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We study generalized Forchheimer (non-Darcy) flows of slightly compressible fluids in porous media with time-dependent Dirichlet boundary data. The long time dynamics is studied in the general L^α spaces for all $\alpha \geq 1$. In addition to estimates of the solution for large time, we prove the structural stability with respect to the coefficients of the Forchheimer polynomials. In dealing with the weak diffusion of this degenerate parabolic equation, we utilize Sobolev-Poincaré type inequality for mixed terms and a non-linear Gronwall's inequality. The stability is established by using a perturbed monotonicity and carefully treating the cross-terms of the solutions and their derivatives. (Received September 01, 2012)