Mathematica Appendix for
“The Conundrum of Recovery Policies: Growth or Jobs”
by Elias Dinopoulos, Wolf-Heimo Grieben, and Fuat Sener

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"Last update: July 2013";

"Our objective is to obtain a steady-state solution and then have explicit closed
   form solutions for all of the model's endogenous variables. We then change the parameters using the
   Manipulate function and observe graphically how the endogenous variables react to parameter changes.

The first step is to express the endogenous variables in terms of the parameters and create graphs.";
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1. Steady-State Equilibrium

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"1.1.Obtaining closed form solutions";
```

In[1]:=

```
"We clear the variables and enter the steady-state equations. We note the slight
   changes in the notation below. Unless otherwise indicated the notation exactly follows the paper.

a. σY here is the subsidy rate to young firms in the paper.
b. σA here is the subsidy rate to adult firms in the paper.
c. NP here is population N in the paper.
d. IN here is the innovation rate i in the paper.
e. We define per capita R&D difficulty as x=X/N.";

Clear[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA];
Clear[RP, MATCH, CD, RP, qEQ ];
Clear[IN, q, u, v, θ, c, VO, VY, x, wH, VA, nA, VTOT, WELF];
```

In[5]:= "Below is the Creative Destruction condition, which is the Beveridge condition in the literature";

```
CD = q * IN * (1 - u) * (1 - ϕ) == A * (θ^η) * (IN + q) * u;
```

"We solve it for u"; Solve[CD, u]

Out[7]= $\left\{\left\{u \to \frac{\text{IN}\, q\, (-1+\phi)}{-\text{IN}\, q - A\, \text{IN}\, \theta^{\eta} - A\, q\, \theta^{\eta} + \text{IN}\, q\, \phi}\right\}\right\}$

"Now, we enter this expression for u";

In[8]:= $u = \frac{\text{IN}\, q\, (-1+\phi)}{-\text{IN}\, q - A\, \text{IN}\, \theta^{\eta} - A\, q\, \theta^{\eta} + \text{IN}\, q\, \phi}$;

In[9]:= "Below is the matching rate q in terms of θ. To obtain this, we assume a Cobb-Douglass matching function: M = $AV^{\eta}U^{1-\eta}$. We note that θ=V/U = v/u (when divided by the relevant population).

Thus q=$A\left(\frac{1}{\theta}\right)^{1-\eta}$ and p = $A(\theta)^{\eta}$.";

```
MATCH = q == A * (1 / θ) ^ (1 - η);
```

Solve[MATCH, θ]

Out[11]= $\left\{\left\{\theta \to \left(\frac{q}{A}\right)^{-\frac{1}{1-\eta}}\right\}\right\}$

In[12]:= $\theta = \left(\frac{q}{A}\right)^{-\frac{1}{1-\eta}}$;

In[13]:= $p = A * \theta^{\eta}$

Out[13]= $A\left(\left(\frac{q}{A}\right)^{-\frac{1}{1-\eta}}\right)^{\eta}$

In[14]:= "We also have the following from the properties of the matching function";

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v = θ * u;
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"We have from the RP condition an expression for the innovation rate i:";

In[16]:= $$IN = \frac{\phi\,(\lambda - 1 + \sigma Y)}{\rho} \Big/ \left(B\,(1 - \sigma R)\left(\frac{\lambda - 1 + \sigma A}{\rho} - \frac{2 * \phi\,(\lambda - 1 + \sigma Y)}{B\,(1 - \sigma R)\,(\rho\text{^}2)} - \frac{(1 - \phi)\,(\lambda - 1)}{\rho + q}\right)\right);$$

"Below is the VC equation, which gives the vacancy matching rate q in terms of the parameters.";

In[17]:= $$q = \frac{\alpha * \rho}{\left(\lambda - 1 + \frac{\sigma A}{1-\phi}\right) - \frac{\phi}{1-\phi} * \left(\frac{2*(\lambda-1+\sigma Y)}{\rho*(1-\sigma R)*B} + \sigma Y\right)};$$

In[18]:= "Now, we enter the expressions for nA, GR, c";

$$nA = \frac{q}{IN + q};\ c = (1 - u) * (1 - s) * \lambda;\ GR = Log[\lambda] * nA * IN;$$

"We now enter x, wH, and the expressions for valuations.";

In[20]:= $$x = \frac{s}{\gamma * nA * (1 + (B * IN))};\ wH = \frac{\phi * c\,(\lambda - (1 - \sigma Y)) * nA * \left(IN + \frac{1}{B}\right)}{\lambda * \rho * (1 - \sigma R) * s};$$

$$VA = \frac{\frac{c*NP*(\lambda-1+\sigma A)}{\lambda} - 2 * wH * \gamma * x * NP}{\rho};$$

In[22]:= $$VO = \frac{(1 - \phi)\,c * NP * (\lambda - 1 + \sigma A)}{(q + \rho) * \lambda};\ VY = \frac{\phi * c * NP * (\lambda - (1 - \sigma Y))}{\rho * \lambda};$$

"VTOT is the total stock market valuation and WELF is Welfare";

$$VTOT = (nA * VA) + ((1 - nA) * ((1 - \phi) * VO + \phi * VY));$$

$$WELF = \frac{1}{\rho}\left(\frac{nA * IN * Log[\lambda]}{\rho} + Log[c / \lambda] - ((1 - nA) * (1 - \phi)\,Log[\lambda])\right);$$

"1.2.Defining the functions in terms of parameters";

```
"We create new functions for IN, u, q, nA, GR, and VTOT  in terms of parameters. We call
   them the variables name followed by EQ. For example, INEQ is the function for the IN expression.
To create the functions, we use the expressions from the 'simplify' command. We suppress the
   outputs of the Simplify command by using ';' because they are extremely long.";
```

In[26]:= **IN // Simplify;**

In[27]:= **INEQ[B_, α_, γ_, η_, s_, NP_, A_, ϕ_, ρ_, λ_, σY_, σR_, σA_] :=**

$$\frac{(-1+\lambda+\sigma Y)\,\phi}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)};$$

In[28]:= **u // Simplify;**

In[29]:=

$$\mathrm{uEQ}[B\_,\ \alpha\_,\ \gamma\_,\ \eta\_,\ s\_,\ NP\_,\ A\_,\ \phi\_,\ \rho\_,\ \lambda\_,\ \sigma Y\_,\ \sigma R\_,\ \sigma A\_] := -\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)^2\,\phi\right) \Big/ \left((1-\sigma R)\,\left(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)\right)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\right.$$

$$\left(\frac{A\,B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)\,\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\right.$$

$$\frac{A\,(-1+\lambda+\sigma Y)\,\phi\,\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{B\,\rho\,(1-\sigma R)\,\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}+(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi)\Big/\Bigg((1-\sigma R)$$

$$\left(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)\right)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Bigg)-$$

$$\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi^2\right)\Big/\Bigg((1-\sigma R)\,\left(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)\right)$$

$$\left.\left.\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Bigg)\right)\right);$$

In[30]:= **q;**

In[31]:= $$\mathrm{qEQ}[B\_,\ \alpha\_,\ \gamma\_,\ \eta\_,\ s\_,\ NP\_,\ A\_,\ \phi\_,\ \rho\_,\ \lambda\_,\ \sigma Y\_,\ \sigma R\_,\ \sigma A\_] := \frac{\alpha\,\rho}{-1+\lambda+\frac{\sigma A}{1-\phi}-\frac{\left(\sigma Y+\frac{2\,(-1+\lambda+\sigma Y)}{B\,\rho\,(1-\sigma R)}\right)\phi}{1-\phi}};$$

In[32]:= **p;**

In[33]:= $$\mathrm{pEQ}[B\_,\ \alpha\_,\ \gamma\_,\ \eta\_,\ s\_,\ NP\_,\ A\_,\ \phi\_,\ \rho\_,\ \lambda\_,\ \sigma Y\_,\ \sigma R\_,\ \sigma A\_] := A\left(\left(\frac{\alpha\,\rho}{A\left(-1+\lambda+\frac{\sigma A}{1-\phi}-\frac{\left(\sigma Y+\frac{2\,(-1+\lambda+\sigma Y)}{B\,\rho\,(1-\sigma R)}\right)\phi}{1-\phi}\right)}\right)^{-\frac{1}{1-\eta}}\right)^{\eta};$$

In[34]:= **nA // Simplify;**

In[35]:= $$\mathrm{nAEQ}[B\_,\ \alpha\_,\ \gamma\_,\ \eta\_,\ s\_,\ NP\_,\ A\_,\ \phi\_,\ \rho\_,\ \lambda\_,\ \sigma Y\_,\ \sigma R\_,\ \sigma A\_] :=$$

$$\left(B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)\right)\Big/\Bigg((-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))$$

$$\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\frac{(-1+\lambda+\sigma Y)\,\phi}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}\right)\Bigg);$$

In[36]:= **GR // Simplify;**

In[37]:= GREQ[B_, α_, γ_, η_, s_, NP_, A_, ϕ_, ρ_, λ_, σY_, σR_, σA_] :=

$$\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi\,\mathrm{Log}[\lambda]\right) \Bigg/ \left((1-\sigma R)\,\left(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)\right) \left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right) \left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\frac{(-1+\lambda+\sigma Y)\,\phi}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}\right)\right);$$

In[38]:= v // Simplify;

In[39]:= **vEQ[B_, α_, γ_, η_, s_, NP_, A_, φ_, ρ_, λ_, σY_, σR_, σA_] :=**

$$
-\left(A\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{\eta}{-1+\eta}}\right)\Bigg/
$$

$$
\left(B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\right.
$$

$$
\left(\frac{A\,B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\right.
$$

$$
\frac{A\,(-1+\lambda+\sigma Y)\,\phi\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}+(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi)\Big/\Big((1-\sigma R)
$$

$$
(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Big)-
$$

$$
\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi^2\right)\Big/\Big((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))
$$

$$
\left.\left.\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Big)\right)\right);
$$

In[40]:= **θ;**

In[41]:=
```
θEQ[B_, α_, γ_, η_, s_, NP_, A_, ϕ_, ρ_, λ_, σY_, σR_, σA_] :=
```
$$\left(\frac{\alpha\,\rho}{A\left(-1+\lambda+\frac{\sigma A}{1-\phi}-\frac{\left(\sigma Y+\frac{2\,(-1+\lambda+\sigma Y)}{B\,\rho\,(1-\sigma R)}\right)\phi}{1-\phi}\right)}\right)^{-\frac{1}{1-\eta}};$$

In[42]:= **VA // Simplify;**

In[43]:=

$$\text{VAEQ}[B\_,\ \alpha\_,\ \gamma\_,\ \eta\_,\ s\_,\ NP\_,\ A\_,\ \phi\_,\ \rho\_,\ \lambda\_,\ \sigma Y\_,\ \sigma R\_,\ \sigma A\_] := \frac{1}{B\,\rho^2\,(-1+\sigma R)}\,NP\,(1-s)\,(B\,\rho\,(-1+\lambda+\sigma A)\,(-1+\sigma R)+2\,(-1+\lambda+\sigma Y)\,\phi)$$

$$\Bigg(1+\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)^2\,\phi\right)\Bigg/\Bigg((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\,\Bigg(\frac{-1+\lambda+\sigma A}{\rho}+$$

$$\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\Bigg)\,\Bigg(\frac{A\,B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+$$

$$\frac{A\,(-1+\lambda+\sigma Y)\,\phi\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}+(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi)\Bigg/\Bigg((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)$$

$$\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Bigg)-$$

$$\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi^2\right)\Bigg/\Bigg((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))$$

$$\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Bigg)\Bigg)\Bigg)\Bigg);$$

In[44]:=

