B The Strategic Debt Analysis model and a comparison of debt issuance strategies

B.1 The Strategic Debt Analysis (SDA) model – which is described in detail in Chapter 6 of the *DMO Annual Review 2005-06* and in a DMO discussion paper[27] - is a debt strategy simulation model used by the DMO to illustrate the debt service cost and risk of different debt issuance strategies, given assumptions about the shape of both the nominal and real yield curves. The model is not used to determine a single optimal debt issuance strategy but to illustrate the cost and risk trade-off of different issuance strategies. Simulations using this model are set out below.

Design of simulation exercises - debt service cost and risk measures

B.2 The cost of the debt in any given period is defined as the sum, in cash flow terms, of all nominal coupon payments.[28] The debt service cost is measured as a ratio with respect to nominal GDP as this provides a clearer indication of the debt cost burden to the Government than does the nominal cost of debt on its own.[29]

B.3 The risk measures capture the concept of financing risk, that is, the uncertainty in the financing or cash flow cost related to a given borrowing strategy. The financing risk associated with a given debt strategy is evaluated by:

- the standard deviation of the debt cost ratio, which measures its volatility in terms of deviations around the average (i.e. a symmetric measure); and
- the debt service cost ratio-at-risk, which is the largest debt cost ratio only exceeded by five per cent of possible realisations according to the probability distribution of the debt cost ratio.[30] The debt service cost ratio-at-risk is a useful risk measure especially when the Government is concerned about avoiding extremely high debt costs (i.e. a tail measure).

Initial conditions for the simulation

B.4 The initial conditions for the simulation exercises in the SDA model are the:

- initial portfolio - gilt portfolio as at 31 March 2009 (excluding all undated gilts). This includes not only the outstanding amounts of gilts issued, but also their coupons (in previous versions of this analysis, coupons were estimated from the yield curve model and were lower than actual coupons);

[27] Pick, A and ML Anthony (2006), "A simulation model for the analysis of the UK's sovereign debt strategy", UK DMO working paper. This paper can be found on the DMO's website at: http://www.dmo.gov.uk/index.aspx?page=Research/DMO_research

[28] The sum of interest payments on nominal bonds, inflation compensated interest payments on inflation-linked bonds and the realised inflation compensation effects on maturing inflation-linked bonds.

[29] The model assumes the debt-to-GDP ratio converges towards 40 per cent.

[30] Or the upper 95th percentile of the debt service cost ratio distribution.

- initial values for the macroeconomic variables,[31] which are their respective long-run average values; and
- initial nominal and real yield curves, which are generated from the long-run average values of those macroeconomic variables that are used to explain how the yield curves vary through time.[32] The yield curves now extend to the 50-year maturity.

B.5 The simulation horizon is 50 years (200 quarters) and 10,000 replications for each simulation exercise are completed.

Issuance strategies

B.6 Table B.1 contains five issuance strategies. Strategies 1 and 4 comprise around 75 per cent conventional gilts and 25 per cent index-linked gilts. Strategies 2 and 3 comprise around 85 per cent conventional gilts and 15 per cent index-linked gilts. Ultra-short (1-year maturity) and ultra-long (50-year maturity) issuance categories have been included.[33] In terms of the maturity breakdown, Strategy 1 has a fairly even allocation across buckets while Strategies 2 and 3 are skewed towards short-term issuance. The skew is more pronounced for Strategy 3, which has the highest proportion of short maturity gilts. On the contrary, strategy 4 is skewed towards long-term issuance. Finally, strategy 5 represents an extreme issuance programme with 100 per allocation to long conventional gilts. It is useful to include this last strategy as it provides a floor in terms of debt service cost and a ceiling in terms of cost at risk given the prevailing downward sloping yield curve.[34]

Table B.1: Composition of issuance strategies (per cent)

	1-year conv[1]	5-year conv	10-year conv	30-year conv	50-year conv	10-year I-L[2]	30-year I-L	50-year I-L	Total I-L
Strategy 1	7.5	17.5	25.0	12.5	12.5	12.5	10.0	2.5	25
Strategy 2	2.0	31.0	33.0	9.5	9.5	4.0	5.5	5.5	15
Strategy 3	15.0	28.0	23.0	11.0	9.0	3.0	8.0	3.0	14.0
Strategy 4	8.8	8.8	17.5	20.0	20.0	12.5	10.0	2.5	25
Strategy 5	0	0	0	50.0	50.0	0	0	0	0
Actual 2008-09	15.6	28.0	23.2	11.0	9.0	2.6	7.6	2.9	13.1

Source: Debt Management Office

1. Conventional gilts
2. Index-linked gilts

[31] The macroeconomic variables in the SDA model are the output gap, the net primary financing requirement (CGNCR, excluding interest payments), the short interest rate, CPI inflation and RPI inflation.

