

Quick tips before trying to solve the OLG model.

1- Determine whether the zero steady state is possible:

if $f(0) = 0$ (or, equivalently, $w(0) = 0$), then the zero (autarky) steady state exists. It may be stable or unstable, but it exists.

Cobb-Douglas production:

$$dAmZZBmsejYq[k_] = i \alpha^j$$

$$In[] := dAmZZBmsejYq[\frac{1}{1}] = \frac{1}{1}$$

$$\frac{1}{1}$$

CES production with complementary inputs: $\rho < 0$

Important remark: verify the exact functional form of the production function, in particular how the exponents are written.

$$In[] := dACQ[k_] = (\alpha * i^\rho + (\frac{1}{1} - \alpha)) (\frac{1}{1} / \rho)^j$$

$$Jgkgr[dACQ[i]]_r i \rightarrow \frac{1}{1}_r$$

$$qqsknrgm\text{ }lq \rightarrow \{\rho < \frac{1}{1}_r \alpha > \frac{1}{1}_r \alpha < \frac{1}{1}\}$$

$$\frac{1}{1}$$

If $f(0) > 0$, then the zero (autarky) steady states does not exist.

$$Jgkgr[dACQ[i]]_r i \rightarrow \frac{1}{1}_r$$

$$qqsknrgm\text{ }lq \rightarrow \{\rho > \frac{1}{1}_r \alpha > \frac{1}{1}_r \alpha < \frac{1}{1}\}$$

$$(\frac{1}{1} - \alpha)^\rho$$

2- Determine whether the interest rate appears in the savings function:

if log-utility, the interest rate does not appear.

$$\text{snpgkcJmeSrgjgrw}[x_]=\frac{1}{1+\beta} \frac{1}{v}$$

$$\text{Qmjt}[\text{snpgkcJmeSrgjgrw}[u - q] == \beta * P * \text{snpgkcJmeSrgjgrw}[P * q] \text{ } _q]$$

$$\left\{ \left\{ q \rightarrow \frac{u \beta}{1 + \beta} \right\} \right\}$$

Other functional forms: CIES, R appears in the savings function:

$$\text{snpgkcAGCQ}[x_]=v \left(-\frac{1}{1+\sigma} \right)^{\sigma}$$

$$\text{In[*]}:= \text{Qmjt}[\text{snpgkcAGCQ}[u - q] == \beta * P * \text{snpgkcAGCQ}[P * q] \text{ } _q]$$

$$\left\{ \left\{ q \rightarrow \frac{P^{\sigma} u \beta^{\sigma}}{P + P^{\sigma} \beta^{\sigma}} \right\} \right\}$$

3 - Pick your own model!

$$\begin{aligned} \text{In[2]}:= & \text{d}[k_ _ \alpha_ _ \rho_]=\text{Gd}[\rho == \frac{1}{1+i} _ \alpha_ (\alpha * i _ \rho + (\frac{1}{1+i} - \alpha)) _ (\frac{1}{1+i})^{\rho}] \\ & \text{s}[x_ _ \sigma_]=\text{Gd}[\sigma == \frac{1}{1+i} _ \text{Jme}[v] _ v _ (\frac{1}{1+i} - \frac{1}{1+i} / \sigma) / (\frac{1}{1+i} - \frac{1}{1+i} / \sigma)]^{\sigma} \\ & \text{udslargm}[k_ _ \alpha_ _ \rho_]=\text{d}[i _ \alpha_ _ \rho_]-\text{B}[\text{d}[i _ \alpha_ _ \rho_] _ i] * i^{\rho} \\ & \text{Pdslargm}[k_ _ \alpha_ _ \rho_]=\text{B}[\text{d}[i _ \alpha_ _ \rho_] _ i]^{\rho} \end{aligned}$$

$$\begin{aligned} \text{In[6]}:= & \text{qYtg}[w_ _ R_ _ \sigma_ _ \beta_]= \\ & q \frac{1}{1+i} \text{Qmjt}[\text{B}[\text{s}[w - q _ \sigma_] _ q] + \beta * \text{B}[\text{s}[R * q _ \sigma_] _ q] == \frac{1}{1+i} q][[\frac{1}{1+i}]] \end{aligned}$$

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In[7]:= bcpgtYrgtc[k1_ k_ α_ β_ σ_ ρ_ n_] =
  -B[
    k1 -
    1/(1 + n)*
    (qYtgLeq[u_ P_ σ_ β] /
      {u → udsLargmL[k_ α_ ρ]_
        P → PdsLargmL[k1_ α_ ρ]})_ k]/
  B[
    k1 -
    1/(1 + n)*
    (qYtgLeq[u_ P_ σ_ β] /
      {u → udsLargmL[k_ α_ ρ]_
        P → PdsLargmL[k1_ α_ ρ]})_ k1]

In[8]:= bcp[sols_ i_ α_ β_ σ_ ρ_ n_] =
  Jgkgr[bcpgtYrgtc[i_ i_ α_ β_ σ_ ρ_ n]_
    {i_ i_} → {i / solS[[i]]_ i_ → i / solS[[i]]}_
    BgpcargmL → {-Dpmk Zmtc -_ -Dpmk Zmtc -}]

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In[9]:= qrYZgjgrw[ $\alpha$   $\beta$   $\sigma$   $\rho$   $n$ ] =
  (Gd[
    Jclerf[LQmjtc[ $i$  ==  $\frac{1}{2}$  / ( $\frac{1}{2}$  +  $n$ ) * qYtgLeq[ $u$   $P$   $\sigma$   $\beta$ ]  $\frac{1}{2}$ 
      { $u \rightarrow$  udsIargml[ $i$   $\alpha$   $\rho$ ]  $P \rightarrow$  PdsIargml[ $i$   $\alpha$   $\rho$ ]}  $\rho$ 
       $i$   $PcYjq$ ] ==  $\frac{1}{2}$   $\rho$  qmj $q$  = {{ $i \rightarrow \frac{1}{2}$ }}]  $\rho$ 
    qmj $q$  = LQmjtc[ $i$  ==  $\frac{1}{2}$  / ( $\frac{1}{2}$  +  $n$ ) * qYtgLeq[ $u$   $P$   $\sigma$   $\beta$ ]  $\frac{1}{2}$ 
      { $u \rightarrow$  udsIargml[ $i$   $\alpha$   $\rho$ ]  $P \rightarrow$  PdsIargml[ $i$   $\alpha$   $\rho$ ]}  $\rho$ 
       $i$   $PcYjq$ ]]
    Dmp[ $g$  =  $\frac{1}{2}$   $\rho$   $g \leq$  Jclerf[qmj $q$ ]  $\rho$ 
      Npgr[ -
        QrcYbw qrYrc -  $\rho$   $g$   $\rho$ 
        -  $\rho$  AYngrYj jctcj -  $\rho$   $i$   $\frac{1}{2}$  qmj $q$ [[ $g$ ]]  $\rho$   $\neg$  BcpgtYrgtc = -  $\rho$ 
        bcp[qmj $q$   $\rho$   $g$   $\alpha$   $\beta$   $\sigma$   $\rho$   $n$ ]  $\rho$ 
        Gd[- $\frac{1}{2}$  < bcp[qmj $q$   $\rho$   $g$   $\alpha$   $\beta$   $\sigma$   $\rho$   $n$ ] <  $\frac{1}{2}$   $\rho$  - QrYZjc -  $\rho$ 
          - SlqrYZjc -]]
       $g++$ ))

