

# CA2 Paper 1 Specimen Paper – Audit trail

## Objective

The purpose of the spreadsheet is to complete the following calculations:

- Project forwards future sales numbers of music singles and albums (to the year 2021), each separately in physical and digital format, based on historic sales data and using three different projection approaches.
- Use these to project forwards also the expected annual sales revenues from each format, using given price information.
- Hence estimate the year in which *annual* sales revenue from digital sales is expected to exceed that from physical sales.
- Analyse the effect on all projections of adjusting for one particularly high selling album in the most recent data year.

*NB: Input cells are shown in blue*

## Historic data

This worksheet includes the raw data provided, which comprises numbers of sales of each of the four music formats (physical singles, physical albums, digital singles, digital albums) from 2007 to 2012 inclusive. This was provided by the Actuarial Recorded Music Industry.

*A quick check by eye suggests that there are no data items missing or materially mis-stated.*

## Assumptions

- The historic sales data provided is correct.
- Historic observed trends in music sales over the period 2007 to 2012 will continue into the future.
- Sales of the Yodelle album were split between physical and digital in the same proportions as all other albums sold in 2012.
- Sales of the Yodelle album occurred uniformly over the twelve months.
- There are no distortions in the historic data other than as described for the Yodelle album.
- No other such material distortions to sales will occur in the future projection period.
- No other musical formats will be introduced in the future projection period.

- Other musical formats (box sets, mini-discs, cassettes, data stick, streaming services, ringtones etc.) are either included in the given data figures or are immaterial and therefore can be ignored.
- There are no other impacts on prices over the projection period, i.e. there is a stable economic situation and underlying inflation remains broadly zero.

## Projected sales numbers

**In this worksheet the historic data is projected forwards to year 2021 using the three different suggested approaches.**

Each of the following tables can be found by scrolling down through the worksheet:

**Table 1:** The historic data is referenced from the previous worksheet. Let  $n_i$  denote the number of sales of a particular format in year  $i$  ( $i = 2007$  to  $2102$ ), as shown in this table.

A chart of this data has been produced to the right of this table (one line for each of the four music formats).

*The line chart confirms that the data seems reasonably complete and valid, with each of the lines being fairly smooth.*

**Table 2:** This table determines  $x_i$  = the % change (year on year) of sales numbers, for  $i = 2008$  to  $2012$ , for each of the four formats.

Each  $x_i$  is calculated as  $\{n_i / n_{i-1}\} - 1$  (from the previous table).

In column J, the mean of all  $x_i$  (from  $i = 2008$  to  $2012$ ) is calculated for each of the four formats in turn, using the function AVERAGE. Let these means be denoted as  $X$  in this audit trail.

An auto-check is included in column K: this checks that a negative average % change corresponds to an overall reduction in sales over the historic period, and a positive mean to an overall increase.

**Table 3:** This table determines  $y_i$  = the ratio of year on year % changes, for  $i = 2009$  to  $2012$ , for each of the four formats.

Each  $y_i$  is calculated as  $x_i / x_{i-1}$  (from the previous table).

In column J, the mean of all  $y_i$  (from  $i = 2009$  to  $2012$ ) is calculated for each of the four formats in turn, using the function AVERAGE. Let these means be denoted  $Y$  in this audit trail.

**Table 4:** This table contains the projection factors required for each of the three proposed approaches, and for each of the four formats. These factors are referenced from Tables 2 and 3 as follows:

For Approach 1, the factor is  $x_{2012}$  (from Table 2).

For Approach 2, the factor is  $X$  (from Table 2).

For Approach 3, the factor is  $Y$  (from Table 3).

**Table 5:** This table contains the historic sales data (as per Table 1) and projects it forwards for each of the four formats, using **Approach 1** i.e. the future year on year % change is constant and at the same level as it was from 2011 to 2012.

This is done by calculating  $n_i = n_{i-1} * (1 + x_{2012})$  for  $i = 2013$  to 2021.

In other words, the number of sales projected in a particular year is calculated as the number of sales in the previous year (previous column), multiplied by  $\{1 + \text{Approach 1 factor from Table 4}\}$ .

**Table 6:** This table contains the historic sales data (as per Table 1) and projects it forwards for each of the four formats, using **Approach 2** i.e. the future year on year % change is constant and at the same level as the mean of the % changes over the historic period.