```
VY // Simplify;
```

In[45]:= $\texttt{VYEQ}[B\_,\ \alpha\_,\ \gamma\_,\ \eta\_,\ s\_,\ NP\_,\ A\_,\ \phi\_,\ \rho\_,\ \lambda\_,\ \sigma Y\_,\ \sigma R\_,\ \sigma A\_] := \frac{1}{\rho} NP\,(1-s)\,(-1+\lambda+\sigma Y)\,\phi$

$$\left(1+\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)^2\,\phi\right)\Big/\left((1-\sigma R)\,\left(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)\right)\left(\frac{-1+\lambda+\sigma A}{\rho}+\right.\right.\right.$$

$$\left.\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\left(\frac{A\,B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)\,\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\right.$$

$$\frac{A\,(-1+\lambda+\sigma Y)\,\phi\,\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{B\,\rho\,(1-\sigma R)\,\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}+(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi)\Big/\Big((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)$$

$$\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Big)-$$

$$\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi^2\right)\Big/\Big((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))$$

$$\left.\left.\left.\left.\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Big)\right)\right)\right)\right);$$

In[46]:= `VO // Simplify;`

In[47]:= VOEQ[B_, α_, γ_, η_, s_, NP_, A_, φ_, ρ_, λ_, σY_, σR_, σA_] :=

$$
\begin{aligned}
&\Bigg(NP\,(1-s)\,(-1+\lambda+\sigma A)\,(1-\phi)\,\Bigg(1+\Big(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)^2\,\phi\Big)\Big/\Bigg((1-\sigma R)\\
&\quad(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\\
&\quad\Bigg(\frac{A\,B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\\
&\quad\frac{A\,(-1+\lambda+\sigma Y)\,\phi\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}+\\
&\quad(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi)\Big/\Bigg((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\\
&\quad\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Bigg)-\Big(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi^2\Big)\Big/\\
&\quad\Bigg((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\Bigg(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\\
&\quad\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\Bigg)\Bigg)\Bigg)\Bigg)\Bigg)\Bigg)\Bigg/\left(\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}\right);
\end{aligned}
$$

In[48]:= **C // Simplify;**

In[49]:= **cEQ[B_, α_, γ_, η_, s_, NP_, A_, ϕ_, ρ_, λ_, σY_, σR_, σA_] :=**

$$(1-s)\,\lambda\left(1+\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)^{2}\,\phi\right)\Big/\left((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^{2}\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\left(\frac{A\,B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)\left(\left(\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\frac{A\,(-1+\lambda+\sigma Y)\,\phi\left(\left(\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^{2}\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}+\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi\right)\Big/\left((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^{2}\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\right)-\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi^{2}\right)\Big/\left((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^{2}\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\right)\right)\right)\right);$$

In[50]:= **VTOT // Simplify;**

In[51]:= VTOTEQ[B_, α_, γ_, η_, s_, NP_, A_, ϕ_, ρ_, λ_, σY_, σR_, σA_] :=

$$
\begin{aligned}
& NP\,(1-s)\Bigg(1+\big(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)^2\,\phi\big)\Big/\Big((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\,\Big(\frac{-1+\lambda+\sigma A}{\rho}+ \\
& \frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\Big)\Bigg(\frac{A\,B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)\,\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+ \\
& \frac{A\,(-1+\lambda+\sigma Y)\,\phi\,\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{B\,\rho\,(1-\sigma R)\,\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}+(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi)\Big/\Big((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y) \\
& \phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\,\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Big)- \\
& \big(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi^2\big)\Big/\Big((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)) \\
& \left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Big)\Bigg)\Big)\Bigg)
\end{aligned}
$$

$$\left((\alpha\,(-1+\phi)\,(B\,\rho\,(-1+\lambda+\sigma A)\,(-1+\sigma R)+2\,(-1+\lambda+\sigma Y)\,\phi))\middle/\left((-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\right.\right.$$

$$\left.\left.\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\frac{(-1+\lambda+\sigma Y)\,\phi}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}\right)\right)\right)+$$

$$\left(\frac{(-1+\lambda+\sigma Y)\,\phi^2}{\rho}+\frac{(-1+\lambda+\sigma A)\,(-1+\phi)^2}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)$$

$$\left(1-\left(B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)\right)\middle/\left((-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\right.\right.$$

$$\left.\left.\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\frac{(-1+\lambda+\sigma Y)\,\phi}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}\right)\right)\right)\Bigg)\Bigg);$$

In[52]:=
```
x // Simplify;
```

In[53]:= xEQ[B_, α_, γ_, η_, s_, NP_, A_, ϕ_, ρ_, λ_, σY_, σR_, σA_] :=

$$\left(s\left(-1+\lambda+\frac{\sigma A}{1-\phi}-\frac{\left(\sigma Y-\frac{2\,(-1+\lambda+\sigma Y)}{B\,\rho\,(-1+\sigma R)}\right)\phi}{1-\phi}\right)\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\frac{(-1+\lambda+\sigma Y)\,\phi}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}\right)\right)\Big/\left(\alpha\,\gamma\,\rho\left(1+\frac{(-1+\lambda+\sigma Y)\,\phi}{\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}\right)\right);$$

In[54]:= wH // Simplify;

In[55]:= wHEQ[B_, α_, γ_, η_, s_, NP_, A_, ϕ_, ρ_, λ_, σY_, σR_, σA_] :=

$$\left((1-s)\,\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi\left(1+\frac{(-1+\lambda+\sigma Y)\,\phi}{\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}\right)\right)$$

$$\left(1+\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)^2\,\phi\right)\Big/\left((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\right)\right)$$

$$\Bigg(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\Bigg)$$

$$\Bigg(\frac{A\,B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)\,\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+$$

$$\frac{A\,(-1+\lambda+\sigma Y)\,\phi\,\left(\left(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{B\,\rho\,(1-\sigma R)\,\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}+(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi)\Big/\Big((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)$$

$$\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\,\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Big)-$$

$$\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi^2\right)\Big/\Big((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))$$

$$\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Big)\Big)\Big)\Big)\Big)\Big/$$

$$\Big(s\,(1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\,\Bigg(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+$$

$$\frac{(-1+\lambda+\sigma Y)\,\phi}{\qquad}\Bigg)\Big);$$

In[56]:= **WELF // Simplify;**

In[57]:= **WELFEQ[B_, α_, γ_, η_, s_, NP_, A_, ϕ_, ρ_, λ_, σY_, σR_, σA_] :=**

$$\frac{1}{\rho}\Bigg((\alpha\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi\,\mathrm{Log}[\lambda])\Big/\Bigg((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))$$

$$\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)$$

$$\Bigg(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\frac{(-1+\lambda+\sigma Y)\,\phi}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}\Bigg)\Bigg)\Bigg)-$$

$$(1-\phi)\,\Bigg(1-\left(B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)\right)\Big/\Bigg((-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))$$

$$\Bigg(\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+\frac{(-1+\lambda+\sigma Y)\,\phi}{B\,\rho\,(1-\sigma R)\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^2\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^2\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}\Bigg)\Bigg)\Bigg)$$

$$\mathrm{Log}[\lambda]+\mathrm{Log}\Big[(1-s)\,\Bigg(1+\left(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)^2\,\phi\right)\Big/\Bigg((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))$$

$$\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^{2}\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)$$

$$\Bigg(\frac{A\,B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)\,\left(\left(\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}+$$

$$\frac{A\,(-1+\lambda+\sigma Y)\,\phi\,\left(\left(\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{A\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))}\right)^{\frac{1}{-1+\eta}}\right)^{\eta}}{B\,\rho\,(1-\sigma R)\,\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^{2}\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)}+(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi)\Big/$$

$$\Bigg((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\,\Bigg(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^{2}\,(-1+\sigma R)}-$$

$$\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\Bigg)\Bigg)-(\alpha\,\rho\,(-1+\sigma R)\,(-1+\lambda+\sigma Y)\,(-1+\phi)\,\phi^{2})\Big/\Bigg((1-\sigma R)\,(-2\,(-1+\lambda+\sigma Y)\,\phi+$$

$$B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi))\,\left(\frac{-1+\lambda+\sigma A}{\rho}+\frac{2\,(-1+\lambda+\sigma Y)\,\phi}{B\,\rho^{2}\,(-1+\sigma R)}-\frac{(-1+\lambda)\,(1-\phi)}{\rho+\frac{B\,\alpha\,\rho^{2}\,(-1+\sigma R)\,(-1+\phi)}{-2\,(-1+\lambda+\sigma Y)\,\phi+B\,\rho\,(-1+\sigma R)\,(1-\lambda-\sigma A-\phi+\lambda\,\phi+\sigma Y\,\phi)}}\right)\Bigg)\Bigg)\Bigg)\Bigg)\Bigg]\Bigg);$$

2. Graphical Analysis

```
"Now, we plot all of the endogenous variables having the
   ability to manipulate them at the same time. We start with the benchmark parameter values";
```

```
" This is the benchmark parameter set

{{B,4.904697146627181`},0.00,280},{{α,2.032388779308036`},0.0,2.4},{{ϕ,0.08814589665902509`},0.0,0.65},{{λ,1.25},1.1,1.7},{{A,
   1.4555491531007312`},0.0,2.0},{{η,0.6},0.0,1.0},{{NP,1},0.5,2.0},{{s,0.05},0.001,0.1},{{γ,1},0.5,1.5},{{σY,0},-1,1},{{σR,0},
   -1,1},{{σA,0},-1,1},
   {{ρ,0.05},0.01,0.14}

";
```

```
"2.1.ANALYSIS OF SUBSIDY TO YOUNG FIRMS σY";
```

In[58]:=

```
Manipulate[{
  Plot[INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σY, -1, 1}, PlotRange → {-1, 1.5},  AxesLabel → {"σY", "IN"}, AxesOrigin → {0, 0}],

  Plot[uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σY, -1, 1}, PlotRange → {-1, 1.5},  AxesLabel → {"σY", "u"}, AxesOrigin → {0, 0}],

  Plot[nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σY, -1, 1}, PlotRange → {-1, 2.5},  AxesLabel → {"σY", "nA"}, AxesOrigin → {0, 0}],

  Plot[GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σY, -1, 1}, PlotRange → {-1, 1.5},  AxesLabel → {"σY", "GR"}, AxesOrigin → {0, 0}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σY, -1, 1}, PlotRange → {-0.1, 0.1},  AxesLabel → {"σY", "wH*x"}, AxesOrigin → {0, 0}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σY, -1, 1}, PlotRange → {-0.01, 0.01},  AxesLabel → {"σY", "IN*x"}, AxesOrigin → {0, 0}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σY, -1, 1}, PlotRange → {-0.06, 0.06},  AxesLabel → {"σY", "x"}, AxesOrigin → {0, 0}],

  Plot[wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σY, -1, 1}, PlotRange → {-1, 4},  AxesLabel → {"σLB", "wH"}, AxesOrigin → {0, 0}],

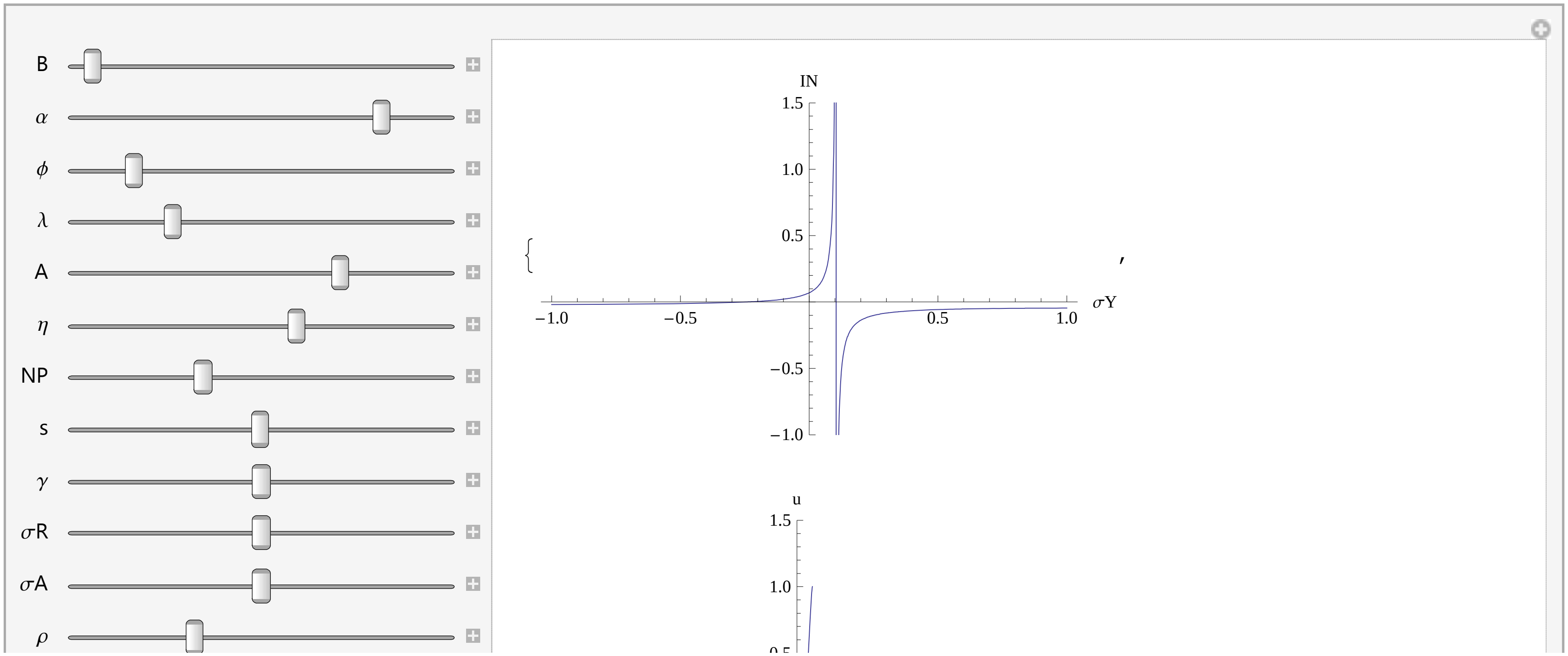
  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σY, -1, 1}, PlotRange → {-0.01, 0.2},  AxesLabel → {"σY", "nA*x"}, AxesOrigin → {0, 0}],
```

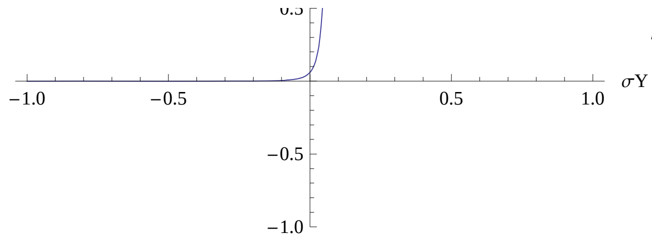
```
 Plot[qEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {σY, -1, 1}, PlotRange → {-1, 4},  AxesLabel → {"σY", "q"}, AxesOrigin → {0, 0}],