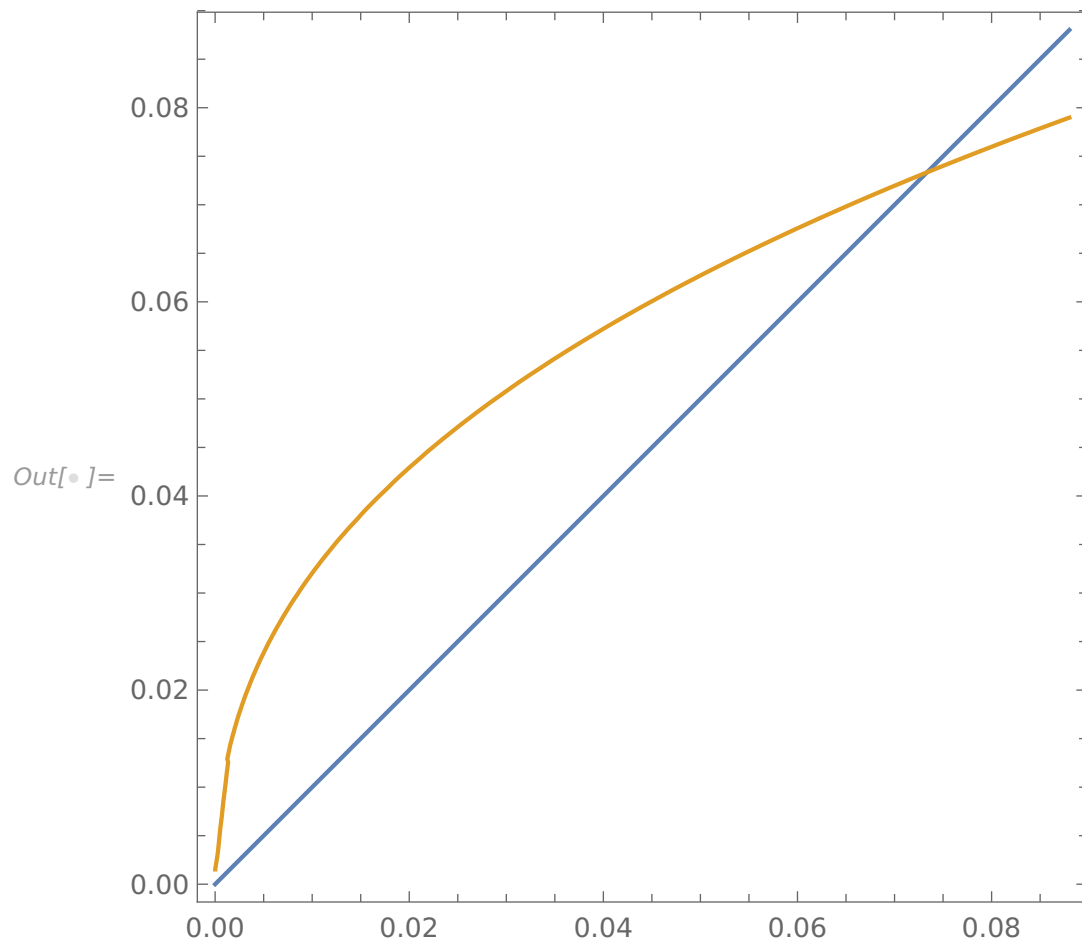
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In[10]:= kwnpmepYk[ $\alpha$   $\beta$   $\sigma$   $\rho$   $n$ ] = (Npgr[
  -NpmbSargml dslargml  $\rho$  d( $i$ ) = -  $\rho$  d[ $i$   $\alpha$   $\rho$ ]  $\rho$  -  $\rho$  -  $\rho$ 
  -Srgjgrw dslargml  $\rho$  s( $a$ ) = -  $\rho$  s[ $a$   $\sigma$ ]  $\rho$  -  $\rho$  -  $\rho$ 
  -QYtgLeq dslargml  $\rho$  q( $u$ (-  $\rho$  QsZqapgnr[ $i$   $r$ ]  $\rho$ 
  -)  $\rho$  -  $\rho$  QsZqsnCPqapgnr[ - $i$  -  $\rho$  - $r$  +  $\frac{1}{2}$  -  $\rho$  -  $\rho$  -]  $\rho$  -)) = -  $\rho$ 
  qYtgLeq[ $u$   $P$   $\sigma$   $\beta$ ]  $\rho$  -  $\rho$  -  $\rho$ 
  -QsZqgrsrgrLe  $\rho$  q( $u$ (-  $\rho$  QsZqapgnr[ $i$   $r$ ]  $\rho$ 
  -)  $\rho$  -  $\rho$  QsZqsnCPqapgnr[ - $i$  -  $\rho$  - $r$  +  $\frac{1}{2}$  -  $\rho$  -  $\rho$  -]  $\rho$  -)) = -  $\rho$ 
  qYtgLeq[ $u$   $P$   $\sigma$   $\beta$ ]  $\frac{1}{2}$ 
  { $u \rightarrow$  udsIargml[ $i$   $\alpha$   $\rho$ ]  $P \rightarrow$  PdsIargml[ $i$   $\alpha$   $\rho$ ]}  $\rho$ 
  -  $\rho$  -  $\rho$ 
  -QrcYbw QrYrcq  $\rho$  Qmjtc -  $\rho$ 
  QsZqapgnr[ - $i$  -  $\rho$  - $r$  +  $\frac{1}{2}$  -]  $\rho$  - ==  $\frac{1}{2}$  / ( $\frac{1}{2}$  +  $\rho$ ) q( $u$ (-  $\rho$ 
  QsZqapgnr[ $i$   $r$ ]  $\rho$  -)  $\rho$  -  $\rho$ 

```

$$\begin{aligned} & \text{QsZqsnpcqapgnr}[-i - r + \frac{1}{n} - \frac{1}{n}]_r - \frac{1}{n} - \frac{1}{n} \\ & - \text{Ugrf rfc nYpYkcrcpq}_r - \frac{1}{n} \\ & \text{Osgcr}[\\ & \text{Gd}[\\ & \quad \text{Jclerf}[\text{LQmjt}[i == \frac{1}{n} / (\frac{1}{n} + n) * \text{qYtg}[\text{leq}[u_r P_r \sigma_r \beta] \frac{1}{n}]] \\ & \quad \{u \rightarrow \text{udslargm}[i_r \alpha_r \rho]_r \\ & \quad P \rightarrow \text{Pdslargm}[i_r \alpha_r \rho]\}_r i_r \text{PcYjq}]] == \frac{1}{n} \\ & \quad \{i \rightarrow \frac{1}{n}\}_r \\ & \quad \text{LQmjt}[i == \frac{1}{n} / (\frac{1}{n} + n) * \text{qYtg}[\text{leq}[u_r P_r \sigma_r \beta] \frac{1}{n}]] \\ & \quad \{u \rightarrow \text{udslargm}[i_r \alpha_r \rho]_r P \rightarrow \text{Pdslargm}[i_r \alpha_r \rho]\}_r \\ & \quad i_r \text{PcYjq}]]_r - \frac{1}{n} - \frac{1}{n} \\ & - \text{QrYZgjgrw}_r \quad \text{Amknsr rfc bcpgtYrgtc} \\ & \quad \text{md} - \frac{1}{n} \text{QsZqapgnr}[-i - r + \frac{1}{n} - \frac{1}{n}]_r \\ & - \text{ugrf pcqncar rm} - \frac{1}{n} \text{QsZqapgnr}[-i - r - \frac{1}{n}]_r \\ & - \text{Ylb ctYjsYrc Yr cYaf qrcYbw qrYrc} - \frac{1}{n} - \frac{1}{n} \\ & - \text{Ugrf rfc nYpYkcrcpq}_r - \frac{1}{n} \\ & \text{pglr}[\text{Osgcr}[\text{qrYZgjgrw}[\alpha_r \beta_r \sigma_r \rho_r n]]] \\ & \text{mj} \text{qQgknjc} = i \frac{1}{n} \text{qmq} \\ & \text{d}[\text{KYv}[\text{qmjqQgknjc}] == \frac{1}{n}]_r \text{kYvi} = \frac{1}{n} \frac{1}{n} \cdot \frac{1}{n} \\ & \text{kYvi} = \frac{1}{n} \frac{1}{n} \frac{1}{n} * \text{KYv}[\text{qmjqQgknjc}] \\ & \text{sgr}[\text{Am} \text{lrmspNjmr}[\\ & \quad \{i \frac{1}{n} == i_r \\ & \quad i \frac{1}{n} == \frac{1}{n} / (\frac{1}{n} + n) * \\ & \quad (\text{qYtg}[\text{leq}[u_r P_r \sigma_r \beta] \frac{1}{n}]] \\ & \quad \{u \rightarrow \text{udslargm}[i_r \alpha_r \rho]_r \\ & \quad P \rightarrow \text{Pdslargm}[i \frac{1}{n}_r \alpha_r \rho]\})_r \{i_r \frac{1}{n}_r \text{kYvi}\}_r \\ & \quad \{i \frac{1}{n}_r \frac{1}{n}_r \text{kYvi}\}]] \\ \end{aligned}$$
