Potash demand to rise, after long-term application shortfall
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A long-term shortfall in potash application has depleted soil nutrient levels in key markets, and will boost future demand for the nutrient, PotashCorp said. The Canadian potash giant forecast demand for the plant nutrient to grow by 3.0% a year over the medium-term.

And the longstanding application deficit in North America could lead to a doubling in potash demand, in the region. Fertilizer consumption has remained stable in the region for the past two decades, but PotashCorp says a trend toward higher crop removal rates is depleting the soil of potash. "We believe this application deficit is not sustainable and if not addressed could jeopardize the soil's long-term productivity," PotashCorp said. Since 2010, the rate of potash depletion in the US has exceeded application by more than 7m short tonnes a year, PotashCorp estimates. "Closing this gap would require farmers to nearly double application rates compared to current levels," the company said.

You would like to analyze how the change to potash market is going to affect the fertilizer's prices and quantities consumed. Suppose that you know that potash demand and supply functions are characterized as:

\[ Q_K^D = 1775 - 0.625P_k - 2.5P_N - 2P_P \]
\[ Q_K^S = 400 + 1.75P_k - 2.5P_L \]

where \( P_k = 200 \) is the price of potash (K), \( P_N = 300 \) is the price of nitrogen (N), \( P_P = 200 \) is the price of phosphate (P), and \( P_L = 100 \) is the price of labor.

You also know that in crop production, fertilizers are consumed in tandem. So, you expect that if the demand for potash, it will impact the nitrogen fertilizer market. This market is characterized as:

\[ Q_N^D = 2001 - 0.67P_N - 4P_K - 2.5P_P \]
\[ Q_N^S = 699 + 2.67P_N - 20P_{NG} \]

where \( P_{NG} = 50 \) is the price of natural gas.

Find the percentage change in the prices of potash and nitrogen and the percentage change in the quantities of potash and nitrogen as a result of the expected shock to the potash market.

\[ \%\Delta P_K = -12.12\%, \%\Delta P_N = 9.67, \%\Delta Q_K = -8.48, \%\Delta Q_N = 15.15\% \]
Railroad service to grain shippers, which has deteriorated in the 2014 fall and winter for several rail carriers, is expected to recover by late summer or fall, but could continue into 2015. Problems associated with deteriorated rail service include grain shippers paying up to $6,000 to obtain empty railcars, grain piling up on the ground outside elevators awaiting rail transportation, and some grain shippers either paying ocean vessel demurrage charges, or missing vessels that departed before the delayed grain shipments could be loaded. BNSF states that poor service has resulted from a simultaneous combination of strained capacity and increased demand for rail service.

On the supply side, current capacity has been reduced by track work to expand future capacity, which involves shutting down lanes at least 10--12 hours daily while the work is being done. In addition, the extreme winter has compounded and made the backlog situation even worse. When temperatures are below --15 degrees Fahrenheit, trains cannot be as long because the cold diminishes the effectiveness of air brakes. This means that railroads require more crew and locomotives to move the same amount of traffic.

You know that the demand for rail services is characterized by the function:

\[ Q^D_R = -2000 - 0.5P_R + 100P_T + 50Q_W \]

where \( P_R = 4000 \) is the price of a railcar, \( P_T = 4 \) is the price of trucking services per mile, and \( Q_W = 200 \) is the supply of wheat in the million bushels. The total inverse supply of rail services is characterized by the function:

\[ P^S_R = -33800 + 4Q^S_R + 800P_{op} + 40P_D \]

where \( P_{op} = 15 \) is the price per hour for a train operator and \( P_D = 5 \) is the price of diesel fuel per gallon.

You also know that elevators can substitute away from rail services if the price of rail cars becomes very high. Instead, they can use trucking services to deliver their grain. The market conditions for trucking services is characterized by the functions:

\[ Q^D_T = 3900 - 25P_T + 0.25P_R - 0.25Q_W - 5Q_c \]
\[ Q^S_T = 4950 + 50P_T - 100P_{TD} - 50P_D \]

where \( Q_c = 170 \) is the quantity produced of cattle (in million head) and \( P_{TD} = 10 \) is the wage per hour for a truck driver.

Find the percentage change in the prices of rail and trucking services and the percentage change in the quantities of rail and trucking as a result of a 4% supply decrease and 2% demand increase of rail services.

\[ \%\Delta P_R = 23.04\%, \%\Delta P_T = 76.80\%, \%\Delta Q_R = -0.40\%, \%\Delta Q_T = 3.94\% \]