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「SEACEN-World Bank Treasury Workshop on
Fixed Income Portfolio Indexation」
心得報告

複製債券指標指數之績效表現

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目 錄

| | |
|------------------------------------|----|
| 前言 | 1 |
| 第一節、 指標指數之選取與管理(Benchmark) | 3 |
| 第二節、 複製指標指數(Indexation) | 8 |
| 一、 排序整理(Sorting)指數成份債券 | 8 |
| 二、 調整(Scaling)指數市值與投資金額相同 | 8 |
| 三、 分層(Bucketing) | 8 |
| 四、 取樣(Security Selecting) | 9 |
| 五、 計算投資面額(Deriving Par Amounts) | 10 |
| 六、 檢視(Reviewing) | 10 |
| 第三節、 重新調整投資組合(Rebalancing) | 16 |
| 一、 排序整理(Sorting)新指數成份債券 | 16 |
| 二、 調整(Scaling)新指數市值與投資金額相同 | 16 |
| 三、 選擇欲調整之債券(Security Selection) | 17 |
| 四、 求解調整金額(Determine Par Values) | 18 |
| 五、 檢視(Reviewing) | 19 |
| 第四節、 績效評估(Performance Measurement) | 26 |
| 第五節、 績效報告(Reporting) | 28 |
| 第六節、 結論與未來發展方向 | 30 |
| 參考文獻 | 32 |

圖表目錄

| | |
|-------------------------------------|----|
| 表 1-1、BoA-ML 1~3 年期美國公債指數(G102)編製範例 | 5 |
| 表 1-2、BoA-ML 指數重新調整規則 | 7 |
| 表 2-1、指數各分層之 Duration | 9 |
| 表 2-2、2010 年 11 月 30 日建立之投資組合 | 11 |
| 表 3-1、2010 年 12 月 31 日投資組合 | 17 |
| 表 3-2、風險報告 | 21 |
| 表 4-1、2010 年 12 月份投資組合績效表現 | 27 |
| 表 5-1、績效報告 | 29 |

| | |
|---|----|
| 圖 1-1、BoA-ML 指數重新調整時間表 | 7 |
| 圖 2-1A、BoA-ML 1~3 年期美國公債指數成份(2010 年 12 月) | 12 |
| 圖 2-1B、Scaled Benchmark | 13 |
| 圖 2-1C、2010 年 12 月投資組合 | 14 |
| 圖 2-1D、檢視投資組合 | 15 |
| 圖 3-1A、BoA-ML 1~3 年期美國公債指數成份(2011 年 1 月) | 22 |
| 圖 3-1B、Excel 規劃求解功能 | 23 |
| 圖 3-1C、2010 年 12 月 31 日調整後投資組合 | 24 |
| 圖 3-2、Key Rate Duration Mapping | 25 |

複製債券指標指數之績效表現

前言

本次「SEACEN-World Bank Treasury Workshop on Fixed Income Portfolio Indexation」研討會，主要講授並實地演練債券投資組合管理中，複製指標指數（Indexation）之技巧。

在 World Bank 及 BIS 舉辦之研討會中，該等國際機構一向建議將外匯存底區分為：(1) 日常營運資金層級（Working Capital Tranche），適合的指數如短期貨幣市場工具，(2) 流動性層級（Liquidity Tranche），適合的指數包括短期至中期貨幣市場債券、政府公債等，具低風險報酬特性之工具，(3) 投資層級（Investment Tranche），適合的指數多為長期政府公債、信用產品等，具較高風險報酬特性之工具。而複製指標指數之技巧多應用於管理流動性層級，亦可應用於投資層級，本次實地演練即為複製 BoA-Merrill Lynch US Treasury 1-3 Years Benchmark Index。

複製指標指數之方法概分為兩種，一為分層取樣法，又稱多孔細胞法（Stratified Sampling Approach or Cellular Approach），二為最適化求解法（Optimization Approach），本次研討會主要由 World Bank Treasury 講授第一種分層取樣法的技巧，至於第二種方法，則另

