Digital Comparison Tools Market Study:

Response form

Your details

(Fields marked * are required)

Title*	[✂]
Forename	[✂]
Surname*	[✂]
Email*	[✂]
What is your role / profession*	[✂]
Are you representing yourself or an organisation?*	Myself
If you are representing yourself rather than an organisation would you be content for us to include your name when we publish your response?*	Yes
Would you be willing for us to contact you to discuss your response?*	Yes

8. What are the barriers, if any, to DCTs increasing competition between suppliers, and how can these be overcome?

Competition between credit card suppliers is hindered by DCTs that are content to regard representative APRs as reliable indicators and don't bother to include listing and sorting by the monthly rates that providers use to calculate interest. Representative APRs claimed by providers do not represent the true cost of their credit cards because regulators tolerate card providers' use of a range of simple interest approximations in their calculations. This is highly unsatisfactory, given that APR is a measure of compound interest, defined both by UK statute and EC directive.

Having visited a DCT, you still have to visit the card providers' sites, one by one, to examine each Summary Box where (if you are lucky) you find a cost example. When you make your survey of the Summary Boxes you can find a range of monthly rates for a selection of cards **with the same "Representative" APR**.

I did a survey on 30-Sep-16 using [✂]. This showed 42 cards from 16 providers, all listed as 18.9%APR, all depending on £1,200 expenditure. By exploring those card providers, I found 7 that gave £1,000 examples with a wide range of costs, only 1 that used £1,200 and 6 that didn't include a worked example. I didn't check one, as their Summary Box was only available after an eligibility check, that I declined. Only 2 providers were bold enough to confess to simple interest in their Summary Boxes (17.43% simple annual and 17.48%) although monthly rates alone are common indicators that simple interest is used (also in savings products, where AER is not even statutory).

Compound interest is given by GrowthFactor = RateFactor {to the power of} Time.

The curve of 18.9%APR can be sampled at any date.
(1+18.9/100)^(1/12)=1.0145306... say 1.453% growth over a mythical average month of 30.4166...days. However, providers can use an average monthly rate in a simple interest (straight line) approximation for day counts other than 30.4166...days. Linear approximation has been obsolete since Henry Briggs published a method for one day of compound interest for a rate based on 365 days to 14 place accuracy in London in 1624.

I found monthly rates that ranged from 1.453% to 1.457%**. That makes a range of about £2.75 per £1,000 of interest for cards with the same "Representative Rate". However, this range is small compared to the range of costs indicated by the 7 providers that offered a basic £1,000 purchase example. I found that £1,000 paid off at £50 monthly would cost the customer anything from £56.53 to £143.32 in interest in the first year, £45.06 to £57.14 in the second year and take from 2 years to 2 years 2 months to clear. The minimum payment payer was warned to expect from £75.92 to £167.22 interest in the first year, £138.84 to £148.04 in the second year and a payment time of 18 years to 18 years and 6 months. These Summary Box examples, taken from cards with free periods from 24 to 41 months, just don't present a clear picture for the customer.
**1.457% monthly means 1.01457^12=1.189554... say 19.0%APR, to the standard 1 decimal place of %. So much for a "Representative" rate of 18.9%APR!

It is clear that regulators and watchdogs have no proper grasp of compound interest or of the accuracy achievable since 1624. Providers need restraining. Regulators and watchdogs need retraining (in the use of school algebra and £ shop scientific calculators).

To overcome these unfair and unnecessary problems:-
1. Regulators must bring reality to Representative Rates (APR and AER) by insisting that simple interest is banned from all banking. Only proper compound interest is acceptable.
2. Regulators must ensure that the credit card Summary Box includes the full exponential equation of APR and a standard worked example of the cost of borrowing (£s of interest per £1,000 purchase, for example, and how long to pay off at a standard monthly payment) since providers can wriggle in the current "Representative" rate system.
3. DCTs must include the result of the same standard credit example and allow sorting by that result.
4. Until simple interest is banned, DCTs must include listing and sorting by monthly rate.

Do you have any other comments you would like to add?

I have only answered Q8. I have modified the form to cut out sections that do not apply.

I have used DCTs to find savings accounts that have lost me net interest and lost HMRC revenue. The tax at source problem is now historical since the government took calculation of the tax on savings interest away from bankers this year. However, the problem of compensation for historical losses has not gone away.

Simple interest has been obsolete since 1624. APR is statutory and compound interest but credit calculations still involve simple interest approximations in monthly bills. AER is still left to bankers to define and they can still use simple interest to deny interest to savers in leap years. What a mess!

How can DCTs be expected to compare faulty products unless they are well versed in compound interest?

I have been writing to account providers, regulators, watchdogs, the government and various media outlets since 2005 concerning the lack of achievable accuracy and fairness in banking. I find it appalling that providers can get away with advertising compound interest (AER and APR) and then delivering approximate outcomes that are based in part on simple interest. It is not the fault of DCTs but it is sad when they can promote financial products without properly analysing their outcomes.

I have yet to see an account advert that includes the equation of the main parameter. Savers and borrowers are expected to rely on account providers to generate the numbers of importance - the actual interest paid or charged. My experience is that account providers use simple interest approximations which muddy the playing field.

My first indication of a problem came when I examined my statements from taxed at source savings accounts. I was receiving over 20% less interest than a tax free saver would receive from the same deposit for the same time at the same advertised AER.

Consider the typical provider's taxed at source interest divided by their tax free interest in an account advertised as 5.00%AER (something common in the noughties):-
[1.04x1.04x1.04-1]/[1.05x1.05x1.05-1]=0.7921586... say 20.8% tax at source

The [✂] acknowledged the "not exactly 20%" effect in their first reply to me in 2006 but has done nothing to correct the problem. The [✂] did not reply to my complaint about their DCT in 2012, that had a savings calculator of the "not exactly 20%" variety.

The government has now taken the calculation of tax at source on savings away from account providers. So that's all right then. But no it isn't, because, despite my lengthy and detailed attempts to inform those in high places about the problems of simple interest, there is still no statutory definition of interest on savings with which to pursue compensation for historical losses by taxed at source savers and by HMRC (who also suffered when net interest was under-calculated). My un-challenged estimate is that providers made £500million annually from their net approximation during the 20% at source period.

It gets more complicated when part-years are involved. Part-years (anything other than the 365 days used to define AER) are the norm in banking. The typical banker's result from 3 years that began 30 days after the start of the 5.00%AER account:-
[(1+0.8x30/365x5/100)x1.04x1.04x(1+0.8x335/365x5/100)-1]/
[(1+30/365x5/100)x1.05x1.05x(1+335/365x5/100)-1]=0.791942...
say "even less than before, <u>for the same total time</u>" and still about 20.8% tax at source.

The part-year equation highlights the problem. The traditional stepwise method employs repeated simple interest (RSI) (an oxymoron). The linear approximations deviate the resultant net interest from the proper and fair calculation that would put the taxed at source growth saver exactly 20% of interest below the tax free saver AT ALL TIMES.

The taxed at source saver in my example should receive:-
(1.05^3-1)x0.8+1=1.1261 as a net growth factor instead of:-
1.04^3=1.124864 (the traditional approximate method)

My attached Figure 16 shows what I call "The Envelope of Inaccuracy" plotted for an advertised 5.00%AER. Clearly, taxed at source savers and HMRC have suffered.

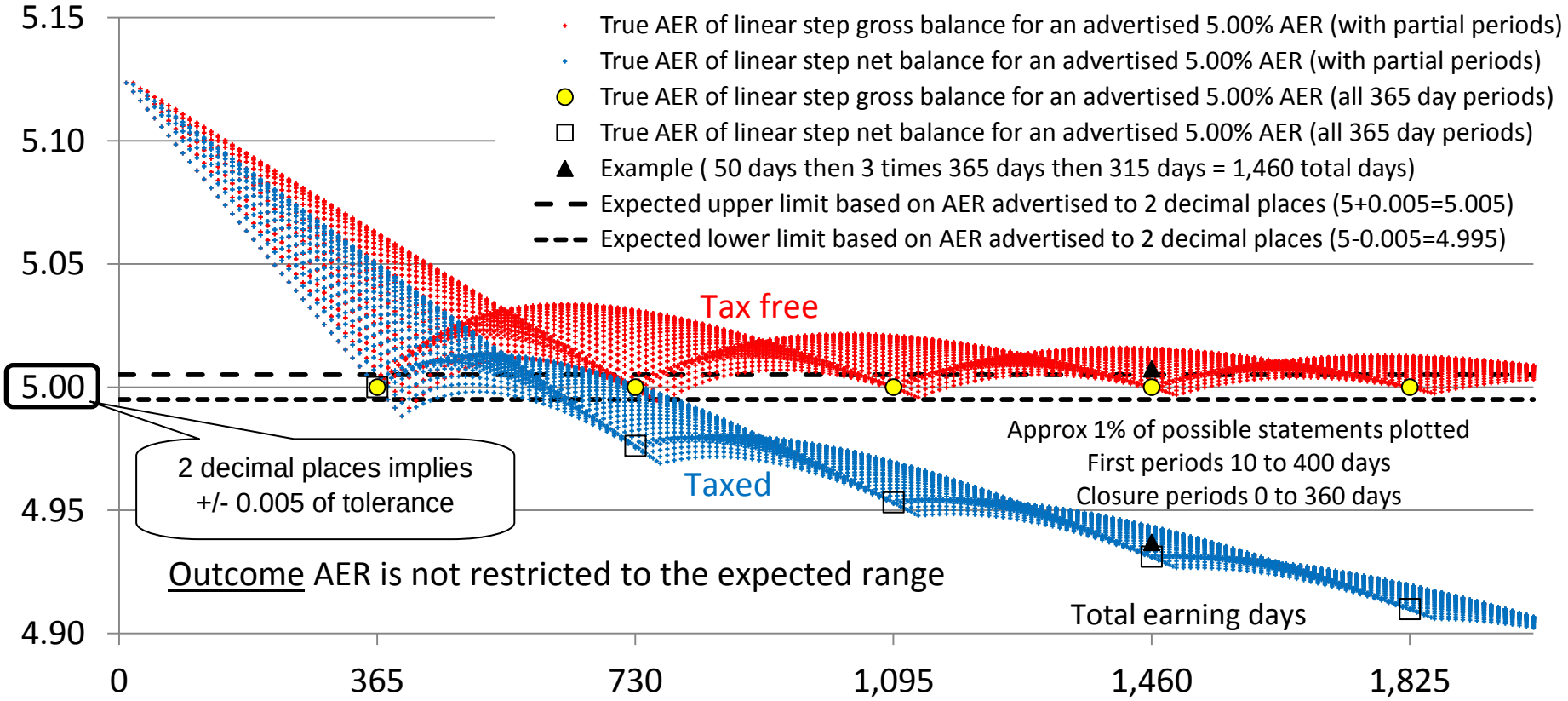
Simple interest pollutes the banking industry wherever monthly rates are used.

As I show in my response to Q8, monthly rates are calculated as the growth% appropriate for 30.4166...days. Providers (savings and loan) then use this rate for other time steps (1 to 31 days, with the possibility of longer when public holidays intervene) in a linear (simple interest) approximation that can disadvantage the customer (in the savings world, especially when leap days go unpaid for).

My attached Word document contains further comments and graphs regarding the simple interest problem.

All of this unfairness and complication would go away if simple interest was banned in favour of the sole use of proper compound interest in all banking. There is hope for accuracy since I have persuaded 5 providers to pay me above their default savings outcomes by explaining proper compound interest.

Advert unreliability at 5.00%AER when annual basis growth accounts are calculated with repeated simple interest. I call this scatter **"The Envelope of Inaccuracy".** Taxed savers and HMRC generally lose. Bankers gain by underpaying taxed savers and HMRC[++].



For example, 50 days then 3x365 days then 315 days (total 4x365 = 1,460 days).

Banker's Gross = (1+0.05x50/365)x(1.05)^3x(1+0.05x315/365) = BG = 1.215848389...

True Gross (proper compound interest) = 1.05^((50+3x365+315)/365) = 1.05^4 = TG = 1.215506250...

Banker's Net (20% taken after each step, before proceeding[+++]) = (1+0.8x0.05x50/365)x1.04^3x(1+0.8x0.05x315/365) = BN = 1.170071332...

True Net (Chancellor's 20% rate applied to True Gross) = (TG-1)x0.8+1 = 1.17240500...

