Chapter 2

graph formating

In[1]:=
```
thinn = AbsoluteThickness[.5];
medum = AbsoluteThickness[1.];
thick = AbsoluteThickness[1.5];
black = GrayLevel[0];
BGray = GrayLevel[0.3];
WGray = GrayLevel[0.6];
SetOptions[Plot, PlotStyle → {{thinn, Black}, {thinn, Black}, {thinn, Black}},
  PlotPoints → 40, ImageSize → 360,
  FrameStyle -> medum, AxesStyle -> medum,
  BaseStyle -> {FontFamily -> "Helvetica", FontSlant → Plain, FontSize → 12}];
SetOptions[ListPlot, AxesStyle -> medum, PlotStyle → medum, ImageSize → 384,
  BaseStyle -> {FontFamily -> "Helvetica", FontSlant -> "Plain", FontSize → 12}];
SetOptions[ParametricPlot, PlotStyle →
   {{thinn, Black}, {thinn, Black}, {thinn, Black}}, PlotPoints → 40,
  FrameStyle -> medum, AxesStyle -> medum, PlotStyle → medum,
  BaseStyle -> {FontFamily -> "Helvetica", FontSlant -> "Plain", FontSize → 12}];
SetOptions[Graphics, BaseStyle ->
   {FontFamily -> "Helvetica", FontSlant -> "Plain", FontSize → 12}];
```

2.8 Detour; Benefit Calculations

Linear

In[11]:=
```
p =.;
w =.;
q0 = 35 000.;
p0 = 3.;
elast = -0.5;
m = elast * q0 / p0;
b = q0 - m * p0;
wlin = m * p + b
plin = p /. Flatten[Simplify[Solve[w == %, p]]]
```

Out[18]= 52 500. - 5833.33 p

Out[19]= 9. - 0.000171429 w

LogLinear

In[20]:=
```
c = q0 / p0^elast;
wlog = c * p^elast
plog = p /. Flatten[Simplify[Solve[w == %, p]]]
```

Out[21]= $\frac{60\,621.8}{p^{0.5}}$

Solve::ifun : Inverse functions are being used by Solve, so some solutions may not be found; use Reduce for complete solution information. ≫

Out[22]= $\frac{3.675\times10^{9}}{w^{2.000000000000000}}$

2.9 MNB

In[23]:=
```
mc = 1.95 + 0.00003 * w;
mnblog = plog - mc
```

Out[24]= $-1.95+\frac{3.675\times10^{9}}{w^{2.000000000000000}}-0.00003\,w$

2.10, 2.11 Two MNBs

In[25]:=
```
plog2 = plog * 0.5;
mc2 = 1.5 + 0.00002 * w;
mnblog2 = plog2 - mc2;
flipmnblog2 = mnblog2 /. w → (50 000 - w);
FindRoot[mnblog - flipmnblog2 == 0, {w, 25 000}]
mnblog /. %
```

Out[29]= {w → 28 056.2}

Out[30]= 1.87707

2.12 Two Sectors with One Yielding Return Flow

Method 1 - graphed

In[31]:=
```
R = 0.25;
flipmnblog2R = mnblog2 /. w → (50 000 - (1 - R) * w)
```

Out[32]= $-1.5+\frac{1.8375\times10^{9}}{(50\,000-0.75\,w)^{2.000000000000000}}-0.00002\,(50\,000-0.75\,w)$

In[33]:=
```
FindRoot[mnblog / (1 - R) - flipmnblog2R == 0, {w, 25 000}]
mnblog /. %
```

Out[33]= {w → 32 407.3}

Out[34]= 0.576995

Method 2

In[35]:=
```
mnb1 = mnblog /. w → w1
mnb2 = mnblog2 /. w → w2
```

Out[35]= $-1.95 + \frac{3.675 \times 10^{9}}{w_1^{2.000000000000000}} - 0.00003\, w_1$

Out[36]= $-1.5 + \frac{1.8375 \times 10^{9}}{w_2^{2.000000000000000}} - 0.00002\, w_2$