This is done by calculating  $n_i = n_{i-1} * (1 + X)$  for  $i = 2013$  to 2021.

In other words, the number of sales projected in a particular year is calculated as the number of sales in the previous year (previous column), multiplied by  $\{1 + \text{Approach 2 factor from Table 4}\}$ .

**Table 7:** This table contains the historic sales data (as per Table 1) and projects it forwards for each of the four formats, using **Approach 3** i.e. the future year on year % change varies, in line with patterns in the historic % changes.

This is done by calculating  $n_i = n_{i-1} * (1 + x_{2012} * Y^N)$  where  $N = i - 2012$ , for  $i = 2013$  to 2021.

In other words, the number of sales projected in a particular year is calculated as the number of sales in the previous year (previous column), multiplied by  $(1 + \text{Approach 1 factor from Table 4 multiplied by } \{\text{Approach 3 factor from Table 4, to the power of } N\})$ .

**Table 8:** This table collects the chosen projections from the above tables. It is therefore the same as Table 7 (Approach 3) except for physical albums, for which the projections are referenced from Table 5 (Approach 1).

Column S includes an auto-check that all projected sales numbers are positive for each of the approaches (Tables 5 to 8). *It shows a problem with physical albums for Approach 3, which helps to support the decision not to use this approach for that format.*

## Approach 3 further check

Below Table 8 (row 69) can be found auto-checks that Approach 3 has been calculated correctly. The first and second order % changes are determined and there is an auto-check in column R which validates that the second order changes are constant (by checking that each of these changes is equal to the mean change across that format).

## Projected sales charts

**In this worksheet three line charts are drawn showing the historic and projected sales numbers under the four formats, with one chart for each of the three projection approaches used.**

The data used for the charts are as per Tables 5, 6 and 7 respectively of the previous worksheet.

*The future projections are all reasonably smooth, which helps to validate the underlying projections.*

*Approach 1 illustrates projection trends which (as expected) are most consistent with those in the final historic year, e.g. digital sales continuing to increase at a fairly steady rate.*

*Approach 2 illustrates more extreme projections, particularly for digital sales, which increase materially in future years. This is consistent with the fact that the approach taken uses historic average increase factors rather than the most recent, and that increases in digital sales have been slowing down over recent years (so historic average increase is higher than most recent increase).*

*Approach 3 illustrates projections which level out more quickly, which is consistent with the use of second order differences. The deceleration of increases in digital sales is projected to continue, and hence these sales start to level out more.*

*The charts therefore suggest at a high level that the projection calculations have been performed correctly.*

## Adjusted sales projections

**This worksheet repeats the sales number projections, but including an adjustment to allow for the potential distortion of high sales of the Yodelle album, by reversing these sales out of the 2012 historic data.**

It is a copy of the worksheet “Projected sales numbers” with the following changes:

Total number of Yodelle album sales in first twelve months is input to cell C3.

In cells C4 and C5 the percentages of total album sales which are physical and digital respectively are calculated from the table in “Projected sales numbers” for the year 2012 (e.g. physical % = physical number / {physical number plus digital number}).

The estimated proportion of total Yodelle album sales occurring in 2012 is input to cell C7 (*input as 10/12, assuming sales are uniformly spread over the year and given that it was issued at the start of March*).

In cells C8 and C9 the physical and digital Yodelle album sales occurring in 2012 are calculated as total Yodelle album sales  $\times$  proportion occurring in 2012  $\times$  physical/digital proportion respectively.

Table 1 is now the “Adjusted numbers of sales”, with the Yodelle physical and digital album sales (from cells C8 and C9) being deducted from the relevant physical and digital album figures in year 2012 only.

All other Tables, projection calculations and checks are as for worksheet “Projected sales numbers”.

In cell L29 a further calculation has been inserted: the differences between the sets of  $Y$  with and without the Yodelle data adjustments have been determined. An auto-check has been included to check that the figures for physical and digital *singles* are unaffected.

An additional auto-check has been included in cell L41, which checks that the total number of projected *singles* (physical plus digital) remains unaffected by the Yodelle adjustment (i.e. the same projected total as for the unadjusted version).

## Projected sales \$m

**This worksheet projects the expected annual sales revenue from 2012 to 2021, and estimates the year at which digital sales are expected to exceed physical.**

In the top left hand corner of this worksheet, 2007 and 2012 prices for each of the four music formats are input.