Outcome AER from BG = (BG^(1/4)-1)x100 = 5.007388... ; Outcome AER from BN = (((BN-1)/0.8+1)^(1/4)-1)x100 = 4.936946038... say 4.94%AER

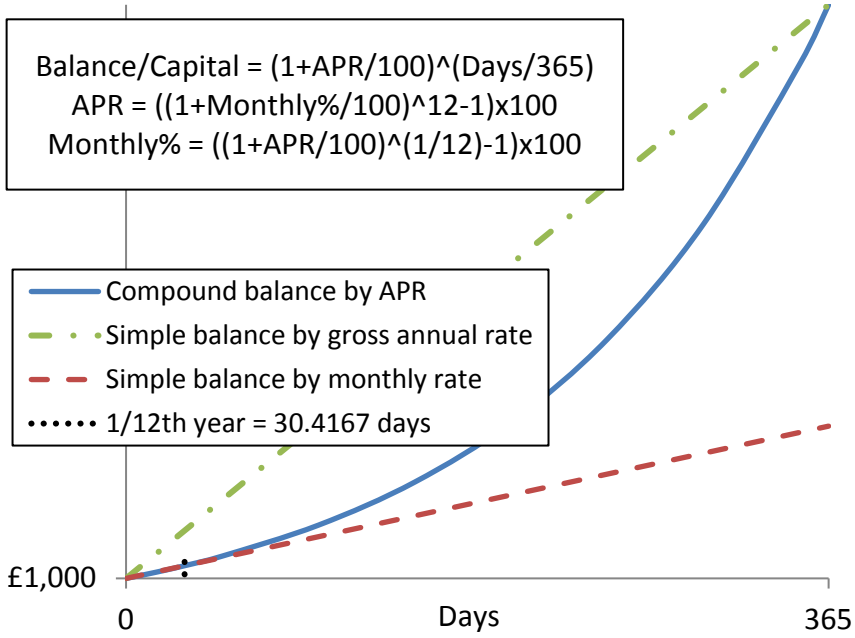
Effective net interest fraction from banker's method = (BN-1)/(BG-1) = 0.78792... say 21.2% deduction at source, not 20.00% (the taxed saver loses).

Banker's tax passed to HMRC = (BN-1)/4 = 0.042517833... ; True tax = (TG-TN) = 0.04310125 (HMRC loses over 1% of revenue).

[++]**Taxation based on the true compound interest tax free saver (TG) is the only fair taxation.** [+++]Banker's method from my experience.

Figures 1 and 2 show the inaccuracy of simple interest in monthly accounts in general (applies to APR and AER). Figures 3 to 6 are about credit card inconsistencies. The credit card data was found on 30-Sep-16, using a DCT to direct me to providers' sites for credit cards all claiming to offer the same "Representative" Rate of 18.9%APR.

Figure 1 - Why simple interest fails in monthly accounts - overview.

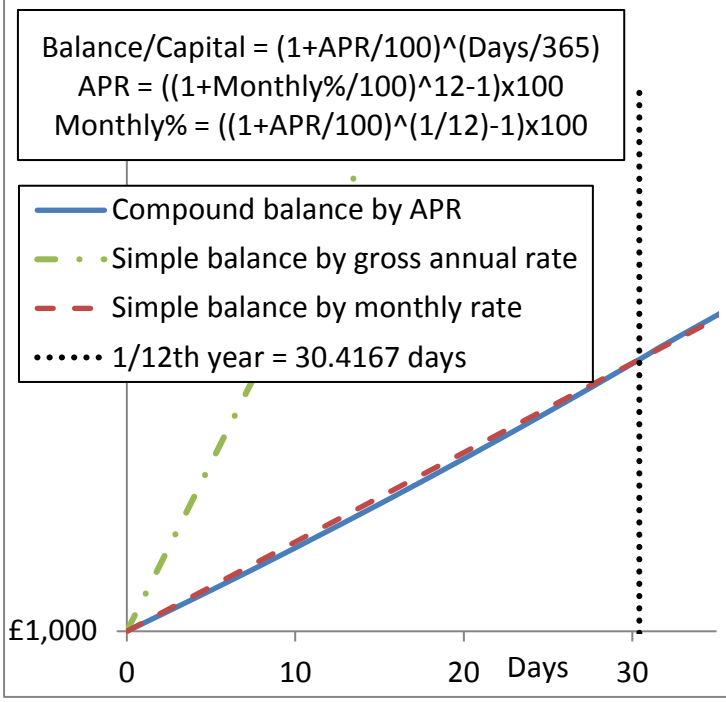


This chart uses a large APR, to amplify the curvature of proper compound growth.

Simple interest at intermediate points based on the annual gross rate is clearly an over-estimate.

The monthly rate looks close enough, until you zoom in to see the detail...

Figure 2 - Why simple interest fails in monthly accounts - detail



This chart uses a large APR, to amplify the curvature of proper compound growth

The average monthly rate is only applicable to a day count of 30.4166... days.

As with any simple interest calculation, intermediate points deviate from the curve of the advertised APR.

Only points on the blue curve fit the equation of the advertised APR.

Until simple interest is banned, monthly rates must be clearly displayed by DCTs because the so-called "Representative" APR is not currently reliable. Figure 3 shows the spread of APRs calculated from summary box monthly rates. 1.457% is 19.0%APR.

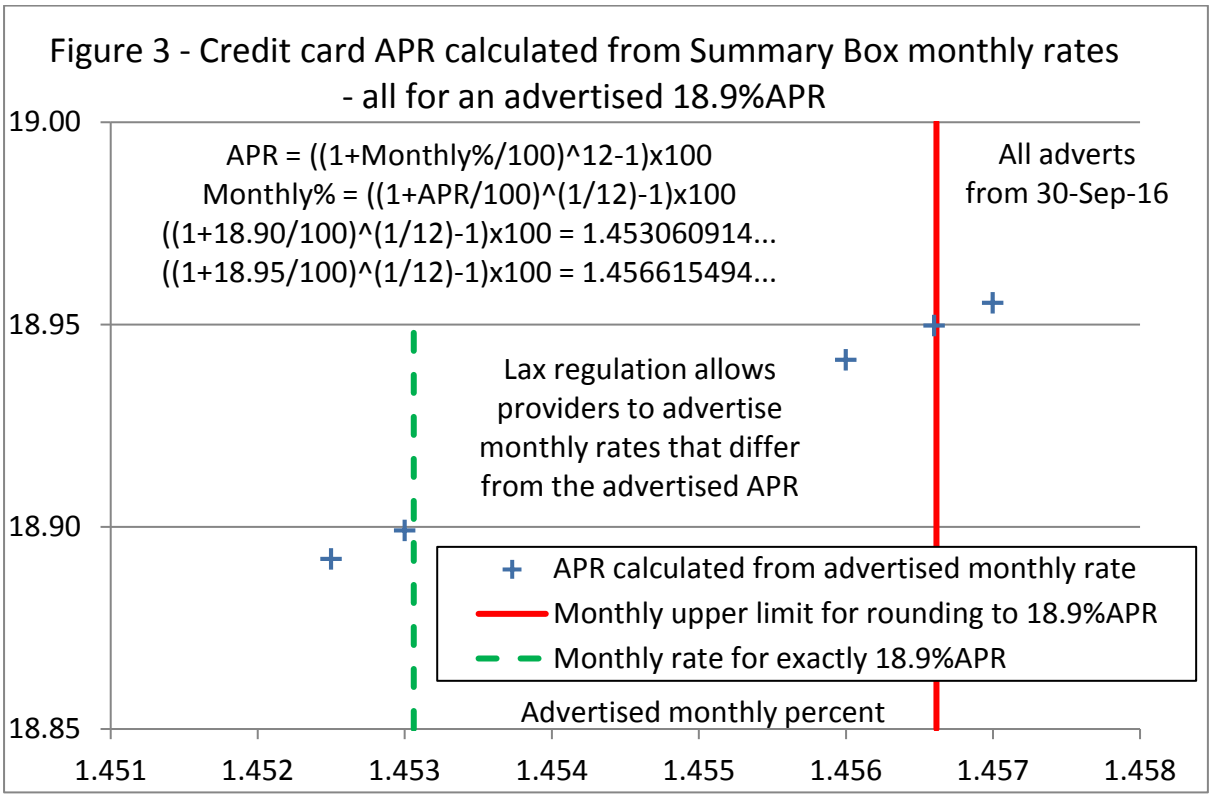
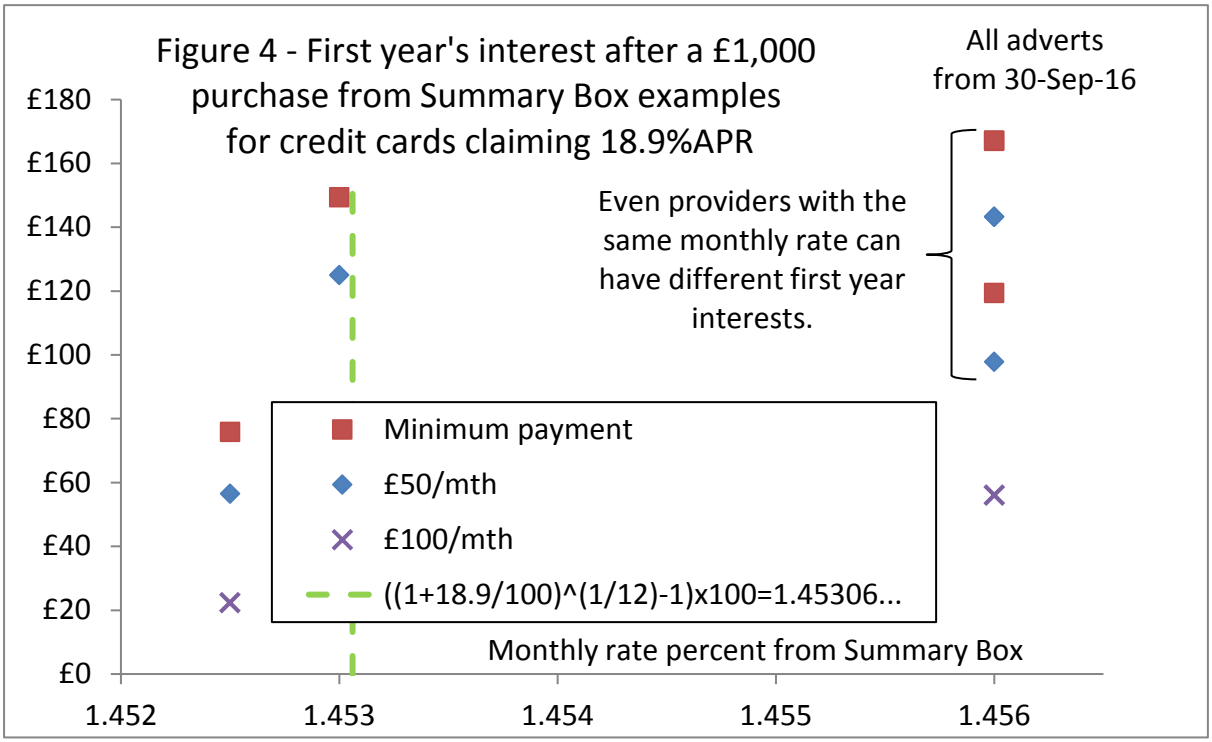


Figure 4 shows the disturbing range of interests reported by providers in their examples for their so-called 18.9%APR products. Where are the regulators and the watchdogs? Can even the account providers calculate proper compound interest?



However, the credit card comparison problem is not completely solved by banning simple interest.

One of the main attractions of a credit card is the delay between purchasing an item in a shop and actually paying for it. This makes analysis of the cash flow more complex.

Card providers generally allow a time between your bill date and the time before you have to make your payment to avoid interest. If you make a payment that does not clear the account but is within this time window then (non-penalty) interest is added to the next bill. If you manage to pay the bill in full within the allotted time window then you won't have any interest carried forward - I call this "interest waiving". This means that your final bill for an example £1,000 purchase paid in £50 monthly amounts will avoid the interest carried over from the previous statement. This final free gift lowers the true outcome APR. Different card users will have different approaches to when they actually pay each monthly bill (as soon as the bill arrives, to minimise total interest, or later, for any number of reasons) and so will have different timing-based effects on the interest eventually charged.