請韓國央行講師分享其經驗。

本報告將詳細介紹分層取樣法，分為五大步驟，依順序安排章節如下，第一節 Benchmark 介紹指標指數之選取與管理，第二節 Indexation 介紹如何複製指標指數，以符合指數之風險輪廓 (risk profile)，第三節 Rebalancing 介紹如何重新調整投資組合，第四節 Performance Measurement 評估投資組合之複製績效，第五節 Reporting 為撰寫績效報告，第六節則為結論與未來發展方向。

第一節、 指標指數之選取與管理 (Benchmark)

對長期策略性資產配置而言，指標指數的功能在反映投資人的長期風險報酬偏好，指標指數提供約 90%的風險報酬來源，另 10%的績效來自於偏離指標指數的積極管理，而偏離程度通常設定在投資準則中，因此，指標指數之選取相當重要，以下略述選取指標指數之考量點。

一、 好的指標指數之特性

- 1、 清楚界定出債券種類 (Universe is well-defined)。
- 2、 債券可投資性 (Securities are investable)。
- 3、 編製規則 (Rules) 透明，且事先設定。
- 4、 指數內容 (Index Characteristics) 可及性：指數本身與成份債券之面額、市值、殖利率、Duration、息票率、債信評等、績效等現況資料容易取得，且歷史資料完整。
- 5、 汰換率低 (Turnover)：成份債券每個月不會有大幅改變。

二、 選擇指數編製公司之考量

- 1、 Coverage：是否充分涵蓋某種債券，且歷史資料足夠。
- 2、 Rules-based Index Methodology：是否清楚設定指數編製規則，如，債券流動性之標準、指數成份之調整原則、利息再

投資之處理、債券評價之資料來源等。

- 3、 Documentation：指數編製方法，是否提供詳細說明文件。
- 4、 Data Access：資料取得管道（如 Bloomberg、Internet）之容易性與即時性。
- 5、 Client Support：是否有專業的編製團隊，足夠的人員提供使用者充分即時的服務，並能滿足客戶特殊要求。
- 6、 Analytics：有的編製公司甚至可提供指數之風險績效貢獻分析（risk/performance attribution）。

一般在評估外部資產管理帳戶操作績效時，知道指標指數每月報酬率或已足夠，但若要內部採行複製指標指數策略時，指標指數管理變得相當重要，以下略述管理指標指數之重點。

三、 指標指數管理

- 1、 Construction Rules：必須了解指數編製規則，表 1-1 為 BoA-ML 1~3 年期美國公債指數之編製範例，表 1-2 為 BoA-ML 指數重新調整之規則，圖 1-1 列示指數重新調整之時間表。
- 2、 Projected Index：每月底須能預覽下個月的新指數成份。
 - (1) BoA-ML publishes the projected index constituents and characteristics around two days prior to the last business day

of the month.

- (2) Citi communicates the new index preliminary profiles on a timetable, roughly 3 business days before the month end day.
- (3) Barclays/Lehman makes projected index available daily.
- (4) JPMorgan publishes the previews of the new indices (at the index level only) on the last day of the month.

3、 Benchmark Updating and Loading：每月須將新指數成份與指數內容上傳至內部系統，並調整（scaling）指數市值，使與投資金額相同（詳第二節）。

4、 Relationship：維持與指數編製公司之良好關係，若指數有任何改變，得以先行被通知；定期審視與指數相關的研究；保持與其他指數編製公司之關係，以便得知產業相關趨勢。

表 1-1、BoA-ML 1~3 年期美國公債指數（G102）編製範例

| | |
|---|--|
| Currency / Products | USD-denominated US Govt Bonds |
| Remaining Term-to-Maturity | Greater than or equal to 1 year, and less than 3 years |
| Coupon Type | Fixed coupon |
| Minimum Amount Outstanding ¹ | US\$ 1 billion |
| Reinvestment Assumptions ² | Intra-month cash flows are not reinvested (since 1/1/2010) |
| Pricing ³ | Prices as of 3 pm NY time, bid side |
| Rebalancing and Lock-out Dates ⁴ | Only the information available as of the |