 Plot[VTOTEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {σY, -1, 1}, PlotRange → {-10, 10},  AxesLabel → {"σY", "VTOT"}, AxesOrigin → {0, 0}],

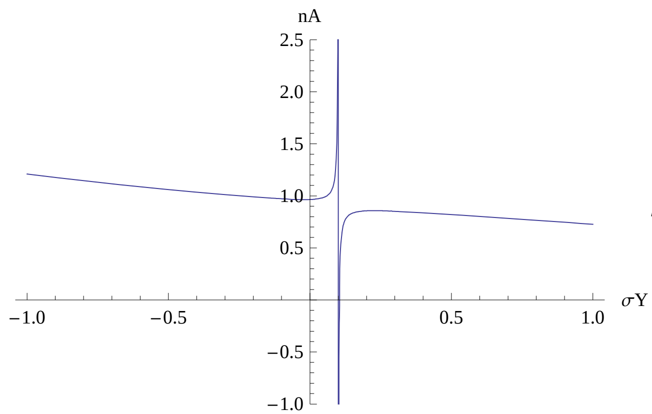
 Plot[WELFEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {σY, -1, 1}, PlotRange → {-10, 10},  AxesLabel → {"σY", "WELF"}, AxesOrigin → {0, 0}]
},

{{B, 4.904697146627181`}, 0.00, 280}, {{α, 2.032388779308036`}, 0.0, 2.4},
{{ϕ, 0.08814589665902509`}, 0.0, 0.65}, {{λ, 1.25}, 1.1, 1.7}, {{A, 1.4555491531007312`}, 0.0, 2.0},
{{η, 0.6}, 0.0, 1.0}, {{NP, 1}, 0.5, 2.0}, {{s, 0.05}, 0.001, 0.1}, {{γ, 1}, 0.5, 1.5}, {{σR, 0}, -1, 1}, {{σA, 0}, -1, 1},
{{ρ, 0.05}, 0.01, 0.14}]
```

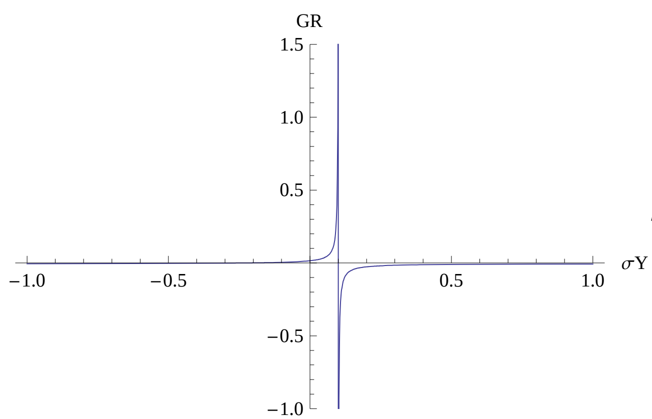



σY
−1.0
−0.5
0.5
1.0
−0.5
−1.0

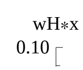
,


nA
2.5
2.0
1.5
1.0
0.5
σY
−1.0
−0.5
0.5
1.0
−0.5
−1.0

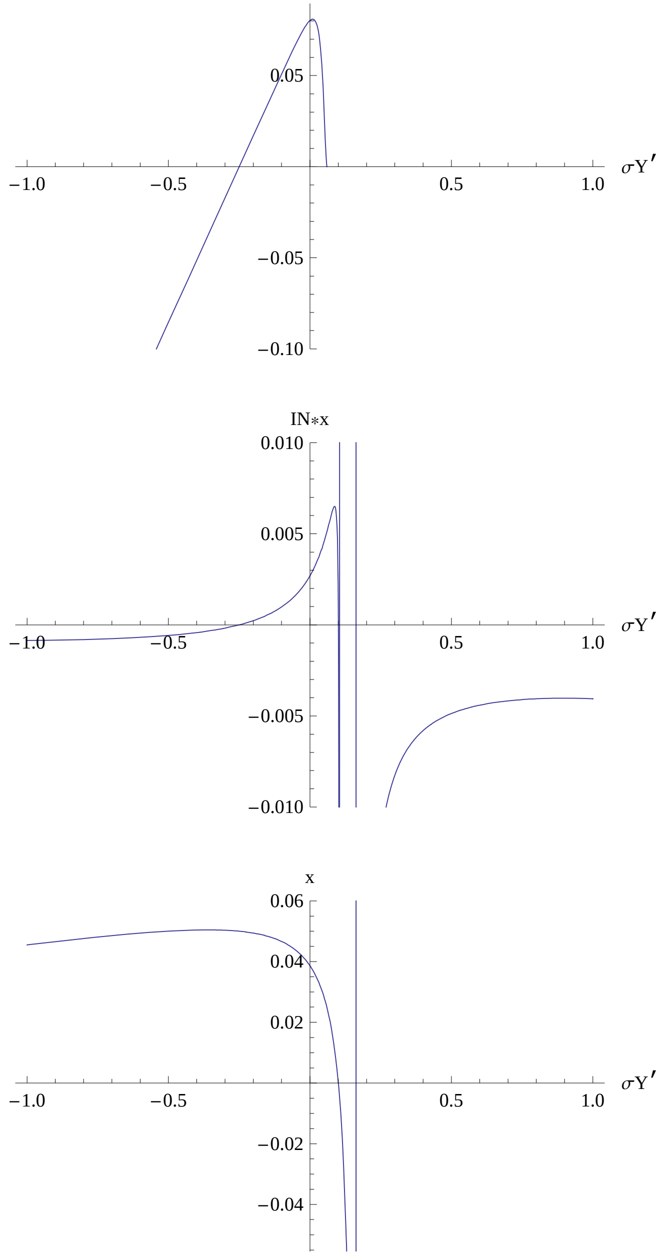
,

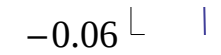

GR
1.5
1.0
0.5
σY
−1.0
−0.5
0.5
1.0
−0.5
−1.0

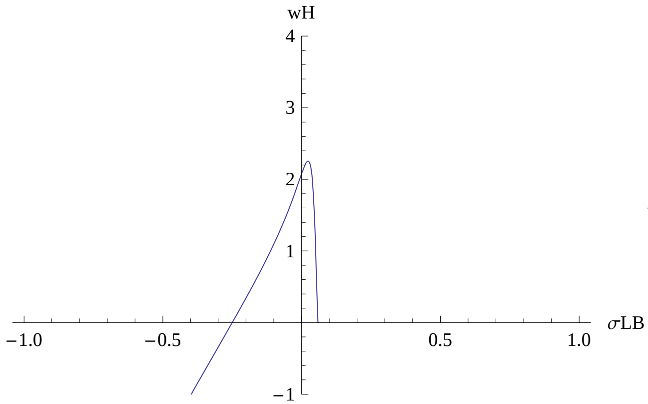
,


wH∗x
0.10

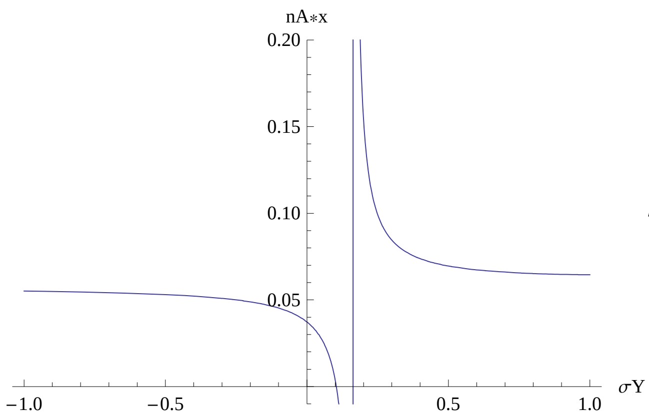
Out[58]=


0.05
−1.0
−0.5
0.5
1.0
σY′
−0.05
−0.10
IN∗x
0.010
0.005
−1.0
−0.5
0.5
1.0
σY′
−0.005
−0.010
x
0.06
0.04
0.02
−1.0
−0.5
0.5
1.0
σY′
−0.02
−0.04

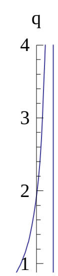

−0.06


wH
4
3
2
1
−1
−1.0
−0.5
0.5
1.0
σLB

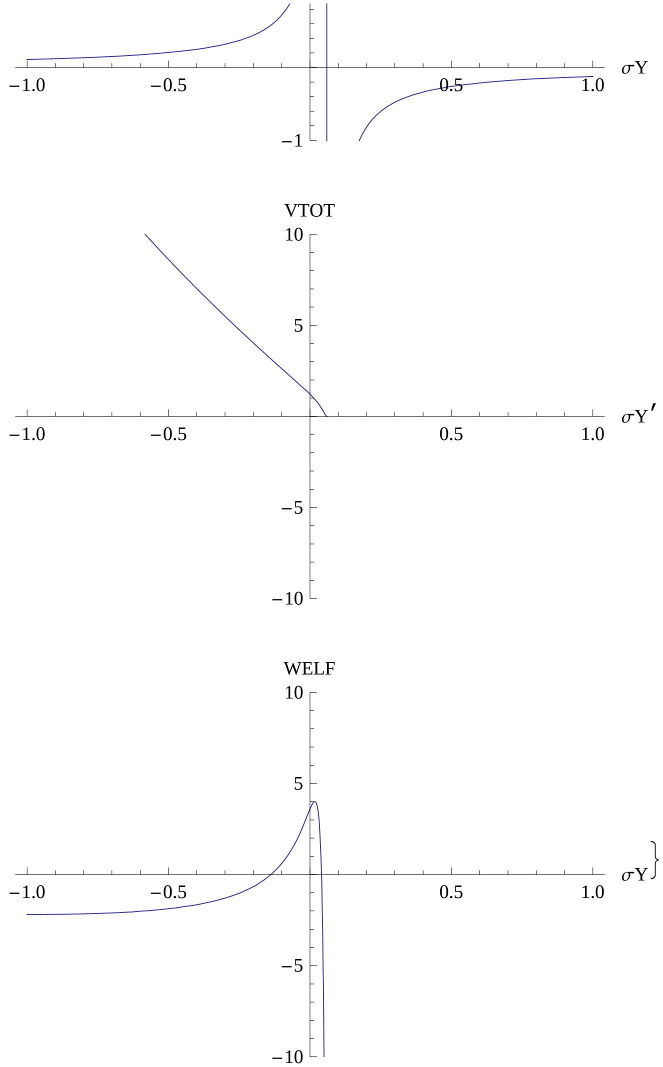
,


nA∗x
0.20
0.15
0.10
0.05
−1.0
−0.5
0.5
1.0
σY

,


q
4
3
2
1

,



"2.2.ANALYSIS OF SUBSIDY TO RESEARCH FIRMS σR";

In[59]:=
```
Manipulate[{
  Plot[INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-2, 2},  AxesLabel → {"σR", "IN"}, AxesOrigin → {0, 0}],

  Plot[uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-1, 1.5},  AxesLabel → {"σR", "u"}, AxesOrigin → {0, 0}],
  Plot[nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-1, 1.5},  AxesLabel → {"σR", "nA"}, AxesOrigin → {0, 0}],
  Plot[GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-1, 1},  AxesLabel → {"σR", "GR"}, AxesOrigin → {0, 0}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-0.1, 0.1},  AxesLabel → {"σR", "wH*x"}, AxesOrigin → {0, 0}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-0.01, 0.01},  AxesLabel → {"σY", "IN*x"}, AxesOrigin → {0, 0}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-0.1, 0.1},  AxesLabel → {"σR", "x"}, AxesOrigin → {0, 0}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-0.05, 0.20},  AxesLabel → {"σR", "nA*x"}, AxesOrigin → {0, 0}],

  Plot[wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-1, 4},  AxesLabel → {"σR", "wH"}, AxesOrigin → {0, 0}],

