Let $p = p(x,b) = \dfrac{e^{cx}-1}{e^{cb}-1}$, where $c = \dfrac{-2\mu}{\sigma^2}$ (1)

$$\omega = \omega(x,b,L) = (1-L)(1-p)(-x) + p(b-x)$$
$$\omega = -x + \cancel{px} + Lx - Lpx + pb - \cancel{px}$$
$$\omega = -x + Lx - Lpx + pb \quad (2)$$

Note $\dfrac{\partial p}{\partial x} = \dfrac{c\,e^{cx}}{e^{cb}-1}$, $\dfrac{\partial p}{\partial b} = \dfrac{(-1)(e^{cx}-1)\,c\,e^{cb}}{(e^{cb}-1)^2}$ (3)

Taking partial derivatives:

$$\frac{\partial \omega}{\partial x} = -1 + L - L\frac{\partial p}{\partial x}\cdot x - Lp + \frac{\partial p}{\partial x}\cdot b$$
$$= L - 1 - Lp - Lx\frac{\partial p}{\partial x} + b\frac{\partial p}{\partial x}$$
$$= L - 1 - L\left(\frac{e^{cx}-1}{e^{cb}-1}\right) - Lx\left(\frac{c\,e^{cx}}{e^{cb}-1}\right) + b\left(\frac{c e^{cx}}{e^{cb}-1}\right)$$

So $\dfrac{\partial \omega}{\partial x} = 0$ gives

$$(L-1)(e^{cb}-1) - L(e^{cx}-1) - Lxce^{cx} + bce^{cx} = 0$$
$$Le^{cb} \cancel{-L} - e^{cb} + 1 - Le^{cx} \cancel{+L} - Lxce^{cx} + bce^{cx} = 0$$
$$Le^{cb} - e^{cb} + 1 - Le^{cx} - Lxce^{cx} + bce^{cx} = 0$$

$$\boxed{Le^{cb} - e^{cb} + 1 - Le^{cx} - Lxce^{cx} + bce^{cx} = 0} \quad (4)$$

$$\frac{\partial w}{\partial b} = -L\frac{\partial p}{\partial b}x + \frac{\partial p}{\partial b}\cdot b + p \qquad \text{(from (2))}$$

So $$\frac{\partial w}{\partial b} = 0 \Rightarrow -L\frac{\partial p}{\partial b}x + \frac{\partial p}{\partial b}b + p = 0$$

$$\Rightarrow \frac{\partial p}{\partial b} = \frac{p}{(Lx-b)} \qquad (5)$$

From (1) & (3) & (5)

$$\frac{(-1)(\cancel{e^{cx}-1})ce^{cb}}{(e^{cb}-1)^{\cancel{2}}} = \frac{p}{(Lx-b)} = \frac{\cancel{(e^{cx}-1)}}{\cancel{(e^{cb}-1)}\cdot(Lx-b)}$$

$$\frac{(-1)ce^{cb}}{(e^{cb}-1)} = \frac{1}{(Lx-b)}$$

$$(-1)ce^{cb}(Lx-b) = e^{cb}-1$$

$$-cLxe^{cb} + bce^{cb} - e^{cb} + 1 = 0 \qquad (6)$$

Subtracting equation (6) from (4)

$$Le^{cb} - Le^{cx} - Lxce^{cx} + bce^{cx} + cLxe^{cb} - bce^{cb} = 0$$

$$e^{cb}(L + cLx - bc) + e^{cx}(-L - Lxc + bc) = 0$$

$$e^{cb}(L + cLx - bc) = e^{cx}(L + Lxc - bc) \qquad (7)$$

if $L+cLx-bc \neq 0$ then $e^{cb} = e^{cx}$, ~~so b=x~~
so $b=x$. This corresponds to not playing and is the degenerate local maximum.

Otherwise, assume $L+cLx-bc=0$ (8)

From equation #6, $e^{cb}(-cLx+bc-1)=-1$

pluggin in $-cLx+bc=L$, we get

$$e^{cb}(L-1)=-1$$

$$e^{cb}=\frac{1}{1-L}$$

$$cb=\ln\left(\frac{1}{1-L}\right)$$

$$\boxed{b=\frac{1}{c}\cdot\ln\left(\frac{1}{1-L}\right)} \quad (9)$$

Then from (8), $\boxed{x=\frac{bc-L}{cL}}$ (10)

$$b=\frac{1}{c}(-1)\ln(1-L)$$

$$\boxed{b=\frac{\sigma^2}{2\mu}\ln(1-L)} \quad (11)$$

$$x = \frac{bc - L}{cL} = \frac{(-1)\ln(1-L) - L}{cL}$$

$$= \frac{\ln(1-L) + L}{-cL}$$

$$= \frac{\sigma^2}{2\mu} \cdot \left(1 + \frac{\ln(1-L)}{L}\right)$$

$$\boxed{x = \frac{\sigma^2}{2\mu}\left(1 + \frac{\ln(1-L)}{L}\right)}$$

$$b - x = \frac{-\sigma^2}{2\mu} - \frac{\sigma^2}{2\mu} \cdot \frac{\ln(1-L)}{L} + \frac{\sigma^2}{2\mu}\ln(1-L)$$

$$\boxed{b - x = \frac{\sigma^2}{2\mu}\left(\ln(1-L) - \frac{\ln(1-L)}{L} - 1\right)}$$