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Reporting and Performance Measurement of Futures and Options

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Summary

The main conclusions of this paper are that:

(a) most institutions have fairly similar reporting requirements, but the portfolio reports they currently receive often leave much to be desired;

(b) the best way to illustrate the impact of futures and options in most cases is to concentrate on associated economic exposure (ie the effective exposure to the underlying security or market being bought or sold) rather than on the size of margins or option premiums;

(c) a reasonably straightforward way to summarise exposure can be formulated. If adopted it would result in considerable improvement in the readability and usefulness of reports. Most managers do not currently report in this way, and it is proposed that this type of format is adopted as an industry standard; and

(d) performance measurement should also concentrate on exposure not margins. There is a general need to improve the liaison between performance measurers and managers, and to increase the level of training of personnel involved in providing source data.

Résumé

Rapports et Mesure de Performance des Contrats à Terme et des Options

Les principales conclusions sont les suivantes:

(a) la plupart des institutions ont des exigences assez similaires en matière d'éléments devant figurer dans les rapports mais les rapports de portefeuilles qu'elles reçoivent actuellement laissent beaucoup à désirer;

(b) la meilleure façon d'illustrer l'impact des contrats à terme et des options dans la plupart des cas, est de se concentrer sur le risque économique associé (associated economic exposure) (c'est-à-dire le risque réel par rapport à la garantie ou marché sous-jacent acheté ou vendu) plutôt que sur la taille des marges ou primes d'options;

(c) il est possible de formuler une façon assez simple de résumer le risque. Si elle était adoptée, elle améliorerait grandement la clarté et l'utilité des rapports. La plupart des gestionnaires n'effectuent pas actuellement leurs rapports de cette façon, et il est proposé que ce type de format soit adopté en tant que norme de l'industrie; et

(d) la mesure de performance devrait également se concentrer sur le risque et non pas les marges. Il existe un besoin général d'améliorer les rapports entre ceux qui mesurent la performance et les gestionnaires, et d'augmenter le niveau de formation du personnel qui s'occupe de la fourniture des données de base.

1. THE IMPACT OF DERIVATIVES ON PORTFOLIO BEHAVIOUR

1.1 Futures

Futures contracts are tools which can alter the effective proportions of the fund held in different types of asset, without assets of one sort being sold and others being bought. A portfolio which includes futures contracts simulates the behaviour of a portfolio with different asset weightings which does not have such futures contracts.

The key advantage of futures is that the asset mix can be altered **quickly**, typically much more quickly than if the underlying securities are actually bought or sold, and this alteration may have less impact on market levels (depending on the liquidity of the futures contract being used). There can also be significant cost benefits to using futures.

1.2 Perhaps an example will illustrate the impact futures have. Suppose a manager has a portfolio consisting of £50m equities, £30m gilts and £20m cash. The manager then decides to reduce exposure to equities by £15m and to increase exposure to gilts by £20m. This requires a balancing decrease in exposure to cash of £5m (ie £20m less £15m). The manager may wish to alter the portfolio's exposure very quickly, more quickly than it is possible to deal in the underlying physical securities markets.

A way to alter the portfolio exposure is to use futures with an **associated economic exposure** of £20m, and to sell equity futures with an associated economic exposure of £15m, pending redistribution of the underlying assets. The portfolio mixes before and after purchase of the futures are:

	Portfolio mix before purchasing futures £m	Impact of futures £m	Effective portfolio mix after purchasing futures £m
Equities	50	- 15	35
Gilts	30	+ 20	50
Cash	20	- 5	15
	100	0	100

NB This approach would usually be refined to meet more detailed accounting requirements.

1.3 The portfolio actually contains £50m equities, £30m gilts and £20m cash as well as a LONG (or positive) position in gilt futures and a SHORT (or negative) position in equity futures. However, it **simulates** the behaviour of a portfolio consisting of £35m equities, £50m gilts and £15m cash which has no futures holdings whatsoever. Thus if the gilt market rose by 10% the value of the portfolio would increase by £5m (ie 10% of £50m), rather than £3m (10% of the £30m actually held in gilts).