In[37]:=
```
FindRoot[{mnb1 == (1 - R) * mnb2, (1. - R) * w1 + w2 == 50000}, {w1, 25000}, {w2, 25000}]
```

Out[37]= $\{w_1 \to 32407.3,\ w_2 \to 25694.5\}$

In[38]:=
```
{mnb1, mnb2} /. %
```

Out[38]= {0.576995, 0.769327}

2.13 MNB Addition for Nonrival Uses (vs Rival)

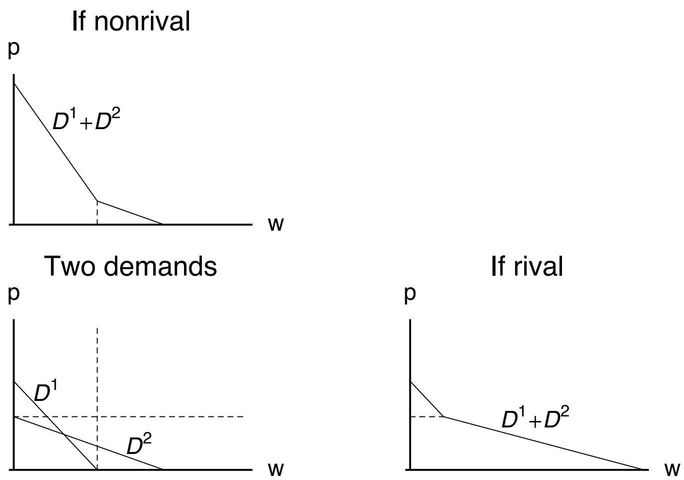
Assuming the a,b line has a lower p intercept (a<c) and a higher q intercept (a/b>c/d):

In[39]:=
```
Clear[a, b, c, d]
d1 = a - b * q;
d2 = c - d * q;
q1 = a / b - p / b;
q2 = c / d - p / d;
Solve[qp == q1 + q2, p]
{a, b, c, d} = {6., 1, 10., 3.};
nonrivalgd = Which[0 <= q <= c / d, a + c - (b + d) q,
   c / d < q <= a / b, d1,
   a / b < q, 0];
rivalgd = Which[0 <= q <= (c - a) / d, d2,
   (c - a) / d < q <= c / d + a / b,
   (b * c + a * d - b * d * q) / (b + d)];

pl213i = Plot[{d1, d2}, {q, 0, c / d + a / b},
   PlotRange → {0, a + c + 1}, AxesOrigin → {0, 0},
AxesLabel → {"w", "p"}, Ticks → None, PlotLabel → "Two demands"];
pl213ii = Show[pl213i,
 Graphics[Text["D^1", {1.3, 9}]],
 Graphics[Text["D^2", {5, 3}]], Graphics[{Dashing[{.02, .02}], thinn,
    Line[{{c / d, 0.}, {c / d, a + c}}], Line[{{0., a}, {c / d + a / b, a}}]}]];
pl213iii = Plot[nonrivalgd, {q, 0, c / d + a / b},
   PlotRange → {0, a + c + 1}, AxesOrigin → {0, 0},
AxesLabel → {"w", "p"}, Ticks → None, PlotLabel → "If nonrival"];
pl213iv = Show[pl213iii,
 Graphics[Text["D^1+D^2", {2.9, 12}]], Graphics[
   {Dashing[{.02, .02}], thinn, Line[{{c / d, 0.}, {c / d, a - b * c / d}}]}]];
pl213v = Plot[rivalgd, {q, 0, c / d + a / b},
   PlotRange → {0, a + c + 1}, AxesOrigin → {0, 0},
AxesLabel → {"w", "p"}, Ticks → None, PlotLabel → "If rival"];
pl213vi = Show[pl213v,
 Graphics[Text["D^1+D^2", {5, 6}]],
   Graphics[{Dashing[{.02, .02}], thinn, Line[{{0., a}, {(c - a) / d, a}}]}]];
pl213 = Show[GraphicsGrid[{{pl213iv, Null},
        {pl213ii, pl213vi}}], ImageSize → 400]
```

Out[44]= $\left\{\left\{p \to \frac{b\,c + a\,d - b\,d\,qp}{b + d}\right\}\right\}$

