APPENDIX I. THE GAUGE DEPENDENCE OF THE RENORMALIZATION GROUP EQUATIONS

Let us consider the time-ordered product of gauge-invariant operators, O_i, which are multiplicatively renormalizable. These could be, say, gauge invariant currents. This renormalized Green's function, which we denote by $G^{(n)}$ will satisfy the renormalization group equation:

$$\left[\mu\frac{\partial}{\partial\mu} + \beta(g,\alpha)\frac{\partial}{\partial g} + \sum_i \gamma_i(g,\alpha)(1-2\alpha\frac{\partial}{\partial\alpha})\right] G^{(n)} = 0, \qquad \text{A.1}$$

where we have used Equation 2.21 and the sum runs over the anomalous dimensions of the operators O_i.

The derivative with respect to the physical gauge parameter can be eliminated using gauge invariance. This implies that the unrenormalized amplitude $G_u^{(n)}$ is independent of the bare gauge parameter α_u

$$\frac{\partial}{\partial\alpha_u} G_u^{(n)} (g_u,\Lambda)\Big|_{g_u,\Lambda \text{ fixed}} = 0. \qquad \text{A.2}$$

When we recall Equation 2.14 and express $G_u^{(n)}$ in terms of the renormalized Green's function we have that

$$\left[(1-\alpha\sigma(g,\alpha))\frac{\partial}{\partial\alpha} + \varepsilon(g,\alpha)\frac{\partial}{\partial g}+\sum_i\sigma_i(g,\alpha)\right] G^{(n)}(g,\alpha,\mu) = 0, \qquad \text{A.3}$$

where

$$\sigma(g,\alpha) = \frac{\partial Z_3}{\partial\alpha_u}\Bigg|_{g_u,\Lambda \text{ fixed}} \qquad \text{A.4}$$