The only degree of freedom examined in the Summary Box examples that I found was the amount repaid each month - generally 1) minimum payment or 2) £50, but two cards also explored £100 monthly. Most examples were based on purchase and bill on the 1st of the month, payment on the 15th. One specified pay on due date (without giving the due date). Most provider examples gave the same 1st and 2nd year interests for each of their different free period (24 to 41 months) balance transfer cards. Only one attempted to give different examples for their different cards. 6 providers gave no example.

I made a spreadsheet to investigate the most commonly found provider example:- £1,000 purchase, £50 per month repaid. I investigated delays between purchase date and date of the first bill of zero to 30 days and the effect of delays between bill date and payment date of zero to 10 days. The proper compound interest chargeable for this model ranges from £175.17 to £195.96. This contrasts with the much wider range from the Summary Boxes of £101.59 to £200.46 for just the first 2 years (with timescales from 24 to 26 months).

Given that early payments of your card bills results in less interest, it is unfair for card providers (and the DCTs that list and sort them) to fail to advertise the benefit to the customer of the saving to be made for various payment strategies (various delays from bill date to payment date). A much more rigorous design and monitoring of the Summary Box is required in order to give potential customers (and the DCTs that they might use) true information for comparison between products.

This may sound complicated, but then what are we trying to achieve by investigating financial product comparisons if not benefit to the customer?

Figure 5 shows the start of the model that I used to calculate the total interests at 18.9%APR for the various delays shown in Figure 6.

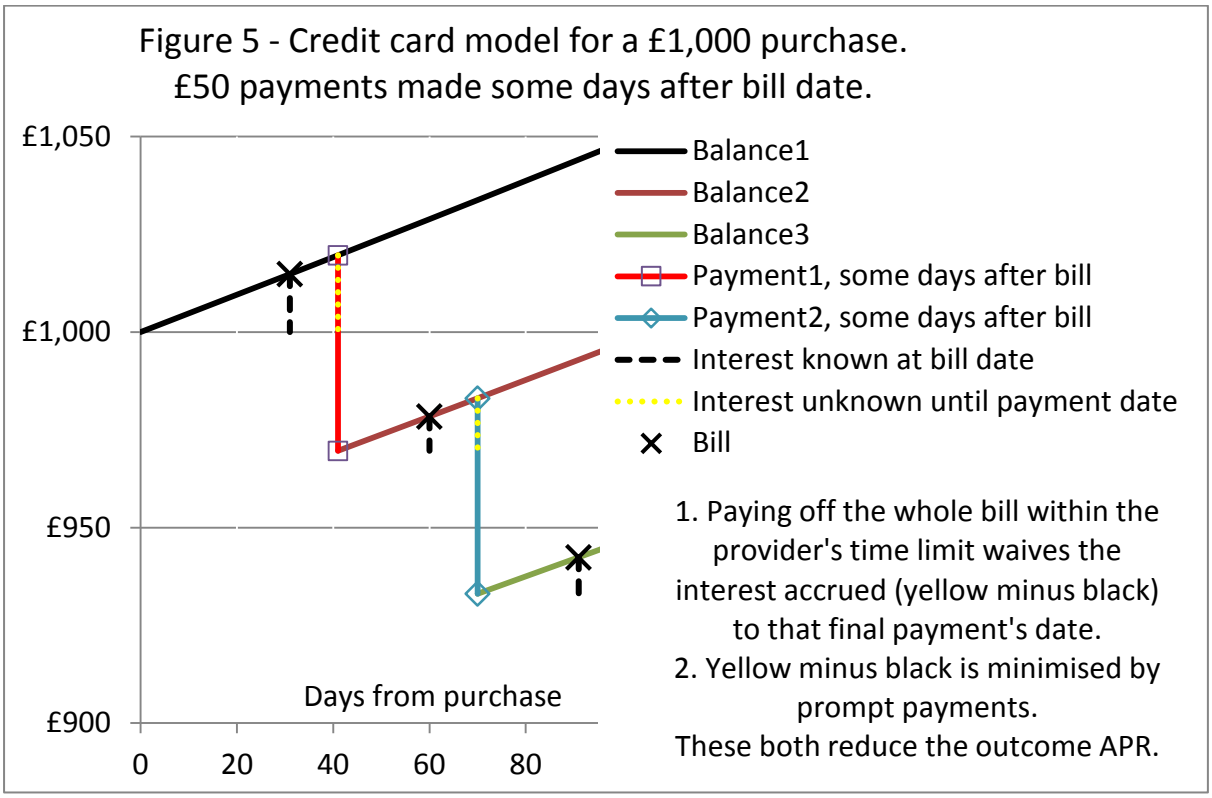
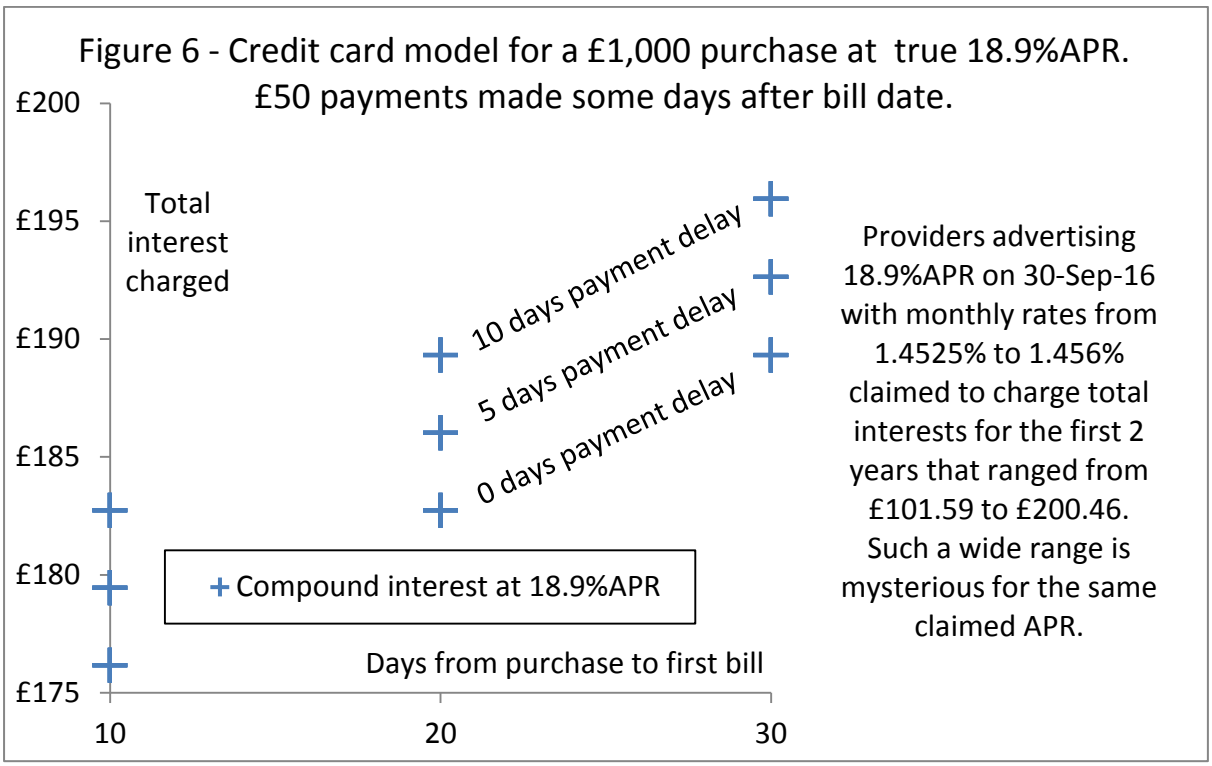


Figure 6 shows the benefits of paying the card bill earlier (under the customer's control) and the effect of delaying the first bill (under the card provider's control). At present, this detail is not formally in the Summary Box and so cannot be used by DCTs.

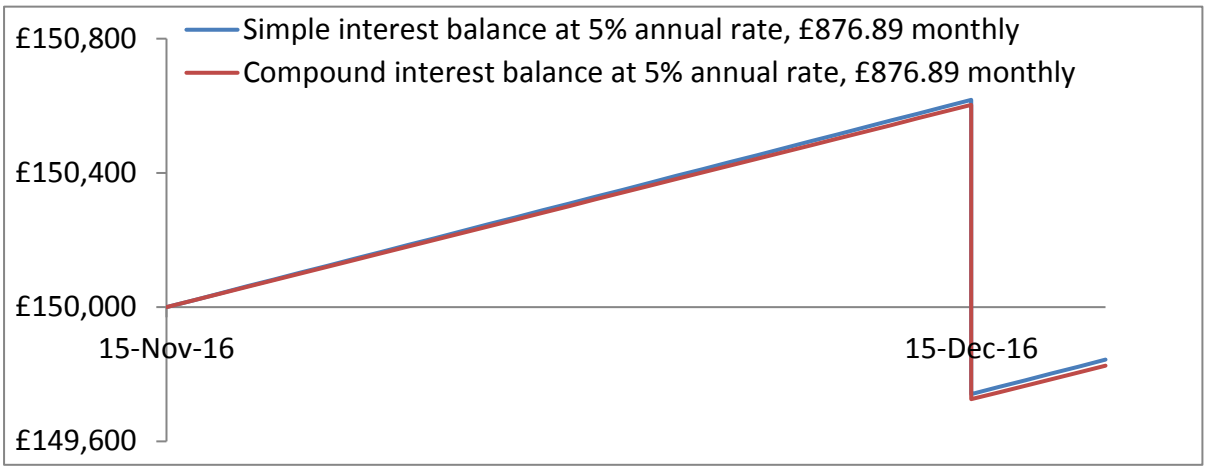


Mortgage finding also suffers from un-necessary simple interest approximation.

DCT's may offer a monthly repayment estimator. The idea is to enter the amount of your required loan (or house cost and deposit), the number of years and the annual rate to receive a monthly repayment estimate (perhaps only to the nearest whole pound). I investigated several such calculators. I found that they agree with the Excel spreadsheet function =PMT() to within pence. This is **a disaster for accuracy** because =PMT() is a simple interest calculator. Simple interest is a straight line approximation to the curve of growth by proper compound interest.

The =PMT() function for monthly repayments advises entering Rate as the annual growth fraction divided by 12 and Time as Years x 12. However, dividing an annual rate by 12 is a simple interest procedure that overestimates the curve of growth based on the same annual compound interest rate at the same 30.4166... day point. The "annual/12" simple interest estimate of the capital remaining before deducting each monthly repayment is therefore higher than that of the true Time Value of Money.

I confirmed this effect with a 25 year monthly repayment calculation for borrowing £150,000 at 5% Standard Variable Rate (SVR) in a 300 step analysis. The monthly repayment calculators of two DCTs estimate £876.89 and £877 respectively for the monthly payment. The online calculators of two Building Societies both find £877. I used the un-rounded =PMT() result of £876.89... and calendar dates (15th day of each month with true day counts, not mythical 1/12th years). Treating each growth step as proper compound interest but using the SVR number as annual rate with £876.89... monthly results in an over-payment of £5,565.05. See Spreadsheet A. A zero final balance comes from £876.89... monthly in a simple interest process (as expected by =PMT()). This graph shows the first month:-



Allowing the interest rate to float using Excel's Goal Seek resulted in a zero closing balance for £876.89 monthly at 5.11395...%APR. **5.00%Simple = 5.11%APR**.

Spreadsheet A also confirms the equivalence of a simple interest repayment plan at 5%SVR and a proper Time Value of Money repayment plan at 5.11%APR for the particular case of £150,000 over 25 years. Spreadsheet B, using only proper compound interest at 5.00%APR, shows the monthly repayment should be £867.39..., a reduction of about £9.50 each month compared to the horrible simple interest approximation at 5%SVR.

The logic of simple interest exposure:-

Simple interest has been an obsolete approximation to the Time Value of Money (proper compound interest) since the 17th century.

=PMT() function uses simple interest.
=PMT() function models DCT mortgage calculators.
Therefore DCT mortgage calculators use simple interest.

IF DCT mortgage calculators model providers' methods
THEN providers use simple interest.
IF DCT mortgage calculators don't model providers' methods
THEN DCT mortgage calculators should be scrapped until they do.

