Is This Spreadsheet a Tax Evader ?
How H. M. Customs & Excise Test Spreadsheet Applications

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Abstract

Spreadsheet models are commonly used by UK Taxpayers to calculate their liabilities. The risks of error from spreadsheets have been exhaustively documented, and applications in this domain are no less at risk of error than those in any other.

Officers of H. M. Customs and Excise in the United Kingdom have been performing field audits of taxpayers' spreadsheet applications since 1985. Building on the experience gained, H. M. Customs and Excise computer auditors have developed a testing methodology and supporting audit support software for use by generalist tax inspectors.

This paper briefly summarises the audit experience, describes the methodology and outlines the results to date of a campaign of spreadsheet testing started in July of 1999.

Key Words : Spreadsheets, Auditing, End-Users, Testing, Errors

1. Introduction

H M Customs & Excise administers and collects a number of indirect taxes (including Value Added Tax) and customs duties in the United Kingdom, all of which are self-assessed by the taxpayers.

The Department's staff of visiting inspectors have varying degrees of IS Audit training and skills. Staff with awareness training are supported by a network of officers with a degree of special training, who are in turn supported by full – time computer auditors.

Officers have legal powers to check the operation of taxpayers' computer systems, and to examine and take copies of their tax records and documents, including computer data files.

Many taxpayers use spreadsheet applications to calculate all or part of their liability.

Customs and Excise computer auditors became concerned about the risks of error from spreadsheet applications almost as soon as their use became widespread, after a number of taxpayers were found to have made elementary mistakes, leading to substantial errors in their tax returns.

Material quantitative errors have been found in 10% of taxpayers' spreadsheets tested, and as a result the department's computer auditors have developed

- **a methodology for risk assessment and testing**
- **computer-assisted audit software to assist testing of spreadsheet applications**

for use by all staff.

2. Objectives of Spreadsheet Testing by Customs & Excise

The objectives of spreadsheet testing by Customs & Excise officers are to

- **Confirm the accuracy of tax returns and calculations made using spreadsheet applications**
- **Identify and quantify material errors in tax returns resulting from errors in the spreadsheets used**

This is a restricted set of objectives – Officers are interested in material quantitative error, i.e. those which :

- **Result in an incorrect amount of tax being paid and**
- **The amount of the error is sufficient to trigger recovery procedures**

Qualitative errors, or small quantitative errors will be ignored.

Officers have to seek both mechanical errors in the spreadsheets tested, and domain errors in the particular taxation regime / area being handled.

3. Development of Spreadsheet testing by Customs & Excise

1.1 1988 - 1992

From 1988 until 1992, all staff trained in computer audit were taught to appreciate the risks of error in spreadsheets, but testing was performed only by the full-time computer auditors. During 1992 a large number of officers were trained in the use of *Spreadsheet Auditor* to

test spreadsheet models. The management information systems in use did not allow full details of all tests to be gathered for study, so only a partial record of the results is available. This record (see table 1) shows that just over 10% of the spreadsheets tested contained material errors.

3.1. Results of the 1992 Tests

Of the **recorded** tests, the results are summarised as follows :

Table 1 : Recorded Results of 1992 Spreadsheet Tests

Spreadsheets Tested	131	
Tax Handled	Total : £36,274,870,454	Average £276,899,774
Containing material Errors	14	10.7%
Value of Errors	Total £2,752,439	Average £196,603
Error as % of Value	0.076%	

While the incidence of error is large, it is lower than that found in other studies. This is not surprising when we consider anecdotal evidence reported by auditors, which indicates that:

- **The Domain expertise of the creators of the spreadsheets, (mainly taxation experts employed by the taxpayers concerned) is relatively high.**
- **The majority of the applications were relatively simple in terms of the arithmetic and spreadsheet functions employed.**

The experience of officers testing spreadsheets during the campaign indicated that :

- **less than 2% of the applications tested were documented at all,**
- **the documentation found was less than adequate,**
- **there was little or no evidence that any of the applications had been tested by the developers until officers started to test them (although Marcella (1988) had described a testing regime for developers and auditors),**
- **little or no attempt had been made to follow any structured design methodology (at least one such methodology had been described by Nevinson in 1987),**
- **the impact of the errors appears small in overall money terms (less than 1% of the tax handled by the spreadsheets tested). However, the total tax handled was distorted by a small number of very high-value applications (Oil refineries and Tobacco producers pay extremely large amounts of tax and duty). The financial and regulatory impact of an error of almost UK£200,000 on an individual taxpayer company can be serious.**

1.2 1992-99

During this period, officers continued to test where they could with *Spreadsheet Auditor*, but the value of the tool was reducing all the time as the .WK1 spreadsheet format became obsolete with the introduction of 3-D spreadsheets and the Windows platform.

