Theorem 1 *Let the step size β_u^i be a fixed constant number β for all batches, and let U^* be the optimal solution to our problem. Given any $\epsilon > 0$, $\exists \beta_0$ s.t. $\forall \beta < \beta_0$, we have:*

$$\lim \inf_{m \to \infty} \sum_{t=1}^{m} \sum_{i} U_i(R_i(t) > U^* - \epsilon$$