$$\ln[\bullet] := \text{kwnpmepYk}[\text{†} \cdot \text{†} \text{†} \text{†} \text{†}]$$



In[] := kwnpmeprYk[$\frac{1}{r} \cdot \frac{1}{r} = \frac{1}{r} - \frac{1}{r} + \frac{1}{r}$]

$$\text{NpmbSargml dslargml}_\gamma \quad d(i) = \frac{1}{\sqrt{\frac{1}{i} + \frac{1}{i+1}}}$$

$$\text{Srgjgrw dslargml}_\gamma \quad s(a) = \frac{1}{\sqrt{a}}$$

$$\text{QYtgleg dslargml}_\gamma \quad q(u(i_r) \mid i_{r+1}) = \frac{\frac{1}{i_r} P u}{\frac{1}{i_r} + \frac{1}{i_{r+1}} P}$$

$$\text{QsZqrgsrsgle}_\gamma \quad q(u(i_r) \mid$$

$$i_{r+1}) = \frac{\frac{1}{i_r} \left(\frac{1}{\sqrt{\frac{1}{i_r} + \frac{1}{i_{r+1}}}} - \frac{\frac{1}{i_{r+1}}}{\left(\frac{1}{i_r} + \frac{1}{i_{r+1}} \right)^{1/2} i_{r+1}} \right)}{\left(\frac{1}{i_r} + \frac{\frac{1}{i_{r+1}}}{\left(\frac{1}{i_r} + \frac{1}{i_{r+1}} \right)^{1/2} i_{r+1}} \right) \left(\frac{1}{i_r} + \frac{1}{i_{r+1}} \right)^{1/2} i_{r+1}}$$

$$\text{QrcYbw QrYrcq}_\gamma \quad \text{Qmjtc } i_{r+1} == \frac{1}{1+(1)} q(u(i_r) \mid i_{r+1})$$

$$\text{Ugrf rfc nYpYkrcrcpq}_\gamma \quad \{i \rightarrow \frac{1}{i}\}$$

$$\text{QrYZgjgrw}_\gamma \quad \text{Amknsr c rfc bcpgtYrgtc md } i_{r+1}$$

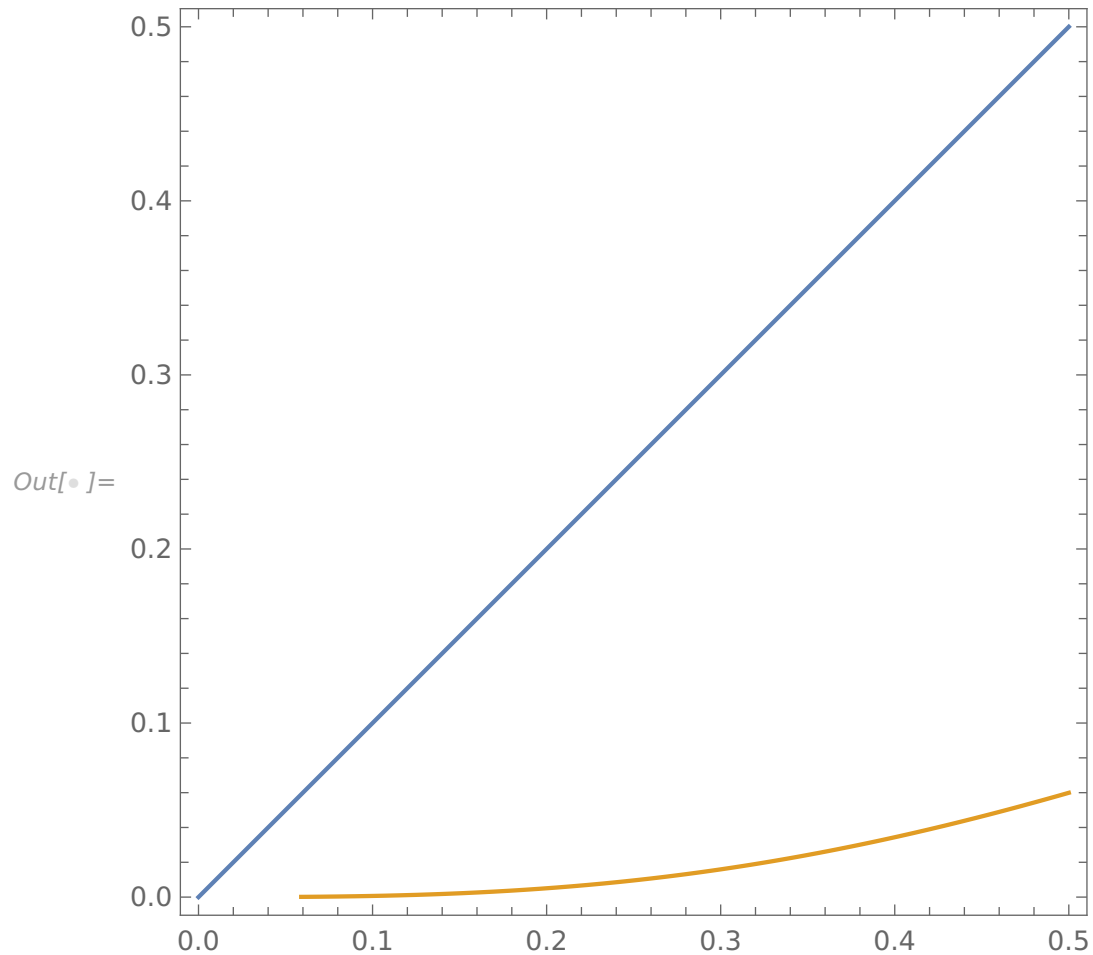
$$\text{ugrf pcqncar rm } i_r \text{ Ylb ctYjsYrc Yr cYaf qrcYbw qrYrc}$$


$$\text{Ugrf rfc nYpYkrcrcpq}_\gamma$$


$$\text{QrcYbw qrYrc } \frac{1}{i}$$

$$\mid \text{AYngrYj jctcj}_\gamma \mid \text{BcpgtYrgtc} = \frac{1}{i} \text{QrYZjc}$$

Lsjj


$$In[\bullet] := \text{kwnpmepYk}[\frac{+}{-}, \frac{+}{-}, +, -, +]$$

 **Solve:** Solve was unable to solve the system with inexact coefficients. The answer was obtained by solving a corresponding exact system and numericizing the result.

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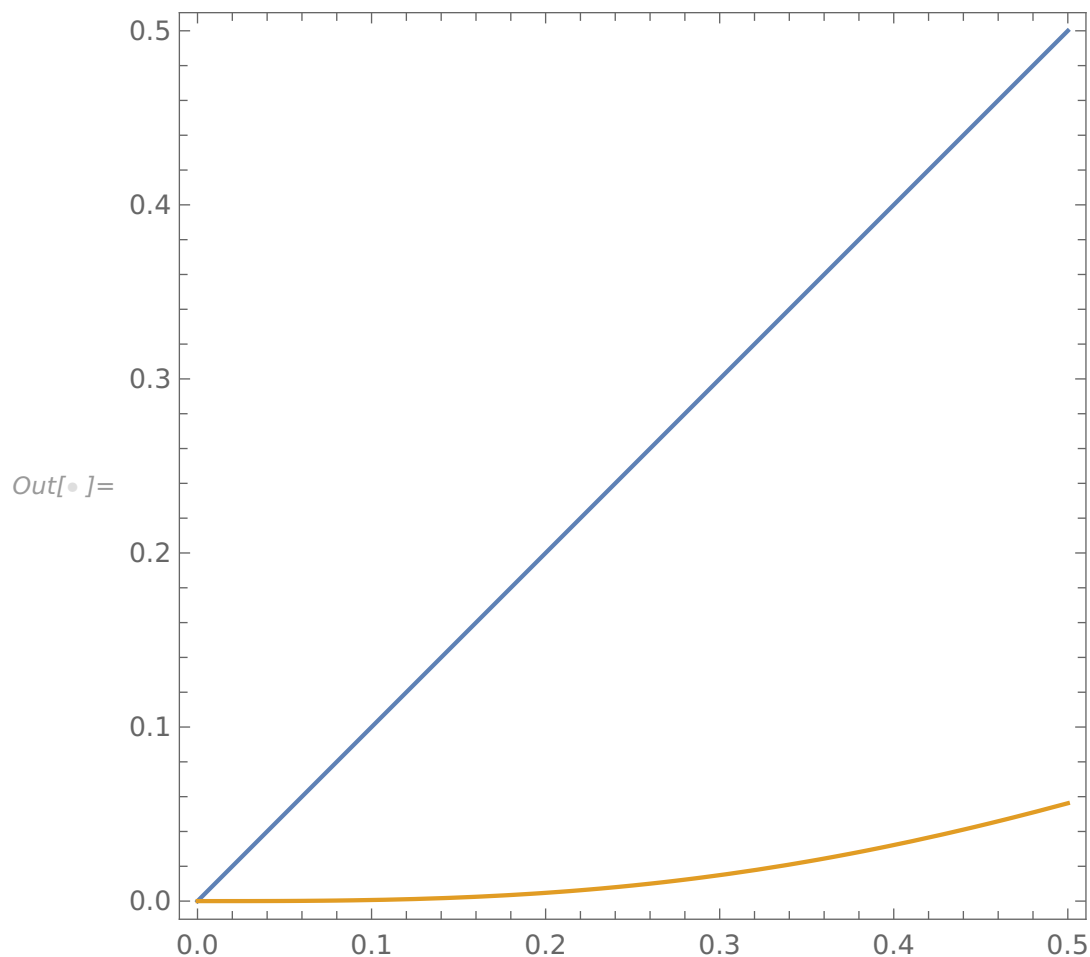