Sheet A

House Price			£200,000.00									
Down payment			£50,000.00									
Loan amount			£150,000.00									
Interest rate SVR%/100			0.0500		5.00%Simple = 5.11%APR							
Loan term years			25									
Monthly payment by PMT			-£876.89	=PMT(0.05/12,25*12,150,000)								
First compound balance			=£150,000*(1+5/100)^(30/365)			=£150,000*(1+5.11395.../100)^(30/365)						
First simple balance										=£150,000*(1+4.997873.../100*30/365)		
Annual rate				5.00	(as %SVR)		5.113950	(by Goal Seek)			4.997873	(by Goal Seek)++
Monthly payment				£876.89	(by PMT)		£876.89	(by PMT)			£876.89	(by PMT)
Payment Count	Step Days	Date	Opening balance	Payment	Closing balance at 5.00%APR	Opening balance	Payment	Closing balance at 5.11395%APR		Simple Opening balance	Payment	Simple Closing balance at 4.99787%SVR
		15-Nov-16	£150,000.00			£150,000.00				£150,000.00		
1	30	15-Dec-16	£150,602.73	£876.89	£149,725.85	£150,616.16	£876.89	£149,739.27		£150,616.18	£876.89	£149,739.29
2	31	15-Jan-17	£150,347.57	£876.89	£149,470.68	£150,374.90	£876.89	£149,498.02		£150,374.90	£876.89	£149,498.01
3	31	15-Feb-17	£150,091.35	£876.89	£149,214.46	£150,132.63	£876.89	£149,255.74		£150,132.60	£876.89	£149,255.71
Hidden rows												
293	31	15-Apr-41	£1,507.88	£876.89	£631.00	£6,913.81	£876.89	£6,036.93		£6,913.81	£876.89	£6,036.93
294	30	15-May-41	£633.53	£876.89	-£243.35	£6,061.73	£876.89	£5,184.84		£6,061.73	£876.89	£5,184.84
295	31	15-Jun-41	-£244.36	£876.89	-£1,121.25	£5,206.85	£876.89	£4,329.97		£5,206.85	£876.89	£4,329.97
296	30	15-Jul-41	-£1,125.75	£876.89	-£2,002.64	£4,347.75	£876.89	£3,470.87		£4,347.75	£876.89	£3,470.87
297	31	15-Aug-41	-£2,010.95	£876.89	-£2,887.84	£3,485.60	£876.89	£2,608.72		£3,485.60	£876.89	£2,608.72
298	31	15-Sep-41	-£2,899.83	£876.89	-£3,776.72	£2,619.79	£876.89	£1,742.90		£2,619.79	£876.89	£1,742.90
299	30	15-Oct-41	-£3,791.89	£876.89	-£4,668.78	£1,750.06	£876.89	£873.18		£1,750.06	£876.89	£873.18
300	31	15-Nov-41	-£4,688.16	£876.89	-£5,565.05	£876.89	£876.89	£0.00		£876.89	£876.89	£0.00
					Compound interest			Compound interest				Simple interest

++ Say 5.00%

Repayment calculation by proper compound interest:-

Loan amount			£150,000.00		**Sheet B**
Loan term years			25		
First compound balance			=£150,000*(1+5/100)^(30/365)		
%APR				5.00	(Time Value of Money)
Monthly payment				£867.39	(by Goal Seek)

Payment Count	Step Days	Date	Opening balance	Payment	Closing balance at 5.00%APR
		15-Nov-16	£150,000.00		
1	30	15-Dec-16	£150,602.73	£867.39	£149,735.34
2	31	15-Jan-17	£150,357.10	£867.39	£149,489.71
3	31	15-Feb-17	£150,110.46	£867.39	£149,243.07
Hidden rows					
293	31	15-Apr-41	£6,841.10	£867.39	£5,973.71
294	30	15-May-41	£5,997.72	£867.39	£5,130.33
295	31	15-Jun-41	£5,151.63	£867.39	£4,284.24
296	30	15-Jul-41	£4,301.46	£867.39	£3,434.07
297	31	15-Aug-41	£3,448.33	£867.39	£2,580.94
298	31	15-Sep-41	£2,591.65	£867.39	£1,724.26
299	30	15-Oct-41	£1,731.19	£867.39	£863.80
300	31	15-Nov-41	£867.39	£867.39	£0.00

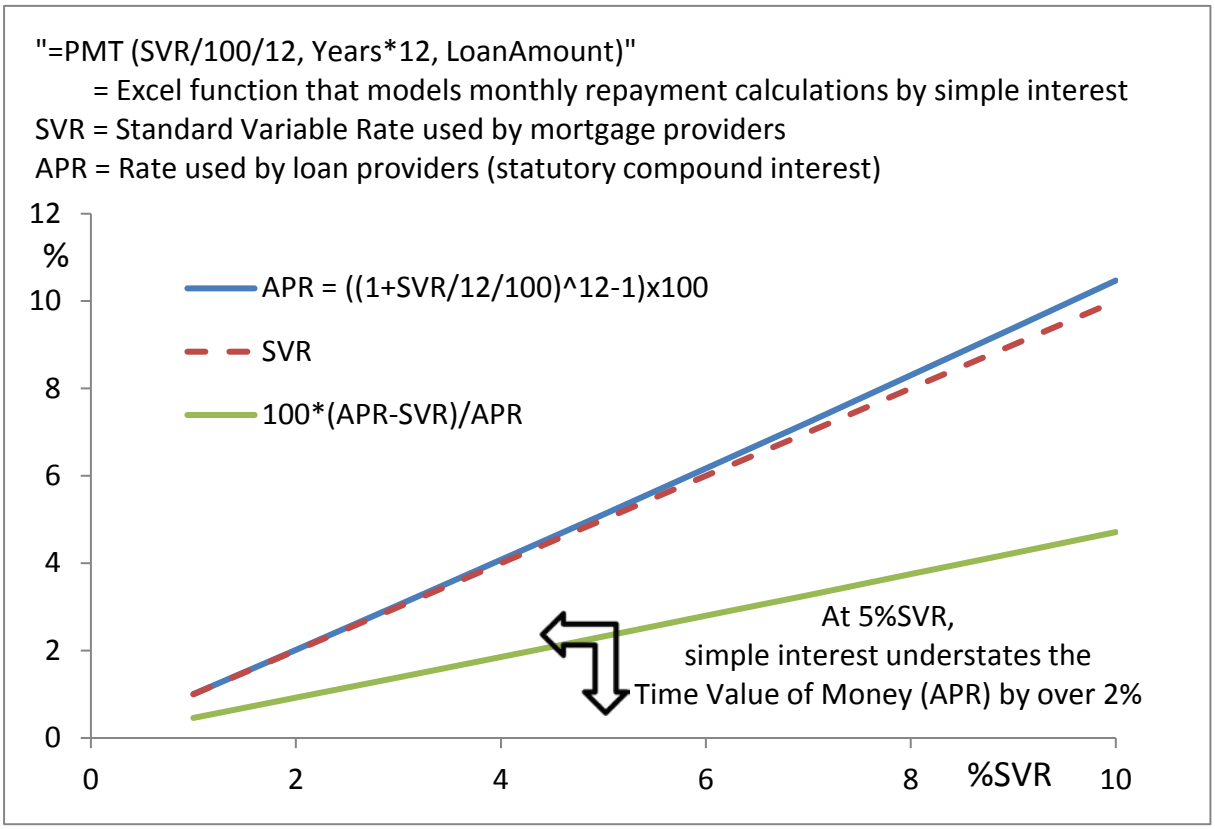
£876.89 - £867.39 = £9.50 extra monthly cost by using simple interest at 5%SVR instead of proper compounding at 5%APR.

Henry Briggs gave us one day of compound interest to 14 place accuracy in 1624.

Microsoft Windows' scientific calculator uses about 32 place accuracy.

And yet, providers still win, customers still lose and DCTs don't tell all.

The relationship between %SVR (in the simple interest approximation) and %APR (proper compound interest) is %APR=((1+%SVR/100/12)^12-1)x100. The over-charging error by simple interest increases as SVR increases. This is easily plotted on a graph.



Providers may refer to their APRC for comparison with others. APRC may include various additions to the main house loan. Neither the SVR, nor the APRC come with equations of growth. Basing APRC on SVR is unsafe since SVR is unsafe when simple interest intervenes. All this is before the complication of fixed rate introductory offers and early repayment.

Statutory APR (revised to exclude the mythical 30.4166... day months and division by 366, that only encourage approximation) must be imposed on mortgages and other loans, including credit cards. When simple interest is removed, providers will have to report truly comparable loan and mortgage compound interest rates. This will result in different advertised rate numbers in the borrowing market for the same monthly repayments, but at least borrowers would be able to trust DCT comparisons and provider adverts based on annual rates.

Repeated simple interest is not the same as proper compound interest. Un-declared simple interest in a product is mis-selling. DCTs will never be able to compare mortgages, loans or savings accurately until simple interest is removed from banking.

Having examined introductory rate mortgages, I am even more convinced that DCTs are unreliable, and will be until simple interest is removed from banking.

I found a DCT that listed over 500 mortgages using £250,000 purchase, £200,000 borrowed (£50,000 deposit) and 25 years as search values. I analysed 9 with fixed rate periods and 3 with lifetime single variable rates. In all 12 cases, the reported initial monthly repayments were modelled exactly by the Excel spreadsheet function =PMT() when excluding fees from the amount borrowed. =PMT() also models the advertised post-introductory repayments within a few pence. Advertised repayments are therefore simple interest approximations to proper compound interest. Sheet C summarises my results. My full spreadsheet runs to over 2,200 rows, to cope with up to 30 year mortgages.

Excluding fees from the calculation is contrary to the definition of APRC. See FCA Handbook MCOB 10A.2 below. Clearly, the two imaginary 2-stage plans in this table will have different APRCs:-

Date	Cash flows including £1,000 fee repayment	Cash flows not including £1,000 fee repayment
1-Dec-16	£201,000	£200,000
1-Jan-17	-£900	-£900
1-Feb-17	-£900	-£900
...		
1-Jan-19	-£1,100	-£1,100
1-Feb-19	-£1,100	-£1,100
...		

I used =XIRR() to find the actual APRCs. =XIRR() demands the actual date of each cash flow and is equal to the method based on summing the present values when only whole day steps are involved. =XIRR() doesn't allow for part days but is easier to apply than the manually iterated (Goal Seek) Present Value method for rate finding.

While =PMT() and =IRR() are simple interest in monthly calculations, =XIRR() is proper compound interest provided (as assumed here) the dates represent whole day steps.

I found that the <u>true</u> APRCs (assuming advertised repayments included covering the fees) were mostly smaller than the <u>advertised</u> APRCs, and most could have claimed to be at least 0.1%APRC less than advertised. See Chart A. This indicates that DCTs, watchdogs, regulators and at least some providers don't know how to calculate an APRC (or at least fail to check what is advertised).

One DCT's repayment calculator doesn't mention fees and only offers to calculate single rate mortgages, with rates limited to 1 dp (2.09% rounds to 2.1% before calculating) and starts at a 2.0% minimum (I was trying to check their own reported rates down to 1.44%). Another DCT's calculator also gives initial repayments modelled by =PMT() but gives fee inclusion as an option and only reports initial monthly payments, the later monthly repayments are not detailed.

Of my 12 examples, only 2 were easy to find on the original providers' web sites. Mostly I failed due to reluctance to put my life story online just to obtain their version of the

numbers reported by others. If such details are really required to get to the mortgage numbers then how can DCTs provide reliable data without those details?

Calculating by simple interest (the obsolete method, implied by providers that agree with =PMT()) gave positive closing balances of up to about £4,700 after 25 years, with fees included in the advertised repayments. A positive closing balance means under-repayment of the mortgage.

Calculating by proper compound interest and assuming that advertised repayments also repaid the fees (the correct method, implied by providers advertising an APRC), some deals had negative closing balances, some had positive closing balances (ranging from minus £4,188 to plus £1,672 respectively). These results are shown on Chart B.

Charts C to K show the results calculated directly by simple and compound interests, both with and without fees included in advertised repayments. Charts L and M required iteration of introductory repayments by Goal Seek to show what I feel should happen (zero closing balance by proper compound interest, fees included in repayments).

By experimenting with Goal Seek, I found that to achieve a zero closing balance by proper compound interest (fees included in the repayments) would need introductory monthly repayment corrections from minus £52.84 to plus £11.73. **This is highly significant** when you consider that the top 14 results from a DCT on 4-Nov-16, sorted by "Initial monthly payments", represented a range of only £14 monthly.