1.4 **Associated Economic Exposure**

What do we mean by the "associated economic exposure" of the future: Take, for example, the FT-SE 100 Index future. In effect the future is a means of buying (or selling) the basket underlying the FT-SE 100 Index. However the margin procedure means that only a deposit needs to be lodged against this purchase. In the case of the FT-SE 100 Index futures this might be a returnable deposit of £2,500 controlling an economic exposure to the index of about £60,000 at current levels.

One way of defining the "associated economic exposure" is to calculate the value of the overall portfolio to which the future relates. As a first approximation this may be calculated as the value of the security (in this case the FT-SE 100 Index futures) times the number of units "purchased" (or "sold") by using the future.

1.5 **It is also possible to define "associated economic exposure" in a manner more in tune with how the portfolio might behave.** This can be done by considering what happens if markets move say 1% up or down. In the above example the portfolio would, all other things being equal, decrease in value by 1% of £15m or £150,000 for each 1% increase in the index, so that another way of defining the "associated economic exposure" to equities of the portfolio from the FT-SE 100 Index futures contracts is:

$$-\frac{£150,000}{1\%} = -£15m$$

This type of calculation might be described as "differential" exposure, as it measures how the value of the portfolio might alter if small "moves" occur in the values of the underlying markets/stocks.

Because a future can be regarded as a surrogate investment, the "associated economic exposure" for a **futures** contract is the same in either calculation. However, this equivalence does **not** hold for options.

The "associated economic exposure" of a future is the most important aid to understanding the impact the future can have on portfolio behaviour, although in certain circumstances it can itself be misleading.

1.6 **Options**

Options can be used by managers either to protect (insure) a portfolio, or to enhance income or portfolio efficiency. If a manager holds a share, eg ICI, and buys a **put** option on that share, ie an option to sell at a given price, then the portfolio is gaining insurance against the share price falling. If, instead, the manager writes a **call** option on that share (ie grants another party the option to buy at a given price) then premium income is generated to enhance income.

There is a fundamental lack of symmetry between the writer (seller) and the buyer of an option. The writer provides the insurance whilst the buyer

obtains it (with the buyer's loss being limited to the amount of the options premium). Premium is normally paid to the seller at the time of the transaction. In order to establish what impact an option contract might have it is necessary not only to identify whether the option is a put or a call but also on which side of the transaction the participant lies and the level at which the option takes effect, ie the option exercise price.

1.7 The "insurance" concept applies only if the underlying security moves in value by large amounts. Thus for example, if a manager holds eg ICI shares, and buys put options on those shares, then a floor is placed below which the combination of shares plus options cannot fall, ie the "risk" of a fall in the value of ICI shares is limited. The option in these circumstances will act in much the same way as a futures contract relating to the whole of the value of the underlying security. Where it differs is if the price of the share rises. In such a case the fund benefits from an appreciation in the value of its holding and can allow the option to lapse without value. A possible way of measuring exposure which relates to this "insurance" concept might therefore be the full market value of the securities underlying the option position.

However, investment managers often use options as a means of gaining market exposure more cheaply or with less risk than buying the underlying securities or as a means to enhance income. **Because of this, it is often more useful with options to record the way in which the portfolio behaves if the underlying security moves by relatively small amounts, ie along the lines of the "differential" exposure.**

1.8 **The lack of symmetry between the buyer and seller of an option means that these two different ways of calculation "associated economic exposure" are not identical.**

Calculating the exposure of an options solely as the current market value of the underlying security is straightforward given readily available details of the option contract. "Differential" exposures are more difficult to calculate. They may be determined from option pricing models or

from option "deltas" or "hedge ratios" often quoted by option brokers in pricing material.

A major weakness of exposure calculated solely by reference to the market value of the underlying securities is that the exposure of a combination of two or more option positions of different types in not necessarily equal to the sum of the exposures of each position in isolation. For example, suppose the portfolio had both a LONG put option exercisable at one price and a similar SHORT put option but exercisable at a different price and at a different date. Each position in isolation would, on this basis, have equal but opposite exposures and if these numbers were merely added together in isolation they would cancel out. However, the combined position does have a significant impact on portfolio behaviour, so it is incorrect to conclude from this that the net impact of the options is zero. In practice this means that any presentation of exposure on such a basis can be rather complicated to present to trustees or management boards.