$$\begin{array}{ll}
 \text{NpmbSargml dslargml}_\gamma & d(i) = \frac{1}{\sqrt{\frac{1}{i} + \frac{1}{i}}} \\
 \text{Srgjgrw dslargml}_\gamma & s(a) = \text{Jme}[a] \\
 \text{QYtgLeq dslargml}_\gamma & q(u(i_r) \cap i_{r+1}^1) = \frac{1}{i} \dots u \\
 \text{QsZqrgrsrgle}_\gamma & q(u(i_r) \cap i_{r+1}^1
 \end{array}$$

$$)) = \frac{1}{i} \dots \left(\frac{1}{\sqrt{\frac{1}{i} + \frac{1}{i}}} - \frac{\frac{1}{i}}{(\frac{1}{i} + \frac{1}{i})^{\frac{1}{i}} i} \right)$$

$$\begin{array}{ll}
 \text{QrcYbw QrYrcq}_\gamma & \text{Qmjtc } i_{r+1} == \frac{1}{i/(i+1)} q(u(i_r) \cap i_{r+1}^1) \\
 \text{Ugrf rfc nYpYkcrcpq}_\gamma & \{\{i \rightarrow \frac{1}{i}\}\} \\
 \text{QrYZgjgrw}_\gamma & \text{AmknsrC rfc bcpgtYrgtc md } i_{r+1} \\
 \text{ugrf pcqncar rm } i_r & \text{Ylb ctYjsYrc Yr cYaf qrcYbw qrYrc} \\
 \text{Ugrf rfc nYpYkcrcpq}_\gamma &
 \end{array}$$

$$\begin{array}{l}
 \text{QrcYbw qrYrc } \frac{1}{i} \\
 \cap \text{AYngrYj jctcj}_\gamma \frac{1}{i} \text{ BcpgtYrgtc} = \frac{1}{i} \text{ QrYZjc}
 \end{array}$$

Lsjj



In[•]:= `kwnpmpYk[...]`

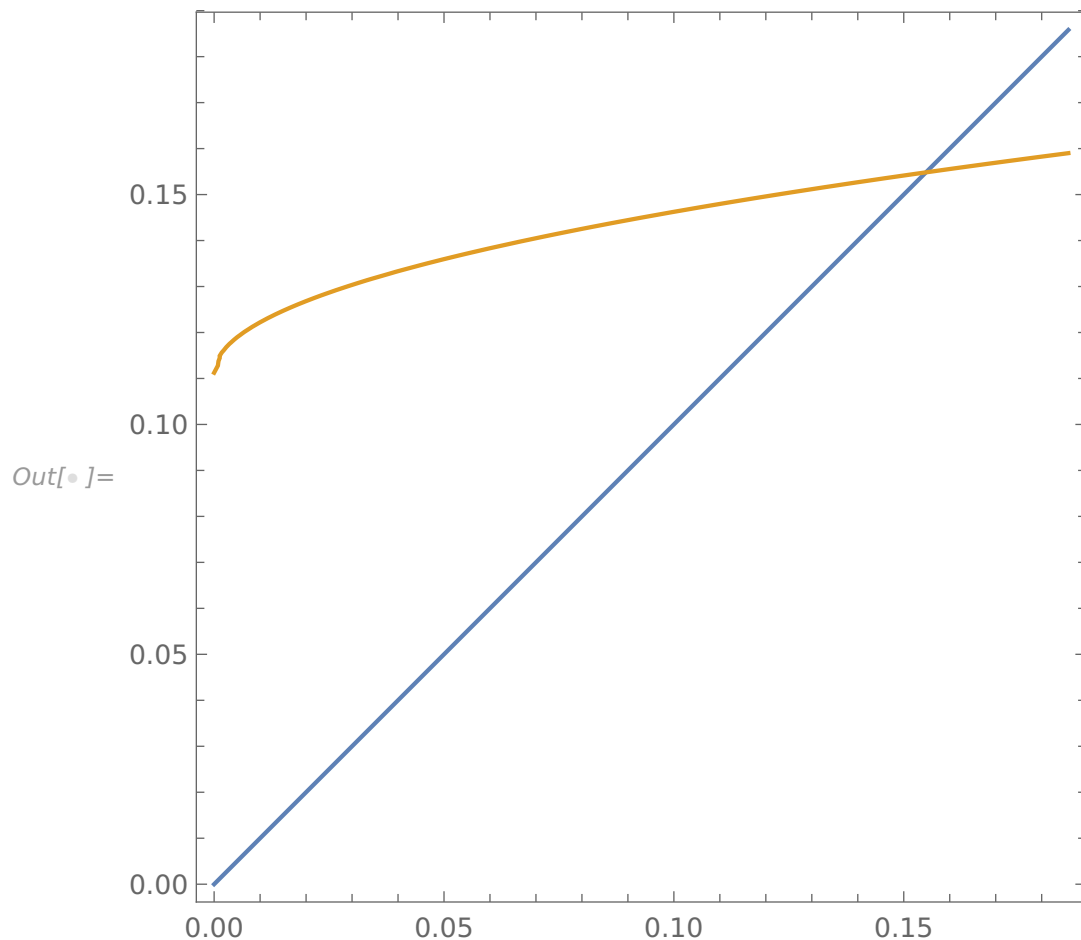
- ... **Solve:** Solve was unable to solve the system with inexact coefficients.
The answer was obtained by solving a corresponding exact system and numericizing the result.
- ... **Solve:** Solve was unable to solve the system with inexact coefficients.
The answer was obtained by solving a corresponding exact system and numericizing the result.

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NpmbSargmL dslargmL      d(i)=( $\frac{1}{i} + \frac{1}{i} \cdot i^{\frac{1}{i}}$ ) $\frac{1}{i}$ 