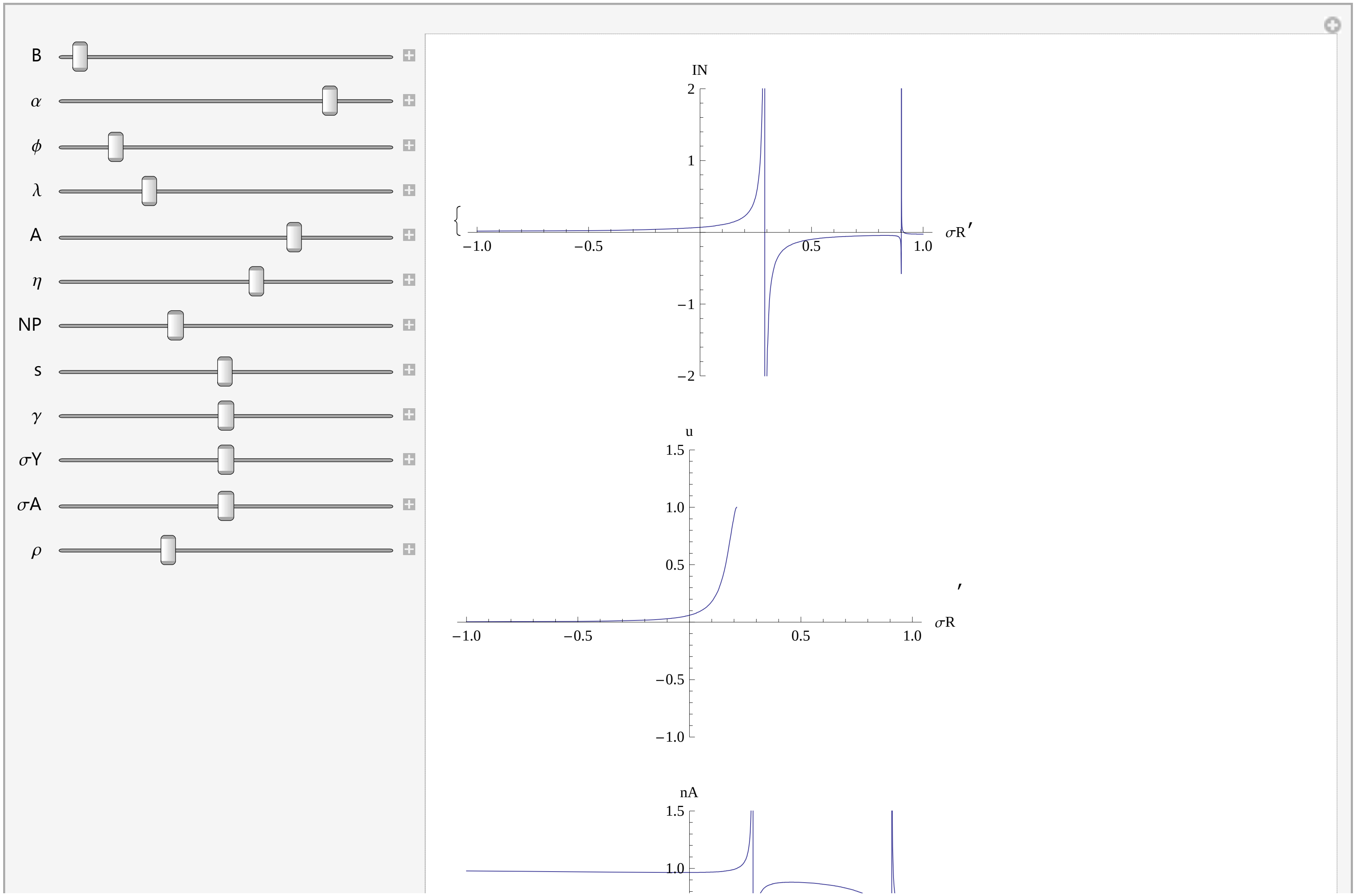
  Plot[qEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-1, 4},  AxesLabel → {"σR", "q"}, AxesOrigin → {0, 0}],

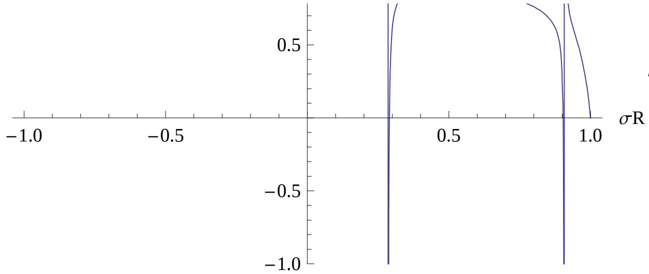
  Plot[VTOTEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-15, 15},  AxesLabel → {"σR", "VTOT"}, AxesOrigin → {0, 0}],

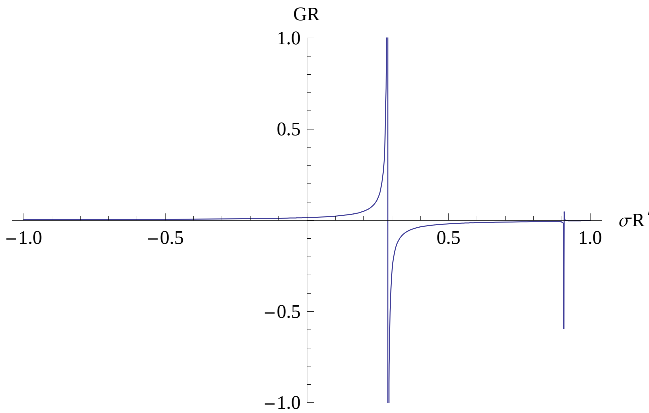
  Plot[WELFEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σR, -1, 1}, PlotRange → {-10, 10},  AxesLabel → {"σR", "WELF"}, AxesOrigin → {0, 0}]
 },

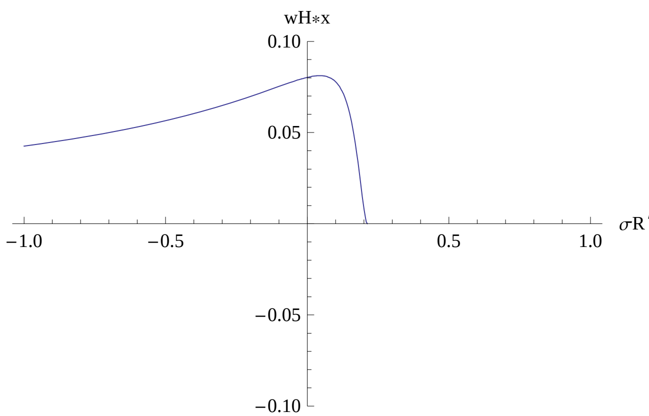
 {{B, 4.904697146627181`}, 0.00, 280}, {{α, 2.032388779308036`}, 0.0, 2.4},
 {{ϕ, 0.08814589665902509`}, 0.0, 0.65}, {{λ, 1.25}, 1.1, 1.7}, {{A, 1.4555491531007312`}, 0.0, 2.0},
```

```
{{η, 0.6}, 0.0, 1.0}, {{NP, 1}, 0.5, 2.0}, {{s, 0.05}, 0.001, 0.1}, {{γ, 1}, 0.5, 1.5}, {{σY, 0}, -1, 1}, {{σA, 0}, -1, 1},
{{ρ, 0.05}, 0.01, 0.14}]
```

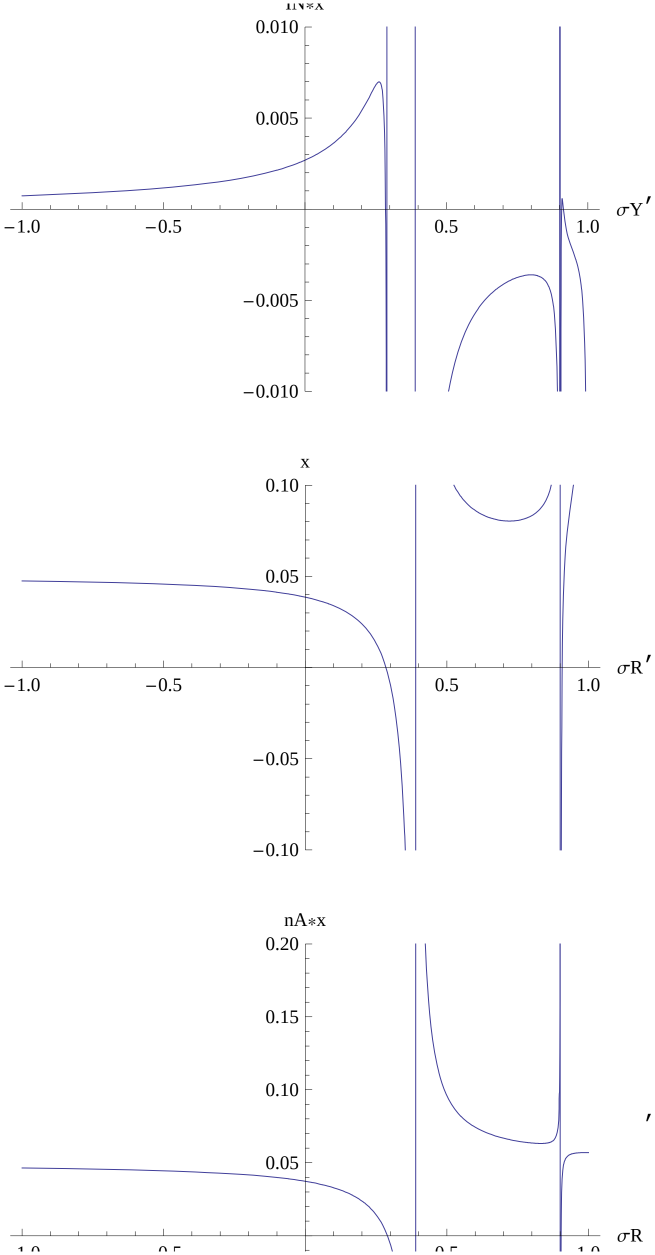


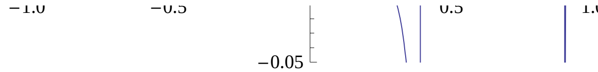

0.5
−0.5
−1.0
σR
−1.0
−0.5
0.5
1.0

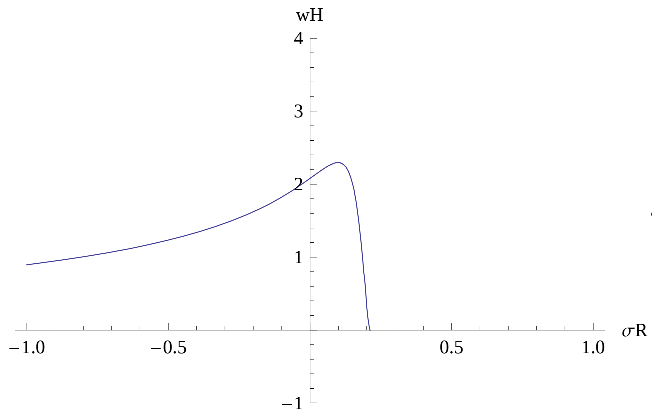

GR
1.0
0.5
−0.5
−1.0
σR′
−1.0
−0.5
0.5
1.0


wH*x
0.10
0.05
−0.05
−0.10
σR′
−1.0
−0.5
0.5
1.0

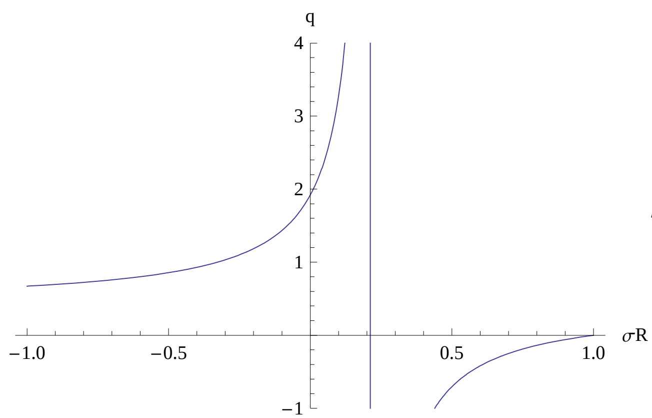
Out[59]=


nN*x
0.010
0.005
−0.005
−0.010
−1.0
−0.5
0.5
1.0
σY′
x
0.10
0.05
−0.05
−0.10
σR′
nA*x
0.20
0.15
0.10
0.05
σR

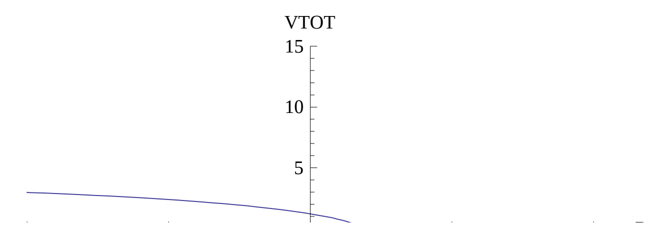

−1.0
−0.5
0.5
1.0
−0.05


wH
4
3
2
1
−1
−1.0
−0.5
0.5
1.0
σR

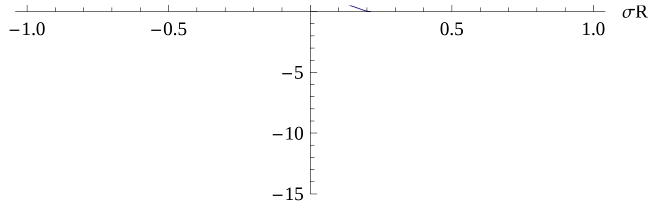
,

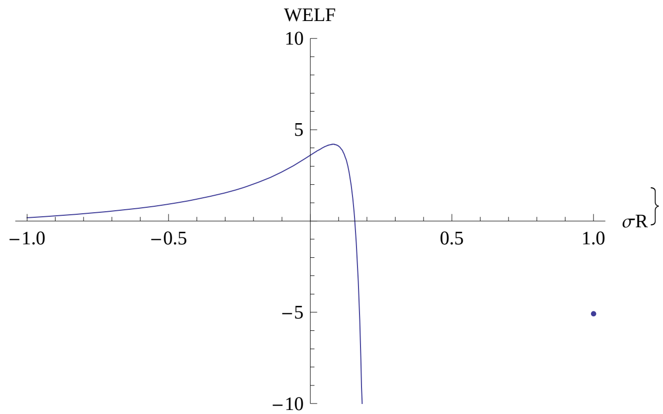

q
4
3
2
1
−1
−1.0
−0.5
0.5
1.0
σR

,


VTOT
15
10
5

,





"2.3.ANALYSIS OF SUBSIDY TO ADULT FIRMS σA";

In[60]:=
```
Manipulate[{
  Plot[INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σA, -1, 1}, PlotRange → {-2, 2},  AxesLabel → {"σA", "IN"}, AxesOrigin → {0, 0}],

