Competition for finite resources causes severe congestion and collisions in wireless networks. Without effective management, the network can become unstable, and users may experience very long delay, significant packet loss and poor throughput. In this paper, we propose a multivariable globalized-local (MG-Local) framework of resource management to find a balance between fair allocation and efficient utilization. This framework uses adaptive multivariable control to improve control effectiveness. Our design combines the advantages of both global and local optimization methods, and drives the system toward a global optimum by intelligently exploiting local information, without message passing. We compare the performance of our proposed method with four other approaches: an estimation-based multivariable control, single-variable control, distributed global-optimization, and CSMA/CA. Our experimental results show that our method significantly outperforms all four alternatives in terms of throughput, packet loss rate, end-to-end delay, and fairness.