1.9 It is worth noting in this context that call and put options are more interchangeable than might appear at first sight. This is because a portfolio consisting of cash plus call options should behave identically to a portfolio consisting of corresponding amounts of securities and put options. This identity, which can be set out algebraically as:

CASH + CALL = SECURITY + PUT

can be rearranged, so that a manager can for example buy a security and put options, by selling cash and be in the same position as if call options had been bought.

NB The same formula also applies if "SECURITY" is replaced by "FUTURE" provided an adjustment is made to reflect the future income receipts.

1.10 **Margin and Premium Payments**

A possible way of showing the behaviour of futures and options is to concentrate on the margins or premiums initially paid when a futures or options position is established.

Exchange-traded futures contracts operate on what is called a margined basis. This means that at any point in time investors opening futures positions have to put up a returnable deposit (typically in cash, although it can be in the form of securities) called the "initial margin" to the exchange's clearing house.

1.11 The amount of the initial margins deposited for a futures contract is **not** the same as the "associated economic exposure" gained from the future; for LIFFE futures contracts it is typically only 0.5-5% of the exposure gained (and this percentage can vary during the lifetime of the future depending on market conditions). **The danger of concentrating on the initial margin is that a portfolio can appear to be highly liquid (ie there can appear to be plenty of cash available for investment) when in fact the portfolio can be overdrawn because it simulates the behaviour of one with a much lower cash balance (possibly negative).**

Thus, for example, a portfolio might consist of £100m, split £50m in equities and £50m in cash. If the manager buys a further £100m of equity exposure using futures, and the margin required for the is 5% of the overall value ie £5m, then at first glance the portfolio appears to have a positive cash balance available for investment of £45m (ie £50m less the margin put up of £50m). However the actual effective portfolio mix after purchase of the future is:

	Apparent Portfolio mix £m	**Impact of futures £m**	**Effective Portfolio mix £m**
Equities	50	+ 100	150
Equity Margins	5	- 5	-
Cash	45	- 95	- 50
	100	0	100

The fund is thus geared or leveraged, because it has a negative effective overall cash holding (despite having a positive apparent cash balance). If equities were to collapse in value to zero, the fund would be left with an overdraft of £50m

without any assets, since the £5m of margin already deposited would have been retained by the clearing house, and a further £95m of additional margin would have been called in as well (see section 1.13). It is thus necessary to hold £95m of **additional cash backing the future** as well as the margin of £5m if the portfolio is not to be overdrawn. Many institutions specifically prohibit their managers from gearing or selling short. If futures are used this prohibition needs to be formulated so that unintentional gearing in the manner set out above is not permitted (in effect the requirement is that all of the numbers in the third column are non-negative).

1.12 It should be noted that while the fund might be geared, or overdrawn, the exchange and the clearing house are not. Futures exchanges operate a "marked to market" system. In this system the daily profit (or loss) from buying or selling the futures is effectively realised at the end of each day and the margin accounts are credited (or debited) accordingly. This profit or loss is called the **variation margin.** Investors can then withdraw funds in excess of the required margin (to invest elsewhere), but they are immediately required to meet any shortfall in funds below the required initial margin. This system generally ensures that any future has a nil (or at most a small positive or negative) net value at the close of each day's trading (in excess of any margin cash that would be released on transfer of the obligation). **It is important to note that the variation margin is received or paid in cash and this can raise practical problems in terms of where to invest the money or where to obtain it if a variation margin is required.**

1.13 To some managers there is a potential advantage from using the margin or premium as the main measure of exposure. Some managers, particularly those running specialist futures and option funds see these derivatives primarily as instruments for allowing a geared investment strategy. These managers use the relatively small up-front margin as the main measure of cost so that they can follow such an investment policy, although this would normally be in association with a cash buffer. While there is a role for this type of fund, we believe that in the normal course of investment most institutions strongly prefer

managers to use the "associated economic exposure" philosophy. However, it does appear to be quite common for fund managers and institutions when they first meet futures to adopt (perhaps unconsciously) the "margin payment" philosophy, and to see futures as high risk and mostly inappropriate for their needs.