Srgjgrw dslargmL         s(a)=Jme[a]
QYtgLeq dslargmL         q(u(ir) $\frac{1}{i_{r+1}}$ )=  $\frac{1}{i}$ ..... u
QsZqrgrsrgrLe           q(u(ir) $\frac{1}{i_{r+1}}$ )=
 $\frac{1}{i}$ ..... (( $\frac{1}{i} + \frac{1}{i} \cdot i^{\frac{1}{i}}$ ) $\frac{1}{i}$  -  $\frac{1}{i}$ ..... ( $\frac{1}{i} + \frac{1}{i} \cdot i^{\frac{1}{i}}$ ) $\frac{1}{i}$  i $\frac{1}{i}$ .....)
QrcYbw QrYrcq           QmjtC ir+1 ==  $\frac{1}{i/(i+1)}$ q(u(ir) $\frac{1}{i_{r+1}}$ )
  Ugrf rfc nYpYkcrCpq   {{i →  $\frac{1}{i} + \frac{1}{i} \cdot i^{\frac{1}{i}}$ }}
QrYZgjgrw              AmknsrC rfc bCpgtYrgtc md ir+1
  ugrf pcqncar rm ir Ylb ctYjsYrc Yr cYaf qrcYbw qrYrc
  Ugrf rfc nYpYkcrCpq

                        QrcYbw qrYrc  $\frac{1}{i}$  AYngrYj jctCj
 $\frac{1}{i} + \frac{1}{i} \cdot i^{\frac{1}{i}}$  BcpgtYrgtc= $\frac{1}{i} + \frac{1}{i} \cdot i^{\frac{1}{i}}$  QrYZjc
Lsjj

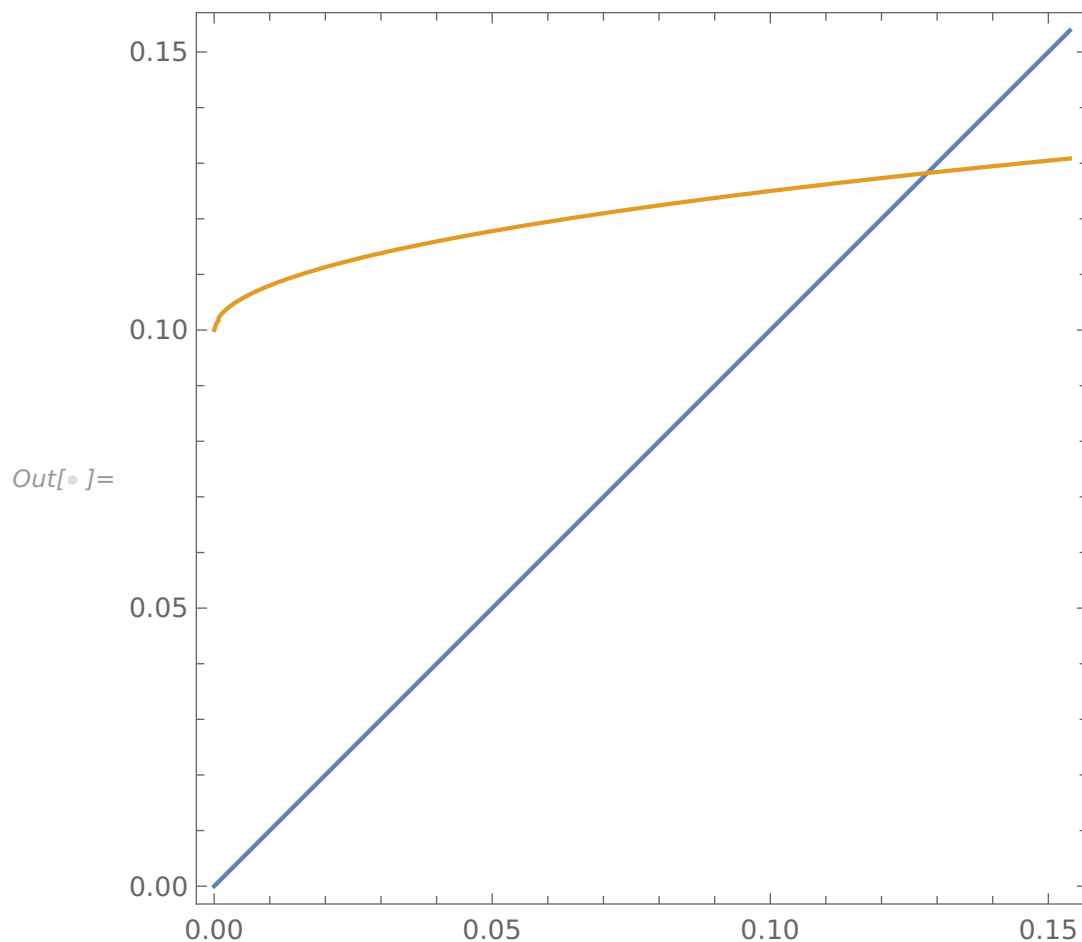
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$ln[\bullet] := \text{kwnpmepYk}[\frac{1}{i} \cdot \frac{1}{i} = \frac{1}{i} \frac{1}{i} \cdot \frac{1}{i}]$
 $\text{NpmbSargml dslargml}_\gamma \quad d(i) = (\frac{1}{i} \cdot \frac{1}{i} + \frac{1}{i} \cdot \frac{1}{i} i^{\frac{1}{i}})^{\frac{1}{i}}$
 $\text{Srgjgrw dslargml}_\gamma \quad s(a) = \frac{1}{i} \sqrt{a}$
 $\text{QYtgLeq dslargml}_\gamma \quad q(u(i_r) i_{r+1}^{\frac{1}{i}}) = \frac{\frac{1}{i} \frac{1}{i} P u}{\frac{1}{i} \frac{1}{i} + \frac{1}{i} \frac{1}{i} P}$
 $\text{QsZqrgsrsgLe}_\gamma \quad q(u(i_r) i_{r+1}^{\frac{1}{i}}) =$

