LSST will obtain photometric redshifts for 4 billion galaxies with the distribution peaking around $z = 1$ and approximately 10% of the galaxies at $z > 2.5$. It will achieve percent level precision on the angular diameter distance at 11 redshifts logarithmically spaced between $z = 0.3$ to 3.6 with a CMB-calibrated standard ruler -- baryon acoustic oscillations (BAO) in the galaxy (and matter) power spectrum. By themselves, LSST BAO will provide weaker constraints on the dark energy equation of state parameters, $w_0$ and $w_a$, than LSST weak lensing (WL). However, because one can calibrate the error distribution of photometric redshifts with galaxy power spectra and determine the galaxy bias with galaxy and WL shear power spectra, a joint analysis of LSST BAO and WL will reduce the error ellipse area in the $w_0 - w_a$ plane to one sixth of that by LSST WL alone.

Gravitational lensing, being not affected by the galaxy bias, can help constrain the galaxy bias. The left panel shows the fractional error on the galaxy bias parameters from BAO (with Planck data) and from joint BAO and WL (also with Planck data, Zhan 2006, JCAP, 08, 008). The thin dashed line represents the external prior on the galaxy bias parameters, which is weak compared to the constraints from LSST data. Galaxy cross power spectra are sensitive to the photo-z error distribution, so that they can self-calibrate the photo-z parameters. This is demonstrated for the photo-z bias (middle panel) and rms error (right panel). In contrast, WL does not self-calibrate the photo-z error distribution because of its broad lensing kernel.

The figure on the left shows the best determined distance modes from LSST WL and BAO, separately (Zhan, Knox, & Tyson 2009, ApJ, 690, 923, arXiv:0806.0937). The WL modes are more concentrated at lower redshifts than the BAO modes, because WL measures the fluctuations at lower redshifts than the source galaxies and because the galaxy power spectra are truncated more at lower redshifts to reduce the impact of the nonlinear evolution. Although in general BAO places tighter constraints on individual $D_A$'s than WL, the WL modes shown actually have smaller errors than the BAO modes.

The figure on the right presents uncorrelated $w_0$ and $w_a$ constraints from 9 $D_A$ eigenmodes (in 3 groups) of LSST WL and BAO. Weak priors on cosmological parameters and $\sigma_P(w_0) = 1$ & $\sigma_P(w_a) = 2$ are applied. The growth parameters and the galaxy bias parameters are marginalized. The solid contours include the contributions of all $D_A$ modes. The BAO error ellipses are relatively narrow but in the same general direction, whereas the WL ones are oriented differently. The effect of combining all the BAO modes is mostly in reducing the area of the error ellipse, without much change in the marginalized errors of $w_0$ & $w_a$ separately.

5. Dark Energy Constraints
As shown in the figure on the left, the constraints on $w_0$ and $w_a$ from LSST BAO are weaker than those from LSST WL. However, a joint analysis of BAO and WL data benefits from the extra information in the galaxy shear power spectra, the calibration of the linear galaxy bias, and the calibration of photo-z parameters by the galaxy power spectra (Zhan 2009, astro-ph/0605696). It tightens the constraints considerably. This forecast assumes 10-year data from LSST and best current estimates of systematic error.