

Project L12

Summary

Banana distribution

Purpose

The overall purpose of this project is to determine suitable prices to pay to producers for bananas, by Grade, and to calculate different measures of profit arising to the wholesaler (BDS) from the distribution of these bananas.

The gradual deterioration in quality of consignments of bananas is projected, these bananas being “downgraded” daily in accordance with a set of given transition rates.

The deterioration projections are first done for the phase of transportation “from Producers to Depot”, and then for the phase of transportation “from Depot to Retailers”.

The prices that can be paid to the producers per banana are then determined, based on the calculated expenses, income received from retailers and the required profit criteria. The internal rate of return of the overall transaction is also determined.

Alternative scenarios (a “banana blight” shock incident impacting both banana volumes and transition rates, and a decision not to transport Grade C bananas) are assessed.

Data

The following key data have been provided:

- Numbers of bananas due to be collected from each of the two producers.
- Daily transition rates between the different Grades (A, B, C and F (rotten)) of banana.
- Expenses incurred in transportation and sorting.
- Prices paid per banana (by Grade) on delivery to the retailers.
- The distributor’s profit criteria.

Assumptions

- The transition rates provided are independent.
- Future inflation can be ignored, since it has been very low recently in Actuaria and the time period considered is relatively short.
- The ratio of prices by Grade of banana paid to the producers should be the same as the ratio of prices by Grade paid by the retailers.

- The number of bananas collected will be exactly as agreed with the two producers.
- The bananas do not hang around in the Depot but are shipped immediately after arriving and sorting, i.e. there is no additional deterioration during that time.
- Grade F (rotten) bananas are identified during the sorting and are not included in the shipment to Cohortico.
- The banana blight impacts all Grades of banana and all transition rates equally, and in the same way for both plantations.
- The transportation expenses are incurred continuously through the periods for which they are incurred, which can be approximated using the mid-point of that period.
- Payment is made to the producers when the bananas are collected, and payment is received from the retailers as soon as the bananas are delivered to them.
- The given profit criterion is the value as at the start of the process, i.e. $t = 0$, the time at which bananas are collected from Producer X.
- Tax can be ignored.
- There are no other costs or expenses other than those listed.
- All data provided are accurate.

Approach

Projections of Numbers of Bananas

The number of bananas, split by Grade, is projected from the time of collection from each producer until reaching the Depot, and then again from the point of shipping from the Depot until reaching the retailers in Cohortico.

During these two transportation phases, the quality of bananas deteriorates according to the matrix of transition rates provided. These daily transition rates are applied to the number of bananas of each Grade the previous day, using formulae such as:

Grade B bananas day x = Grade B bananas day $x - 1$ multiplied by Transition rate B to B *plus*
Grade A bananas day $x - 1$ multiplied by Transition rate A to B

(where Transition rate B to B = $1 - \text{sum of Transition rates from B to all other lower Grades, i.e. to C and F}$). Each Grade of banana is projected forwards in this way.

Pricing Calculations

The above projections are then used to determine the costs of transporting the bananas and the income received from the retailers.

The costs of transportation are calculated separately for each journey (Producer X to Depot, Producer Y to Depot, Depot to Retailers).

The number of boxes required is first determined by dividing the total number of bananas to be shipped by the number of bananas permitted per box, then this figure is rounded up to the nearest integer. Total cost is then: No. of days in transit \times Daily cost where Daily cost = daily fixed cost + daily cost per box \times number of boxes used. The income received from the retailers is determined by multiplying the known per banana prices (by Grade) by the number of bananas of that Grade that are projected to reach the retailers.