1.14 **Summary**

- The best way in most circumstances to illustrate the impact of futures and options is to concentrate on **associated economic exposure.**

- Normally the most useful way to calculate the associated economic exposure of an options is to use **differential** exposure.

- The use of margins or premium is rarely justified unless nothing better is available.

- Where the impact of futures or options could be substantial we recommend this is explained further in accompanying notes.

2. PORTFOLIO VALUATIONS

2.1 Suppose a portfolio initially consists of £100m, invested £50m in equities, £30m in gilts and £20m in cash. It initially has no futures or options. The portfolio mix can be summarised as follows:

	Portfolio Mix **£m**
Equities	50
Gilts	30
Cash	20
	100

If equities rise or fall by 1% but gilts remain unchanged the portfolio will make or lose £500,000 (ie 1% of £50m).

2.2 The investment manager now takes out a negative (SHORT) futures position in UK equities with a total associated economic exposure to the market of £15m. It is assumed that the future is at "fair" value. Suppose the initial margin (ie the

returnable deposit which futures exchanges call from both buyers and sellers of futures contracts) is £0.7m. The net impact of this futures position is to alter the way the portfolio behaves so that it has £15m less exposure to equities. It is as if the portfolio actually contained only £35m in equities (ie £50m - £15m) and £35m in cash (ie £20m + £15M). If equities rise or fall by 10% the portfolio will make or lose £3.5m (ie 10% of £35m). The impact of the future can be shown and explained in a very straightforward way by the following table:

	(1) Apparent Portfolio Mix £m	(2) Impact of Futures £m	(3) Effective Portfolio Mix £m	%
Equities	50.0	- 15.0	35.0	35
Gilts	30.0	0.0	30.0	30
Cash				
- margin	0.7	- 0.7	0.0	0
- remainder	19.3	+ 15.7	35.0	35
	100.0	0.0	100.0	100

Suppose the equity market rose by 10%. The position would then alter to:

	Apparent Portfolio Mix £m	Impact of futures £m	Effective Portfolio Mix £m	%
Equities	55.0	- 16.5**	38.5	37
Gilts	30.0	0.0	30.0	29
Cash				
- margin	0.7	- 0.7	0.0	0
- remainder	17.8*	+ 17.2	35.0	34
	103.5	0.0	103.5	100

* £19.3m less £1.5m (ie 10% of £15m) of variation margin required on futures contract.

** This is the new "associated economic exposure" of the futures contract, ie 110% of £15m (because the market has risen by 10%).

It is possible to show that the behaviour of the

portfolio is as per the "effective asset mix" under other scenarios, eg interest rate changes (provided that the future remains at fair value, and the cash sector is broken down into a number of various component parts reflecting the different sorts of cash actually being simulated).

This approach can also be presented in a single column format, if such a format is considered preferable.

2.3 Gilts can be treated in the same way as equities. However it may be deemed appropriate to adjust the table to take account of differences between the durations of the underlying gilts and the gilt future.

For example, suppose the manager had also taken out a negative (SHORT) futures position, using the long gilt future so as to hedge the gilt portfolio. Suppose the long gilt future currently has a duration of 15 years, and the underlying gilt portfolio has a duration of 10 years. Before adjusting for durations the position might be shown as:

	Apparent Portfolio Mix £m	**Impact of futures** £m	**Effective Portfolio Mix** £m	%
Equities	50	-15	35	35
Gilts	30	-20	10	10
Cash*	20	+35	55	55
	100	0	100	100

* NB - The cash would normally be subdivided into at least the contents of the margin account and the remainder.

This table suggests that if gilts rise in value by 1% then the portfolio would increase in value by 1% of £10m ie £100,000. However, such a price rise implies a fall in the yield on the gilt-edged portfolio which is different to the fall in the yield underlying the future. A more plausible scenario may be to assume that these two yields move by the same amount. If the market value of the gilt edged portfolio rises by 1% (ie £300,000)

then a similar change in the yield underlying the future should cause its "market" value to rise by 1% times the ratio of the duration underlying the future to the duration of the underlying portfolio, ie 1% x 15/10, which is 1.5%. Hence its "market" value also rises by £300,000 (1.5% of £20m) and the net gain or loss to the portfolio is actually nil - the gilt edged portfolio is wholly hedged against uniform shifts in yields, and a more appropriate table may be:

	(1) Apparent portfolio mix £m	(2) Impact of futures £m	(3) Effective portfolio mix £m	%
Equities	50	- 15	35	35
Gilts	30	- 30	0	0
Cash	20	+ 45	65	65
	100	0	100	100

As the net impact of the futures on the gilt weighting has changed, the net impact of the future on the cash weighting must also change to ensure that the total of column (2) is still zero.

