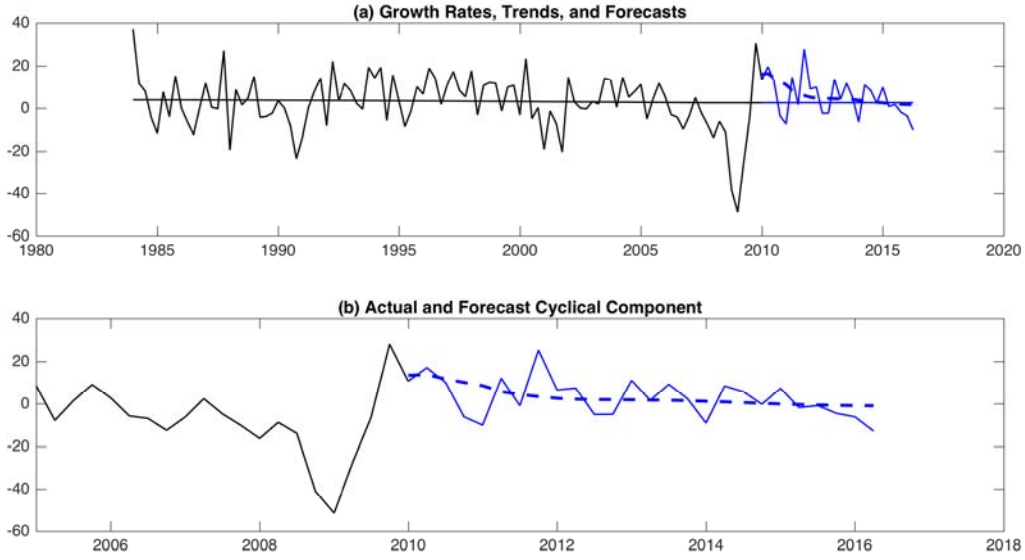
(r) PCE: other services



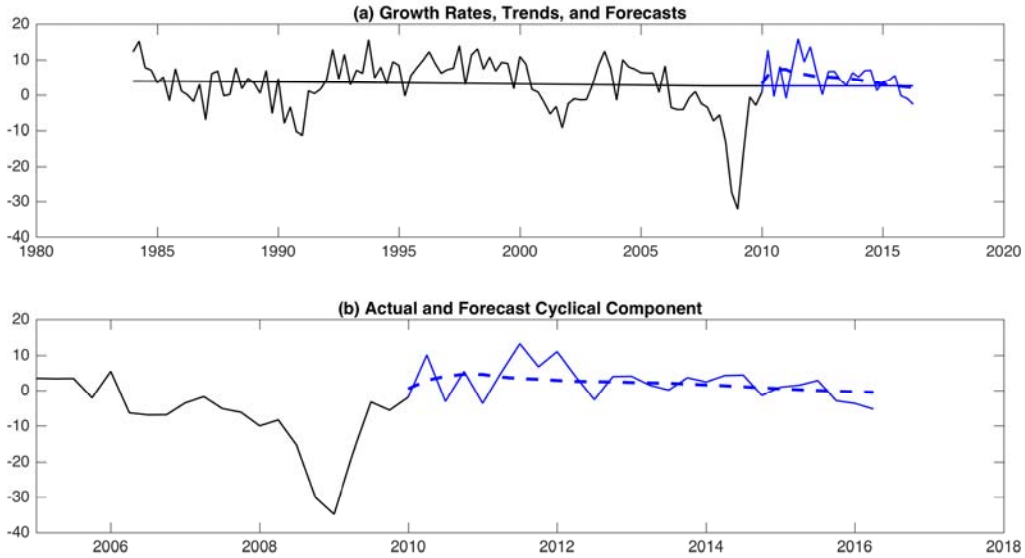
(s) PCE: NPISH



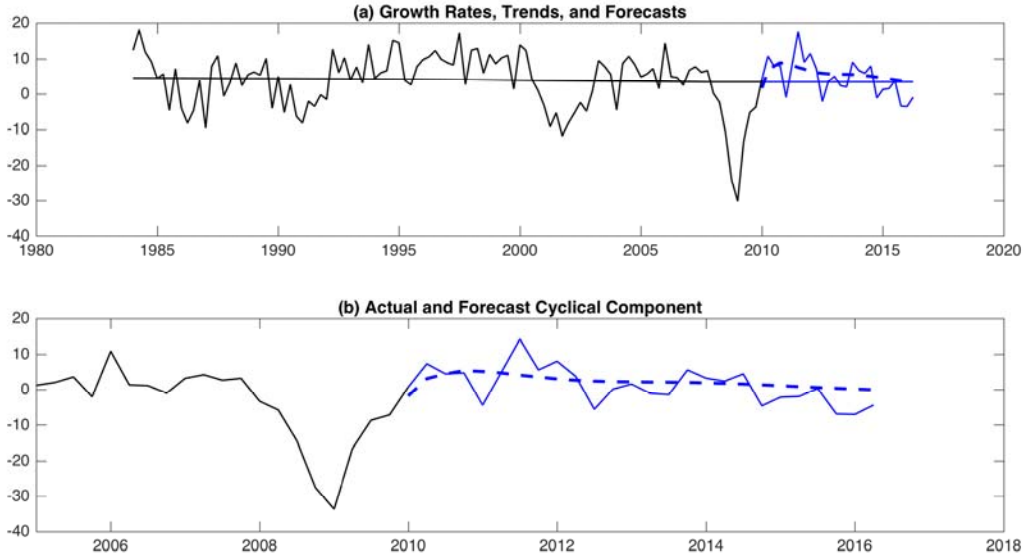