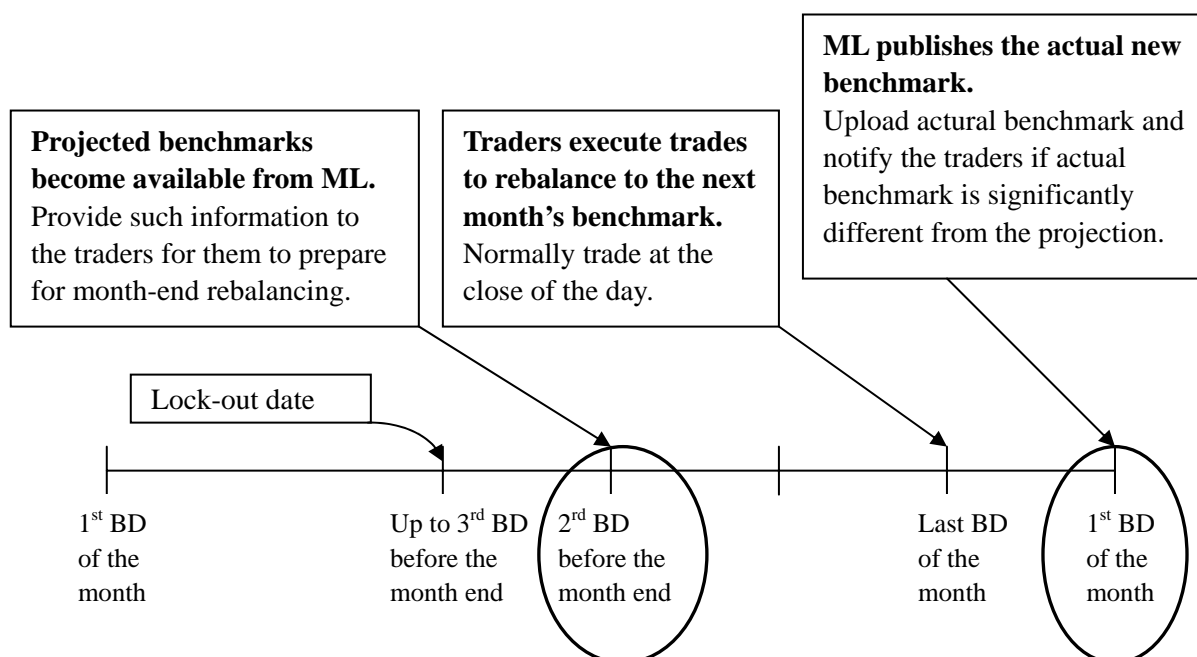
| | |
|--|---|
| | lock-out date will be used in deriving the index constituents |
|--|---|

1. BoA-ML and Citigroup use country specific liquidity criterion.
Barclays/Lehman uses regional-based criteria.
JPM does not have a minimum outstanding amount, instead it relies on “investibility”.
2. BoA-ML and Barclays/Lehman – no reinvestment
Citi – daily average of local deposit rate
JPM – back into index
3. (1) BoA-ML, Citigroup and Barclays/Lehman – bid-side prices
JPM – mid prices
(2) Pricing sources vary – usually outsourced
(3) Closing time varies –
 - B) US/Canada: all at 3:00 EST
 - C) Japan/Asia: all at 3:00 Tokyo Local Close
 - D) EMU, UK and other Europe: ML
BoA-ML: at 4:00 London
Citi, Barclays/Lehman: 4:15 London
JPM: 4:10 pm
4. BoA-ML rebalances on the last calendar day of month; lock-out is the 3rd to last business day.
Citi rebalances on the last business day of month; lock-out is the 5th to last business day.
Barclays/Lehman does not have a lock-out date (implicitly is the last business day).
JPM rebalances on the 1st weekday of the month.

表 1-2、BoA-ML 指數重新調整規則

| | |
|----------------------------|---|
| Rebalancing date | The last <u>calendar</u> day of the month |
| Lock-out date | Based on information available <u>up to and including</u> the 3 rd business day prior to the last business day of the month. |
| New issues | New issues are included if: <ul style="list-style-type: none"> - Auctioned on or before the lock-out day, and - Settled on or before the month end rebalancing date |
| No settlement requirements | Buybacks or re-opening of existing issues will be included if the amount is known on or before lock-out day. |
| Rating changes | Rating changes take place on or before the lock-out date. |
| Early redemption | For example, calls, can take place up to the rebalancing date, if the intent was previously known. |

圖 1-1、BoA-ML 指數重新調整時間表



第二節、複製指標指數 (Indexation)