In principle a similar sort of adjustment can be applied to equity portfolios if "beta adjusted hedging" is occurring.

2.4 Unlike futures, options do not guarantee that a contract will be exercised. Instead they involve granting an option to carry out an exchange which might or might not be exercised. This means that a simple tabular approach may not be appropriate for options.

Suppose, for example, the manager in example 2.1 instead of opening a future position writes call options on £10m worth of equities with an average "delta" of 0.5. If markets move up or down by a small amount eg 1% then a delta of 0.5 indicates that the "differential" exposure to the market is 0.5 times £10, ie £5m, and all other things being equal the options will increase or decrease in value by £50,000, ie 1% of £5m. Suppose the

option premium is £0.7m, so that the market value of equities plus equity options is £49.3m (ie £50m less £0.7m). Receipt of the premium of £0.7m results in an addition to the market value of the cash sector of £0.7m ie to £20.7m.

Possible ways of setting out the position are:

(a) **"Differential exposure" approach**

This can be set out in three columns as for futures, eg

	Apparent Portfolio Mix £m	**Impact of Options** £m	**Effective Portfolio Mix** £m	%
Equities and Equity Options	49.3	- 4.3	45.0*	45
Gilts	30.0	0.0	30.0	30
Cash	20.7	+ 4.3	25.0	25
	100.0	0.0	100.0	100

* This is £50m of equities minus the £5m of "differential exposure" arising from the options. The effective exposure to cash increases accordingly.

Its main advantage is that it is easily incorporated into the same format as the future and a variety of different option positions can be accommodated simultaneously. It may be appropriate to show the impact of futures and options in two separate columns. Its main disadvantage is that "differential exposure" may be complicated to explain or to calculate, and will vary according to the information source used.

(b) **"Full exposure" approach**

This also can be set out in a three column format as per (a), but requires a balancing item to ensure that the effective portfolio mix still totals £100m. Its main weakness is that the impact of the option is not symmetrical and different tables are needed for up and down movements in markets, and for different types of

option. However, this method does have the advantage that it does identify the face value of the securities underlying the options.

(c) **Multiple Ranges of Market Movements**

A table or series of tables could show how the portfolio might behave under a range of potential market movements. For example the table might show:

Portfolio Mix		**Equity Market Moves by**				
	£m	**-100%**	**-1%**	**0**	**1%**	**100%**
Equities	50.0					
Equity Options	-0.7	0	-0.65	-0.7	-0.75	-10.0
Gilts	30.0					
Cash	20.7					
	100.0					

This layout is more comprehensive than either (a) or (b) although it does not directly identify the face value of the securities underlying the options positions. It could be set out either in a single table as above, or as a series of different tables each identifying what happens under a specific market event.

The central figures (ie -1%, 0% and 1% market movements) provide effectively the same information as approach (a) ie differential exposures. The extremes provide information more akin to the "full" exposure basis mentioned in (b).

3. PERFORMANCE MEASUREMENT

3.1 It is apparently conventional wisdom to incorporate futures and options in formal accounts on a "margin payments" or "option premium" basis (rather than on the "associated economic exposure" basis). This approach can be used for performance measurement purposes in the absence of any other information, but the results can then fail to agree with what common sense actually indicates is

going on. The performance measurement of a portfolio containing options can also be carried out merely on a "option premium" basis (and this is normally the only information available). Again, however, the results of calculations based on such data can defy common sense and hence can be very difficult to follow. When exposure adjusted information is available much more meaningful performance figures can be derived.