(t) Gross private domestic investment (growth rate)



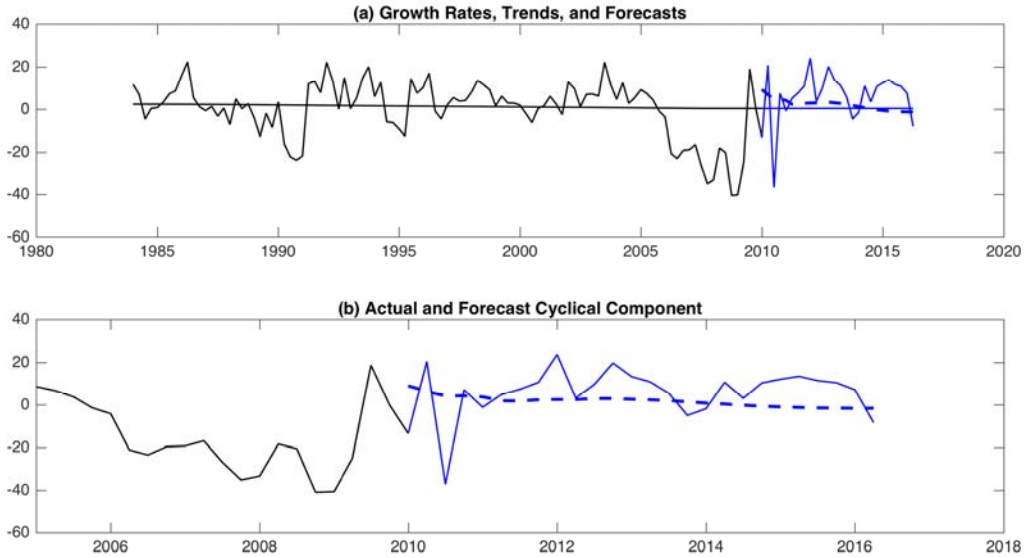
(u) Fixed private investment



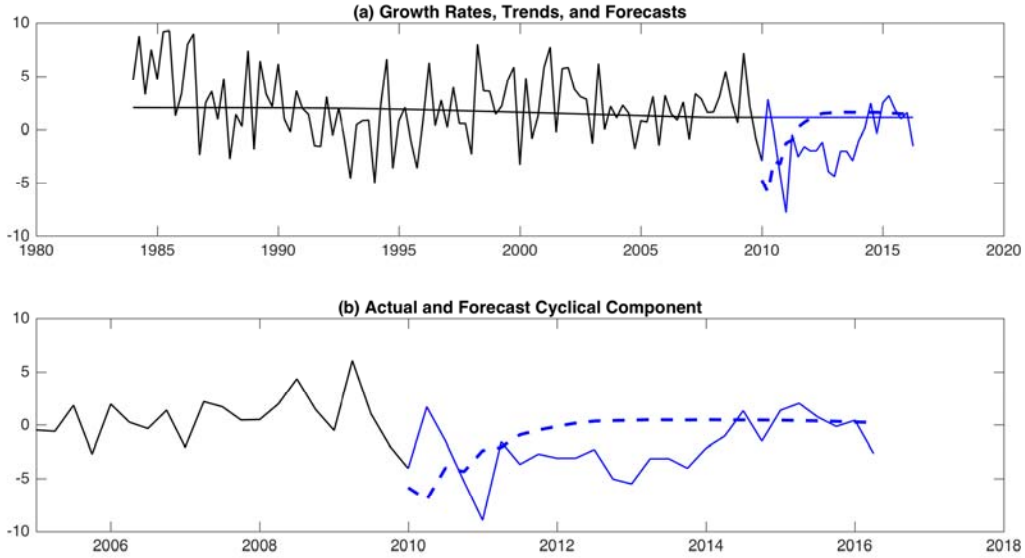
(v) Fixed private investment: nonresidential