Out[54]=



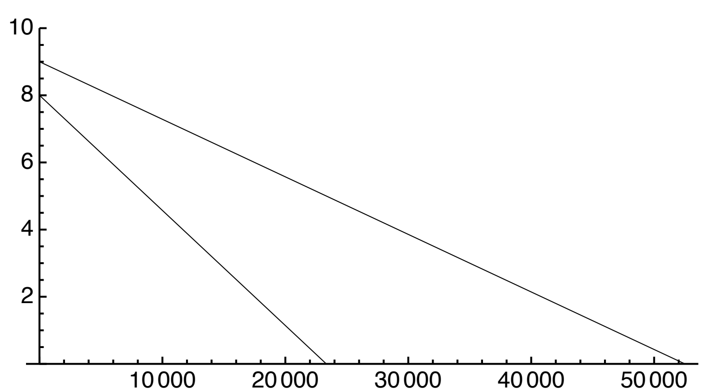
2.14-2.16 Neutral Efficiency

In[55]:=
```
plin
plin2 = Expand[plin * 2. - 10.]
Plot[{plin, plin2}, {w, 0, 52 500},
 PlotRange → {0, 10},
 AspectRatio → 0.5]
```

Out[55]= 9. - 0.000171429 w

Out[56]= 8. - 0.000342857 w

Out[57]=



Assuming the a,b line has a lower p intercept (a<c) and a higher q intercept (a/b>c/d):

In[58]:=
```
Clear[a,b,c,d]
d1=a-b*q;
d2=c-d*q;
q1=a/b-p/b;
q2=c/d-p/d;
Solve[q*p==q1+q2,p]
```

Out[63]= $\left\{\left\{p \to \frac{b\,c + a\,d}{b + d + b\,d\,q}\right\}\right\}$

In[64]:=
```
{a,b,c,d}={8.,0.000342857,9.,0.000171429};
dtotal=Which[0<=q<=(c-a)/d,d2,
        (c-a)/d<q<=c/d+a/b,
        (b*c+a*d-b*d*q)/(b+d)]
```

Out[65]= $\text{Which}\left[0 \le q \le 5833.32,\ d2,\ \frac{c-a}{d} < q \le \frac{c}{d} + \frac{a}{b},\ \frac{b\,c + a\,d - b\,d\,q}{b + d}\right]$

In[66]:=
```
v = p /. Flatten[Solve[((b * c + a * d - b * d * 55 000) / (b + d)) == p, p]]
```

Out[66]= 2.38094

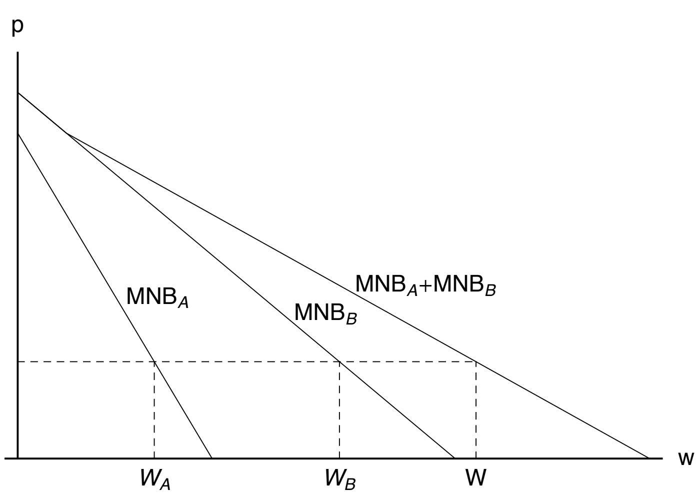
In[67]:=
```
wa = q1 /. p → v
wb = q2 /. p → v
```