本節以在 2010 年 11 月 30 日，欲建立一名目本金為 US\$ 100,000,000 之投資組合，以複製 BoA-Merrill Lynch 1~3 年期美國公債指數為例，詳細介紹其步驟。

一、 排序整理 (Sorting) 指數成份債券

取得 2010 年 12 月之指數成份債券，及所含債券在 2010 年 11 月 30 日之資料，並將債券依 Effective Duration 由短至長依序排列，見圖 2-1A 之第 8 欄，該指數共含 68 支公債，為節省篇幅，僅展示部份公債，故圖 2-1A 之列數編號不連續。

二、 調整 (Scaling) 指數市值與投資金額相同

所謂複製指標指數，主要是在複製指數之風險輪廓，而風險係由 PV01 來衡量，故須將指標指數之原始市值 (US\$ 2,106,245 mil) 比例縮小至與投資組合金額相同，重新計算指數中每支債券之 PV01，與指數之累積 PV01，見圖 2-1B 之第 13 至 16 欄。

三、 分層 (Bucketing)

將指數依市值權重分為數層 (例如 4 層)，計算出每一層之 Index

Duration，如表 2-1。

表 2-1、指數各分層之 Duration

| | Index Duration | Portfolio PV01 Difference |
|----------|----------------|---------------------------|
| Bucket 1 | 1.176 | -2.0 |
| Bucket 2 | 1.588 | -1.4 |
| Bucket 3 | 2.047 | -0.4 |
| Bucket 4 | 2.624 | -1.0 |
| Total | | -1.0 |

例如，Index 之 Bucket 1 含 17 支公債，

$$\text{Duration} = \frac{\sum_{i=1}^{17} \text{Index PV01}_i}{\sum_{i=1}^{17} \text{Scaled Index MV}_i} * 10000 = 2,933 / 24,949,237 * 10000。$$

四、取樣 (Security Selection)

在每一層中，任選兩支債券，在滿足下列兩條件下：(1) 兩支債券之加權平均 Duration 與 Index 該層之 Duration 相同，(2) 兩支債券之市值加總與 Index 該層之總市值相同，便可求出兩支債券之投資權重與市值，見圖 2-1C 之第 17 至 20 欄。

$$\begin{cases} Dur_1 * MV_1 + Dur_2 * MV_2 = Dur_B * MV_B, & (1) \\ MV_1 + MV_2 = MV_B & (2) \end{cases}$$

其中， $Dur_1 < Dur_B < Dur_2$ 。

$$MV_1 = MV_B * \frac{Dur_2 - Dur_B}{Dur_2 - Dur_1} \quad (3)$$

$$W_1 = \frac{MV_1}{MV_B} \quad (4)$$

至於任選兩支債券之標準為何，可考慮下列因素：(1) 流動性，如 Bid/Ask spread、Issue size、On/Off-the-run (近期發行之債券流動性較佳)，(2) 收益性，如 coupon relative to current market yield。

五、計算投資面額 (Deriving Par Amounts)

將第四步驟求出之債券投資市值 (圖 2-1C 第 20 欄) 除以債券之含息價 (Dirty Price, 圖 2-1A 第 10 欄)，再取整數 (美國公債之最小可投資面額為 US\$ 10,000)，便可轉換成約當投資面額，如圖 2-1C 之第 21 欄，此時投資組合總面額為 US\$ 96,280,000。另外，為避免實際交易時，因債券市價變動，使總投資金額超過名日本金 (US\$ 100,000,000)，需預留一些現金，故主觀選擇減少第 1 支債券之投資面額 US\$ 20,000，使投資組合總面額降為 US\$ 96,260,000，見圖 2-1C 之第 22 欄。

六、檢視 (Reviewing)

最後一步檢視投資組合，見圖 2-1D 之第 25 至 30 欄，第 25 與 26

欄顯示 8 支債券之投資市值與 PV01，第 27 欄最後一列顯示投資組合之累積 PV01 為\$18,582，第 28 與 29 欄最後一列分別顯示投資組合之累積市值為 US\$ 99,989,375，尚保留現金 US\$ 10,625 未投資。