$$\frac{\frac{1}{i} (\frac{1}{i} \cdot \frac{1}{i} + \frac{1}{i} \cdot \frac{1}{i} i^{\frac{1}{i}})^{\frac{1}{i}} ((\frac{1}{i} \cdot \frac{1}{i} + \frac{1}{i} \cdot \frac{1}{i} i^{\frac{1}{i}})^{\frac{1}{i}} - \frac{1}{i} \cdot (\frac{1}{i} \cdot \frac{1}{i} + \frac{1}{i} \cdot \frac{1}{i} i^{\frac{1}{i}})^{\frac{1}{i}} i^{\frac{1}{i}})}{(\frac{1}{i} \frac{1}{i} + \frac{\frac{1}{i} (\frac{1}{i} \cdot \frac{1}{i} + \frac{1}{i} \cdot \frac{1}{i} i^{\frac{1}{i}})^{\frac{1}{i}}}{i^{\frac{1}{i}}}) i^{\frac{1}{i}}}$$

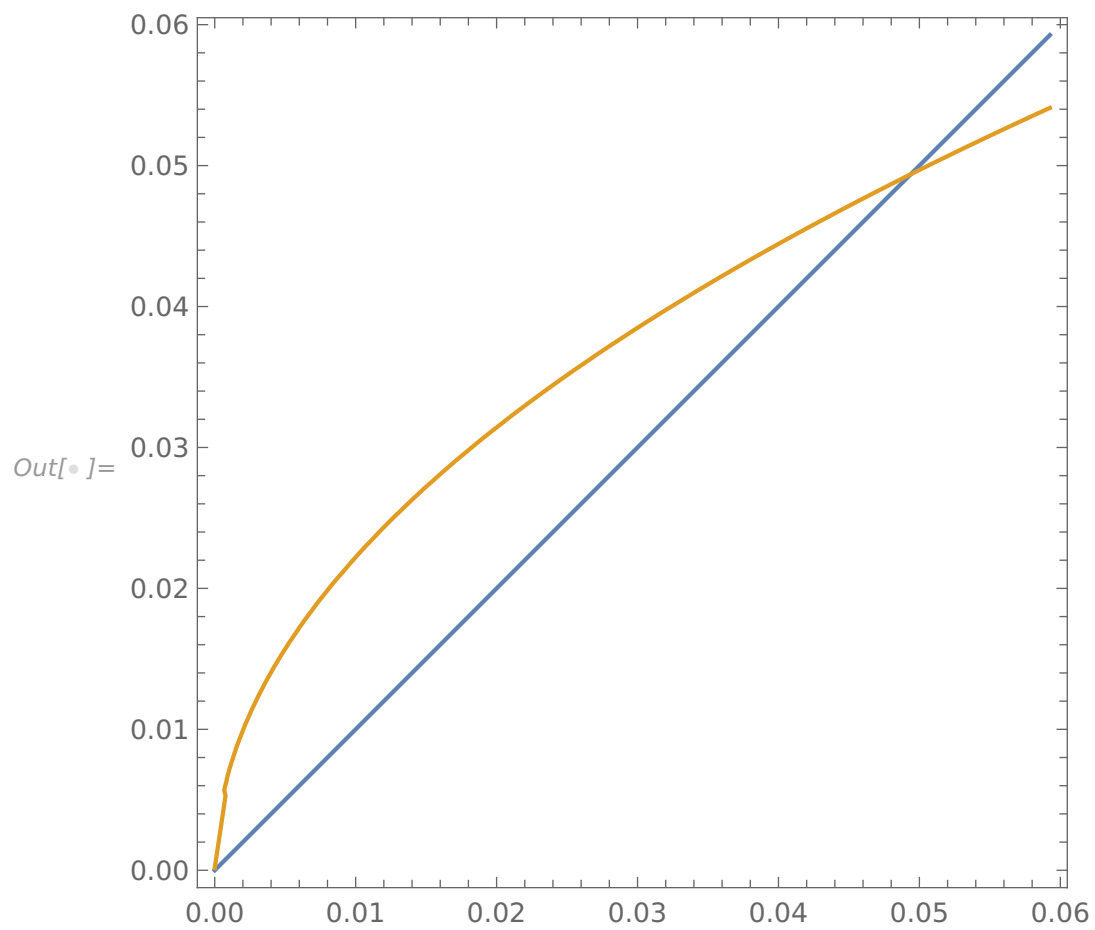
 $\text{QrcYbw QrYrcq}_\gamma \quad \text{Qmjtc } i_{r+1} = \frac{1}{i} / (\frac{1}{i} + 1) q(u(i_r) i_{r+1}^{\frac{1}{i}})$
 $\text{Ugrf rfc nYpYkcrcpq}_\gamma \quad \{i \rightarrow \frac{1}{i} \frac{1}{i} = \frac{1}{i} \frac{1}{i}\}$
 $\text{QrYZgjgrw}_\gamma \quad \text{Amknsrc rfc bcpgtYrgtc md } i_{r+1}$
 $\text{ugrf pcqncar rm } i_r \text{ Ylb ctYjsYrc Yr cYaf qrcYbw qrYrc}$
 $\text{Ugrf rfc nYpYkcrcpq}_\gamma$
 $\text{QrcYbw qrYrc } \frac{1}{i} \text{ AYngrYj jctcj}_\gamma$
 $\frac{1}{i} \frac{1}{i} = \frac{1}{i} \frac{1}{i} \text{ BcpgtYrgtc} = \frac{1}{i} \frac{1}{i} : \frac{1}{i} = \text{QrYZjc}$
 Lsjj



In[]:= `kwnpmepYk[...]`

- ... **Solve:** Solve was unable to solve the system with inexact coefficients. The answer was obtained by solving a corresponding exact system and numericizing the result.
- ... **Solve:** Solve was unable to solve the system with inexact coefficients. The answer was obtained by solving a corresponding exact system and numericizing the result.

Npmbargsm1 dslargm1₁ d(i)=i^{††}
 Srgjgrw dslargm1₁ s(a)=Jme[a]
 QYtg1eq dslargm1₁ q(u(i_r)i_{r+1}[†])=††-----u
 QsZqrgsrsg1eq q(u(i_r)i_{r+1}[†])=††††††††i^{††}
 QrcYbw QrYrcq₁ Qmjtc i_{r+1} == †/(†+1)q(u(i_r)i_{r+1}[†])
 Ugrf rfc nYpYkcrqp₁ {{i → ††}}_r {i → †††·||†-†:}}
