Computing R and ϕ (0)

In[1]:=
```
JU[U_] = 1 + U (Log[U] - 1)
```
Out[1]= $1 + U(-1 + \text{Log}[U])$

In[2]:=
```
D[JU[U], U]
```
Out[2]= $\text{Log}[U]$

In[3]:=
```
Simplify[D[JU[U], U] == Log[U]]
```
Out[3]= True

In[4]:=
```
Wbar[η_] = 0.595 + η / 3.7 + η^4.55
```
Out[4]= $0.595 + 0.27027\,\eta + \eta^{4.55}$

In[5]:=
```
D[Wbar[η], η]
```
Out[5]= $0.27027 + 4.55\,\eta^{3.55}$

In[6]:=
```
Simplify[D[Wbar[η], η] == 1 / 3.7 + 4.55 η^3.55]
```
Out[6]= True

In[7]:=
```
q[Wbar_] = (2 Wbar - 1) / (1 - Wbar)
```
Out[7]= $\frac{-1 + 2\,\text{Wbar}}{1 - \text{Wbar}}$

In[8]:=
```
Simplify[D[q[Wbar], Wbar]]
```
Out[8]= $\frac{1}{(-1 + \text{Wbar})^2}$

In[9]:=
```
Simplify[D[q[Wbar], Wbar] == (Wbar - 1)^-2]
```
Out[9]= True

In[10]:=
```
GU[U_, q_] = (U - 1 - (1 - 1 / U^(1+q)) / (1 + q)) / ((2 + q) Ju[U])
```
Out[10]= $\frac{-1 + U - \frac{1 - U^{-1-q}}{1+q}}{(2 + q)\,\text{Ju}[U]}$

In[11]:=
```
Simplify[Expand[GU[U, q]]]
```
Out[11]= $-\frac{2 + q - U - q\,U - U^{-1-q}}{(2 + 3\,q + q^2)\,\text{Ju}[U]}$

In[12]:=
```
Simplify[GU[U, q] == (U (1 + q) - (2 + q) + U^(-1-q)) / ((1 + q) (2 + q) Ju[U])]
```
Out[12]= True

In[13]:= `D[GU[U, q], U]`

Out[13]=
$$\frac{1+\frac{(-1-q)\,U^{-2-q}}{1+q}}{(2+q)\,Ju[U]}-\frac{\left(-1+U-\frac{1-U^{-1-q}}{1+q}\right)Ju'[U]}{(2+q)\,Ju[U]^2}$$

In[14]:=
$$\frac{\left(-1+U-\frac{1-U^{-1-q}}{1+q}\right)Ju'[U]}{(2+q)\,Ju[U]^2}\Big/ GU[U, q]$$

Out[14]=
$$\frac{Ju'[U]}{Ju[U]}$$

In[15]:=
$$\text{Simplify}\left[D[GU[U,q],U]==\frac{1-U^{-2-q}}{(2+q)\,Ju[U]}-\left(\frac{Ju'[U]}{Ju[U]}\right)GU[U,q]\right]$$

Out[15]= True

In[16]:= `D[GU[U, q], q]`

Out[16]=
$$-\frac{-1+U-\frac{1-U^{-1-q}}{1+q}}{(2+q)^2\,Ju[U]}+\frac{\frac{1-U^{-1-q}}{(1+q)^2}-\frac{U^{-1-q}\,Log[U]}{1+q}}{(2+q)\,Ju[U]}$$

In[17]:=
$$\frac{-1+U-\frac{1-U^{-1-q}}{1+q}}{(2+q)^2\,Ju[U]}\Big/ GU[U, q]$$

Out[17]=
$$\frac{1}{2+q}$$

In[18]:=
$$\text{Simplify}\left[\frac{1-U^{-1-q}}{(1+q)^2}-\frac{U^{-1-q}\,Log[U]}{1+q}\right]$$

Out[18]=
$$\frac{U^{-1-q}\left(-1+U^{1+q}-(1+q)\,Log[U]\right)}{(1+q)^2}$$

In[19]:=
$$\text{Simplify}\left[D[GU[U,q],q]==\left(\frac{\left(U^{1+q}-1\right)-(1+q)\,Log[U]}{Ju[U]\,U^{1+q}\,(1+q)^2}-GU[U,q]\right)\Big/(2+q)\right]$$

Out[19]= True

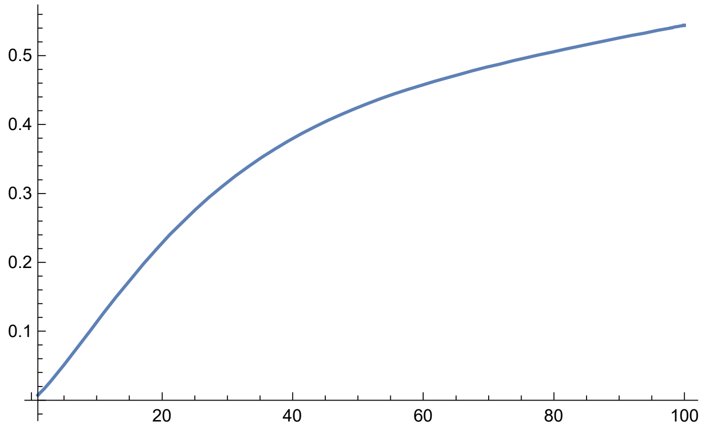
In[20]:=
$$\text{CForm}\left[\left(\frac{\frac{1-U^{-1-q}}{(1+q)^2}-\frac{U^{-1-q}\,Log[U]}{1+q}}{Ju[U]}-GU[U,q]\right)\Big/(2+q)\right]$$