  Plot[uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σA, -1, 1}, PlotRange → {-1, 1.5},  AxesLabel → {"σA", "u"}, AxesOrigin → {0, 0}],
  Plot[nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σA, -1, 1}, PlotRange → {-1, 1.5},  AxesLabel → {"σA", "nA"}, AxesOrigin → {0, 0}],
  Plot[GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σA, -1, 1}, PlotRange → {-1, 1},  AxesLabel → {"σA", "GR"}, AxesOrigin → {0, 0}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {σA, -1, 1}, PlotRange → {-0.1, 0.1},  AxesLabel → {"σA", "wH*x"}, AxesOrigin → {0, 0}],
```

```
 Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {σA, -1, 1}, PlotRange → {-0.01, 0.01},  AxesLabel → {"σY", "IN*x"}, AxesOrigin → {0, 0}],

 Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {σA, -1, 1}, PlotRange → {-0.1, 0.1},  AxesLabel → {"σA", "x"}, AxesOrigin → {0, 0}],

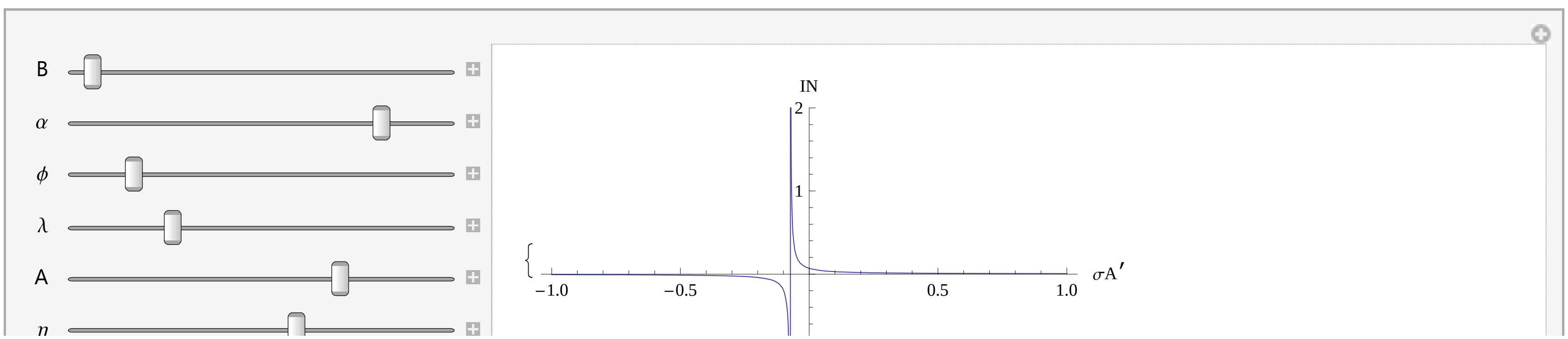
 Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {σA, -1, 1}, PlotRange → {-0.05, 0.10},  AxesLabel → {"σA", "nA*x"}, AxesOrigin → {0, 0}],

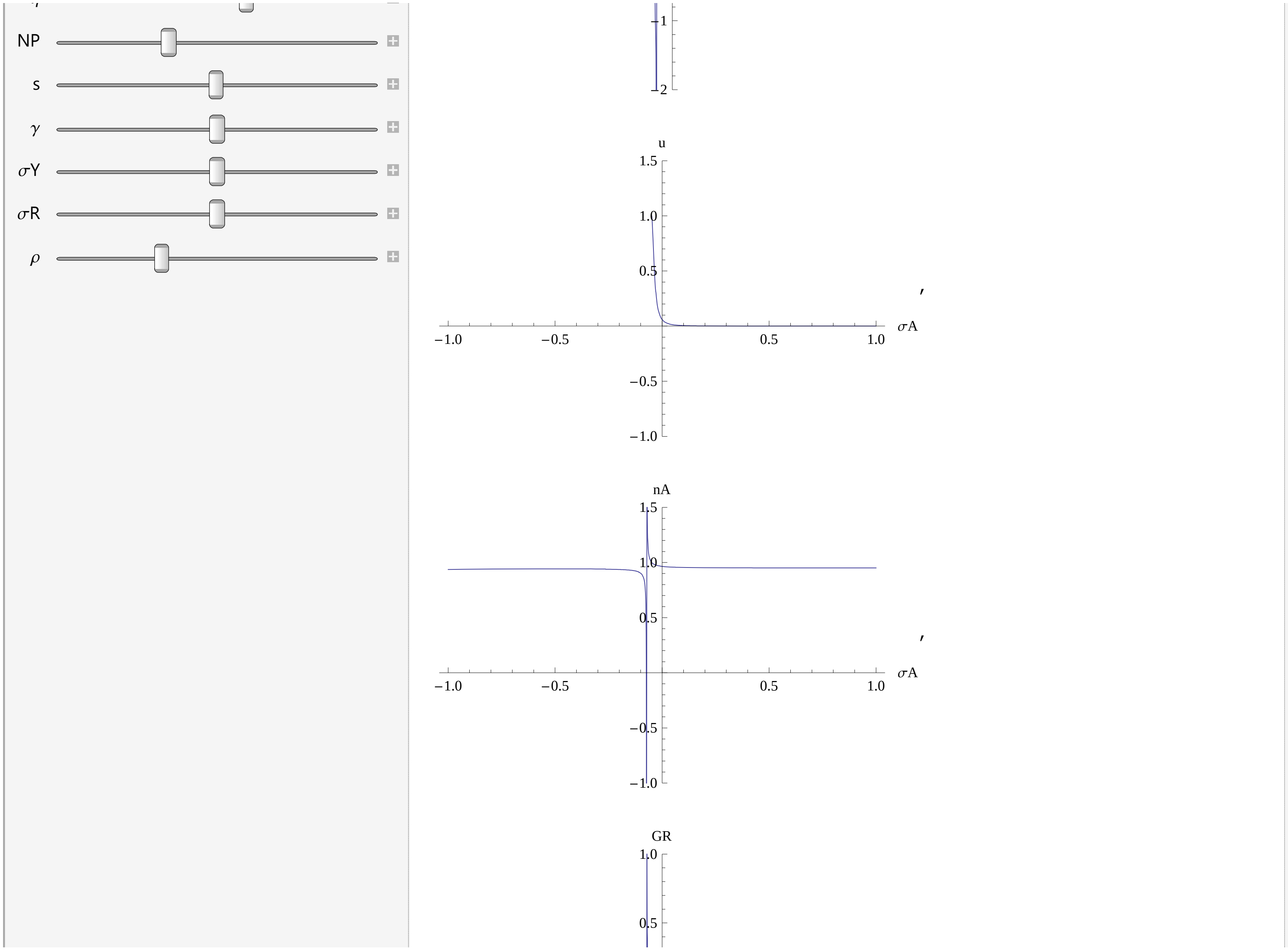
 Plot[wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {σA, -1, 1}, PlotRange → {-1, 4},  AxesLabel → {"σA", "wH"}, AxesOrigin → {0, 0}],

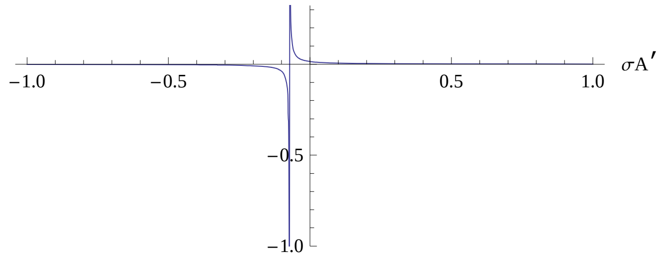
 Plot[qEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {σA, -1, 1}, PlotRange → {-1, 3},  AxesLabel → {"σA", "q"}, AxesOrigin → {0, 0}],

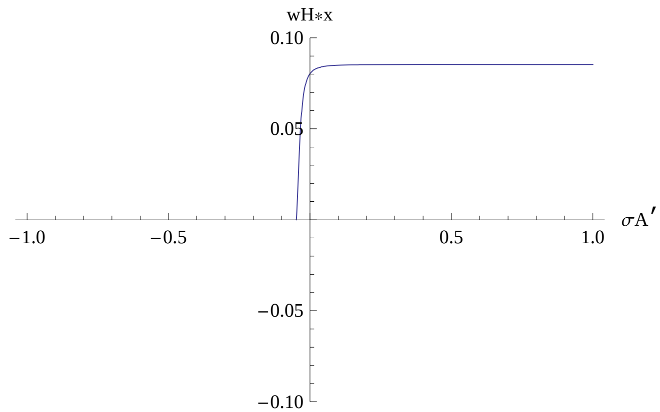
 Plot[VTOTEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {σA, -1, 1}, PlotRange → {-15, 15},  AxesLabel → {"σA", "VTOT"}, AxesOrigin → {0, 0}],