Futures

3.2 Suppose the fund starts off with a portfolio as in 2.1 (but without the gilts). At the start of the quarter the manager takes out the SHORT position of UK equities as described in example 2.2. This gives the portfolio an effective asset mix of:

	Apparent Portfolio Mix £m	Impact of Futures £m	Effective Portfolio Mix £m
Equities	50	-15	35
Cash	20	+15	35
	70	0	70

Of £20m cash, £700,000 is initial margin.

Assume that the return on cash (including that in margin accounts) over the quarter is 3% and the dividend income on the equities is 1% and that both are paid on average one-half way through the quarter.

Suppose equities rise in value smoothly over the quarter by 12% but that the required initial margin rises by 20%. The face value of the future should only rise by about 10% (assuming that the future is fairly priced). This allows for the 2% differential income received on cash (ie 3%-1%). Suppose, however that the "market" value of the future actually rises by 10.1% (because of market forces). There is a limit to how different the change in the "market" value can be to 10% as otherwise arbitrageurs would operate in the market.

If we apply common sense we can conclude:

(a) The return on equities should be about 13% (ie the 12% rise in capital value plus the 1% dividend yield).

(b) The return on cash should be about 3% (ie the amount of income received).

(c) The return on the overall portfolio should be about 8% (since the portfolio is effectively equally weighted between equities and cash).

Hence client institutions and their consultants are likely to reject any performance measurement statistics which do not coincide roughly with the following:

	Return %
Equities	13
Cash	3
Total	8

3.3 The capital gains/losses and the investment income on the portfolio can be apportioned (at least approximately) as overleaf. This table adjusts for the net impact of the futures to determine the effective portfolio behaviour allowing for the futures. The detailed way in which figures are derived is as follows:

Column (a)
The market values at the start of the quarter are as per 2.3 (without the gilts).

Column (b)
The capital gain on equities actually held ie 1.1(b), is £6m (ie 12% of £50m). The "market" value of the future has risen by 10.1% ie from £15m to £16.5m, so there is an apparent capital loss to the portfolio from the SHORT futures position of £1.515m. The net impact of the future is to transfer this loss to equities. Cash generates no capital gain or loss.

Column (c)

The investment income on equities actually held, ie 1.1(c), is 1% of £50m ie £0.5m.

The futures initial margin at the beginning of the quarter of £0.7m, and at the end of the quarter is £0.840m, so on average it is £0.770m. Hence the apparent investment income on the initial margin (ie 1.2(c)) is £0.023m (ie 3% of £0.770m).

If we ignore investment income on cash then the amount of "other" cash held at the end of the quarter would be:

	£000's
Start Cash Balance	19,300
Investment Income on Equities	500
Variation Margin (ie capital loss on futures)	(1,515)
Extra Amount needed to meet Increase in Futures Initial Margin	(140)
End Cash Balance	18,145

Hence on average the "other" cash balance would have been £18,723m and the interest earned on this, ie 1.3(c) is £0.562m.

It is important to exercise care when reallocating this investment income to allow for the net impact of the future. The total cash backing of the future (including initial margin) was £15m at the start of the quarter, but rose to £16.515 by the end of the quarter. Hence the interest that would have been earned had this sum been held in a segregated cash account would be £0.473m (3% of the average amount of £15.758m). This amount needs to be transferred from the equity income to the cash, and the income on the futures initial margin also needs to be transferred to cash (if the futures position had been a LONG one the transfer would have been in the other direction).

EXAMPLE OF IMPACT OF FUTURES ON PERFORMANCE MEASUREMENT

		(a) Value at start £000	(b) Capital gain £000	(c) Investment income £000	(d) Net transfer £000	(e) Value at end £000	(f) Rate of return %
1.	**On a "margin payment" basis**						
1.1	Equities	50,000	6,000	500	(500)	56,000	13.1
1.2	Futures	700	(1,515)	23	1,623	840	-81.2
1.3	Cash	19,300	0	562	(1,132)	18,730	3.0
1.4	Total	70,000	4,485	1,085	0	75,570	8.0
2.	**Net impact of futures**						
2.1	Equities	(15,000)	(1,515)	(473)	473	(16,515)	
2.2	Futures	(700)	1,515	(23)	(1,632)	(840)	
2.3	Cash	15,700	0	496	1,159	17,355	
2.4	Total	0	0	0	0	0	
3.	**On an "associated economic exposure" basis**						
3.1	Equities	35,000	4,485	27	(27)	39,485	12.9
3.2	Cash	35,000	0	1,058	27	36,085	3.0
3.3	Total	70,000	4,485	1,085	0	75,570	8.0

