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Do large recessions reduce output permanently?☆

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HIGHLIGHTS

- We test whether large recessionary shocks have a permanent effect on US GDP.
- We use a quantile autoregression based unit root test.
- The test allows for differences in the persistence of positive and negative shocks.
- We find that all shocks including large recessionary shocks have permanent effects on the level of GDP.

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ABSTRACT

We apply a recent quantile autoregression unit root test to US GDP. The test takes into account that the transmission of a shock might depend on the sign and the size of the shock. We find that positive and negative shocks including large recessionary shocks like the 2008/2009 crisis have permanent effects on output.

1. Introduction

The financial crisis has triggered two types of GDP forecasts, those in which output returns to its pre-crisis trend, and those in which output is lowered permanently. An example of the former is the forecast by the White House Administration who predicted in early 2009 strong US GDP growth rates over the following years which would lead to a rebound to the long run GDP trend by the end of 2013. In contrast private sector forecasts as summarized by the Blue Chip consensus predicted growth rates close to the long run average from 2009 onwards without a rebound to the pre-crisis GDP trend. Fig. 1 shows these forecasts together with the long run GDP trend.

These opposing forecasts led to an intense debate among leading economists as summarized in Cushman (2012). One group argued that recessions must be followed by rebounds because otherwise the unemployment rate would never return to normal. The other group pointed out instead that this argument is based on the assumption of trend stationarity and that shocks to GDP might very well have permanent effects if GDP has a unit root. The trend stationarity vs. unit root debate is well-anchored in economic research, but the literature has not converged to a conclusive answer, yet. Some authors have taken into account the possibility that the persistence of the GDP impact of recessionary shocks might differ from that of expansionary shocks. Examples include Hamilton (1989), Perron (1989), Balke and Fomby (1991), Beaudry and Koop

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(1993), Murray and Nelson (2000) and Kim et al. (2005). Some of these studies find permanent effects of recessions and temporary effects of expansions (e.g. Hamilton, 1989), while others find exactly the opposite (e.g. Beaudry and Koop, 1993).

Our contribution to this line of research is that we test the unit root hypothesis not only at the conditional mean of GDP, but also in the tails of the distribution using a quantile autoregression (QAR) based unit root test. In contrast to least squares estimates we do not only capture the average effect of shocks on GDP, but we can distinguish between GDP realizations that are high or low relative to GDP realizations in previous quarters. In particular recessions may be viewed in the QAR context as data realizations in the lower conditional quantiles.

The usage of a QAR-based unit root test has several advantages. First, we allow for the possibility that shocks of different sign and magnitude have a different impact on GDP. Second, our approach is not restricted to a specific number of regimes, but allows generally for differences in the transmission of all kinds of different shocks. Third, our approach avoids the estimation of additional regime parameters and therefore reduces estimation uncertainty. Fourth, the QAR-based unit root test has higher power than conventional unit root tests as shown by Koenker and Xiao (2004). Fifth, the QAR-based unit root test is superior to standard unit root tests in case of departure from Gaussian residuals.

Using our general approach, we find that positive and negative shocks including large recessionary shocks have permanent effects on real GDP. Especially, the point estimates in the lower tail of the conditional GDP distribution are extremely close to one. Therefore, the Great Recession—which is an event in the lower tail—has a permanent effect on GDP. A quick rebound of GDP to its pre-crisis path is unlikely. This result confirms related findings from other papers. Cerra and Saxena (2008) find using panel data for a large number of countries that economic contractions are not followed by offsetting fast recoveries. Haltmaier (2013) focuses directly on potential output estimates and finds that the Great Recession might have resulted in declines in trend output growth averaging about 3% for advanced economies. Oulton and Sebastiá-Barriel (2013) find that financial crises reduce labour productivity, the level of capital and GDP permanently. Boysen-Hogrefe et al. (2010) find that recessions associated with banking or housing crises reduce output permanently, while ordinary recessions are followed by recoveries that make up for almost all of the preceding shortfall in output.

2. Methodology

Let y_t denote the log of real US GDP and ϵ_t a serially uncorrelated error term. An AR(q) process for log real GDP with drift a and deterministic trend t is given by:

$$y_t = a + bt + \sum_{i=1}^{q} \gamma_i y_{t-i} + \epsilon_t, \quad t = q+1, q+2, \ldots, n. \tag{1}$$

The sum of the autoregressive coefficients is $\alpha = \sum_{i=1}^{q} \gamma_i$. This is the measure of persistence that we focus on. Rewriting Eq. (1) as:

$$y_t = \alpha y_{t-1} + a + bt + \sum_{i=1}^{q-1} \phi_i \Delta y_{t-i} + \epsilon_t \tag{2}$$

one can run the usual unit root test. If $\alpha = 1$ then US GDP has a unit root and, therefore, shocks have permanent effects on GDP. If $\alpha < 1$ then US GDP is trend stationary. In the latter case shocks have temporary effects only.

