**The Balance Condition[[1]](#footnote-1)
Instructional Primer[[2]](#footnote-2)**

Let’s start with the notion that a firm has to choose what inputs to use in production and that’s its choice is between Capital (K) and Labor (L). The firm has only so much money to spend, which amount is informed by its total revenues (P x Q), which then sets the limit for its total costs since it can’t spend more than it brings in (or at least it shouldn’t). So the firm has a budget that can be expressed as (W x L) + (PK x K) = TC = TR when profits = 0. In this construction W is the price of labor, L is the number of labor units, PK is the price of capital, and K is the number of units of capital.

Let’s assume the firm sells 1,000 pairs of shoes at $75 per pair, so its total revenue is $75,000, which means its cost budget is also $75,000. It can spend all of that on capital, all on labor, or some combination of capital and labor. If the price of one unit of capital is $300, the firm can use all of its budget and buy as many as 250 units of capital. Similarly, if the wage is $100 per day the firm can use all of its budget and buy 750 days of labor. This gives us the firm’s budget curve as indicated below, where the slope of the curve is PK/PL (rise/run). This is sometimes referred to as the firm’s IsoCost curve, because at any point on the curve the firm has a constant level of cost, which is $75,000 in this case.

0

50

100

150

200

250

300

100

200

300

400

500

600

Capital

Labor

700

800

IsoCost (PK/PL)

Firm’s also have IsoQuant curves, or a curve on which the quantity of output is constant – in this case that quantity is 1,000 pairs of shoes. This curve is informed by the marginal productivity of capital (MPK) and the marginal productivity of labor (MPL). In capital and labor space on a Cartesian coordinate graph the curve can be thought of in much the same way we think of a consumer’s indifference curve: it is downward sloping, convex, any point on the curve represents the same level of output (1,000), as the curve shift out and to the right the level increases, and the curve is monotonic (always travels in the same basic direction). This curve has a slope equal to MPK/MPL.

0

50

100

150

200

250

300

100

200

300

400

500

600

Capital

Labor

700

800

IsoQuant (MPK/MPL)

We know the firm wants as much output as possible from its budget, so we also know the IsoQuant will be tangent to the IsoCost curve such that at the point of tangency IsoQuant equals IsoCost. In this case that tangency represents 1,000 pair of shoes. Given the budget the firm can’t produce more than 1,000 (infeasible) and at less than 1,000 the firm won’t make its revenue target (inefficient).

IsoCost (PK/W)

0

50

100

150

200

250

300

100

200

300

400

500

600

Capital

Labor

700

800

IsoQuant (MPK/MPL)

At this point of tangency it appears the firm uses approximately 130 units of capital and 360 units of labor. If we knew the values for MPL and MPK we could know these unit values specifically, but we don’t have them for this discussion. We also know that $\frac{MP\_{K}}{MP\_{L}}= \frac{P\_{K}}{W}$ at the point of tangency. If we rearrange this equation by dividing both sides by PK and multiplying both sides by MPL we arrive at $\frac{MP\_{K}}{P\_{K}}= \frac{MP\_{L}}{W}$, which you should recognize as the *balance condition* for optimization in competitive markets.

If the *balance condition* equation is not in equilibrium it means the IsoCost and IsoQuant curves are not equal to one another and some inefficiency is observed, so management needs to act to restore efficient (optimal) operations. Recall that firms in competitive markets can’t set prices, so management has no control over PK or W. It takes time and money to change the amount of capital being used in a firm, so management can’t easily change the use of capital in the near term. All this leaves is changing the level of labor to increase or decrease MPL since we know that as the use of labor increases MPL decreases (and vice versa) from the law of diminishing marginal productivity.

Since we know the wage is $100, the firm is in a competitive market such that MRPL = W and we know the price of shoes is $75, we can deduce MPL as follows:

$W=MRP\_{L}= MP\_{L} x P$ (1)

Substitute known values

$100=MP\_{L} x 75$

Solve for MPL

$\frac{100}{75}= MP\_{L}=1.33$

If we know MPL = 1.33 and the firm is operating at optimality, we can then also deduce MPK through the balance condition as follows:

$\frac{MP\_{K}}{P\_{K}}= \frac{MP\_{L}}{W}$ (2)

Substitute in known values

$\frac{MP\_{K}}{300}= \frac{1.33}{100}$

Solve for MPK

$MP\_{K}= \frac{1.33 x 300}{100}= \frac{400}{100}=4$

Now let’s see if the values for labor (L) and capital (K) make sense to us. To do this we can go back to the Total Revenue = Total Cost equation since that sets the firm’s operating budget:

$(W x L) + (P\_{K} x K) = TC$ (3)

Substitute in known values

$\left(100 x 360\right)+ \left(300 x 130\right)= 75,000$

And compare it to the firm’s Total Revenue

$P x Q=TR$ (4)

Substitute in known values

$75 x 1,000=75,000$

And we confirm that the firm is at the *zero profit condition* for profit maximization and at the *balance condition* for optimization… Cool!

1. This primer one of the microeconomic conditions for profit optimization referred to as the Balance Condition is intended for illustrative purposes only and is not a full recitation of the concepts and calculations underlying the condition. [↑](#footnote-ref-1)
2. Prepared by Richard Haskell, PhD, (2016), Assistant Professor of Finance, Bill and Vieve Gore School of Business, Westminster College, Salt Lake City, Utah, 2016 rhaskell@westminstercollege.edu [↑](#footnote-ref-2)