Columns (d) & (e)

At the end of the quarter the market values of equities is £56m and of futures initial margin is £0.840m. Hence the transfers into/(out of) these two sectors may be found by subtraction (eg for futures initial margin it is £1.632m, ie £0,840m - £0.7m + £1.515m - £0.023m). The net transfer into/(out of) "other" cash (1.3(d)), is a balancing item (since 1.4(d) must be zero) and the market value of cash at the end of the quarter, ie. 1.3(e), can thus be calculated by adding 1.3(a), 1.3(b), 1.3(c) and 1.3(d) together.

The market values in 2(e) and 3(e) can be found along the lines of 2.3 noting that the "market" value of the future is £16.515m, and initial margin requirement is £0.840m. It is probably easiest to calculate 2(d) and 3(d) from (e) - (a) - (b) - (d), ie as balancing items.

Column (f)

The returns on each part of the portfolio can be calculated using the formula:

$$M1\ (1+i) + C(1+i)^{\frac{1}{2}} = M2$$

Where M1 = market value at start of quarter
M2 = market value at end of quarter
C = new money (ie net transfer into sector)
i = rate of interest (as a decimal)

The returns on each individual line can then be determined; in practice trustees and other management boards are only likely to be interested in the final three numbers which closely accord with the common sense answers identified in 3.2

Options

3.4 The sorts of calculations set out in 3.3 can also be carried out if the portfolio contains options. However, the added versatility and complexity of options means that a variety of approaches are possible, each with advantages and disadvantages.

Suppose, for example the portfolio initially had

£50m in equities and £20m in cash, and the manager then wrote call options with market value of £(0.7m) as per 2.4. The apparent portfolio mix is:

	£m
Equities	50.0
Equity options	(0.7)
Cash	20.7
	70.0

Suppose the market rises by 1% in a week and the market value of the options rise by 7.1% in consequence (as per 2.4 ie £0.05m/£0.7m).

Some of the possible alternative ways of calculating performance are:

(a) All three of these asset types could be treated as separate sectors, eg a return on equities, a return on options and a return on cash could be calculated. The disadvantages with this type of approach is that equity options would appear to be the best sort of investment, forgetting that they are effectively geared versions of the underlying equities, eg:

	Return over week
Equities	1%
Equity options	7.1%

A further disadvantage is that because the options are written, this high return is bad for the portfolio, which is not directly identifiable from by the above figures.

(b) The equity options could merely be treated as if they were high performance equities by adding into the equity portfolio. The market value of equities rises by £0.5m to £50.5m whilst that for equity options falls by £0.05m, to £(0.75)m. Hence the overall value of both together rises by £0.45m (£49.75m - £49.3m), and the calculated return is 0.91% (£0.45m/£49.3m). If the rationale for writing the option was to shed equity exposure the performance numbers purpose to show that shedding exposure this way is more expensive than

shedding it by selling the underlying securities or by using futures (because it appears to reduce the return from 1% to 0.91%).

(c) The position could be adjusted as per 2.4 (a), and capital gains/losses and investment income apportioned as if the portfolio held a negative futures position so that the net overall exposure to equities is £45m. Assuming market movements are as implied in the option pricing model being used to calculate the option "deltas" and "differential" exposure then the performance shown for equities would be 1% ie £0.45m/£45m. This approach, ie using "differential" exposure, would seem to be the most consistent way of expressing performance if the use of options is primarily orientated towards gaining or shedding market exposure (rather than as a means of buying or selling insurance).

(d) Finally the position could be adjusted as per 2.4(b) using the full value of the "covered" equities. There are a variety of ways in which this sort of exposure can be calculated. One way would be to treat £40m of the equities as free (the return on that part of the portfolio would be 1%) and to bracket the other £10m "covered" equities with the written call options. The "covered" equities and written call options would in aggregate rise in value by £50,000 (ie 1% of £10m less 7.1% of £0.7m) from £9.3m to £9.35m. It is not immediately apparent what use can be made of such a calculation.