檢視投資組合之目的，在於確保投資組合每一層之 PV01 與指數每一層之 PV01 差異不大（目標為接近 0），第 30 欄顯示投資組合每一層累積 PV01 與指數每一層累積 PV01 之差異（即第 27 欄減去第 16 欄），如第一層之差異為-2 bps（= 2,931 - 2,933），而最後一列顯示投資組合與指數累積 PV01 之總差異為-1 bps（= 18,582 - 18,583），另可參見表 2-1。表 2-2 摘要整理 2010 年 11 月 30 日所建立之投資組合。

表 2-2、2010 年 11 月 30 日建立之投資組合

| Holdings as of Nov 30, 2010 | | | | | | | | | | | |
|-----------------------------|--------|--------|----------|-------------|------------|---------|-------|-------------|-----------------------|-------------|--|
| CUSIP | Issuer | Coupon | Maturity | M. Duration | Face Value | Price | Accr. | Dirty Price | Market Value | Weight | |
| US9128277L09 | UST | 4.875 | 02/15/12 | 1.17 | 19,860,000 | 105.479 | 1.431 | 106.910 | 21,232,247 | 21% | |
| US912828KC34 | UST | 1.375 | 02/15/12 | 1.20 | 3,640,000 | 101.251 | 0.404 | 101.654 | 3,700,221 | 4% | |
| US912828NS58 | UST | 0.625 | 06/30/12 | 1.57 | 7,660,000 | 100.351 | 0.262 | 100.613 | 7,706,929 | 8% | |
| US912828LB42 | UST | 1.500 | 07/15/12 | 1.60 | 16,230,000 | 101.822 | 0.567 | 102.389 | 16,617,682 | 17% | |
| US912828MB33 | UST | 1.125 | 12/15/12 | 2.01 | 13,850,000 | 101.280 | 0.519 | 101.800 | 14,099,253 | 14% | |
| US912828MG20 | UST | 1.375 | 01/15/13 | 2.09 | 12,000,000 | 101.834 | 0.519 | 102.353 | 12,282,391 | 12% | |
| US912828NN61 | UST | 1.000 | 07/15/13 | 2.58 | 6,830,000 | 101.049 | 0.378 | 101.427 | 6,927,459 | 7% | |
| US912828JK78 | UST | 3.125 | 08/31/13 | 2.64 | 16,190,000 | 106.823 | 0.794 | 107.617 | 17,423,192 | 17% | |
| Cash | - | - | - | - | - | - | - | - | 10,625 | 0% | |
| Total Holdings | | 2.325 | | | | | | | 100,000,000.00 | 100% | |

圖 2-1A、BoA-Merrill Lynch 1~3 年期美國公債指數成份 (2010 年 12 月)