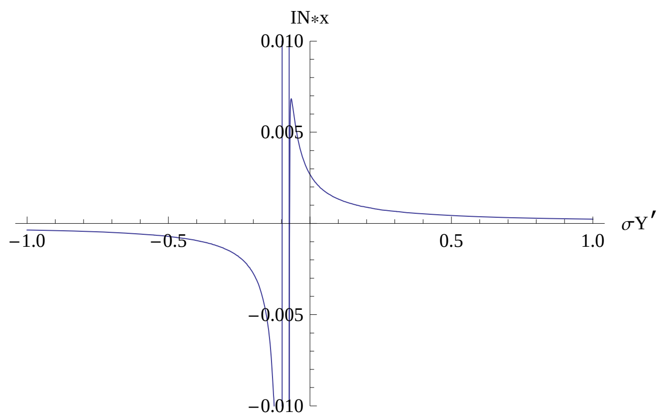

 Plot[WELFEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {σA, -1, 1}, PlotRange → {-10, 10},  AxesLabel → {"σA", "WELF"}, AxesOrigin → {0, 0}]
},
{{B, 4.904697146627181`}, 0.00, 280}, {{α, 2.032388779308036`}, 0.0, 2.4},
{{ϕ, 0.08814589665902509`}, 0.0, 0.65}, {{λ, 1.25}, 1.1, 1.7}, {{A, 1.4555491531007312`}, 0.0, 2.0},
{{η, 0.6}, 0.0, 1.0}, {{NP, 1}, 0.5, 2.0}, {{s, 0.05}, 0.001, 0.1}, {{γ, 1}, 0.5, 1.5}, {{σY, 0}, -1, 1}, {{σR, 0}, -1, 1},
{{ρ, 0.05}, 0.01, 0.14}]
```




NP
s
γ
σY
σR
ρ
u
σA
nA
σA
GR

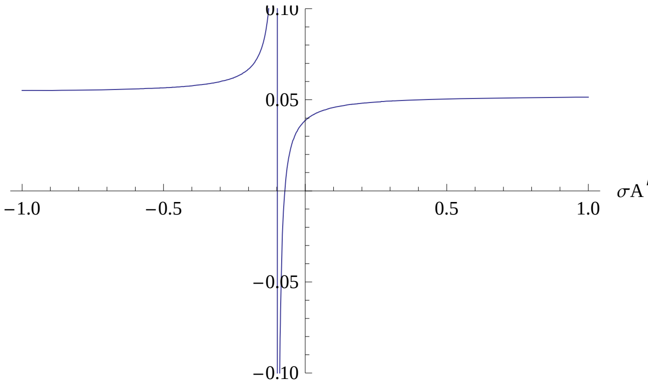

σA′
−1.0
−0.5
0.5
1.0
−0.5
−1.0


wH∗x
0.10
0.05
σA′
−1.0
−0.5
0.5
1.0
−0.05
−0.10

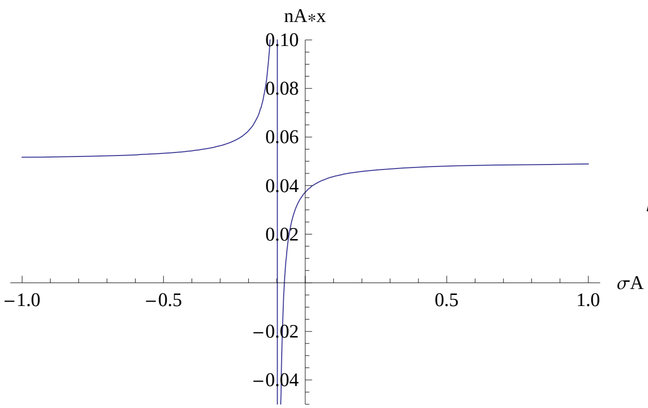

IN∗x
0.010
0.005
σY′
−1.0
−0.5
0.5
1.0
−0.005
−0.010

Out[60]=

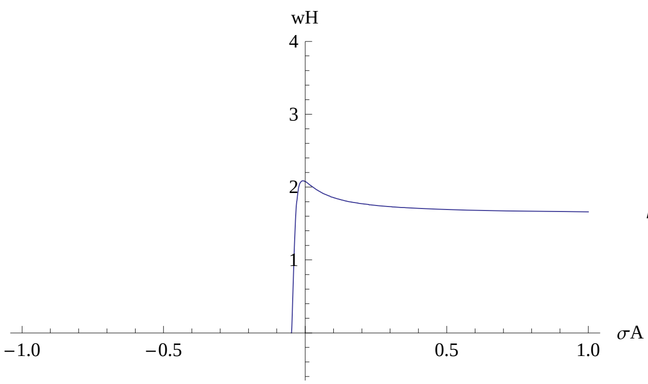
x


0.10
0.05
−0.05
−0.10
−1.0
−0.5
0.5
1.0
σA

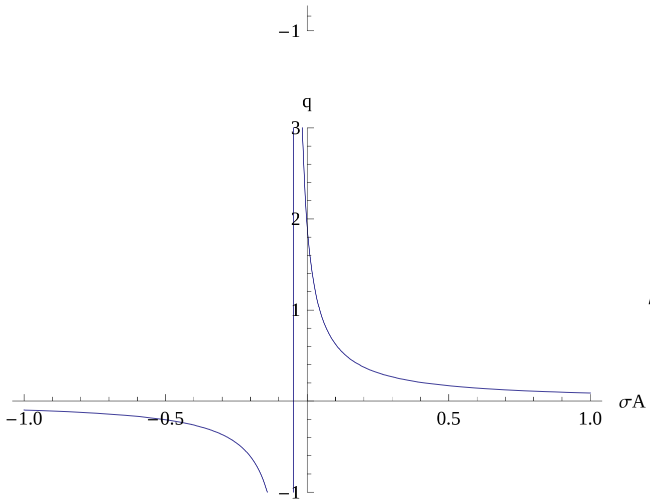
,


nA∗x
0.10
0.08
0.06
0.04
0.02
−0.02
−0.04
−1.0
−0.5
0.5
1.0
σA

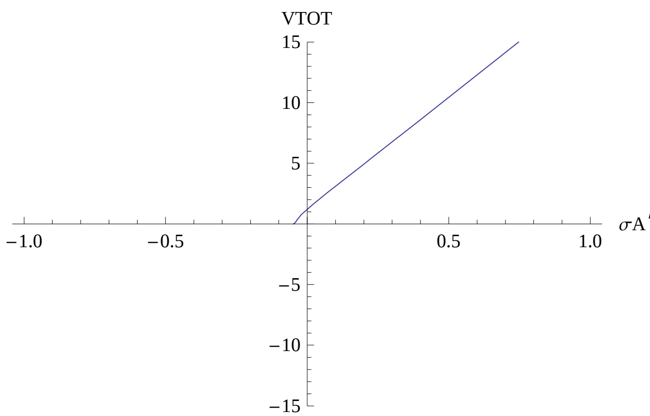
,


wH
4
3
2
1
−1.0
−0.5
0.5
1.0
σA

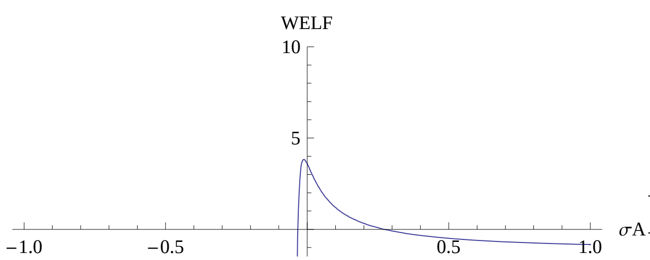
,


q
σA

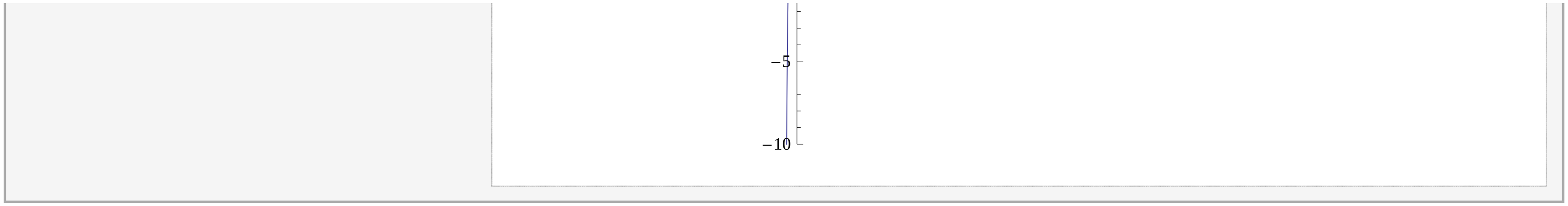
,


VTOT
σA

,


WELF
σA

}




```
"2.4.ANALYSIS OF INNOVATION SIZE λ";
```

```
In[61]:= Manipulate[{
  Plot[INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {λ, 1.1, 1.7}, PlotRange → {-0.1, 0.5},  AxesLabel → {"λ", "IN"}],

  Plot[uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {λ, 1.1, 1.7}, PlotRange → {-0.1, 0.5},  AxesLabel → {"λ", "u"}],
  Plot[nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {λ, 1.1, 1.7}, PlotRange → {-1, 1.5},  AxesLabel → {"λ", "nA"}],
  Plot[GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {λ, 1.1, 1.7}, PlotRange → {-0.05, 0.05},  AxesLabel → {"λ", "GR"}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {λ, 1.1, 1.7}, PlotRange → {-0.1, 0.1},  AxesLabel → {"λ", "wH*x"}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {λ, 1.1, 1.7}, PlotRange → {-0.01, 0.01},  AxesLabel → {"λ", "IN*x"}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {λ, 1.1, 1.7}, PlotRange → {-0.1, 0.1},  AxesLabel → {"λ", "x"}],

  Plot[xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] * nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {λ, 1.1, 1.7}, PlotRange → {-0.05, 0.20},  AxesLabel → {"λ", "nA*x"}],

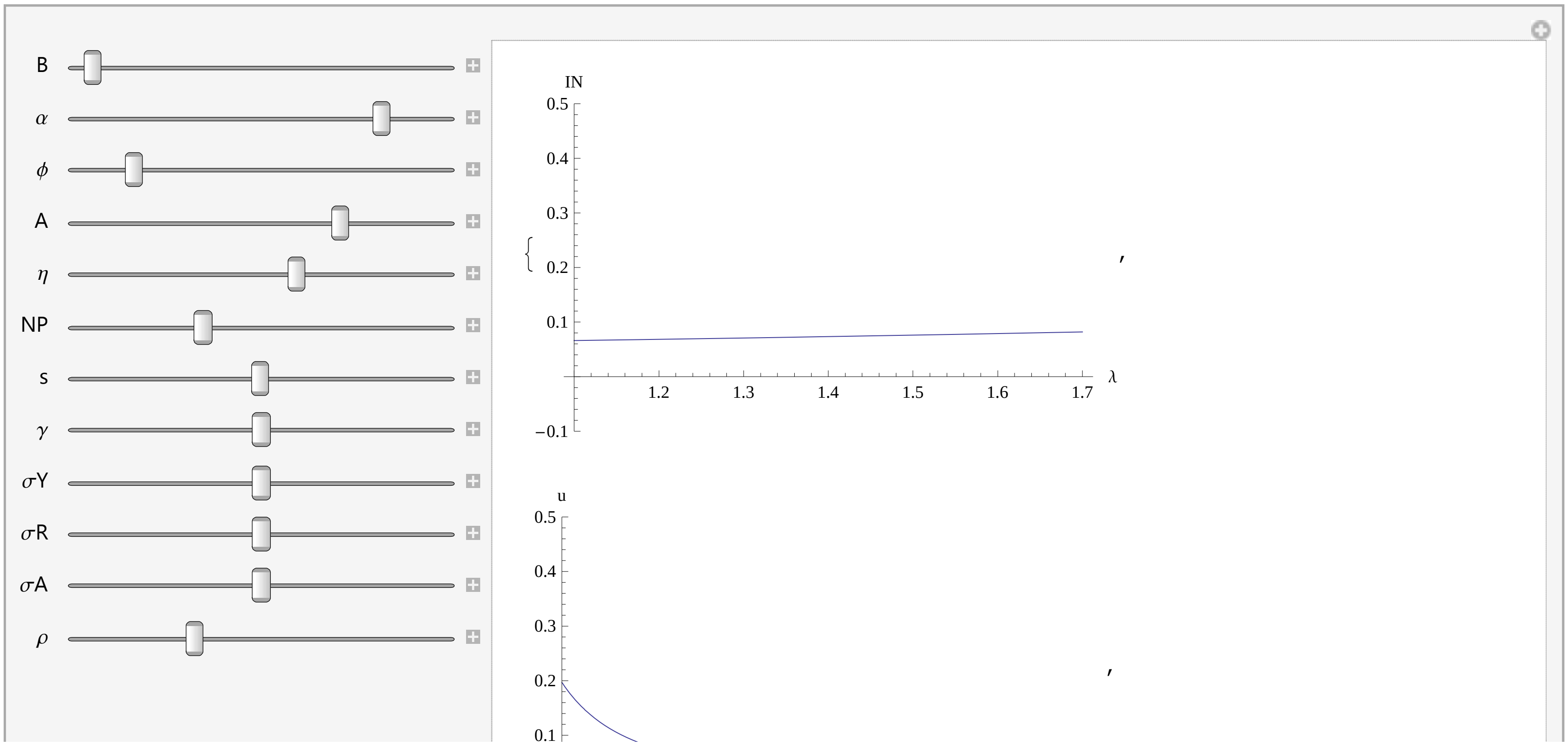
  Plot[wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {λ, 1.1, 1.7}, PlotRange → {-1, 4},  AxesLabel → {"λ", "wH"}],

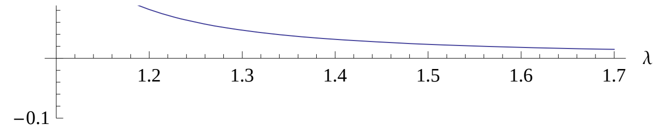
  Plot[qEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   {λ, 1.1, 1.7}, PlotRange → {-1, 4},  AxesLabel → {"λ", "q"}],
```

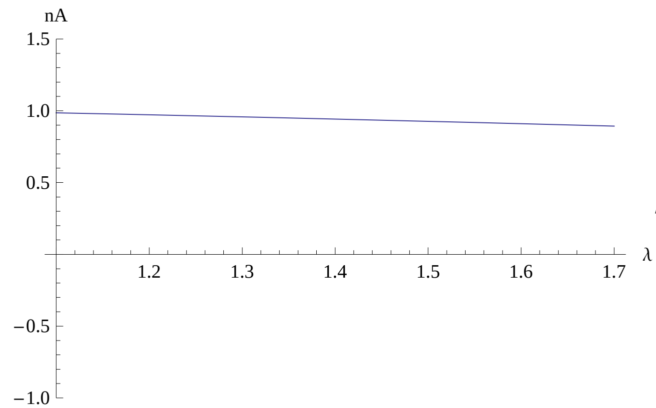
```
 Plot[VTOTEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {λ, 1.1, 1.7}, PlotRange → {-5, 5},  AxesLabel → {"λ", "VTOT"}],

