

DPS equation

```
In[177]:= multipliers = {(ad/36), 1 + (crit/5000), 1 + (aspd/3333)};  
dps = Times@@multipliers  
  
Out[178]=  $\frac{1}{36} \text{ad} \left(1 + \frac{\text{aspd}}{3333}\right) \left(1 + \frac{\text{crit}}{5000}\right)$   
  
In[494]:= constraints = {ad ≥ 0, crit ≥ 0, aspd ≥ 0, crit ≤ 5000, aspd + ad + crit == 10000};  
{knownBestDPS, knownBestDistro} = Maximize[{dps, constraints}, {ad, crit, aspd}]  
  
Out[495]=  $\left\{ \frac{8452264653}{22220000}, \{\text{ad} \rightarrow 6111, \text{crit} \rightarrow 1111, \text{aspd} \rightarrow 2778\} \right\}$ 
```

Path of steepest ascent

```
In[180]:= g = Grad[dps /. {ad → x, crit → y, aspd → z}, {x, y, z}]  
  
Out[180]=  $\left\{ \frac{1}{36} \left(1 + \frac{y}{5000}\right) \left(1 + \frac{z}{3333}\right), \frac{x \left(1 + \frac{z}{3333}\right)}{180000}, \frac{x \left(1 + \frac{y}{5000}\right)}{119988} \right\}$   
  
In[181]:= {ad2critUnbounded, ad2aspdUnbounded} = {y[x], z[x]} /. DSolve[{  
    y'[x] == (g[[1]] /. y → y[x]) / g[[2]],  
    z'[x] == (g[[1]] /. {y → y[x], z → z[x]}) / (g[[3]] /. y → y[x]),  
    y[ad /. knownBestDistro] == (crit /. knownBestDistro),  
    z[ad /. knownBestDistro] == (aspd /. knownBestDistro)},  
    {y[x], z[x]}, x]  
  
ad2crit[attack_] := Max[0, ad2critUnbounded] /. x → attack  
ad2aspd[attack_] := Max[0, ad2aspdUnbounded] /. x → attack  
  
Out[181]= {-5000 + x, -3333 + x}}
```

```
(* rewrite 'gADodd' in terms of Piecewise because ConditionalExpression interacts oddly
gADodd = x /. Solve[{ad2crit[x] + ad2aspd[x] + Max[0,x] == h, h ≥ 0}, x,
Method → Reduce]
gADfixed = Piecewise[gADodd /. ConditionalExpression[xx_, yy_] :> {xx, yy}]

gAD[gold_] := gADfixed /. h → gold
gCrit[h_] := ad2crit[gAD[h]]
gAspd[h_] := ad2aspd[gAD[h]]
```

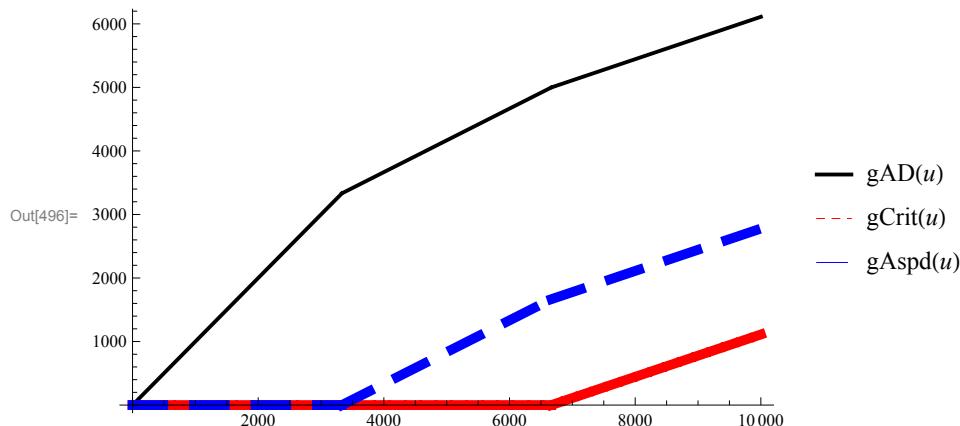
Out[184]= $\left\{ \begin{array}{l} \text{ConditionalExpression}[h, 0 < h < 3333], \\ \text{ConditionalExpression}\left[\frac{3333+h}{2}, 3333 < h < 6667\right], \\ \text{ConditionalExpression}\left[\frac{8333+h}{3}, h > 6667\right] \end{array} \right\}$