With such anomalies in the mortgage industry, how can DCTs offer a reliable service?

In a free market, providers are allowed to offer what rates and repayments they choose, but surely they must be restricted to advertising rates and repayments that at least give a zero closing balance by proper compound interest - the true time value of money!

Proper compound interest must be demanded. Obsolete simple interest must be retired.

Below:- Extract from FCA Handbook MCOB 10A.2
Chart A - Calculated APRC vs Advertised APRC
Chart B - Summary of closing balance results
Chart C - Proper compound interest, fees included in advertised repayments
Chart D - The final year of Chart C
Chart E - Compound interest, fees as extras (not repaid by advertised repayments)
Chart F - The final year of Chart E
Chart G - Simple interest, fees included in advertised repayments
Chart H - The final year of Chart G (No Chart I)
Chart J - Simple interest, fees as extras (not repaid by advertised repayments)
Chart K - The final year of Chart J
Chart L - Proper compound interest, fees included, "Goal Seeked" introductory repayments
Chart M - The final year of Chart L (L & M are my best efforts to show what should happen)
Sheet C - The first few rows of my 2,212 row spreadsheet

Extract from FCA Handbook

Repetition of "repayment or repayment of charges" emphasises that APRC calculation (as for statutory APR) includes fees. Note (3) includes appalling invitations to use un-necessary approximation.

MCOB 10A.2 APRC: mathematical formula and assumptions

MCOB 10A.2.1G21/03/2016
The mathematical formula for calculating the *APRC* in *MCOB 10A.2.2 R* is a basic equation for establishing the *APRC*. This equates, on an annual basis, the total present value of drawdowns on the one hand and the total present value of repayments and payments of charges on the other.
[**Note:** Annex I, Part I of the *MCD*]
MCOB 10A.2.2R21/03/2016
The equation referred to in *MCOB 10A.2.1 G* is:

$$\sum_{k=1}^{m} C_k (1+X)^{-t_k} = \sum_{l=1}^{m'} D_l (1+X)^{-s_l}$$

where:

- X is the *APRC*
- m is the number of the last drawdown
- k is the number of a drawdown, thus $1 \leq k \leq m$
- C_k is the amount of drawdown k
- t_k is the interval, expressed in years and fractions of a year, between the date of the first drawdown and the date of each subsequent drawdown, thus $t_1 = 0$
- m' is the number of the last repayment or payment of charges
- l is the number of a repayment or payment of charges
- D_l is the amount of a repayment or payment of charges
- s_l is the interval, expressed in years and fractions of a year, between the date of the first drawdown and the date of each repayment or payment of charges.

[**Note:** Annex I, Part I of the *MCD*]
MCOB 10A.2.3R21/03/2016
The following matters must be applied when calculating the *APRC*.
(1) The amounts paid by both parties at different times must not necessarily be equal and must not necessarily be paid at equal intervals.
(2) The starting date must be that of the first drawdown.
(3) (a) Intervals between dates used in the calculations must be expressed in years or in fractions of a year. A year is presumed to have 365 days (or 366 days for leap years), 52 weeks or 12 equal months. An equal month is presumed to have 30.41666 days (ie, 365/12), regardless of whether or not it is a leap year.
(b) Where intervals between dates used in the calculations cannot be expressed as a whole number of weeks, months or years, the intervals must be expressed as a whole number of one of those periods in combination with a number of days. Where using days:
(i) every day must be counted, including weekends and holidays;
(ii) equal periods and then days must be counted backwards to the date of the initial drawdown;
(iii) the length of the period of days must be obtained excluding the first day and including the last day and must be expressed in years by dividing this period by the number of days (365 or 366 days) of the complete year counted backwards from the last day to the same day of the previous year.

(4) The result of the calculation must be expressed with an accuracy of at least one decimal place. If the figure at the following decimal place is greater than or equal to 5, the figure at the preceding decimal place must be increased by one.
(5) The equation can be rewritten using a single sum and the concept of flows (Ak), which will be positive or negative, in other words either paid or received during periods 1 to n, expressed in years, using the following formula:

$$s = \sum_{k=1}^{n} A_k (1+X)^{-t_k}$$

where s is the present balance of flows. If the aim is to maintain the equivalence of flows, the value of s will be zero.

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My comment on the FCA's document:-

The equations are true enough, if rather too small and fuzzy. Enlargement is not the answer. They are images pasted by the FCA from an original source. This is a pity since the equations are the most important parts. Hindrances to the use of proper compound interest must be removed.

$$\sum_{k=1}^{m} C_k (1+X)^{-t_k} = \sum_{l=1}^{m'} D_l (1+X)^{-s_l}$$

$$s = \sum_{k=1}^{n} A_k (1+X)^{-t_k}$$

According to the Time Value of Money:- Present Value = Future Value / $(1+i)^n$ where

i = period growth factor, n = number of periods.

APRC merely values all money flows on a common time basis (the not-necessarily-whole number of 365 day periods from the start, with the rate based on 365 days).

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Chart A - Calculated APRC vs Advertised APRC