No commercial spreadsheet testing software fully met the needs of the department's staff.

In 1998 H M Customs staff set out to develop their own software to support the testing methodology. The SpACE (Spreadsheet Auditing by Customs & Excise) software facilitates testing of spreadsheet applications in any file format which can be read by Excel 5.x, '95 and ’97. It was released to Customs & Excise personnel in July 1999.

1.3 1999

Around 300 officers are being trained to use the methodology described below, and the supporting software in the period August 1999 to April 2000 and are creating a data base of information on the tests made. A summary of the information gathered to date is given below.

4. Testing Methodology

4.1. Purpose and Scope

This testing methodology used is intended to allow staff with a relatively low level of spreadsheet knowledge, working alone or as part of a team and with limited time at their disposal to:

- **identify the highest risk elements of a spreadsheet application,**
- **establish whether the risks identified have led to material, quantitative errors, and then**
- **assess the impact of those errors on the results of the application.**

The methodology is equally applicable to single – sheet calculations, multi - sheet files, or complex multi-file suites of spreadsheets. In cases of extreme complexity, full “Traditional” systems analysis & documentation is recommended in addition to spreadsheet testing.

The terminology used reflects the fact that Microsoft Excel is the standard spreadsheet program in use in the department.

It should be remembered that efficient and effective testing along the lines of the methodology described hereunder requires the use of some form of Computer-Assisted Audit Tool.

The testing methodology breaks down into 3 stages,

- **Overall Risk Assessment,**
- **Risk Identification / Test Planning, and**
- **Detail Testing**

4.2. Overall Risk Assessment

H. M. Customs and Excise's overall testing strategy is governed by the need to deploy resources to address

quantified risks. The auditor must therefore determine the impact and possible incidence of risks before setting out on a testing programme.

4.2.1. Impact of Errors

The auditor determines the amount of revenue handled by / at risk from the application

- **In the current instance**
- **Annually, if the current instance is a template for future re-use**

The use of an application as a template for regular use will multiply both the revenue handled and the impact of any errors.

At this point the auditor can decide whether the amount of revenue at risk from the application justifies the work required to ascertain the likely incidence of errors.

4.2.2. Likely Incidence of Errors

To inform a judgement of the likely incidence of errors in an application, the auditor must consider the answers to the following questions :

Domain Questions

How complex are the business or revenue issues that the model purports to address? Is there evidence that the developer of the spreadsheet has an adequate understanding of those issues?

Testing Questions

What evidence is there that the application was thoroughly tested before being brought into use? And thoroughly tested again each time a material change was made?

Documentation Questions

Has the developer documented the application adequately? Good documentation should make clear statements of :

- **the application's purpose, what it does and how it does it,**
- **any assumptions made in its design,**
- **what standing data constants (e.g. tax, duty and exchange rates) are used and where they are held,**
- **who developed it and when, and**
- **when and how it has been changed since being brought into use.**

Clear instructions for use should also be present.

Questions about the complexity of the application

How complicated is the application ? Can it be checked manually ? – if it is small and simple, manual checking of the arithmetic and base figures could be all that is required.

Again, the answers to these questions inform the auditor's decision whether or not it is worth proceeding to the next stage.

4.3. Risk Identification & Test Planning

Given that testing can be justified, the auditor now needs to establish the size and complexity of the application (to help plan the time needed to test it), and which parts of it pose the highest risk (to help direct the tests to those risk areas).

4.3.1. Size of the task

Auditors are tasked with finding out how many files are involved in the application.

For each file, the test support software reports how many worksheets are present and how many links to other files are used. This gives an idea of the boundaries of the testing.

