In the usual setting non-demographic noise, emanating, e.g., from environmental variability, is manifested by time-varying reaction rates. In this work we investigate a different type of non-demographic noise in the form of uncertainty in the reaction step-size, and demonstrate that this type of noise can have a dramatic effect on the stability of self-regulating populations. By employing the usual reaction scheme *mA -> kA*, but allowing, e.g., the product number *k* to be a-priori unknown and sampled from a given distribution, we show that such non-demographic noise can greatly increase the population's stability compared to the case of fixed *k*. Our analysis is tested against numerical simulations, and by using empirical data of different species, we argue that certain distributions may be more evolutionary beneficial than others.