| Index Universe: | | Dec-10 | | | | | | | | | |
|-----------------------------|----------|--------------|----------|-------------|--------|---------|---------|--------------------|---------|------------|---------|
| As of Date | | 30-Nov-10 | | | | | | | | | |
| Totals: | | Idx Cpn | | | | | | | | | |
| | | 1.931 | | | | | | | | | |
| | | | | Idx Eff Dur | | | | Idx Orig Mkt Value | | | |
| | | | | 1.858 | | | | 2,106,245 | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Index Security Descriptions | | | | | | | | | | | |
| Bucket | ISIN | Cpn | Maturity | Par Amt | Price | Accrued | Eff Dur | Dirty price | %Index | Cum Weight | |
| 1 | Bucket 1 | US912828GA24 | 4.500 | 2011/11/30 | 17,037 | 104.164 | 0.012 | 0.984 | 104.176 | 0.84% | 0.84% |
| 2 | Bucket 1 | US912828MM97 | 0.750 | 2011/11/30 | 45,322 | 100.438 | 0.002 | 0.993 | 100.440 | 2.16% | 3.00% |
| 9 | Bucket 1 | US9128277L09 | 4.875 | 2012/2/15 | 24,780 | 105.479 | 1.431 | 1.172 | 106.910 | 1.26% | 13.10% |
| 10 | Bucket 1 | US912828KC34 | 1.375 | 2012/2/15 | 33,630 | 101.251 | 0.404 | 1.196 | 101.654 | 1.62% | 14.73% |
| 16 | Bucket 1 | US912828KK59 | 1.375 | 2012/4/15 | 35,558 | 101.414 | 0.178 | 1.360 | 101.591 | 1.72% | 24.12% |
| 17 | Bucket 1 | US912828GQ75 | 4.500 | 2012/4/30 | 16,450 | 105.839 | 0.385 | 1.379 | 106.224 | 0.83% | 24.95% |
| 18 | Bucket 2 | US912828NB24 | 1.000 | 2012/4/30 | 44,939 | 100.907 | 0.086 | 1.403 | 100.993 | 2.15% | 27.10% |
| 19 | Bucket 2 | US912828KP47 | 1.375 | 2012/5/15 | 41,194 | 101.444 | 0.061 | 1.441 | 101.505 | 1.99% | 29.09% |
| 24 | Bucket 2 | US912828NS58 | 0.625 | 2012/6/30 | 41,192 | 100.351 | 0.262 | 1.568 | 100.613 | 1.97% | 36.48% |
| 25 | Bucket 2 | US912828LB42 | 1.500 | 2012/7/15 | 35,592 | 101.822 | 0.567 | 1.597 | 102.389 | 1.73% | 38.21% |
| 26 | Bucket 2 | US912828GZ74 | 4.625 | 2012/7/31 | 15,804 | 107.049 | 1.546 | 1.599 | 108.595 | 0.81% | 39.03% |
| 33 | Bucket 2 | US912828HE37 | 4.250 | 2012/9/30 | 15,874 | 106.986 | 0.724 | 1.770 | 107.710 | 0.81% | 49.27% |
| 34 | bucket 3 | US912828NX44 | 0.375 | 2012/9/30 | 37,134 | 99.880 | 0.064 | 1.824 | 99.944 | 1.76% | 51.03% |
| 42 | bucket 3 | US912828HM52 | 3.625 | 2012/12/31 | 15,657 | 106.592 | 1.517 | 1.998 | 108.109 | 0.80% | 61.75% |
| 43 | bucket 3 | US912828MB33 | 1.125 | 2012/12/15 | 40,217 | 101.280 | 0.519 | 2.010 | 101.800 | 1.94% | 63.69% |
| 44 | bucket 3 | US912828MG20 | 1.375 | 2013/1/15 | 41,552 | 101.834 | 0.519 | 2.089 | 102.353 | 2.02% | 65.71% |
| 45 | bucket 3 | US912828HQ66 | 2.875 | 2013/1/31 | 15,700 | 105.210 | 0.961 | 2.099 | 106.171 | 0.79% | 66.50% |
| 51 | bucket 3 | US912828MX52 | 1.750 | 2013/4/15 | 42,928 | 102.810 | 0.226 | 2.327 | 103.036 | 2.10% | 75.65% |
| 52 | bucket 4 | US912828HY90 | 3.125 | 2013/4/30 | 20,743 | 106.223 | 0.268 | 2.338 | 106.491 | 1.05% | 76.70% |
| 59 | bucket 4 | US912828BH22 | 4.250 | 2013/8/15 | 33,521 | 109.742 | 1.247 | 2.562 | 110.990 | 1.77% | 86.54% |
| 60 | bucket 4 | US912828NN61 | 1.000 | 2013/7/15 | 35,010 | 101.049 | 0.378 | 2.583 | 101.427 | 1.69% | 88.22% |
| 61 | bucket 4 | US912828JK78 | 3.125 | 2013/8/31 | 23,837 | 106.823 | 0.794 | 2.640 | 107.617 | 1.22% | 89.44% |
| 62 | bucket 4 | US912828NU05 | 0.750 | 2013/8/15 | 36,036 | 100.343 | 0.220 | 2.677 | 100.563 | 1.72% | 91.16% |
| 68 | bucket 4 | US912828PU86 | 0.500 | 2013/11/15 | 32,000 | 99.398 | 0.022 | 2.939 | 99.420 | 1.51% | 100.00% |