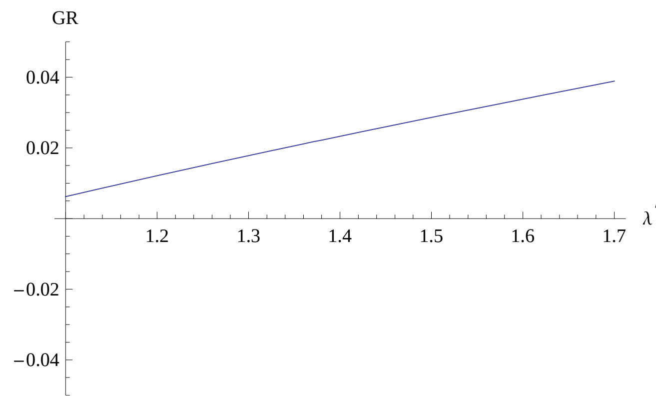
 Plot[WELFEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  {λ, 1.1, 1.7}, PlotRange → {-10, 10},  AxesLabel → {"λ", "WELF"}]

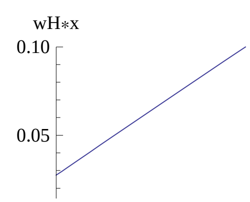
},
{{B, 4.904697146627181`}, 0.00, 280}, {{α, 2.032388779308036`}, 0.0, 2.4},
{{ϕ, 0.08814589665902509`}, 0.0, 0.65}, {{A, 1.4555491531007312`}, 0.0, 2.0}, {{η, 0.6}, 0.0, 1.0},
{{NP, 1}, 0.5, 2.0}, {{s, 0.05}, 0.001, 0.1}, {{γ, 1}, 0.5, 1.5}, {{σY, 0}, -1, 1}, {{σR, 0}, -1, 1}, {{σA, 0}, -1, 1},
{{ρ, 0.05}, 0.01, 0.14}]
```



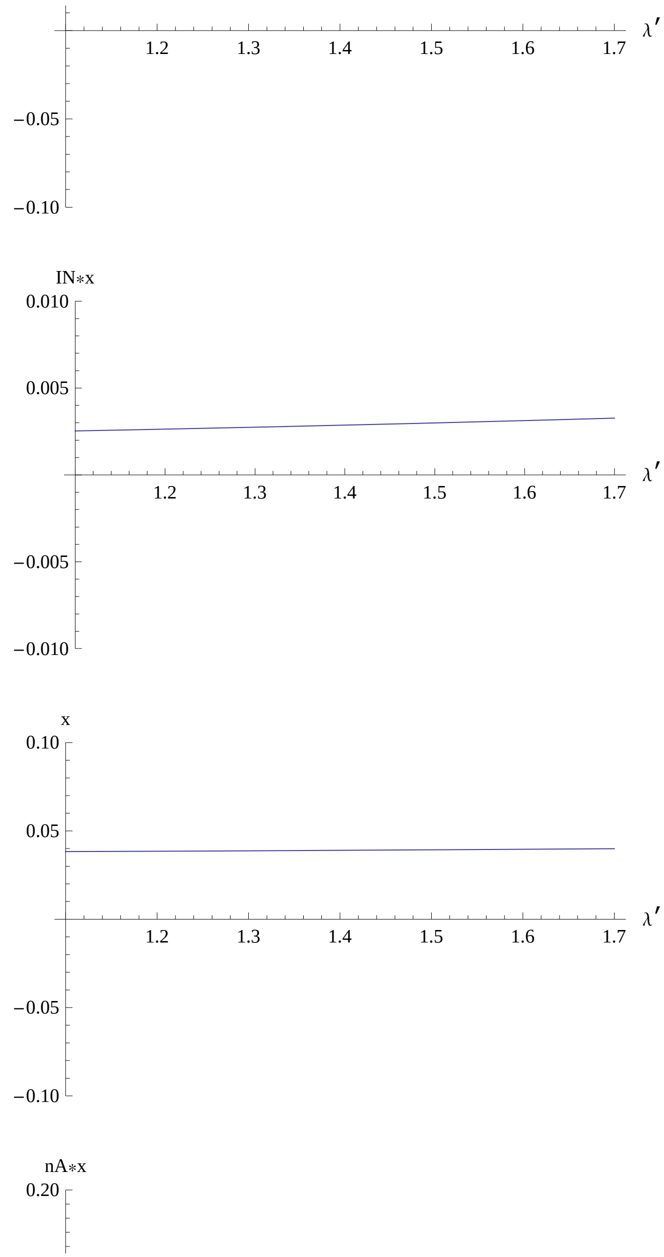

λ
1.2
1.3
1.4
1.5
1.6
1.7
−0.1

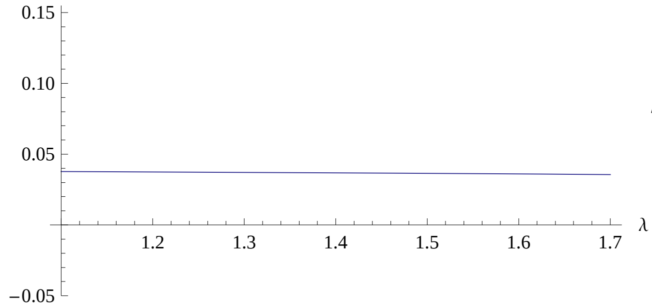

nA
1.5
1.0
0.5
λ
1.2
1.3
1.4
1.5
1.6
1.7
−0.5
−1.0


GR
0.04
0.02
λ
1.2
1.3
1.4
1.5
1.6
1.7
−0.02
−0.04

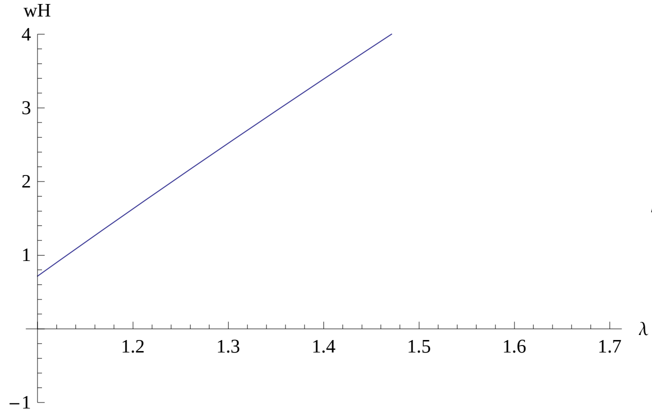

wH∗x
0.10
0.05

Out[61]=

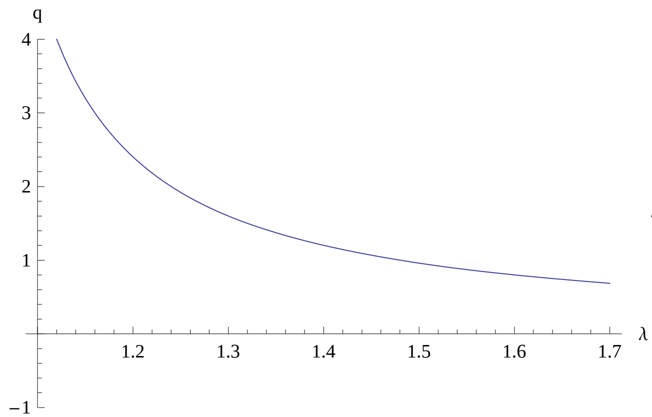

λ′
1.2
1.3
1.4
1.5
1.6
1.7
−0.05
−0.10
IN∗x
0.010
0.005
λ′
1.2
1.3
1.4
1.5
1.6
1.7
−0.005
−0.010
x
0.10
0.05
λ′
1.2
1.3
1.4
1.5
1.6
1.7
−0.05
−0.10
nA∗x
0.20


0.15
0.10
0.05
−0.05
1.2
1.3
1.4
1.5
1.6
1.7
λ

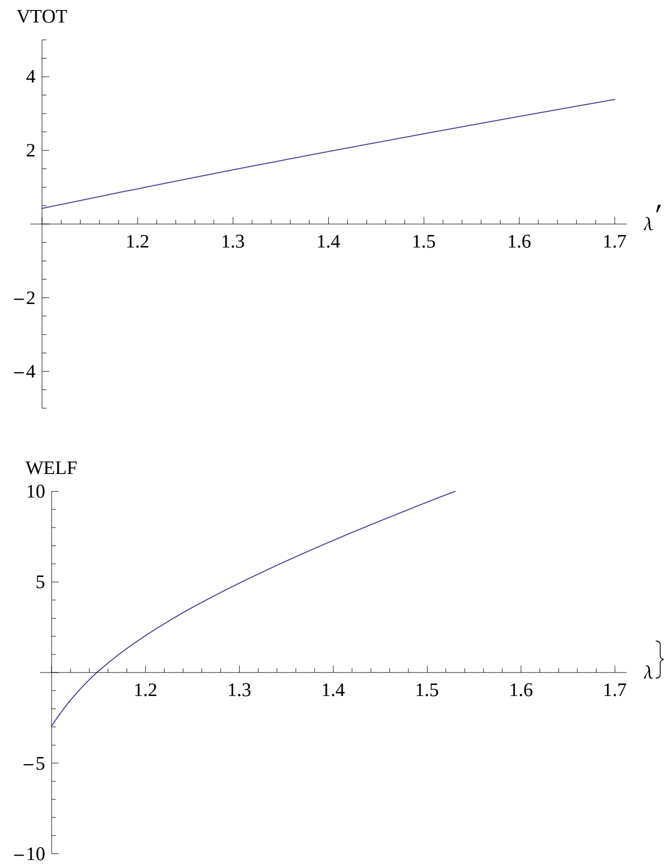
,


wH
4
3
2
1
−1
1.2
1.3
1.4
1.5
1.6
1.7
λ

,


q
4
3
2
1
−1
1.2
1.3
1.4
1.5
1.6
1.7
λ

,



3. Numerical Analysis

```
"We can see the exact numerical outcomes in Table 1 by using the codes below";
```

```
"THE NUMERICAL OUTCOME FOR THE SELECTED SET OF VARIABLES";
```

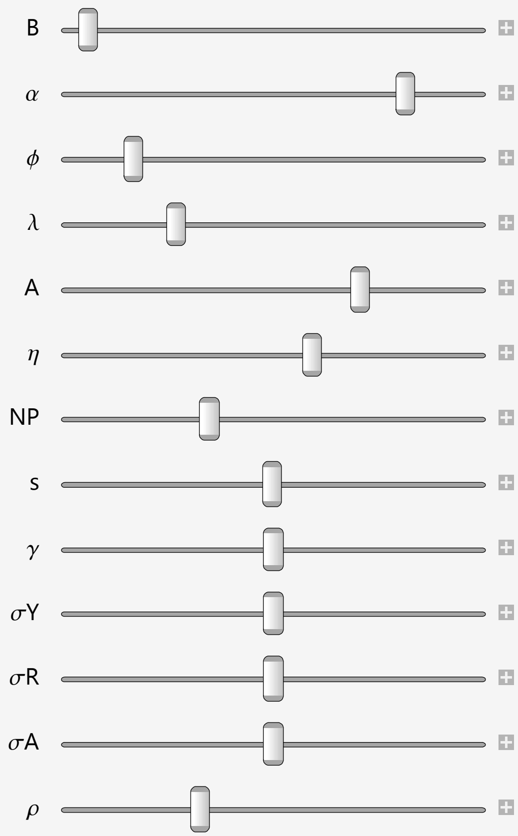
In[62]:=
```
Manipulate[
 {
  "IN" -> INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "u" -> uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "nA" → nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "GR" → GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "v" → vEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "θ" → θEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "x" → xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "wH" → wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "q" → qEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "VTOT" → VTOTEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA]

 },

 {{B, 4.904697146627181`}, 0.00, 280}, {{α, 2.032388779308036`}, 0.0, 2.4}, {{ϕ, 0.08814589665902509`}, 0.0, 0.65},
 {{λ, 1.25}, 1.1, 1.7}, {{A, 1.4555491531007312`}, 0.0, 2.0}, {{η, 0.6}, 0.0, 1.0}, {{NP, 1}, 0.5, 2.0},
 {{s, 0.05}, 0.001, 0.1}, {{γ, 1}, 0.5, 1.5}, {{σY, 0}, -1, 1}, {{σR, 0}, -1, 1}, {{σA, 0}, -1, 1},
 {{ρ, 0.05}, 0.01, 0.14}

]
```

Out[62]=



{IN → 0.0696594, u → 0.06, nA → 0.965, GR → 0.015, v → 0.03, θ → 0.5, x → 0.038619, wH → 2.07783, q → 1.92061, VTOT → 1.21583}

"OBSERVATIONS:

1. We can generate higher IN and lower u through some combination of policies. For example set σA=0.2 and σY=0.4. In general, setting σY greater than σA work to promote IN and lower u. Alternatively, we can set σR=0.30 and set σA at 0.05 to get lower u and higher IN.

2. One can generate the coordinates for IN and u as depicted in Figure 2 by changing the values fo λ and ρ";

```
"THE NUMERICAL OUTCOME FOR THE FULL SET OF VARIABLES";

"The code below provides the outcomes for the complete set of variables in Table 1 and also the Welfare levels. One can
   obtain the levels in Table 1 by simply moving the ruler for each parameter to the right and to the left.";