Further details are then obtained for each worksheet - how many formulas are found, how many Numbers are manipulated, how many labels are found and how many links to other worksheets exists. Again, this information is provided automatically, and informs time management (how much time is this likely to take ?) and resource to risk (does the money at risk justify spending that time ?) decisions.

4.3.2. How complex is the task ?

This gives a further indication of the time that has to be expended on testing. The software tells the auditor (or helps him find out) how many

- **external references,**
- **unique formulas (i.e. those which are not replicated in a worksheet), and**
- **original Formulas (i.e. those which are copied within a worksheet)**

are present in each file.

The auditor has to consider how complex the revenue / business issues the application addresses are, and how complex its structure and logic are. Drawing a map or flowchart of the application at this point can help comprehension of the structure and interaction of its components.

The degree to which similar worksheets are used within a file or across a series of (ostensibly) identical files is also a factor. Automated comparison of worksheets will quickly identify any significant differences between the formulas & structure of a known and tested original worksheet and those of copies - This can significantly reduce the amount of substantive testing that has to be performed.

4.3.3. Identification of Set-up Risks

Identification of the use of high-risk functions or features, and an assessment of the use of security features and the way the application is set up helps the auditor to judge the amount of risk and the amount of work needed to test the application.

The software reports on:

- **The recalculation settings of each file (Manual or automatic? If manual, is it set to recalculation before save set ? How are iteration & calculation rules set ?**
- **The use of macros (Whether macros are present in the file, and indications of any traces of their use that may be present - With modern spreadsheets, macros are often an attribute of the user's individual set-up rather**

than the spreadsheet file itself) and user-defined functions,

- **Hidden Rows, Columns or sheets in the file,**
- **The use of protection against unauthorised changes,**
- **The use of consolidation,**
- **The use of range names in formulas, and of named variables, and**
- **The use of techniques that are inappropriate to financial accounting (as opposed to business planning), such as Scenarios, Goal Seeking, Solver, Pivot Tables, Report or View Manager and equivalent features.**

4.3.4. Identification of the riskiest / most important formulas

The software identifies any failed formulas, formulas returning error messages and unlocked formulas, all of which may have an actual or potential impact on the results of the application, and helps the auditor identify user-defined functions.

It identifies original and unique formulas, and helps the auditor make visual checks for illogical breaks in the pattern of numbers and copied formulas in each worksheet.

4.4. Detail Testing

At this stage, the auditor will know whether the scale and incidence of risk from the application justifies further work, and will know which areas of the application require detailed scrutiny.

4.4.1. Testing the Set-Up

The auditor determines the impact of recalculation settings, and calculation rules, by making any necessary changes on a copy of the worksheet and recalculating.

The impact of any use of alternative scenarios, report manager and goal-seeking are assessed.

Base numbers are checked to ensure they match source documents or other data.

4.4.2. Testing the Logic of the application

The auditor identifies the path from raw input number(s) to the end result - the software follows the chain(s) of dependent cells from number to result so that key formulas can be identified and tested. (S)he assesses whether the path from raw number to “bottom line” is logical, and whether the formulas on that path are arithmetically & logically correct. This process identifies the basic rules of the application, and allows the correctness of the design to be determined relatively quickly.

To back this judgement up, the auditor also checks the original formulas (i.e. those which are copied around the worksheet) which affect the result. (S)he determines whether they are arithmetically and logically correct, and (again with the assistance of the software) checks that the clones of those formulas are used appropriately.

Some authorities question the effectiveness of this approach, contending that a 100% code check of all formulas is required.

Providing that the auditor is able to confirm that copied formulas are being used in a "fit for purpose" manner (for example a SUM formula totalling a column of 10 figures is not erroneously copied to the foot of a column of 12 figures, or a formula to calculate tax to be added to a net figure is not copied to a place where a calculation of tax already included in a gross figure is required). This approach has been found in practice to make considerable savings in time at minimal risk of undiscovered error.