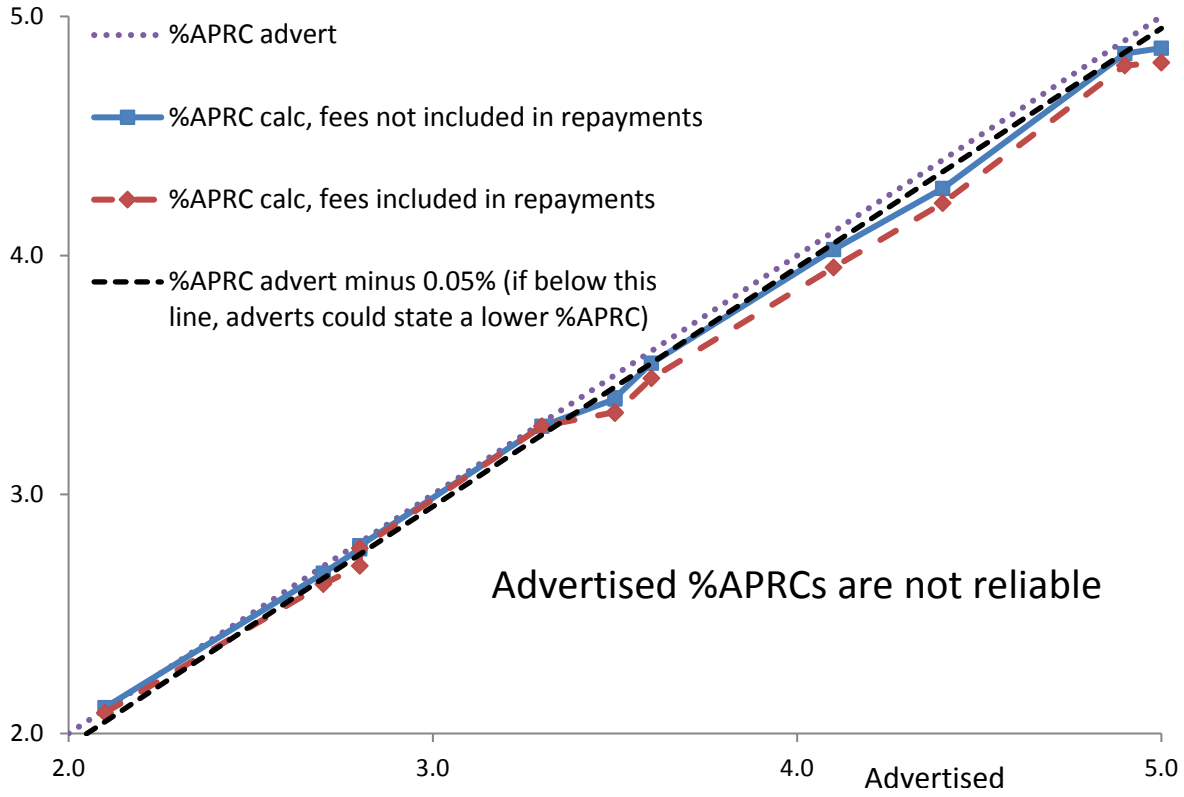


Chart B - Summary of closing balance results

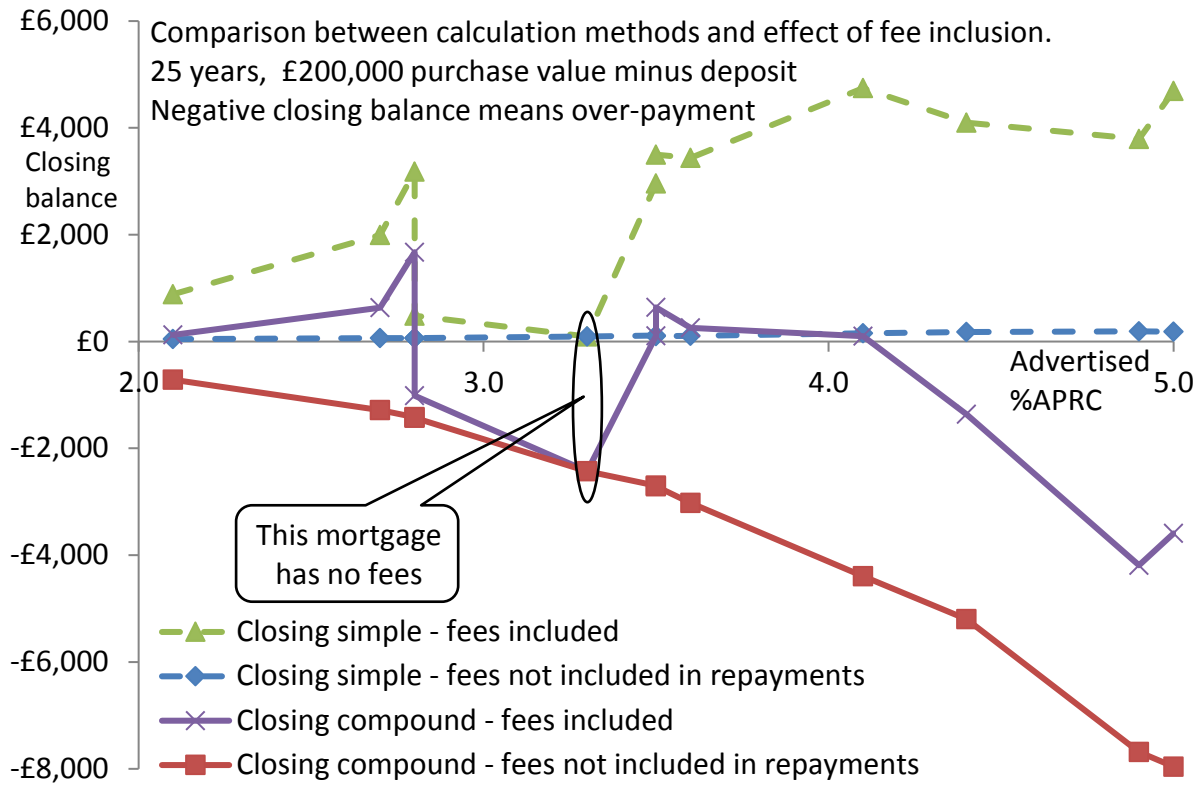


Chart C - Proper compound interest, fees included in advertised repayments

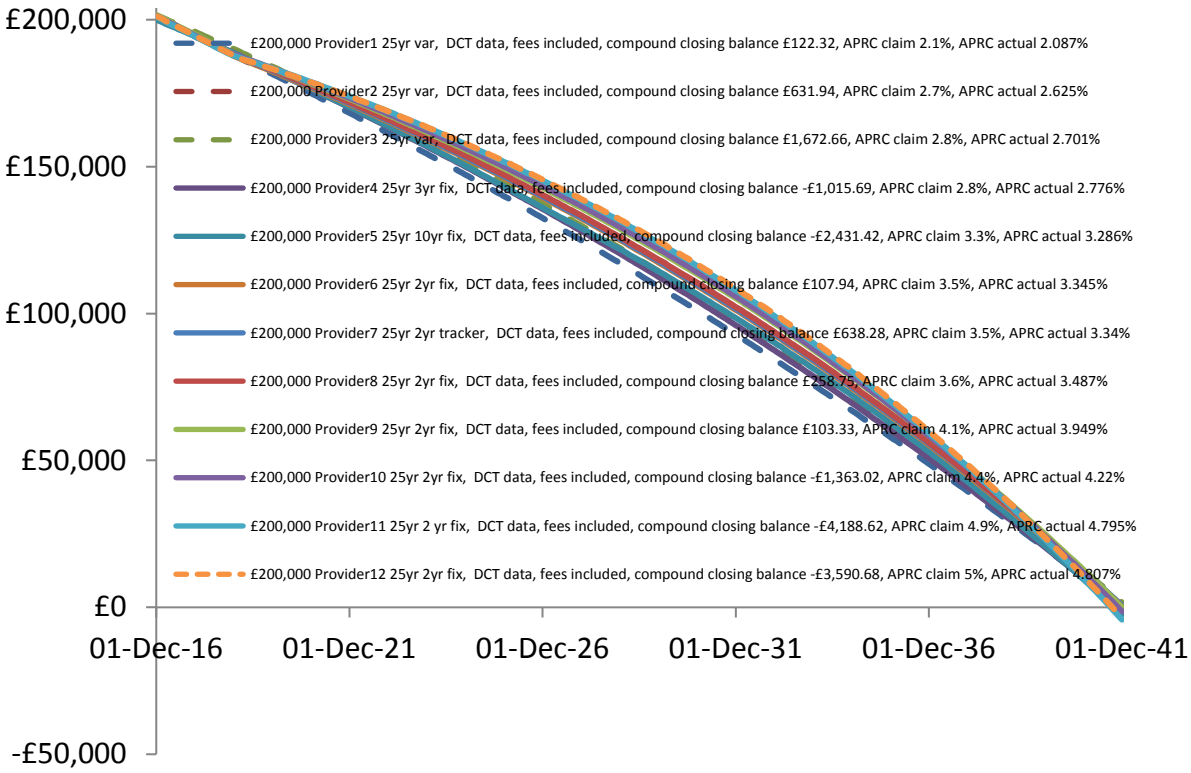


Chart D - The final year of Chart C

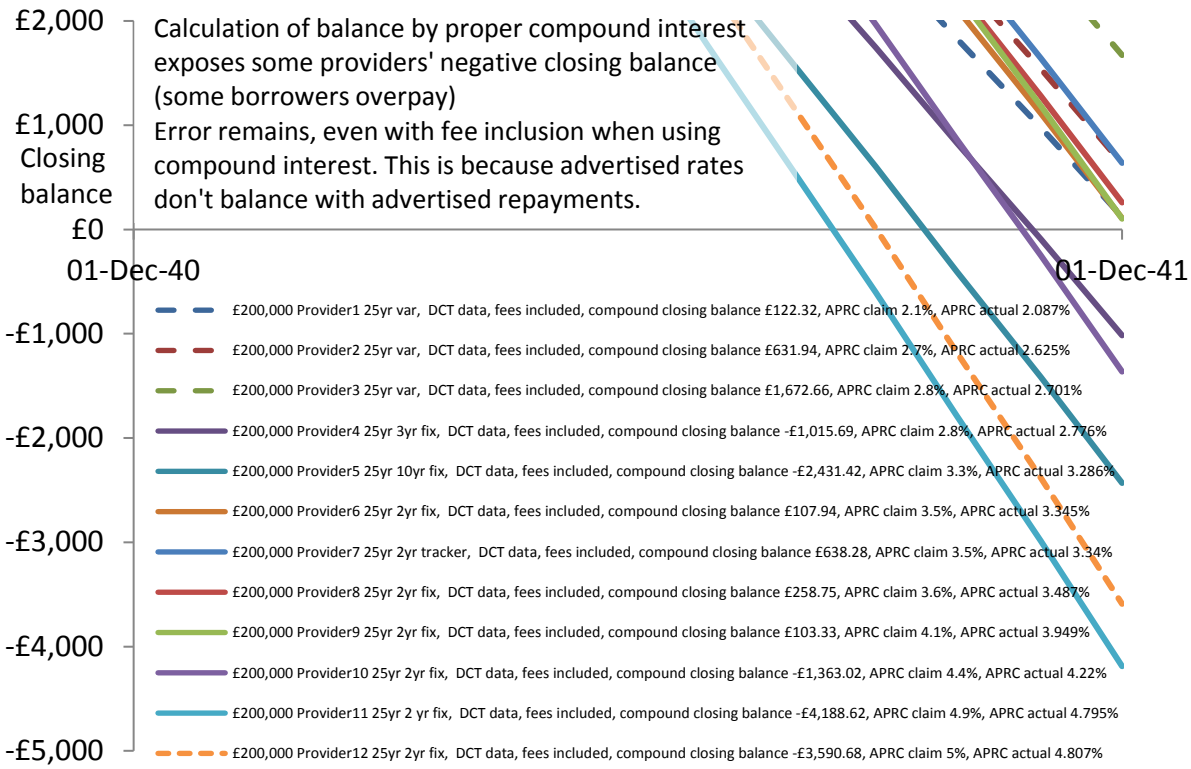


Chart E - Compound interest, fees as extras (not repaid by advertised repayments)

