Supporting Information for *Non-random network connectivity comes in pairs*

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**SI1**

Solving

$$\mu = px + (1 - p)y$$  \hspace{0.5cm} (1)

for $p$ gives

$$p = \frac{\mu - y}{x - y},$$  \hspace{0.5cm} (2)

which, plugged into

$$\varrho = \frac{px^2 + (1 - p)y^2}{\mu^2},$$  \hspace{0.5cm} (3)

yields

$$\varrho = \frac{\left(\frac{\mu - y}{x - y}\right)x^2 + \left(1 - \frac{\mu - y}{x - y}\right)y^2}{\mu^2},$$  \hspace{0.5cm} (4)

$$= \frac{\left(\frac{\mu - y}{x - y}\right)(x^2 - y^2) + y^2}{\mu^2},$$  \hspace{0.5cm} (5)

$$= \frac{(\mu - y)(x + y) + y^2}{\mu^2},$$  \hspace{0.5cm} (6)

$$= \frac{x + y}{\mu} - \frac{xy}{\mu^2}.\hspace{0.5cm} (7)$$

**SI2**

Solve

$$p = \frac{\mu - y}{x - y}$$  \hspace{0.5cm} (8)

for $y$ and since $x \geq \mu$,

$$y = \frac{\mu - px}{1 - p} \leq \frac{\mu - p\mu}{1 - p} = \mu.$$  \hspace{0.5cm} (9)
Figure S1: Relative overrepresentation $\varrho$ of bidirectional connections in networks with a fraction of pairs connected with a high probability $x$ and the rest of the pairs connected with a low probability $y$. **Top** Overall connection probability in the network $\mu = 0.2$ **Bottom** $\mu = 0.5$