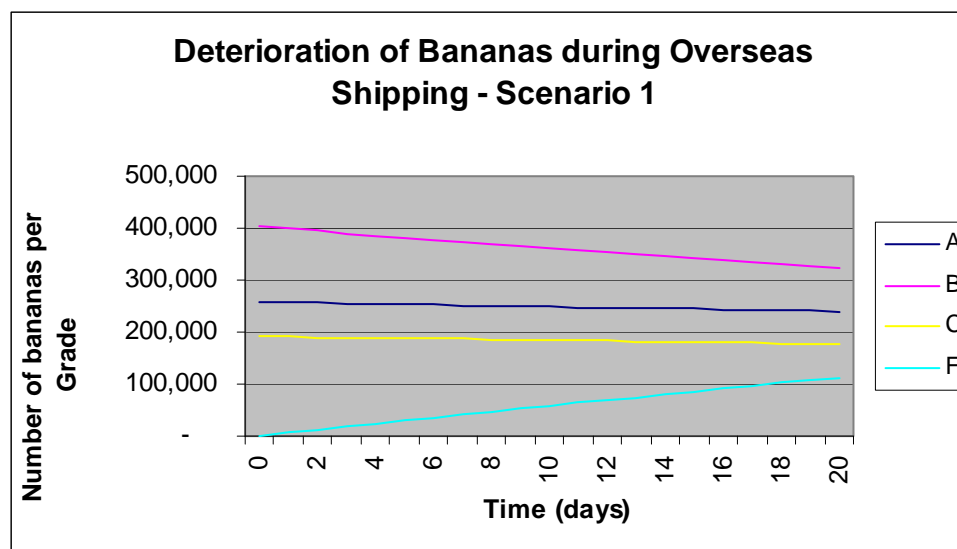
Assumptions are made regarding the timing of each of the expense and income cashflows, and these are then discounted at the given discount rate of 15% per annum (first converted to a daily rate) to the start of the distribution process.

The prices payable to the producers for each banana collected is then varied, assuming that the Grade A, B and C banana prices have the same ratios to each other as do the prices paid by the retailers. The required prices are those that result in the net present value of all income (payments from the retailers) less all outgo (expenses plus payments to the producers) being equal to the required profit criterion. Finally, the internal rate of return (IRR) is determined as the discount rate which results in an overall net present value of profit of zero.

Scenario 2

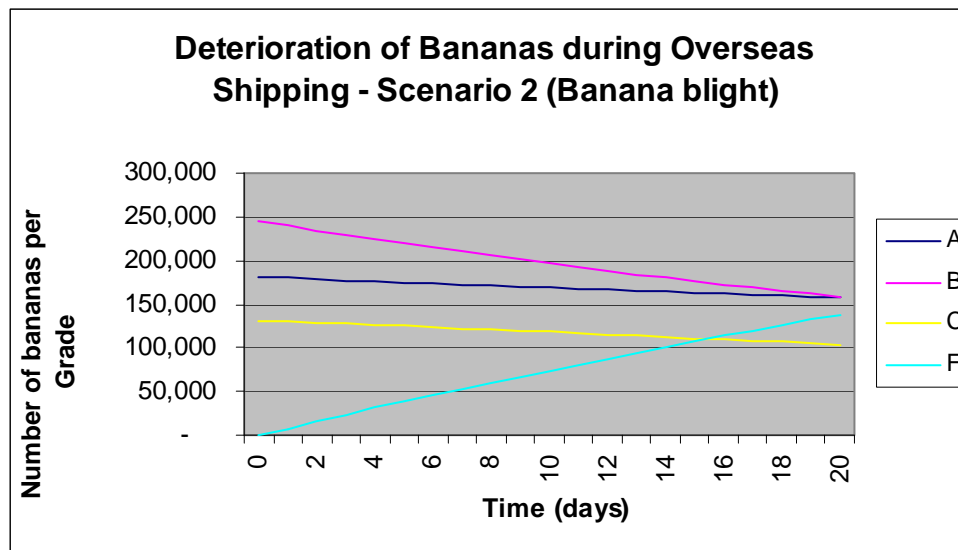
The projection of banana numbers is repeated, but assuming a “banana blight” scenario, which results in 25% of all initial volume being lost (thus reducing the initial collected numbers to 75% of the Scenario 1 volumes). Furthermore, transition rates (i.e. the rates of banana deterioration) are all doubled. The overall profit and IRR are also recalculated, assuming that the prices payable to the producers are unchanged from Scenario 1.