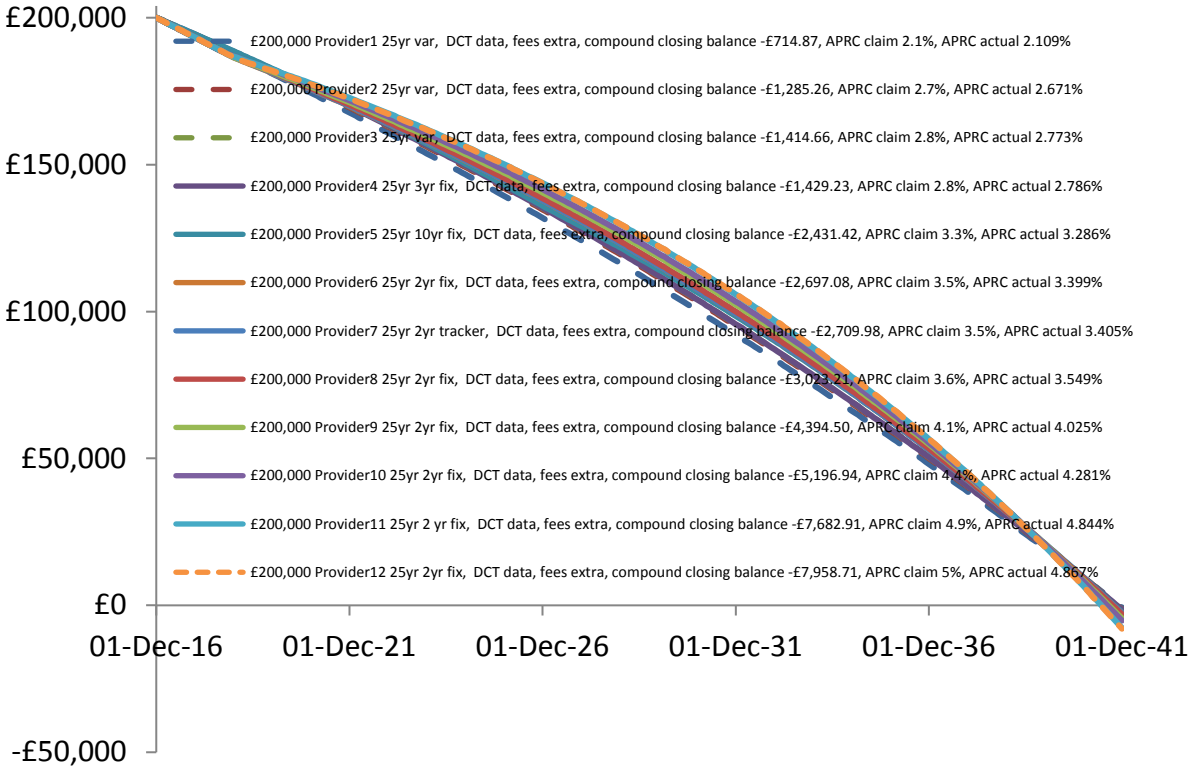


Chart F - The final year of Chart E

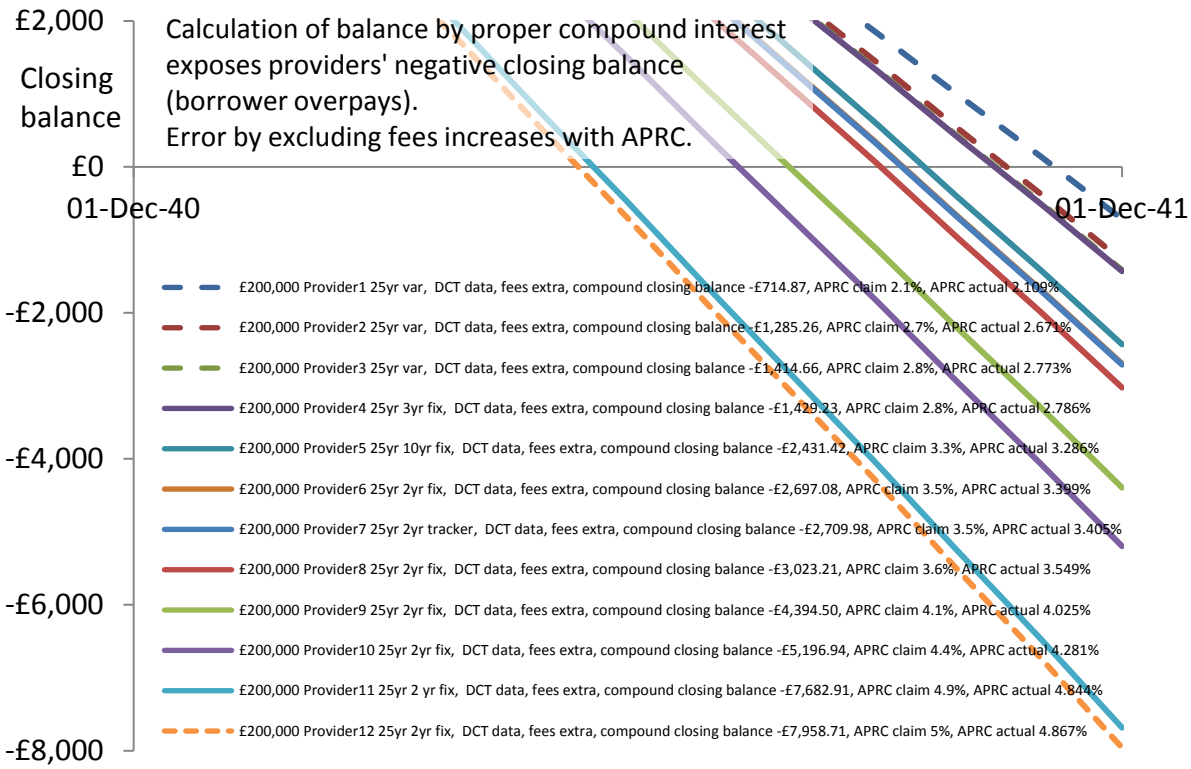


Chart G - Simple interest, fees included in advertised repayments

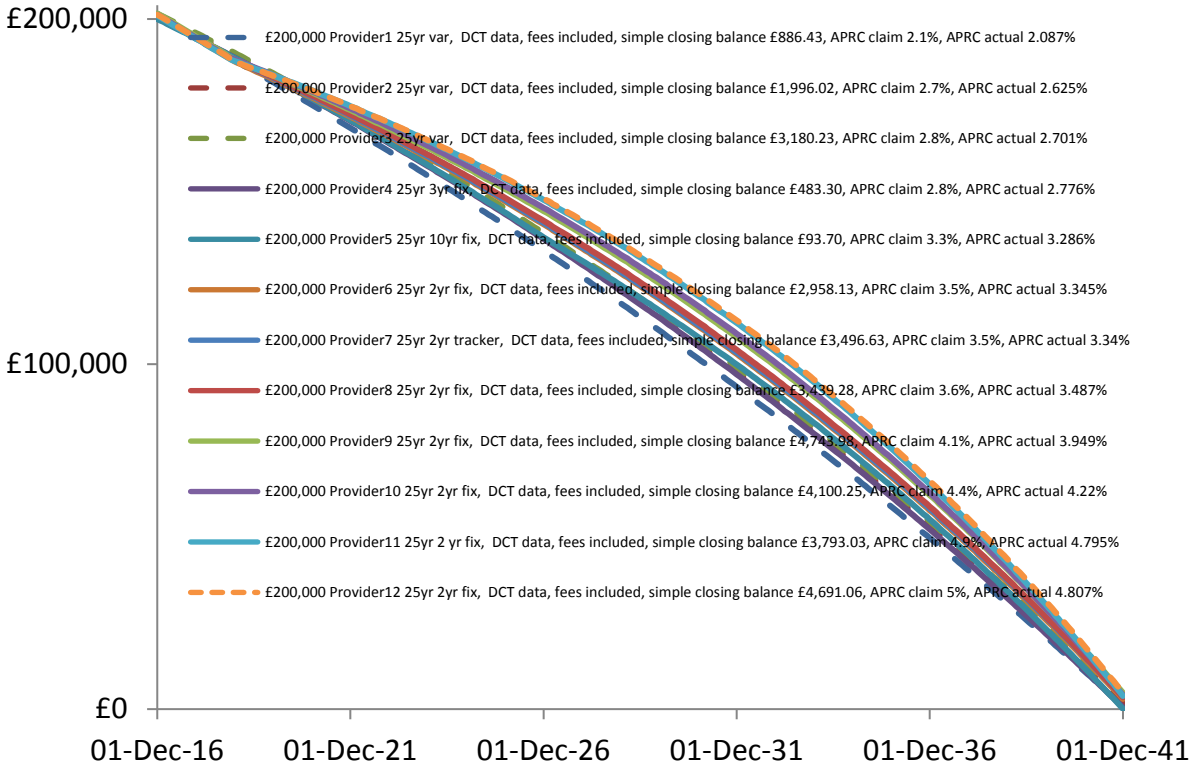


Chart H - The final year of Chart G

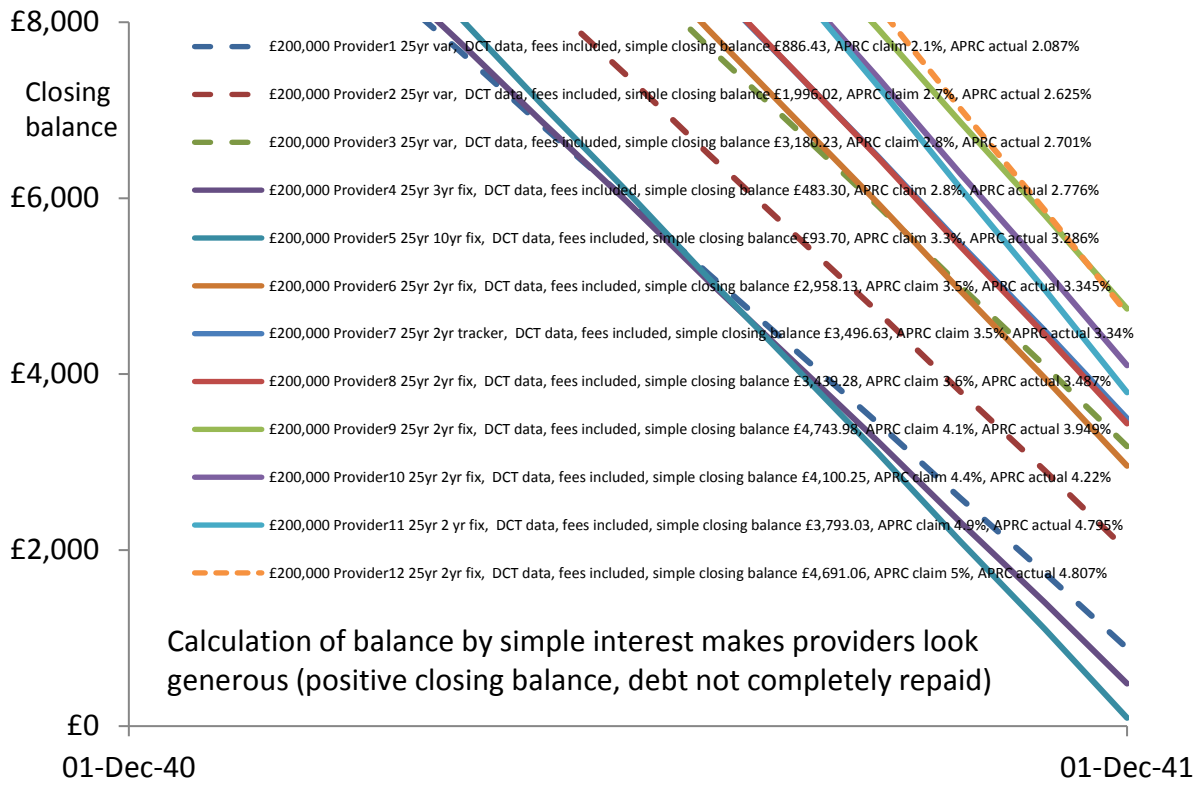


Chart J - Simple interest, fees as extras (not repaid by advertised repayments)

This combination of interest method and fee policy is my guess at what generally happens with mortgages. The near approach to a zero closing balance is the clue. Sadly, simple interest is not a true representation of the time value of money.

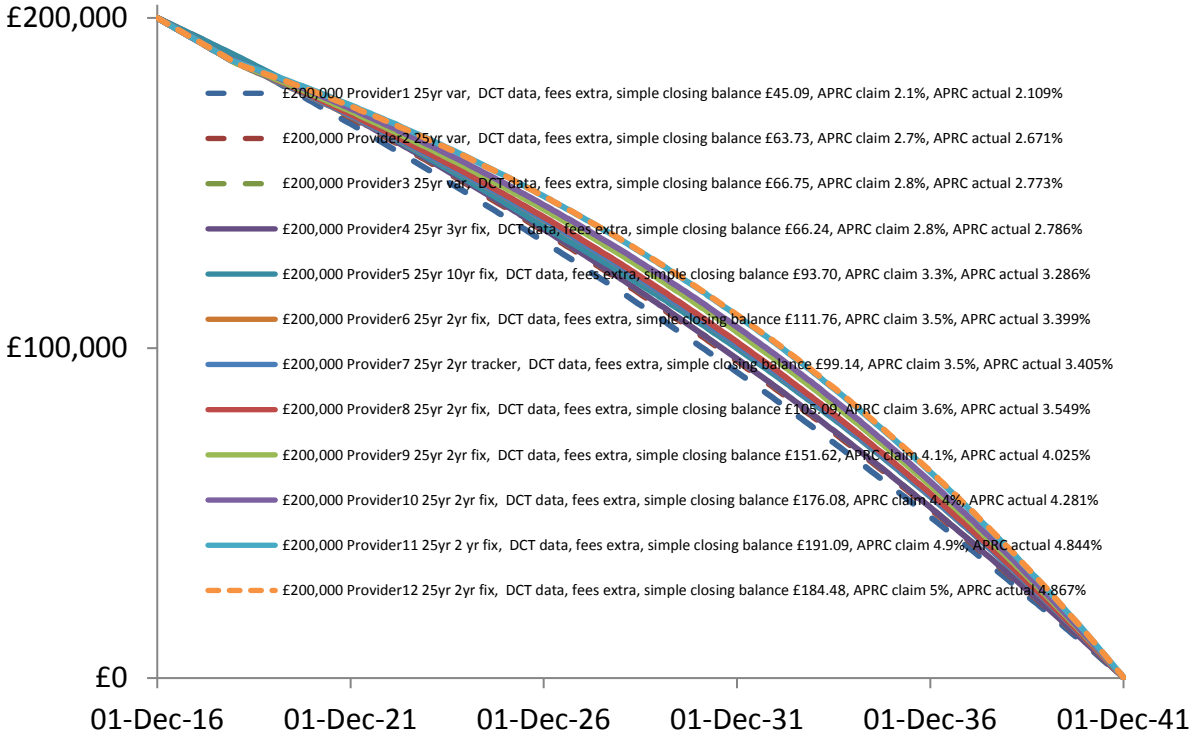


Chart K - The final year of Chart J

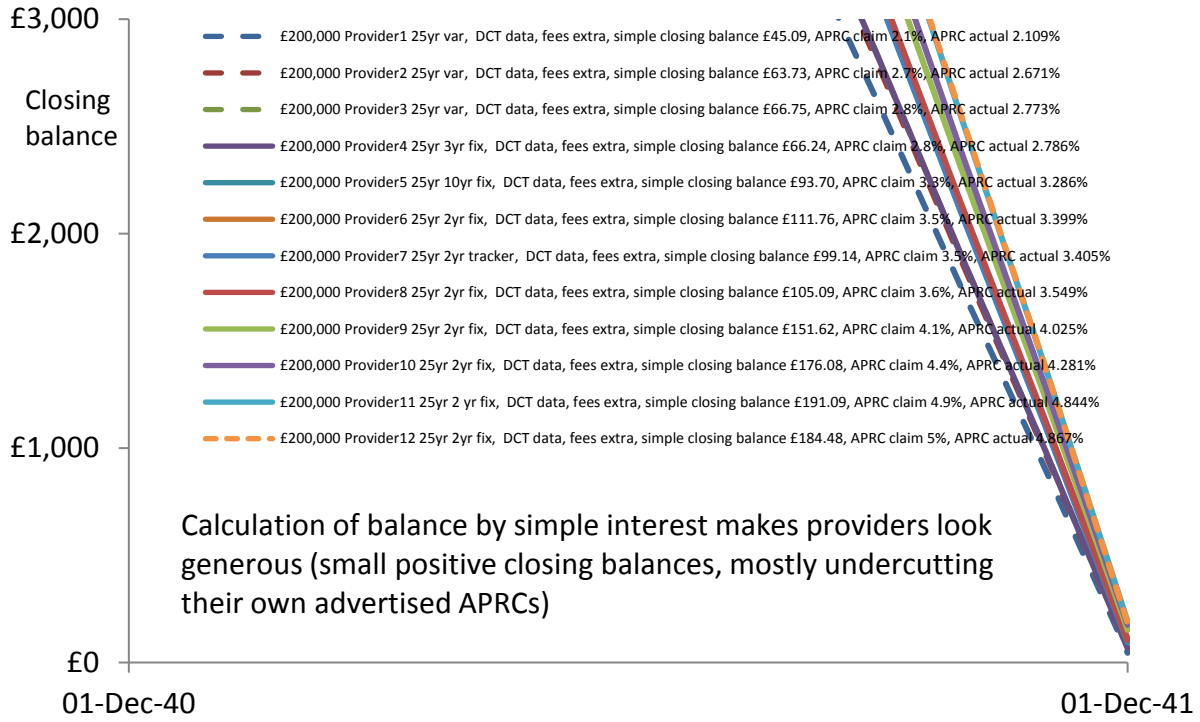


Chart L - Proper compound interest, fees included, "Goal Seeked" introductory repayments.

This is my best attempt so far to show what should happen.