The average annual growth rate ( $g$ ) for each of the four formats is then calculated (column E) as:  $(\text{Price in 2012} / \text{Price in 2007})^{1 / (2012 - 2007)} - 1$

In rows 13 to 16, the projected price for each of the four music items is calculated as the price in 2012 multiplied by  $(1 + g)^{(N - 2012)}$  where  $N$  is the projection year (from 2013 to 2021).

In rows 21 to 24, these prices are multiplied by the numbers of items sold (referenced from Table 8 of the “Projected sales numbers” worksheet) for each of the four formats and for each of the years 2012 to 2021. This determines the projected annual sales revenues for each format.

Total revenues in each year for physical and digital are then determined (i.e. albums plus singles), and in row 29 the % digital (digital / total digital plus physical) is then calculated for each projection year to 2021. Denote this % as  $d_i$  for year  $i$ .

The target minimum digital proportion is input to cell N4 (coloured blue). Denote this % as  $t$ . *For digital sales to exceed physical sales, input  $t = 50\%$ .*

Row 30 contains a Y/N indicator (using IF statements, comparing the value of each  $d_i$  with  $t$ ), working on an annual revenue basis:

- $N$  means that the target digital proportion has not yet been reached at the end of that year ( $d_i < t$ ).
- $Y$  means that the target digital proportion has just been reached (and exceeded) at the end of that year ( $d_i > t$  and  $d_{i-1} < t$ ).
- A blank cell means that the target digital proportion has already been reached at a prior year ( $d_i > t$  and  $d_{i-1} > t$ ).

The year in which annual digital sales are expected to have exceeded the minimum target percentage  $t$  must then equal  $i$ . This is captured in cell L7 (using HLOOKUP to identify the year corresponding to the only column in which “Y” appears in row 30).

Rows 34 to 47 contain exactly the same calculations as above, but using the sales figures after adjustment for the Yodelle album (i.e. now taken from worksheet “Adjusted sales projections”). An auto-check has been added in cell Q39 which checks that the total revenues arising from sales of singles is the same as in the above tables, i.e. unaffected by the Yodelle adjustment.

The relevant year for the adjusted data are determined in cell L8.

### ***Reasonableness checks***

The results show the estimated revenue “crossover” points being in the years 2015/16. This is consistent with the charts of projected sales numbers, which show the digital and physical album lines crossing at around that point (i.e. digital numbers sold being higher) for the chosen Approaches 1 and 3. Since sales revenue is dominated by albums (higher price per unit) this is consistent with the results obtained here, thus demonstrating the reasonableness of the calculation approach.

After the Yodelle album adjustment, digital sales are expected to exceed physical sales earlier than for the unadjusted data. This makes sense because:

- Albums have a higher weighting towards physical rather than digital; singles are almost entirely digital.
- Reducing the total number of albums in the projections will therefore have a relatively greater reducing impact on revenues from physical than on revenues from digital.
- Hence digital revenues are more likely to exceed physical earlier than otherwise.

## **Sales revenue charts**

**This worksheet summarises the annual sales revenue results from the previous two worksheets and produces related graphs:**

- Projected total physical sales revenue (albums plus singles) and total digital sales revenue (albums plus singles) in each year to 2021, with no adjustment for the Yodelle album. This is presented as a stacked bar chart, so also shows total sales revenue across all formats.
- Projected total overall sales revenue (added across all formats) in each year to 2021, without and with adjustment for the Yodelle album. This is presented as a side by side bar chart.

### ***Further reasonableness checks***

- Projected total annual sales revenue from physical formats is shown as reducing materially over time, which is reasonable due to both falling numbers of sales and reducing prices. Sales revenue from digital formats is broadly unchanged from year to year (a slight rise followed by a slight fall), which reflects the combined impact of increasing numbers of sales but reducing prices.
- Projected overall total annual sales revenue falls over time, which is consistent with the total of the above effects. As well as the contribution from falling prices, this pattern is also consistent with the gradual shift from physical to digital formats within the future projections, digital having lower prices (and thus revenue) per unit.
- Projected total annual sales revenue with the Yodelle adjustment is lower in all future years than without the adjustment, which is reasonable given that the adjustment removes material numbers of album sales from the data and hence from the future projections (i.e. it assumes such significant album releases do not reoccur in future years). However, the pattern of run-off is broadly unchanged – which is also reasonable as the historic trends continue to be projected forwards, just at a lower level.