Supporting Information

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This section includes additional analyses of the forcing statistics in driven chemical reaction network realizations. In Fig. S1, the dynamics and forcing statistics are presented for different randomly realized networks that exhibit distinct properties in their fixed-point ensembles. Figs. S2 and S3 reproduce the analysis of Figs. 3 and 4 of the main text for an ensemble of chemical reaction networks in which the driven reaction time constants are independently sampled. Figs. S2 and S3 demonstrate that the effects are robust to additional disorder in the reaction rates.

Fig. S1. Comparison of two reaction networks: a network that tends to evolve to a low-force fixed point (Top row) and a network that tends to evolve to a high-force fixed point (Bottom row). (Left to Right) Representative time evolution of the concentrations of the 25 chemical species: time evolution of the total thermodynamic force $F_{\text{tot}}$ for 10 different initial conditions, normalized histogram of the total force $F_{\text{tot}}$ from 1,000 uniform samples of configuration space (orange) compared with the normalized histogram of the total force $F_{\text{tot}}$ attained after $10^7$ s for 500 trajectories with uniform initial conditions (blue), and work per maximum current $\eta$ as a function of time for the representative trajectory.

Fig. S2. Characterization of final total forcing $F_{\text{tot}}$ rarity with bare rate constants $k$ and $k'$ for undriven and driven reactions sampled independently. Shown is the frequency ratio of the percentile ranks of final total forces $F_{\text{tot}}$ to percentile ranks of uniformly sampled control measured relative to a uniformly sampled distribution of forces over configuration space. Shading delimits the region where the final total force $F_{\text{tot}}$ occurs less often than the control. Coloring signifies high-force fixed points (red) and low-force fixed points (blue). Parameters are the same as in Fig. 3 of the main text.
Fig. S3. Characterization of driven and undriven dynamics with bare rate constants $k$ and $k'$ for undriven and driven reactions sampled independently. (Left) Normalized histogram of Pearson correlation between driven and undriven force fields, $F_{\text{driven}}$ and $F_{\text{undriven}}$, for low-force configurations (orange) and high-force configurations (blue). (Right) Scatter plot of the magnitude of the undriven force field $||F_{\text{undriven}}||$ vs. the driven force field $||F_{\text{driven}}||$ conditioned on low-force configurations (orange) and high-force configurations (blue).