[32] The macroeconomic variables used to explain the behaviour of the yield curves are the output gap, the short interest rate, CPI inflation and RPI inflation. The yield curve has been re-estimated and re-calibrated to include the last four and a half years of data up to the second quarter of 2008.

[33] In order to split short 5-year issuance into ultra-short and short categories, historical proportions of 30 per cent ultra-short and 70 per cent short have been applied (these represent actual issuance in the years 2003 and 2004 when ultra-short issuance was used). Similarly, in order to split long 30-year issuance into long and ultra-long categories, historical proportions of 50 per cent long and 50 per cent ultra-long have been applied (these represent actual issuance in the last 4 years since 2005 when ultra-long issuance started).

[34] As discussed in Chapter 6: Strategic Debt Analysis (SDA), DMO Annual Review 2005-06.

Simulation results

B.7 The debt service cost-risk trade-off of each of the five issuance strategies has been calculated assuming that the nominal and real yield curves are downward sloping at the long end of the curve. Specifically, the simulated average shape and slope of the nominal yield curve have similar properties to the average nominal yield curve from 1998 to 2008 - as the SDA model has been recently re-calibrated on the basis of this dataset (previously, it included data up to 2004 only). This can be seen in Table B.2 when comparing the mean and standard deviation of selected maturity points on the actual nominal yield curve with those on the simulated yield curve.

Table B.2: Actual and simulated nominal interest rates (per cent)

	Actual (1998 Q1 – 2004 Q4)		Simulated (1998 Q1 – 2004 Q4)		Actual (1998 Q1 – 2008 Q2)		Simulated (1998 Q1 – 2008 Q2)	
	Mean	Standard deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
1-year	4.7	0.9	4.6	0.7	4.9	0.9	4.5	0.9
5-year	4.9	0.7	4.6	0.6	4.9	0.6	4.8	0.7
10-year	4.8	0.4	4.5	0.4	4.8	0.4	4.7	0.6
30-year	4.5	0.2	4.3	0.2	4.5	0.3	4.4	0.3

Source: Debt Management Office

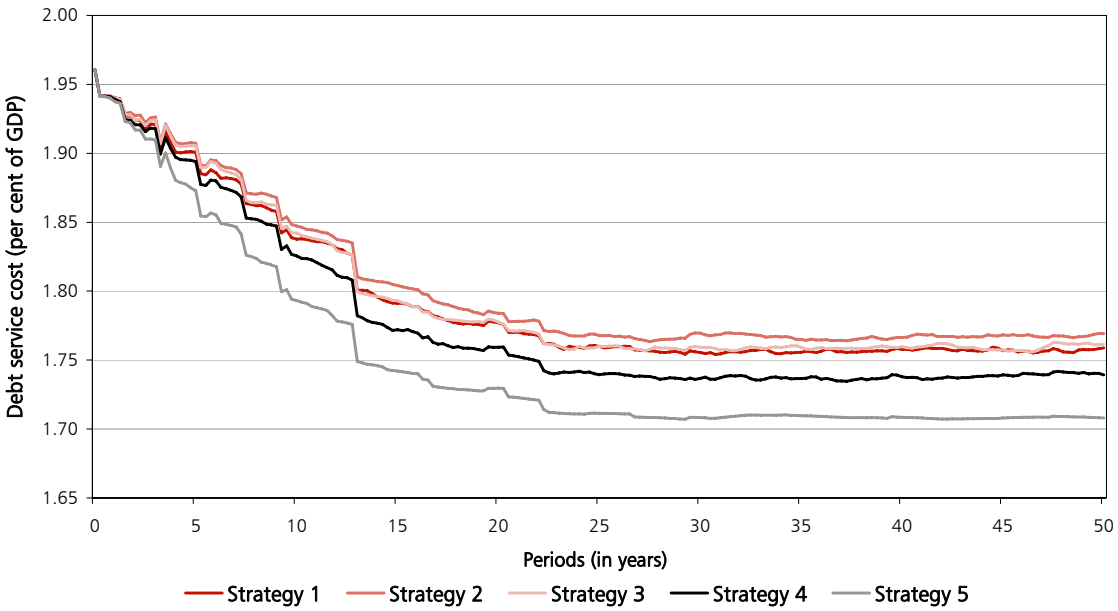
B.8 As explained in Box 3.B, short maturity gilt yields have fallen significantly during the last year, resulting in an upward sloping average nominal yield curve in that maturity segment. In this context, it should be emphasized that the SDA models what the yield curve has been, on average, from 1998 to 2008. Within that average, its 10,000 replications include many different shapes of the yield curve, some of which will be upward sloping as a result of different economic outcomes. Overall, actual mean yields over the updated period continue to be consistent with an underlying downward sloping yield curve, in line with the SDA's calibration approach.