Results from banana projections



Comments:

- The number of Grade A bananas reduces day on day, as this Grade has only decrements and no increments.
- Grades B and C also decline day on day: there are now increments (from higher Grades that have deteriorated) as well as decrements, but the total rate of decrement is higher than the total rate of increment (as can be seen from the transition rates provided).
- The Grade F (rotten) bananas increase over time, as once a banana is rotten it stays rotten, and other rotten bananas join this Grade every day.



Comments:

- The doubling of the transition rates has resulted in acceleration in the declines in Grades A, B and C numbers, which is as would be expected given that these Grades all have a net outflow.
- The increase in Grade F (rotten) bananas is also correspondingly much faster.

Results from pricing calculations

In order to meet the profit criteria under Scenario 1 and to keep the ratio of banana prices per Grade the same as per the retailer, the amounts that should be paid to the producers per banana are:

Grade	Price (\$)
A	0.129
B	0.078
C	0.026

Using these prices, the expected net present value of profit under Scenario 1 is \$10,000 (the required profit criterion) and the IRR is 0.196% per day (104% p.a.).

Under Scenario 2 this reduces to a loss of \$48,852 and an IRR of -1.145% per day (-98.5% p.a.).

The lower volume of bananas collected under Scenario 2 increases the burden of the fixed costs. The higher rates of deterioration (“transition”) have a significant negative impact on the overall quality after transportation, and hence on the amount of income received from the retailers. Overall, the banana blight scenario therefore has a significant adverse effect.

Scenario 3

The Scenario 1 projections were repeated, but assuming that the Grade C bananas were not collected from the producers and no Grade C bananas were shipped from the Depot. The banana blight rumour was ignored.

Under Scenario 3 the profit increases to \$17,485 and the IRR to 0.338% per day (242.1% pa).

This additional profit relative to Scenario 1 is due to the fairly high proportion of Grade C bananas expected to become rotten during the 45 day total transportation period. The Grade C bananas deteriorate quickly (2% per day) and the cost of transporting them exceeds the benefit obtained from the sales of the (low) proportion that has not gone rotten.

Potential next steps

- Validate all other information provided, such as the expected transition rates – are there any other sources or studies against which this could be checked?
- Check the validity of the banana blight rumour and the accuracy of the predictions of its impact.
- Verify all own assumptions made, e.g. the timing of transport expense payments, there being no delay at the Depot, and whether the banana blight would impact all grades of banana equally and the two producers equally.
- Perform sensitivity tests on key parameters, e.g. the discount rate, expenses, transition rates.
- Investigate other pricing structures, e.g. whether could pay more per banana to Producer Y to reflect the lower total transportation costs.
- Suggest that the price per banana paid to the Producer could be lowered if the banana blight rumours proves to be true, to reflect their lower inherent quality.
- Suggest that BDS might prefer a profit target which is a % of sales rather than a fixed amount.
- Test the two suggestions in Scenario 3 (not collecting Grade C bananas and not shipping Grade C bananas overseas) separately to check whether they both increase profits.
- Investigate the potential outcome if Scenario 3 is combined with Scenario 2.

- Investigate whether the rotten (Grade F) bananas could be sold, e.g. for animal feed, and include this additional income in the model.
- Investigate whether the proposed prices are acceptable to the two producers.
- Investigate whether there are any other potential retailers who might pay higher prices, or producers who might accept lower prices or who are closer to the Depot.
- Investigate whether there are any other (cheaper) transportation options for any of the journeys and model these.
- Investigate whether the journeys to the producers could be combined to achieve a lower overall transportation cost.
- Consider whether past experience of low inflation is expected to continue and, if not, incorporate inflation into the model.

Investigate methods that could be used to slow down banana deterioration, e.g. methods of packaging or refrigeration, and model the impact of these.

END