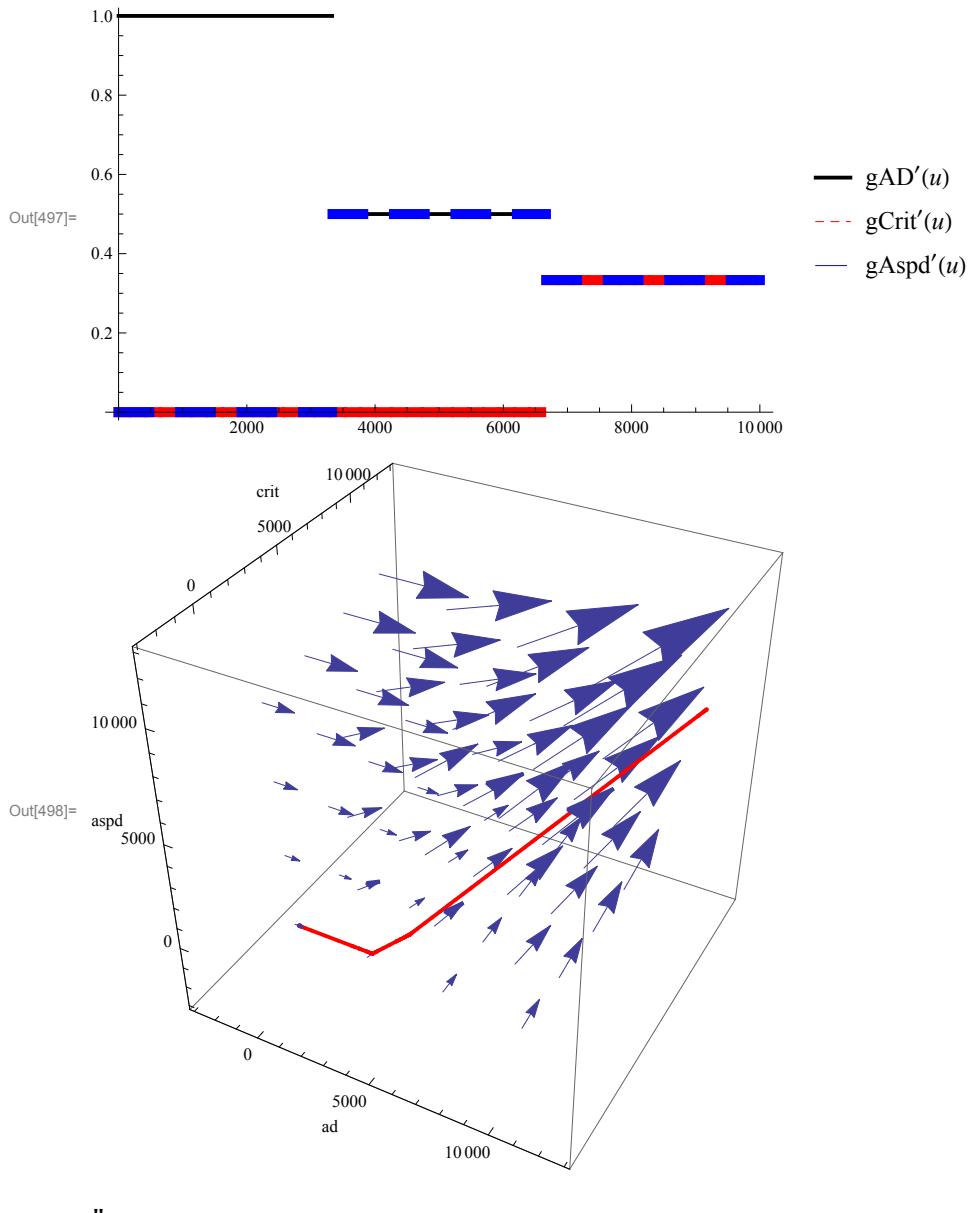
Out[185]= $\left\{ \begin{array}{ll} h & 0 < h < 3333 \\ \frac{3333+h}{2} & 3333 < h < 6667 \\ \frac{8333+h}{3} & h > 6667 \\ 0 & \text{True} \end{array} \right.$