B.9 The results for the average debt service cost (see Chart B.1) show that all the issuance strategies which are skewed to long maturity gilts have lower average debt service cost than Strategy 2, which is the most expensive. Strategy 5 is the cheapest strategy as it contains the largest share of the relatively cheaper long maturity gilts than the other strategies. Strategies 1 and 3 exhibit almost identical costs and are slightly cheaper than strategy 4, despite the larger proportion of long maturity gilts in strategy 4. It should be noted that the starting point of the chart is around 8 per cent higher than it would have been if the estimated coupons had been used rather than the actual ones (see paragraph B.4).

B.10 The downward trend in the average debt service cost of strategies 2 to 5 in Chart B.1 reflects two factors. First, and as a result of using actual coupons for the starting portfolio, maturing old gilt issues with high coupons are gradually being replaced by new gilt issues with estimated coupons, which are comparatively lower, for historical reasons. Second, over time, the maturity mix of the starting portfolio is being altered towards a composition as defined by the issuance strategies, for example, introducing new cheaper gilts if the issuance strategy increases the long-term skew.

B.11 It should be noted that although strategy 2 appears to be the most expensive, this is due to the assumption of a downward sloping yield curve. Under different assumptions (such as the current scenario of low short-term nominal yields) the same strategy would become cheaper.