4.4.3. High Risk Cells

Even if they appear arithmetically and logically correct, further checks are made on formulas that

- **look up named ranges, e.g. standing data,**
- **contain constants (e.g. net * 17.5% instead of net * a named variable or range “VAT rate”),**
- **contain absolute references (which will not automatically respond to changes to the sheet),**
- **reference a block of cells (e.g. SUM A1:B7 may indicate errors in input of the formula),**
- **have no precedents (e.g. additions of numbers within a cell, which always gives rise to audit trail problems),**
- **depend on**
  - **numbers formatted as text (which may cause errors or unpredictable results), or**
  - **blank cells (which may reveal errors in construction or in data input),**
- **have no dependant cells (If not the end result, may be an error),**
- **address hidden cells, rows or columns,**
- **address cells which fail or return an error message,**
- **address linked sheets and workbooks,**
- **have an inherently high risk of user error (e.g. =NPV),**
- **As well as the checks on formulas, auditors are encouraged to check :**
  - **all cells where the pattern of copied formulas breaks (this is accomplished by reviewing a map view) - looking, for example, for numbers in places where formulas could be expected and**
  - **the impact of unused numbers - these, like formulas without dependants, often show that figures have been added to a worksheet as an afterthought, and have bot been carried forward to the totals.**

All these circumstances are known to pose a high risk of error.

5. Results of the 1999 campaign

Customs & Excise record the results of spreadsheet testing, to allow monitoring of :

- **the use of the audit software and confirm the benefits of its use,**
- **the number, impact and broad causes of errors (Domain or mechanical error),**
- **the size and complexity of the spreadsheet applications in use for taxation calculations,**

All auditors using the spreadsheet testing methodology and software provide useful information about the spreadsheets under test, including :

- **Size and complexity of model, expressed by :**
  - **No. of Workbooks in Application,**
  - **No. of Worksheets in each workbook,**
  - **No. of Formulas in each Workbook,**
  - **No. of Constants (Text & numeric cells) in each Workbook, and**
  - **No. of links to other files in each workbook.**
- **Amount of tax / duty handled**
  - **Individual Model, and**
  - **Copies of model (per year)**
- **Total number of quantitative (i.e. money) errors found,**
- **Total value of quantitative (i.e. money) errors found, and**
- **Cause of Error (Domain (Business) or mechanical).**

This enables us to calculate Cell Error Rates for formulas, as well as the cruder incidence of spreadsheets in error partially recorded in 1992.

The results (to date) are summarised in table 2 below. Subject to taxpayer confidentiality, H. M. Customs & Excise are committed to sharing these results with researchers, and will be making updated figures available via the Information Systems Audit & Control Association Northern UK Chapter (www.isaca.org.uk/northern)

6. Conclusions

The conclusions drawn from the audit exercises are :

- **The incidence of errors, while not approaching the figures documented elsewhere is still alarming.**
- **Cost-effective testing of spreadsheets by staff with the degree of expertise and training available is not feasible without the use of some sort of computer-assisted audit tool.**
- **Even in a domain such as indirect taxation, which is characterised by :**
  - relatively simple calculations,
  - relatively high domain knowledge by developers, and
  - generally well-documented calculation rules.

  The use of spreadsheet applications is fraught with danger and errors.
- **The presence of a spreadsheet application in an accounting system can subvert all the controls in all the other parts of that system.**
- **Use of a more formalised development and testing methodology for these applications would help reduce the risk of error, but errors can be detected by the use of a structured testing methodology such as that described above, combined with supporting computer-assisted audit software.**

7. References

The methodology described above has developed over a period of years. Much of it is based on the experience of Customs & Excise officers and it is not possible to credit the exact source of each element.

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Table 2 - Results of Spreadsheet Testing August - September 1999

	Total	Minimum	Average	Maximum
No. Applications Tested	7			
Size & Complexity				
No.Files	7	1	1	1
No.Worksheets	21	1	3	5
No. Constants	41,986	671	5,998	16,246
No. Formulas	4,993	-	713	3,021
No. Links between Files				
Impact of Applications - revenue handled				
Instance Tested	£12,382,978	£ -	£ 1,768,997	£9,323,298
Annual	£12,382,978	£ -	£ 1,768,997	£9,323,298
Errors Found				
Number	19	-	3	11
Value	£ 1,375,285	£ -	£ 196,469	£ 1,213,554
Main Cause				
Domain Errors	-			
Mechanical Errors	4			
Impact of Errors				
Cell Error Rate (Formulas Only)	0.38%			
Errors as % of revenue handled	11.11%			