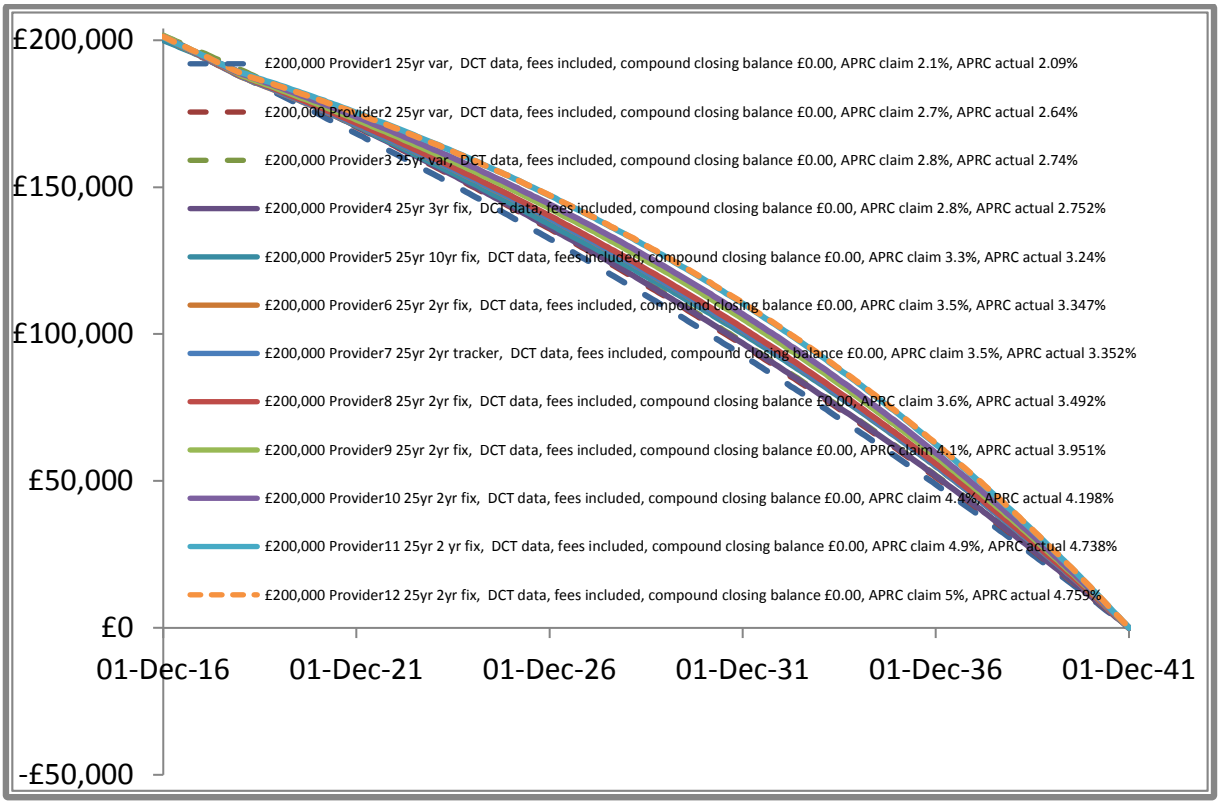
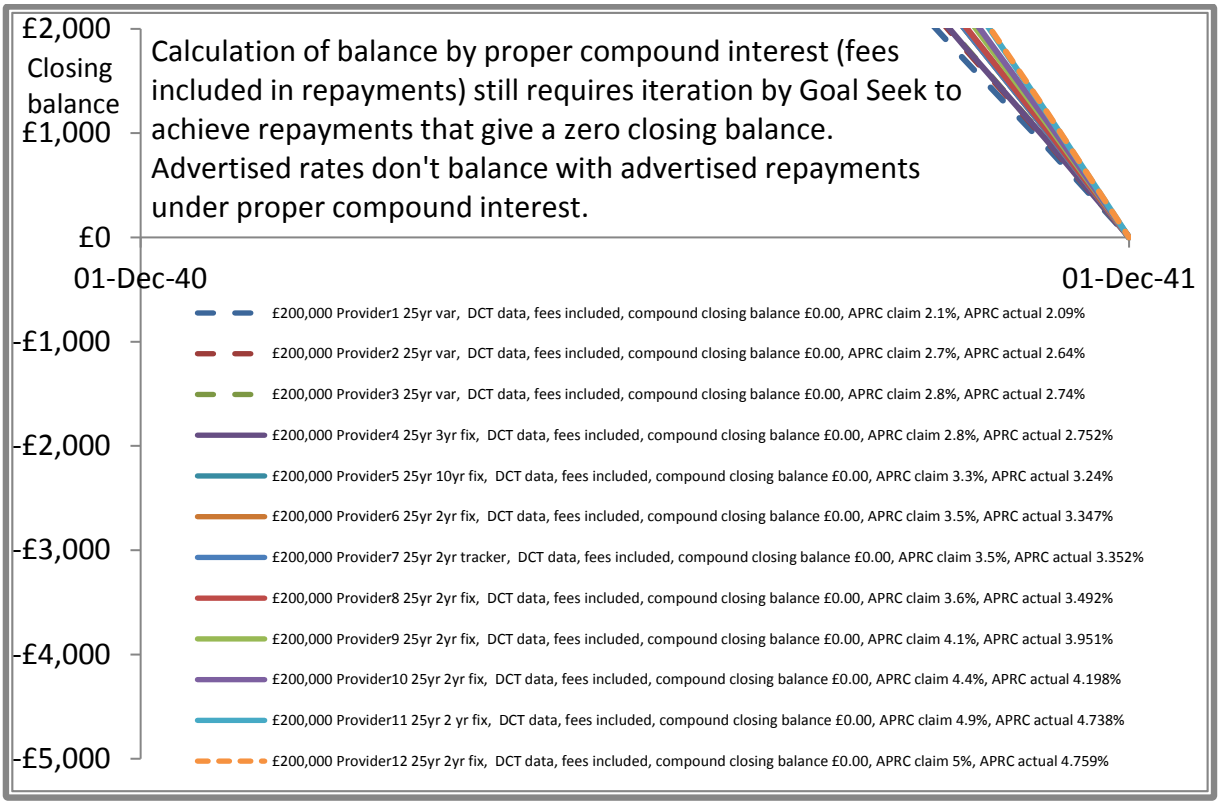


Chart M - The final year of Chart L



Sheet C The first few rows of my 2,212 row spreadsheet (sized for analysing up to a 30 year mortgage).

This version shows the closing balances using the advertised monthly repayments and rates. It also shows the corrections to the initial repayment (Monthly A) needed to bring the proper compound interest (fees included in repayments) closing balance to zero. In my current opinion, a multi-rate repayment mortgage has too many degrees of freedom for there to be a single equation linking all parameters and iteration is therefore required to achieve a zero closing balance. The Calc1 and Calc2 checks investigate inconsistencies in reported data sets.

	Count	Date	Provider1 25yr var	Provider2 25yr var	Provider3 25yr var	Provider4 25yr 3yr fix	Provider5 25yr 10yr fix	Provider6 25yr 2yr fix	Provider7 25yr 2yr	Provider8 25yr 2yr fix	Provider9 25yr 2yr fix	Provider10 25yr 2yr fix	Provider11 25yr 2 yr fix	Provider12 25yr 2yr fix	input
Source			DCT data	DCT data	DCT data	DCT data	DCT data	DCT data	DCT data	DCT data	DCT data	DCT data	DCT data	DCT data	input
Mortgage (Purchase Value - Deposit)			£200,000.00	£200,000.00	£200,000.00	£200,000.00	£200,000.00	£200,000.00	£200,000.00	£200,000.00	£200,000.00	£200,000.00	£200,000.00	£200,000.00	input
Int% A			2.09	2.64	2.74	2.79	2.89	1.45	1.44	1.54	1.49	1.50	1.50	1.49	input
Int% B			2.09	2.64	2.74	2.74	3.99	3.75	3.74	3.89	4.49	4.74	5.44	5.54	input
Stated %APRC			2.1	2.7	2.8	2.8	3.3	3.5	3.5	3.6	4.1	4.4	4.9	5.0	input
%APRC calc, fees not included in repayments			2.10894	2.67066	2.77312	2.78555	3.28620	3.39938	3.40517	3.54896	4.02503	4.28129	4.84430	4.86749	calc
%APRC calc, fees included in repayments			2.08676	2.62498	2.70107	2.77585	3.28620	3.34506	3.34028	3.48710	3.94921	4.21955	4.79474	4.80667	calc
%APRC calc, fee effect			0.02218	0.04568	0.07204	0.00970	0.00000	0.05432	0.06489	0.06186	0.07581	0.06174	0.04956	0.06083	calc
Months A			300	300	300	35	121	24	23	23	24	22	23	25	input
Monthly A advert			£856.50	£911.40	£921.60	£926.72	£937.02	£795.18	£794.25	£803.64	£798.93	£799.87	£799.87	£798.93	input
Monthly A for proper zero closing balance			£856.81	£912.90	£925.51	£911.37	£927.34	£797.08	£805.98	£808.23	£800.47	£778.97	£747.03	£757.83	Goal Seek
Monthly A correction for proper zero closing balance			£0.31	£1.50	£3.91	-£15.35	-£9.68	£1.90	£11.73	£4.59	£1.54	-£20.90	-£52.84	-£41.10	calc
Months B			0	0	0	265	179	276	277	277	276	278	277	275	input
Monthly B			£0.00	£0.00	£0.00	£922.13	£1,010.31	£1,009.66	£1,009.35	£1,025.29	£1,085.36	£1,113.87	£1,187.89	£1,195.76	input
Stated Int			£56,949.75	£73,419.95	£76,479.47	£76,798.55	£94,225.08	£97,750.96	£97,857.87	£102,488.52	£118,733.21	£127,252.35	£147,442.66	£148,806.98	input
Admin/Product fee			£499.00	£800.00	£1,295.00	£0.00	£0.00	£995.00	£995.00	£995.00	£1,499.00	£895.00	£999.00	£995.00	input
Valuation fee			£0.00	£199.00	£275.00	£210.00	£0.00	£173.00	£400.00	£325.00	£0.00	£380.00	£0.00	£235.00	input
Booking fee			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	input
CHAPS fee			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£90.00	£0.00	£0.00	£0.00	input
Total fees			£499.00	£999.00	£1,570.00	£210.00	£0.00	£1,168.00	£1,395.00	£1,320.00	£1,589.00	£1,275.00	£999.00	£1,230.00	calc
Stated total payable			£257,448.75	£274,418.95	£278,049.47	£277,008.55	£294,225.08	£298,918.96	£299,252.87	£303,808.52	£320,322.21	£328,527.35	£348,441.66	£350,036.98	input
Calc1 = Monthlies + fees			£257,449.00	£274,419.00	£278,050.00	£277,009.65	£294,224.91	£298,918.48	£299,252.70	£303,809.05	£320,322.68	£328,528.00	£348,441.54	£350,037.25	calc
Calc2 = Mortgage + fees + interest			£257,448.75	£274,418.95	£278,049.47	£277,008.55	£294,225.08	£298,918.96	£299,252.87	£303,808.52	£320,322.21	£328,527.35	£348,441.66	£350,036.98	calc
Calc1 minus Stated			£0.25	£0.05	£0.53	£1.10	-£0.17	-£0.48	-£0.17	£0.53	£0.47	£0.65	-£0.12	£0.27	calc
Calc2 minus Stated			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	calc
minus PMT() A			£856.50	£911.40	£921.60	£926.72	£937.02	£795.18	£794.25	£803.64	£798.93	£799.87	£799.87	£798.93	calc
Monthly A minus minus PMT()			£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	calc
End A simple balance			£45.09	£63.73	£66.75	£183,189.68	£136,157.93	£186,529.27	£187,085.47	£187,243.53	£186,595.09	£187,741.29	£187,180.59	£186,032.30	calc
minus PMT() B						£922.15	£1,010.57	£1,009.66	£1,009.37	£1,025.31	£1,085.36	£1,113.86	£1,187.91	£1,195.79	calc
Monthly B minus minus PMT()						-£0.02	-£0.26	£0.00	-£0.02	-£0.02	£0.00	£0.01	-£0.02	-£0.03	calc
Closing simple, fees not included in repayments			£45.09	£63.73	£66.75	£66.24	£93.70	£111.76	£99.14	£105.09	£151.62	£176.08	£191.09	£184.48	calc
Closing compound, fees not included in repayments			-£714.87	-£1,285.26	-£1,414.66	-£1,429.23	-£2,431.42	-£2,697.08	-£2,709.98	-£3,023.21	-£4,394.50	-£5,196.94	-£7,682.91	-£7,958.71	calc
Closing simple, fees included			£886.43	£1,996.02	£3,180.23	£483.30	£93.70	£2,958.13	£3,496.63	£3,439.28	£4,743.98	£4,100.25	£3,793.03	£4,691.06	calc
Closing compound, fees included			£122.32	£631.94	£1,672.66	-£1,015.69	-£2,431.42	£107.94	£638.28	£258.75	£103.33	-£1,363.02	-£4,188.62	-£3,590.68	calc
Opening balance, fees not included		01-Dec-16	-£200,000.00	-£200,000.00	-£200,000.00	-£200,000.00	-£200,000.00	-£200,000.00	-£200,000.00	-£200,000.00	-£200,000.00	-£200,000.00	-£200,000.00	-£200,000.00	
	1	01-Jan-17	£856.50	£911.40	£921.60	£926.72	£937.02	£795.18	£794.25	£803.64	£798.93	£799.87	£799.87	£798.93	
	2	01-Feb-17	£856.50	£911.40	£921.60	£926.72	£937.02	£795.18	£794.25	£803.64	£798.93	£799.87	£799.87	£798.93	