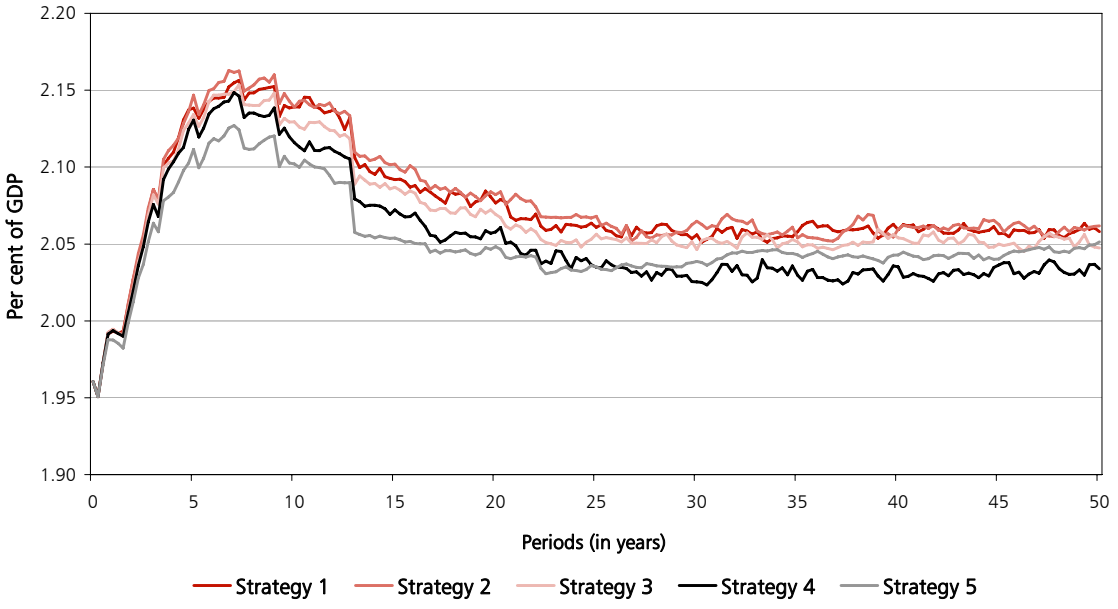
Chart B.1: Average debt service cost



Source: Debt Management Office

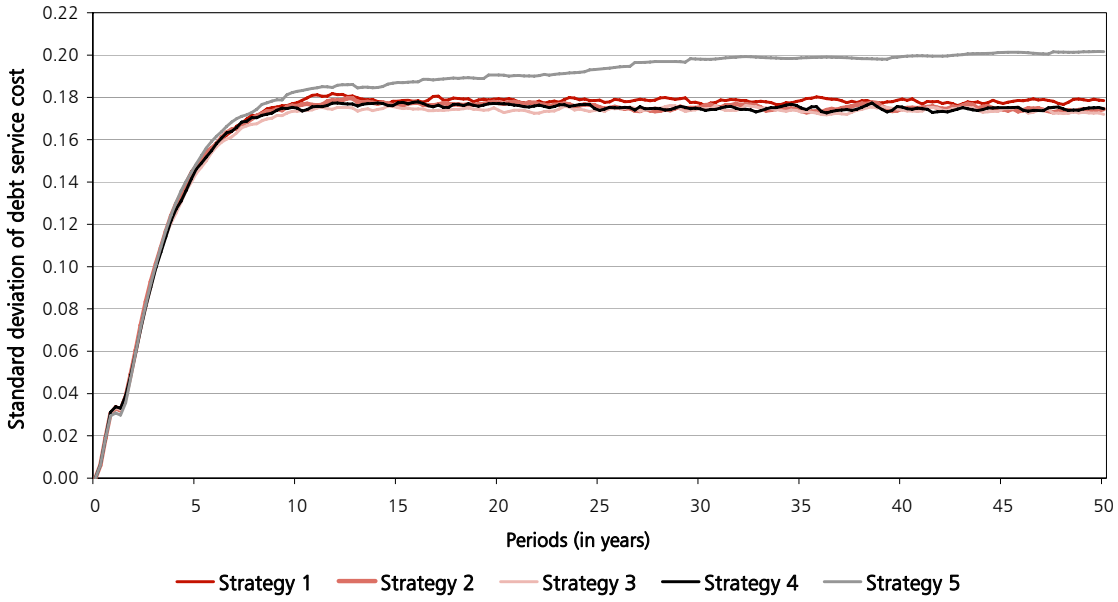
B.12 The results for risk show that overall strategies 1 and 2, closely followed by 3, are less risky than the other issuance strategies (see Charts B.2 and B.3 below). This reflects the larger shares of long maturity gilts compared to strategy 1. Strategy 5 seems to be less risky than strategy 4 during the first half of the simulation horizon but later becomes increasingly riskier. This is because, as time progresses and more of the existing portfolio consists of longer-term gilts, strategy 5 only samples long-term yields and, although these yields vary across replications and time periods, they are highly correlated affecting negatively the risk measures.

Chart B.2: Debt service cost at risk



Source: Debt Management Office

Chart B.3: Standard deviation of debt service cost



Source: Debt Management Office

B.13 The general profile for both measures of risk is somewhat similar. In the first 5 to 10 years of the simulation, there is a sharp increase in the risk measures, followed by a reduction thereafter (albeit more evident in Chart B.2 than Chart B.3) before settling. This reflects mainly two effects. On the one hand, at the start of the simulation the range of the debt service cost widens as the economic outcomes vary, while over time their distribution and volatility settles. On the other hand, existing high coupon gilts are unwinding and being replaced by new gilts with lower, more stable, coupons, reducing cost volatility gradually.

B.14 Simulation results from the SDA model confirm its initial finding that the Government could achieve a better debt service cost - risk trade-off by skewing issuance towards long maturity gilts in circumstances in which the average yield curve is downward sloping. Issuance strategies that display a larger proportion of long maturity gilts tend to be cheaper and less risky than issuance strategies with a smaller allocation of these gilts. This result is robust to a re-calibration of the yield curve extending the dataset considered to mid-2008. However, a strategy such as strategy 3, in which the short-term skew is pronounced, still achieves similar cost but lower risk than strategy 1, which has an even allocation of issuance across maturity buckets. This might be due to the impact of the 2008-09 data on the model, which influences the results by allowing for lower yields in the short end of the curve while maintaining a downward sloping yield curve in the medium and long end.

B.15 It is worth bearing in mind that the highly stylised simulation modelling only captures one risk to which the Government's gilt issuance plans expose the Exchequer (i.e., the variability in debt servicing costs over time reflecting different economic scenarios, which affect the yield curve, the amount of financing needed and the resulting cost of refinancing at those yields). In practice, debt issuance exposes the Exchequer to other risks that lie outside the scope of the model, such as, for example, execution risk. In light of volatile financial market conditions, in which gilt yields can move sharply, the market value of gilts held by dealers can change. This risk is higher for long maturity and index-linked gilts because the market value of these gilts is particularly sensitive to a given change in yields. This may translate into increased execution risk for the DMO and the markets. The Government considers all of these risks when making its gilt issuance decisions.