To get more detailed estimates to analyse persistence not only at the conditional mean, but also in the tails of the conditional distribution of y_t we can estimate Eq. (2) using quantile autoregression methods. The τ-th conditional quantile is defined as the value $Q_\tau\left(y_t|y_{t-1}, \ldots, y_{t-q}\right)$ such that the probability that output conditional on its recent history will be less than $Q_\tau\left(y_t|y_{t-1}, \ldots, y_{t-q}\right)$ is τ. For example, if output is very high (low) relative to recent output realizations this means that a large positive (negative) shock has occurred and that y_t is located above (below) the mean conditional on past observations $y_{t-1}, \ldots, y_{t-q}$ somewhere in the upper (lower) conditional quantiles.

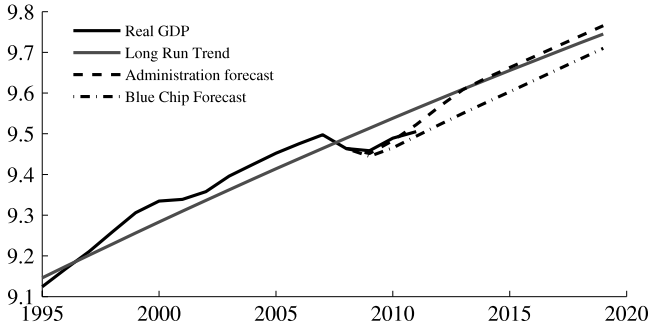

Fig. 1. GDP forecasts. Notes: The trend growth rate has been computed by regressing the log of quarterly real GDP data from 1947Q1 to 2012Q1 on a constant, a linear and a quadratic trend.

The AR(q) process of real GDP at quantile τ can be written as:

$$Q_\tau\left(y_t|y_{t-1}, \ldots, y_{t-q}\right) = \alpha(\tau)\, y_{t-1} + a(\tau) + b(\tau)\, t + \sum_{i=1}^{q-1} \phi_i(\tau)\, \Delta y_{t-i}. \tag{3}$$

By estimating Eq. (3) at different quantiles $\tau \in (0, 1)$ we get a set of estimates of the persistence measure $\alpha(\tau)$. We can test $\alpha(\tau) = 1$ at different values of τ to analyse the persistence of the GDP impact of positive and negative shocks and shocks of different magnitude using the quantile autoregression based unit root test by Koenker and Xiao (2004). The test has been extended by Galvao (2009) to include deterministic components which is essential for unit root tests of drifting time series like GDP.

Let $\widehat{\alpha}(\tau)$ be the quantile regression estimator. To test $H_0 : \alpha(\tau) = 1$ we use the t-stat for $\widehat{\alpha}(\tau)$ proposed by Koenker and Xiao (2004) which can be written as

$$t_n(\tau) = \frac{f\left(\widehat{F^{-1}(\tau)}\right)}{\sqrt{\tau(1-\tau)}} \left(Y'_{-1} M_Z Y_{-1}\right)^{1/2} \left(\widehat{\alpha}(\tau) - 1\right), \tag{4}$$

where $f(u)$ and $F(u)$ are the probability and cumulative density functions of ε_t, Y_{-1} is the vector of lagged log-GDP and M_Z is the projection matrix onto the space orthogonal to $Z = (1, t, \Delta y_{t-1}, \Delta y_{t-2}, \ldots, \Delta y_{t-q+1})$. We use the results derived by Koenker and Xiao (2004) and Galvao (2009) to find the critical values of $t_n(\tau)$ for different quantile levels. We estimate $f\left(F^{-1}(\tau)\right)$ following the rule given in Koenker and Xiao (2004).

Besides allowing for asymmetric effects of shocks on GDP an important advantage of QAR-based unit root tests over standard unit root tests is that they have more power (Koenker and Xiao, 2004). Hansen (1995) shows that including more covariates can lead to substantial power gains when compared to univariate unit root tests. Interestingly the limiting distribution of the t-statistic of Koenker and Xiao (2004) and Galvao (2009) resembles the limiting distribution of tests discussed in Hansen (1995). Hence QAR autoregression could be seen as a tool for systematically resorting to the framework of Hansen (1995) without including additional covariates.