Out[67]= 16 388.9

Out[68]= 38 611.1

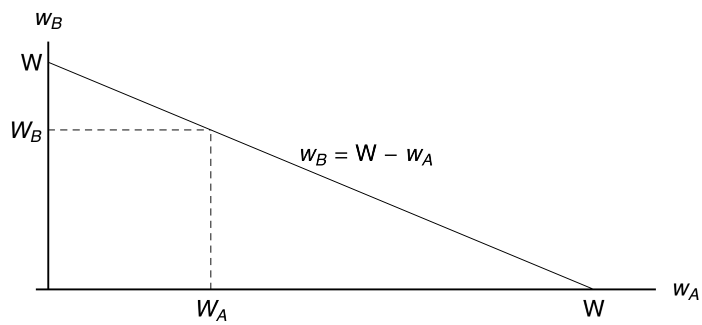
In[69]:=
```
pl214i = Plot[{d1, d2, dtotal}, {q, 0, c / d + a / b},
   PlotRange → {0, c + 1}, AxesOrigin → {0, 0}, AxesLabel → {"w", "p"},
   Ticks → {{{wa, "W_A", 0}, {wb, "W_B", 0}, {55 000, "W", 0}}, {{v, "", 0}}}];
```

In[70]:=
```
pl214 = Show[pl214i,
  Graphics[Text["MNB_A", {16 800, 4}]],
  Graphics[Text["MNB_B", {37 000, 3.6}]],
  Graphics[Text["MNB_A+MNB_B", {49 000, 4.3}]],
  Graphics[{Dashing[{.01, .01}], thinn,
    Line[{{55 000, 0}, {55 000, v}}],
    Line[{{0, v}, {55 000, v}}],
    Line[{{wa, 0}, {wa, v}}],
    Line[{{wb, 0}, {wb, v}}]}]]
```

Out[70]=


```
In[71]:= pl215a = Plot[55 000 - wa, {wa, 0, 60 000},
    PlotRange → {0, 60 000},
    AxesOrigin → {0, 0},
    AspectRatio → 0.9,
    AxesLabel → {"wA", "wB"},
    Ticks → {{{wa, "WA", 0}, {55 000, "W", 0}}, {{wb, "WB", 0}, {55 000, "W", 0}}},
    DisplayFunction → Identity];
pl215 = Show[pl215a,
  Graphics[Text["wB = W - wA", {32 000, 33 000}]],
  Graphics[{Dashing[{.01, .01}], thinn,
    Line[{{wa, 0}, {wa, wb}}],
    Line[{{0, wb}, {wa, wb}}]}],
  ImageSize → 360,
  AspectRatio → 0.4]
```

Out[72]=



In[73]:= NBA = $\int_0^w d1 \, dq$

NBB = $\int_0^w d2 \, dq$

Out[73]= $8. w - 0.000171429 w^2$

Out[74]= $9. w - 0.0000857145 w^2$

```
In[75]:= sata = q /. Flatten[Solve[d1 == 0, q]]
satb = q /. Flatten[Solve[d2 == 0, q]]
```

Out[75]= 23 333.3

Out[76]= 52 499.9

So the Pareto frontier should only be plotted so the neither sector gets more than their satiation amounts (a's is 23333, b's is 52500).

```
In[77]:= NBA /. w → wa
NBA /. w → sata
NBB /. w → wb
NBB /. w → satb
```

Out[77]= 85 066.2

Out[78]= 93 333.4

Out[79]= 219 715.

Out[80]= 236 249.

In[81]:=
```
effpt = {85 066.2, 219 715.}
```
Out[81]=
```
{85 066.2, 219 715.}
```

In[82]:=
```
flipNBB = NBB /. w → (55 000 - w)
```
Out[82]=
```
9. (55 000 - w) - 0.0000857145 (55 000 - w)^2
```

In[83]:=
```
pl216i = ParametricPlot[{NBA, flipNBB}, {w, 55 000 - satb, sata},
    PlotStyle → {{thinn, Black}},
    AxesLabel → {"NB_A", "NB_B"},
    AxesOrigin → {0, 150 000},
    AspectRatio → .5,
    PlotRange → {{0, 108 000}, {150 000, 250 000}}];
pl216 = Show[pl216i, Graphics[{PointSize[.015], Point[effpt]}],
   ImageSize → 360,
   AspectRatio → 0.5]
```

Out[84]=