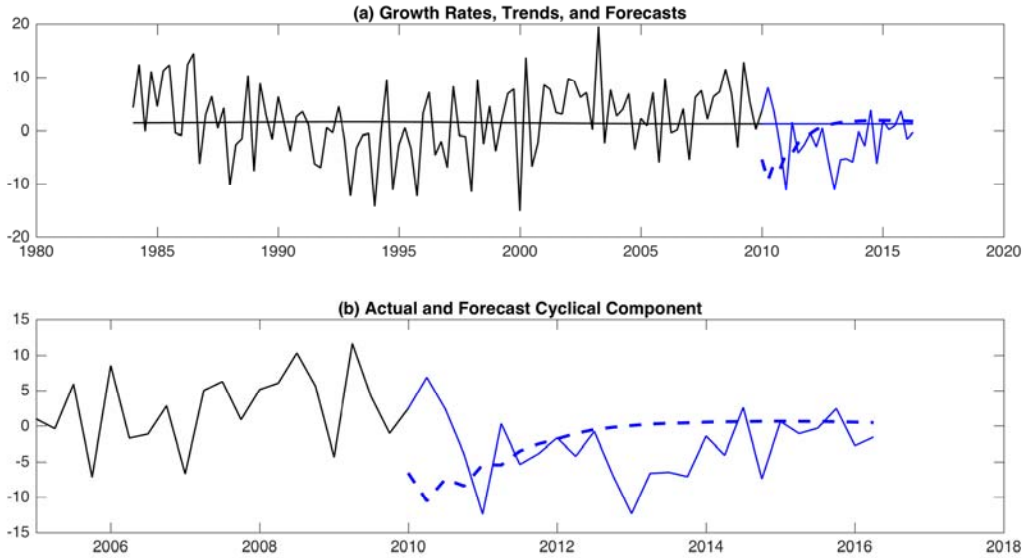
(w) Fixed private investment: residential