Out[20]//CForm=
```
(-((-1 + U - (1 - Power(U,-1 - q))/(1 + q))/((2 + q)*Ju(U))) +
   ((1 - Power(U,-1 - q))/Power(1 + q,2) - (Power(U,-1 - q)*Log(U))/(1 + q))/Ju(U))/(2 + q)
```

In[21]:=
$$etaBar[Zbarb\_] = 1.75\times 10^{-3}\,Zbarb + 0.37\left(1-Exp\left[-0.015\,Zbarb^{1.3}\right]\right)$$

Out[21]=
$$0.37\left(1-e^{-0.015\,Zbarb^{1.3}}\right)+0.00175\,Zbarb$$

In[22]:=
```
Plot[etaBar[z], {z, 1, 100}]
```

Out[22]=


In[23]:=
```
D[etaBar[Zbarb], Zbarb]
```

Out[23]= $0.00175 + 0.007215\, e^{-0.015\, \text{Zbarb}^{1.3}}\, \text{Zbarb}^{0.3}$

In[24]:=
```
Simplify[D[etaBar[Zbarb], Zbarb] == 0.00175 + 0.007215 Exp[-0.015 Zbarb^1.3] Zbarb^0.3]
```

Out[24]= True

In[25]:=
```
R[Zbarb_, E0_] = 1 - etaBarZ[Zbarb] WbarZ[Zbarb] (1 - G[E0, Zbarb])
```

Out[25]= 1 - etaBarZ[Zbarb] (1 - G[E0, Zbarb]) WbarZ[Zbarb]

In[26]:=
```
D[R[Zbarb, E0], Zbarb]
```

Out[26]= $-(1 - \text{G}[\text{E0}, \text{Zbarb}])\, \text{WbarZ}[\text{Zbarb}]\, \text{etaBarZ}'[\text{Zbarb}] - \text{etaBarZ}[\text{Zbarb}]\, (1 - \text{G}[\text{E0}, \text{Zbarb}])\, \text{WbarZ}'[\text{Zbarb}] + \text{etaBarZ}[\text{Zbarb}]\, \text{WbarZ}[\text{Zbarb}]\, \text{G}^{(0,1)}[\text{E0}, \text{Zbarb}]$

In[27]:=
```
Simplify[D[R[Zbarb, E0], Zbarb] ==
  etaBarZ[Zbarb] (WbarZ[Zbarb] G^(0,1)[E0, Zbarb] - (1 - G[E0, Zbarb]) WbarZ'[Zbarb]) -
   (1 - G[E0, Zbarb]) WbarZ[Zbarb] etaBarZ'[Zbarb]]
```

Out[27]= True

In[28]:=
```
D[R[Zbarb, E0], E0]
```

Out[28]= $\text{etaBarZ}[\text{Zbarb}]\, \text{WbarZ}[\text{Zbarb}]\, \text{G}^{(1,0)}[\text{E0}, \text{Zbarb}]$

In[29]:=
```
Simplify[D[R[Zbarb, E0], E0] == etaBarZ[Zbarb] WbarZ[Zbarb] G^(1,0)[E0, Zbarb]]
```

Out[29]= True

In[30]:=
```
Phi0[etaBar_, U0_] = 1 + 33 / 10 (1 - 1 / U0^(2-23/10 etaBar)) etaBar^(6/5)
```

Out[30]= $1 + \frac{33}{10}\, \text{etaBar}^{6/5} \left(1 - \text{U0}^{-2+\frac{23\, \text{etaBar}}{10}}\right)$

In[31]:=
```
Simplify[D[Phi0[etaBar, U0], etaBar]]
```

Out[31]=
$$-\frac{33\ \text{etaBar}^{1/5}\left(12\left(-\text{U0}^2+\text{U0}^{23\ \text{etaBar}/10}\right)+23\ \text{etaBar}\ \text{U0}^{23\ \text{etaBar}/10}\ \text{Log}[\text{U0}]\right)}{100\ \text{U0}^2}$$

In[32]:=
```
Simplify[D[Phi0[etaBar, U0], etaBar] ==
  etaBar^(1/5) (396 / 100 (1 - U0^(23/10 etaBar-2)) - 759 / 100 etaBar U0^(23/10 etaBar-2) Log[U0])]
```

Out[32]= True

In[33]:=
```
D[Phi0[etaBar, U0], U0]
```

Out[33]=
$$-\frac{33}{10}\ \text{etaBar}^{6/5}\left(-2+\frac{23\ \text{etaBar}}{10}\right)\text{U0}^{-3+\frac{23\ \text{etaBar}}{10}}$$

In[36]:=
```
Simplify[D[Phi0[etaBar, U0], U0] == -33 / 10 etaBar^(6/5) (-2 + 23 / 10 etaBar) U0^(23/10 etaBar-3)]
```

Out[36]= True

In[35]:=
```
3 * 0.869565
```

Out[35]= 2.6087