 QrYZgjgrw₁ Amknsrsrc rfc bcpgtYrgtc md i_{r+1}
 ugrf pcqncar rm i_r Ylb ctYjsYrc Yr cYaf qrcYbw qrYrc
 Ugrf rfc nYpYkcrqp₁
 QrcYbw qrYrc †
_r AYngrYj jctcj₁ ††₁ BcpgtYrgtc=∞ SlqrYZjc
 QrcYbw qrYrc †
_r AYngrYj jctcj₁ †††·||†-†:; BcpgtYrgtc=††· QrYZjc
 Lsjj



In[32]:= kwnpmpYk[$\frac{1}{i}r - \frac{1}{i}r - \frac{1}{i}r$]

$$\text{Npmbargml dslargml}_\gamma \quad d(i) = \frac{1}{\frac{1}{i}r + \frac{1}{i}r}$$

$$\text{Srgjgrw dslargml}_\gamma \quad s(a) = \frac{1}{\sqrt{a}}$$

$$\text{QYtgleg dslargml}_\gamma \quad q(u(i_r) r^{i_{r+1}}) = \frac{\frac{1}{i}r P u}{\frac{1}{i}r + \frac{1}{i}r P}$$

$$\text{QsZqgrsrgle}_\gamma \quad q(u(i_r$$

$$) r^{i_{r+1}}) = \frac{\frac{1}{i}r \left(\frac{1}{\frac{1}{i}r + \frac{1}{i}r} - \frac{\frac{1}{i}r}{(\frac{1}{i}r + \frac{1}{i}r) \frac{1}{i}r} \right)}{\left(\frac{1}{i}r + \frac{\frac{1}{i}r}{(\frac{1}{i}r + \frac{1}{i}r) \frac{1}{i}r} \right) (\frac{1}{i}r + \frac{1}{i}r) \frac{1}{i}r}$$

$$\text{QrcYbw QrYrcq}_\gamma \quad \text{Qmjtc } i_{r+1} == \frac{1}{1/(1+l)q(u(i_r) r^{i_{r+1}})}$$

$$\text{Ugrf rfc nYpYkcrcpq}_\gamma \quad \{i \rightarrow \frac{1}{i}r - \frac{1}{i}r\} r \{i \rightarrow \frac{1}{i}r - \frac{1}{i}r\}$$

$$\text{QrYZgjgrw}_\gamma \quad \text{Amknsr rfc bcpgtYrgtc md } i_{r+1}$$

$$\text{ugrf pcqncar rm } i_r \text{ Ylb ctYjsYrc Yr cYaf qrcYbw qrYrc}$$

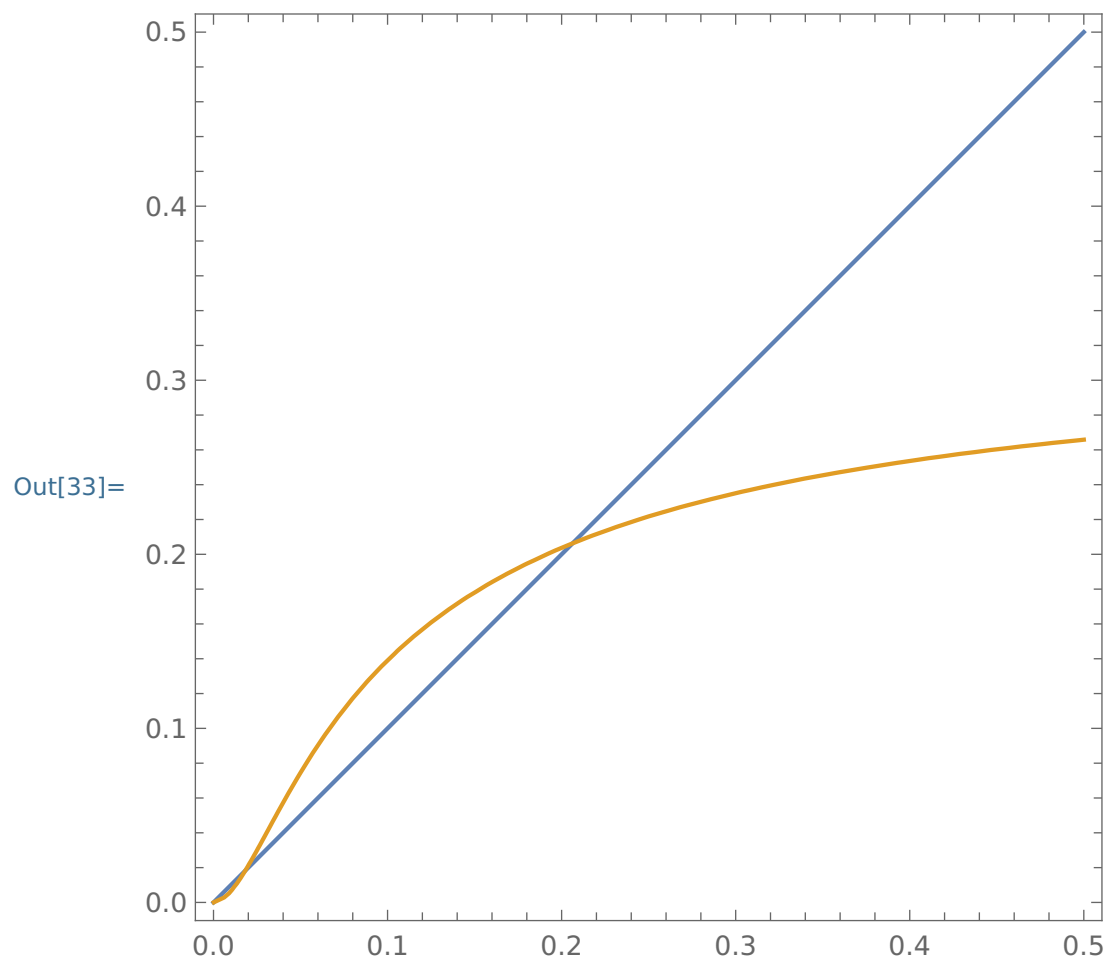
$$\text{Ugrf rfc nYpYkcrcpq}_\gamma$$

Out[32]= Zmprcb

```

In[33]:= AmlrmspNjmr[
  {i+ == i ,
   i+ ==
    +/(++)*
    (qYtgLeq[u , P , ++ ] /+
     {u → udsIargmL[i , ++ , -+ ] ,
      P → PdsIargmL[i+ , ++ , -+ ]}} , {i , + , kYvi} ,
  {i+ , + , kYvi}]

```



```

In[34]:= Cvnmpr[ -vYknjcq++nbd - , CtYjsYrgmLLmrcZmmi[] ]

```