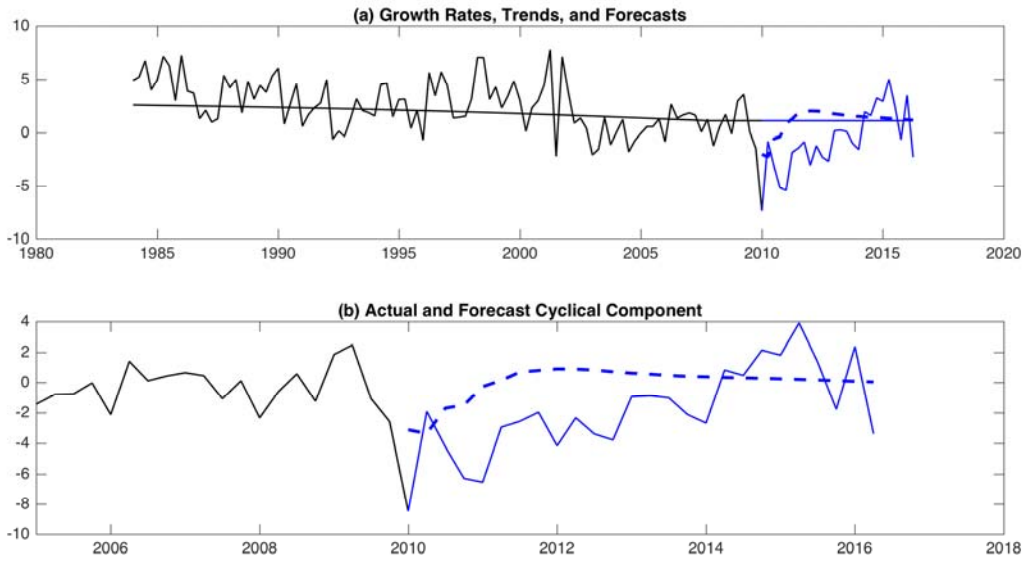
(x) Government spending



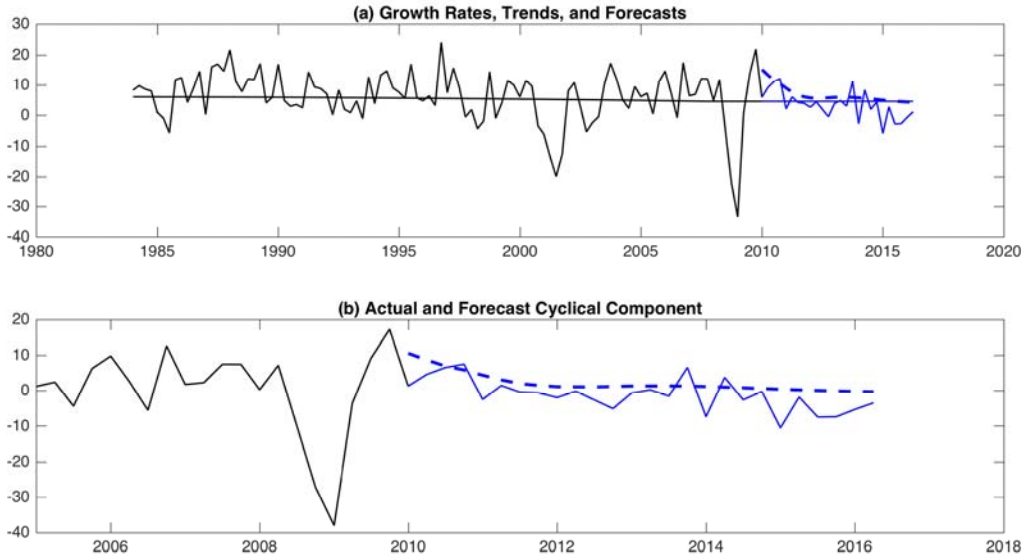
(y) Government spending, federal



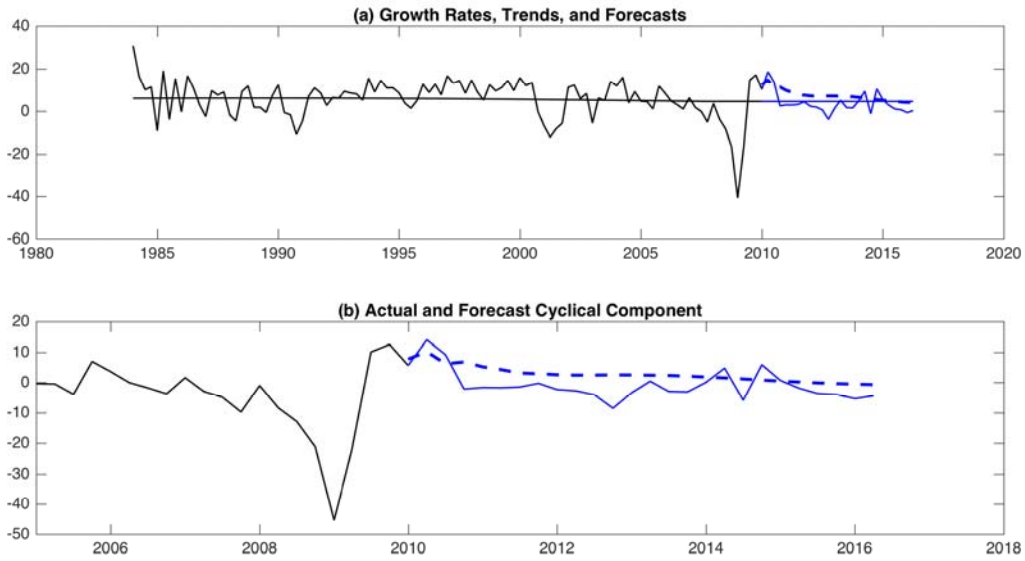
(z) Government spending, state & local (growth rates)



(aa) Exports



(ab) Imports



Notes: Trends and growth rate forecasts are described in the text. The unemployment rate forecasts (panels (g)-(i)) were constructed from a regression of the unemployment rate onto a constant, two own lags and current and two lags of the factors over the sample period 1984q1-2007q4 together with the VAR(3) model for the factors described in the text.