In[496]:= Plot[{gAD[u], gCrit[u], gAspd[u]}, {u, 0, 10000},
PlotLegends -> "Expressions",
PlotStyle -> {Directive[Black, Thick],
Directive[Dashed, Red, Thickness[0.015]],
Directive[Blue, Thickness[0.015], Dashing["Large"]]}]

Plot[{Derivative[1][gAD][u], Derivative[1][gCrit][u], Derivative[1][gAspd][u]}, {u, 0,
PlotLegends -> "Expressions",
PlotStyle -> {Directive[Black, Thick],
Directive[Dashed, Red, Thickness[0.015]],
Directive[Blue, Thickness[0.015], Dashing["Large"]]}]}

Show[
VectorPlot3D[g, {x, 0, 10000}, {y, 0, 10000}, {z, 0, 10000},
VectorPoints -> Coarse,
AxesLabel -> {ad, crit, aspd}],
ParametricPlot3D[{gAD[u], gCrit[u], gAspd[u]}, {u, 0, 30000},
PlotStyle -> Directive[Red, Thick]]
]





Comparison against gradient ascent results

```
In[233]:= threshold = 92.58 * 36
old[u_] := {ad → gAD[u], crit → gCrit[u], aspd → gAspd[u]}
new[u_] := Piecewise[{{
    {ad → u, crit → 0, aspd → 0}, u ≤ threshold},
    {ad → threshold, crit → 0, aspd → u-threshold}, True}
  }]
```

Out[233]= 3332.88

```
In[504]:= tab[u_] := {{"func", "dps", "gold distribution", "sum", "multipliers"}, {"old", N[dps]/. old[u], N@old[u], {ad+crit+aspd}/. old[u], N@(multipliers {"new", N[dps]/. new[u], N@new[u], {ad+crit+aspd}/. new[u], N@(multipliers tab[threshold] // TableForm
tab[5000] // TableForm
tab[15000] // TableForm

dps /.{ad->6577.67, crit->3377.67, aspd->5044.67}
dps /.{ad->6577.67, crit->3357.67, aspd->5064.67}

Plot[{dps /. new[u], dps /. old[u]}, {u,0,30000},
      PlotStyle -> {Directive[Dashed, Red, Thick],
                      Directive[Black, Thick]},
      PlotLegends -> {new.old}]
```

Out[505]//TableForm=					
	func	dps	gold distribution	sum	multipliers
old		92.58	ad → 3332.88		92.58
			crit → 0.	3332.88	1.
			aspd → 0.		1.
new		92.58	ad → 3332.88		92.58
			crit → 0.	3332.88	1.
			aspd → 0.		1.

Out[506]:= TableForm=					
	func	dps	gold distribution	sum	multipliers
old		144.679	ad → 4166.5		115.736
			crit → 0.	5000	1.
			aspd → 833.5		1.25008
new		138.887	ad → 3332.88		92.58
			crit → 0.	5000.	1.
			aspd → 1667.12		1.50019

Out[507]:= TableForm=					
	func	dps	gold distribution	sum	multipliers
old		784.224	ad → 7777.67		216.046
			crit → 2777.67	15000	1.55553
			aspd → 4444.67		2.33353
new		416.655	ad → 3332.88		92.58
			crit → 0.	15000.	1.
			aspd → 11667.1		4.50049

Out[508]= 769.504

Out[509]= 769.499

