1. GLS Chapter 6, Question 3

Numbers in italics were given in the problem. Numbers in regular text are the answers.

<table>
<thead>
<tr>
<th>Labor input</th>
<th>Total product</th>
<th>Marginal product</th>
<th>Average product</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>70</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>135</td>
<td>65</td>
<td>67.5</td>
</tr>
<tr>
<td>3</td>
<td>189</td>
<td>54</td>
<td>63</td>
</tr>
<tr>
<td>4</td>
<td>240</td>
<td>51</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>300</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>366</td>
<td>66</td>
<td>61</td>
</tr>
</tbody>
</table>

2. GLS Chapter 6, Question 9

(a) Suppose that capital can be hired for $24 per hour. Label each of the isocost lines with the appropriate total expenditure for the firm.

The top isocost line \((K = 14)\) implies a total expenditure of \(24 \times 14 = 336\). The middle isocost line implies a total expenditure of \(10 \times 24 = 240\), and the bottom isocost line implies a total expenditure of \(8 \times 24 = 192\).

(b) Suppose that labor can be hired for $36 per hour. Label the horizontal intercept of each isocost line, and determine the slope of each line.

Top line: Intercept is \(336/36 = 9.3\).
Middle line: Intercept is \(240/36 = 6.7\)
Bottom line: Intercept is \(192/36 = 5.3\).

Slope for all lines is \(-\frac{W}{R} = -36/24 = -1.5\). Note that the slope is the ratio of the negative of the wage and capital rental rate. This does not vary by isocost curve, so all curves have the same slope.

(c) Can the firm produce 248,000 units of output for $336?

Yes, the firm can produce this level of output for $336, since the isoquant for \(Q = 248,000\) intersects the isocost curve for a total expenditure of $336. However, the firm would not be
making a wise choice in doing so, for reasons you will see in part (d).

(d) What is the minimum cost for which 248,000 units of output can be produced?

The firm can produce 248,000 units of output for $240, since the isoquant for \( Q = 248,000 \) is tangent to the isocost for total expenditure of $240.

(e) Suppose the firm is spending exactly $240 to make 248,000 units of output. If the marginal product of labor is 400 units of output, what must the marginal product of capital be?

We know that at this combination of output and expenditure, the firm is behaving optimally. At the optimum, the firm equates

\[ \text{MRTS}_{L,K} = \frac{W}{R}. \]

We can re-write this as

\[ \frac{MU_L}{MU_K} = \frac{W}{R}, \]

and we know all the components of this equation except for \( MU_K \).

Therefore, we can write

\[ \frac{400}{MU_K} = \frac{36}{24}, \]

\[ \frac{400}{1.5} = MU_K \]

\[ MU_K = 266.7 \]

3. GLS Chapter 6, Question 12

(a) Suppose that Gloucester currently has 20 ATMs and 20 tellers. If 3 ATMs fail, how many additional tellers must the bank hire to maintain their original level of service?

We can find the original level of service from the production function: \( Q = 4K + 6L = 4(20) + 6(20) = 200. \)

If the bank loses 3 ATMs, production will fall to \( Q = 4K + 6L = 4(17) + 6(20) = 188, \) or by 12 units (which you can note = \( 4\Delta K = 4(3) = 12 \)).

Each teller produces 6 units of service, so the bank would need to hire two additional tellers.
(b) Does your answer to (a) change if Gloucester originally uses only 17 ATMs? 30 ATMs?

If Gloucester originally uses 17 ATMs and loses 3, \( Q_{K=17} - Q_{K=14} = (4(17) + 6(20)) - (4(14) + 6(20)) = 4(17 - 14) = 4 \times 3 = 12 \). The bank would again need to hire 2 tellers. No change.

Similarly, if Gloucester originally uses 30 ATMs and loses 3, \( Q_{K=30} - Q_{K=27} = (4(30) + 6(20)) - (4(27) + 6(20)) = 4(30 - 27) = 4 \times 3 = 12 \). No change.

Note that in this production function, capital and labor have no complementarity (equivalent to saying that they are substitutes). Because of this, the exchange rate between capital and labor in production does not change with the level of production.

(c) What do production isoquants look like for Gloucester Old Bank?

Because the inputs are substitutes, isoquants are straight lines with a negative slope. The bank could produce \( Q = 200 \) with 33.3 units of labor and no capital, or 50 units of capital and no labor. These are the endpoints of the isoquant for \( Q = 200 \).

(d) How would you verbally describe the relationship between tellers and ATMs?

They are substitutes. Tellers are more productive than ATMs, per unit of input.

(e) Suppose that installing and maintaining an ATM costs $20, and hiring a teller costs $32. What will happen to Gloucester’s total number of customers served if it lays off 2 workers and installs 3 ATMs? What will happen to the bank’s costs?

Recall that the original level of service is \( Q = 4K + 6L = 4(20) + 6(20) = 200 \).

If the bank lays off 2 workers and installs 3 ATMs, the new level of service will be \( Q = 4(20 + 3) + 6(20 - 2) = 4(23) + 6(18) = 200 \). The level of service is therefore unchanged.

The bank’s original total cost was \( C = WL + RK = (32)L + (20)K = (32)(20) + (20)20 = 1040 \). With this change in production, the banks’s costs are now \( C = (32)(18) + 20(23) = 1036 \). The bank’s costs decline by $4.

(f) Using the idea developed in (e), if Gloucester Old Bank is interested in minimizing its costs, what strategy should it employ regarding its input mix?

For me, the clearest way to think about this problem is to think about the marginal product of labor or capital per dollar of cost. Because the production function is linear and labor and capital are substitutes, we can see that an additional unit of labor yields 6 units of output.
An additional unit of capital yields 4 units of output.

Consider the value, in marginal product terms, per dollar of input: \( \frac{MP_L}{P_L} = \frac{6}{32} = \frac{3}{16} = 0.1875 \), and \( \frac{MP_K}{P_K} = \frac{4}{20} = \frac{1}{5} = 0.2 \). Tellers are more productive than ATMs, but their greater cost means that the bank would be best off using only ATMs.

4. Returns to Scale

Should the newly signed Trans-Pacific Partnership should be more beneficial to firms with increasing returns to scale or constant returns to scale? Explain your answer succinctly.

If TPP increases the size of the market for firms, those firms with increasing returns to scale should be the most likely to benefit. They can leverage their same fixed costs over a larger output. Firms with constant returns to scale will be no more profitable in a larger market, all else equal.