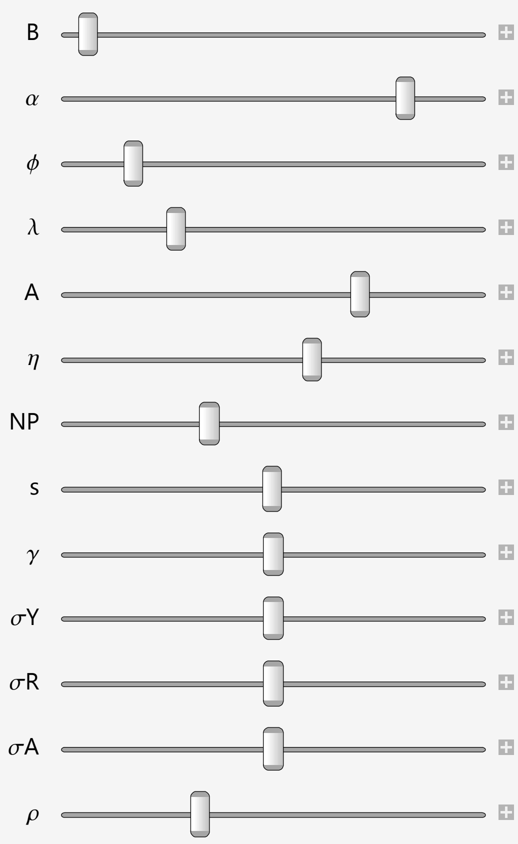
In[63]:= Manipulate[
 {
  "IN" -> INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "u" -> uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "nA" → nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "c" → cEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "GR" → GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "v" → vEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "θ" → θEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "x" → xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "wH" → wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "p" → pEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "q" → qEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "VA" → VAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "VY" → VYEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "VO" → VOEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "VTOT" → VTOTEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "WELF" → WELFEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA]

 },

 {{B, 4.904697146627181`}, 0.00, 280}, {{α, 2.032388779308036`}, 0.0, 2.4}, {{ϕ, 0.08814589665902509`}, 0.0, 0.65},
 {{λ, 1.25}, 1.1, 1.7}, {{A, 1.4555491531007312`}, 0.0, 2.0}, {{η, 0.6}, 0.0, 1.0}, {{NP, 1}, 0.5, 2.0},
 {{s, 0.05}, 0.001, 0.1}, {{γ, 1}, 0.5, 1.5}, {{σY, 0}, -1, 1}, {{σR, 0}, -1, 1}, {{σA, 0}, -1, 1},
 {{ρ, 0.05}, 0.01, 0.14}

]
```

Out[63]=




```
{IN → 0.0696594, u → 0.06, nA → 0.965, c → 1.11625, GR → 0.015,
 v → 0.03, θ → 0.5, x → 0.038619, wH → 2.07783, p → 0.960304, q → 1.92061,
 VA → 1.25525, VY → 0.393571, VO → 0.103304, VTOT → 1.21583, WELF → 3.59419}
```

Simulation 3a: Annual, target v=0.03

```
"Now, focus on annual rates again. Target growth rate is 1.5% and discount rate is 0.05. Target v=0.03";
```

In[64]:=

```
Clear[ρ, A, B, ϕ, α]
```

```
In[65]:= {B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA}

Out[65]= {B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA}

In[66]:= λ = 1.25; η = 0.6; NP = 1; s = 0.05; γ = 1; σY = 0; σR = 0; σA = 0; ρ = 0.05;

In[67]:=
NSolve[{uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.06,
  GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.015,
  vEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.03,
  nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.965},

 {A, B, ϕ, α}]

Out[67]= {{A → -1.17756 - 0.85555 ⅈ, B → 93.0837 + 27.3553 ⅈ, ϕ → 1.73771 + 0.535974 ⅈ, α → 16.0522 - 4.55531 ⅈ},
 {A → -1.17756 + 0.85555 ⅈ, B → 93.0837 - 27.3553 ⅈ, ϕ → 1.73771 - 0.535974 ⅈ, α → 16.0522 + 4.55531 ⅈ},
 {A → 1.45555, B → 4.9047, ϕ → 0.0881459, α → 2.03239}}

In[68]:= ρ = 0.05;

In[69]:= NSolve[{uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.06,
  GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.015,
  vEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.03,
  nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.965}, {A, B, ϕ, α}]

Out[69]= {{A → -1.17756 - 0.85555 ⅈ, B → 93.0837 + 27.3553 ⅈ, ϕ → 1.73771 + 0.535974 ⅈ, α → 16.0522 - 4.55531 ⅈ},
 {A → -1.17756 + 0.85555 ⅈ, B → 93.0837 - 27.3553 ⅈ, ϕ → 1.73771 - 0.535974 ⅈ, α → 16.0522 + 4.55531 ⅈ},
 {A → 1.45555, B → 4.9047, ϕ → 0.0881459, α → 2.03239}}

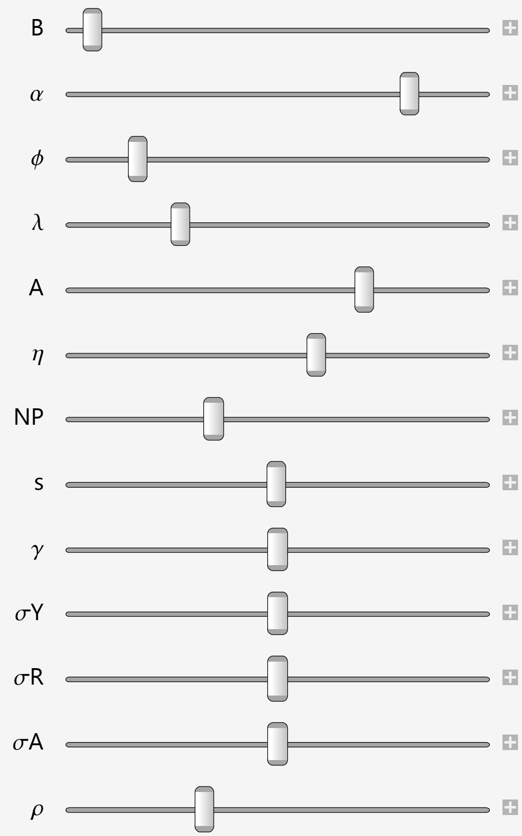
"THE NUMERICAL OUTCOME FOR THE FULL SET OF VARIABLES ANNUAL";
```

```
In[70]:= Manipulate[
  {
   "IN" -> INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "u" -> uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "nA" → nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "c" → cEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "GR" → GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "v" → vEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "θ" → θEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "x" → xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "wH" → wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "p" → pEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "q" → qEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "VA" → VAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "VY" → VYEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "VO" → VOEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "VTOT" → VTOTEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
   "WELF" → WELFEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA]

  },

  {{B, 4.904697146627181`}, 0.00, 280}, {{α, 2.032388779308036`}, 0.0, 2.4}, {{ϕ, 0.08814589665902509`}, 0.0, 0.65},
  {{λ, 1.25}, 1.1, 1.7}, {{A, 1.4555491531007312`}, 0.0, 2.0}, {{η, 0.6}, 0.0, 1.0}, {{NP, 1}, 0.5, 2.0},
  {{s, 0.05}, 0.001, 0.1}, {{γ, 1}, 0.5, 1.5}, {{σY, 0}, -1, 1}, {{σR, 0}, -1, 1}, {{σA, 0}, -1, 1},
  {{ρ, 0.05}, 0.01, 0.14}
 ]
```

Out[70]=



{IN → 0.0696594, u → 0.06, nA → 0.965, c → 1.11625, GR → 0.015, v → 0.03, θ → 0.5, x → 0.038619, wH → 2.07783, p → 0.960304, q → 1.92061, VA → 1.25525, VY → 0.393571, VO → 0.103304, VTOT → 1.21583, WELF → 3.59419}

Comments: Note that p and q are now higher because they are annual rates now.

Simulation 3b: Annual, target v=0.03, u=0.05, Pre Great Recession Levels

```
"Now, focus on annual rates again. Target growth rate is 1.5% and discount rate is 0.05. Target v=0.03";
```

```
In[71]:= Clear[ρ, A, B, ϕ, α]

In[72]:= {B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA}

Out[72]= {B, α, 1, 0.6, 0.05, 1, A, ϕ, ρ, 1.25, 0, 0, 0}

In[73]:= λ = 1.25; η = 0.6; NP = 1; s = 0.05; γ = 1; σY = 0; σR = 0; σA = 0; ρ = 0.05;

In[74]:=
NSolve[{uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.05,
  GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.015,
  vEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.03,
  nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.965},

 {A, B, ϕ, α}]

Out[74]= {{A → -1.26665 - 0.920276 i, B → 92.6798 + 27.0779 i, ϕ → 1.72994 + 0.530333 i, α → 16.1189 - 4.60377 i},
 {A → -1.26665 + 0.920276 i, B → 92.6798 - 27.0779 i, ϕ → 1.72994 - 0.530333 i, α → 16.1189 + 4.60377 i},
 {A → 1.56567, B → 5.43743, ϕ → 0.0977444, α → 1.94994}}

"Let's use the below code to generate the unemployment vacany rates";

In[75]:= B = 5.437428351716653`; ϕ = 0.09774436089868918`; α = 1.949942394529639`; Clear [A, λ]

In[76]:= NSolve[{uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.078,
  vEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.026}, {A, λ}]

Out[76]= {{A → 1.37906, λ → 1.22436}, {A → 1.26812 - 0.0391701 i, λ → 0.807223 - 0.149367 i}, {A → 1.26812 + 0.0391701 i, λ → 0.807223 + 0.149367 i}}

In[77]:= NSolve[{uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.078,
  vEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA] == 0.026}, {A, λ}]

Out[77]= {{A → 1.37906, λ → 1.22436}, {A → 1.26812 - 0.0391701 i, λ → 0.807223 - 0.149367 i}, {A → 1.26812 + 0.0391701 i, λ → 0.807223 + 0.149367 i}}

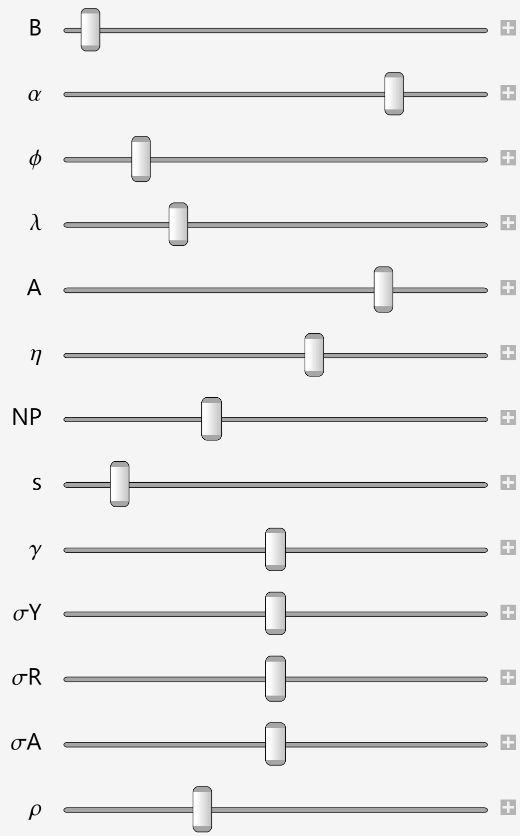
"THE NUMERICAL OUTCOME FOR THE FULL SET OF VARIABLES ANNUAL";
```

In[78]:=
```
Manipulate[
 {
  "IN" -> INEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "u" -> uEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "nA" → nAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "c" → cEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "GR" → GREQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "v" → vEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "θ" → θEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "x" → xEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "wH" → wHEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "p" → pEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "q" → qEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "VA" → VAEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "VY" → VYEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "VO" → VOEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "VTOT" → VTOTEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA],
  "WELF" → WELFEQ[B, α, γ, η, s, NP, A, ϕ, ρ, λ, σY, σR, σA]

 },

 {{B, 5.437428351716653`}, 0.00, 280}, {{α, 1.949942394529639`}, 0.0, 2.4}, {{ϕ, 0.09774436089868918`}, 0.0, 0.65},
 {{λ, 1.25}, 1.1, 1.7}, {{A, 1.5656669145966426`}, 0.0, 2.0}, {{η, 0.6}, 0.0, 1.0}, {{NP, 1}, 0.5, 2.0},
 {{s, 0.01}, 0.001, 0.1}, {{γ, 1}, 0.5, 1.5}, {{σY, 0}, -1, 1}, {{σR, 0}, -1, 1}, {{σA, 0}, -1, 1},
 {{ρ, 0.05}, 0.01, 0.14}
]
```

Out[78]=



{IN → 0.0696594, u → 0.05, nA → 0.965, c → 1.17562, GR → 0.015,
v → 0.03, θ → 0.6, x → 0.00751591, wH → 11.2472, p → 1.15237, q → 1.92061,
VA → 1.32117, VY → 0.459643, VO → 0.107653, VTOT → 1.27991, WELF → 4.63219}

Comments: Note that p and q are now higher because they are annual rates now.