圖 2-1B、Scaled Benchmark

| Index Universe: | | Dec-10 | | | | | | | | | |
|-----------------------------|----------|--------------|----------|--------------------|------------|-----------------|---------------------|-------------|-----------------------|--------|--|
| As of Date | | 30-Nov-10 | | | | | | | | | |
| Totals: | | Idx Cpn | | Idx Orig Mkt Value | | Idx Mkt Value | | 18,583 | | | |
| | | 1.931 | | 2,106,245 | | 100,000,000 | | 1.8583 | | | |
| 1 | 2 | 3 | 4 | 11 | 12 | 13 | 14 | 15 | 16 | | |
| Index Security Descriptions | | | | | | Scaling | | | | | |
| Bucket | ISIN | Cpn | Maturity | %Index | Cum Weight | Scaled Index MV | Cum Scaled Index MV | Index PV01 | Cumulative Index PV01 | | |
| 1 | Bucket 1 | US912828GA24 | 4.500 | 2011/11/30 | 0.84% | 0.84% | 842,663 | 842,663 | 83 | 83 | |
| 2 | Bucket 1 | US912828MM97 | 0.750 | 2011/11/30 | 2.16% | 3.00% | 2,161,250 | 3,003,913 | 215 | 298 | |
| 9 | Bucket 1 | US9128277L09 | 4.875 | 2012/2/15 | 1.26% | 13.10% | 1,257,793 | 13,103,093 | 147 | 1,414 | |
| 10 | Bucket 1 | US912828KC34 | 1.375 | 2012/2/15 | 1.62% | 14.73% | 1,623,096 | 14,726,190 | 194 | 1,608 | |
| 16 | Bucket 1 | US912828KK59 | 1.375 | 2012/4/15 | 1.72% | 24.12% | 1,715,081 | 24,119,614 | 233 | 2,819 | |
| 17 | Bucket 1 | US912828GQ75 | 4.500 | 2012/4/30 | 0.83% | 24.95% | 829,623 | 24,949,237 | 114 | 2,933 | |
| 18 | Bucket 2 | US912828NB24 | 1.000 | 2012/4/30 | 2.15% | 27.10% | 2,154,793 | 27,104,030 | 302 | 3,235 | |
| 19 | Bucket 2 | US912828KP47 | 1.375 | 2012/5/15 | 1.99% | 29.09% | 1,985,239 | 29,089,269 | 286 | 3,521 | |
| 24 | Bucket 2 | US912828NS58 | 0.625 | 2012/6/30 | 1.97% | 36.48% | 1,967,690 | 36,483,028 | 309 | 4,641 | |
| 25 | Bucket 2 | US912828LB42 | 1.500 | 2012/7/15 | 1.73% | 38.21% | 1,730,197 | 38,213,225 | 276 | 4,917 | |
| 26 | Bucket 2 | US912828GZ74 | 4.625 | 2012/7/31 | 0.81% | 39.03% | 814,832 | 39,028,056 | 130 | 5,048 | |
| 33 | Bucket 2 | US912828HE37 | 4.250 | 2012/9/30 | 0.81% | 49.27% | 811,773 | 49,270,236 | 144 | 6,795 | |
| 34 | bucket 3 | US912828NX44 | 0.375 | 2012/9/30 | 1.76% | 51.03% | 1,762,055 | 51,032,291 | 321 | 7,116 | |
| 42 | bucket 3 | US912828HM52 | 3.625 | 2012/12/31 | 0.80% | 61.75% | 803,639 | 61,745,399 | 161 | 9,174 | |
| 43 | bucket 3 | US912828MB33 | 1.125 | 2012/12/15 | 1.94% | 63.69% | 1,943,780 | 63,689,180 | 391 | 9,565 | |
| 44 | bucket 3 | US912828MG20 | 1.375 | 2013/1/15 | 2.02% | 65.71% | 2,019,225 | 65,708,405 | 422 | 9,987 | |
| 45 | bucket 3 | US912828HQ66 | 2.875 | 2013/1/31 | 0.79% | 66.50% | 791,401 | 66,499,805 | 166 | 10,153 | |
| 51 | bucket 3 | US912828MX52 | 1.750 | 2013/4/15 | 2.10% | 75.65% | 2,100,011 | 75,647,262 | 489 | 12,193 | |
| 52 | bucket 4 | US912828HY90 | 3.125 | 2013/4/30 | 1.05% | 76.70% | 1,048,758 | 76,696,020 | 245 | 12,439 | |
| 59 | bucket 4 | US912828BH22 | 4.250 | 2013/8/15 | 1.77% | 86.54% | 1,766,405 | 86,537,906 | 453 | 14,873 | |
| 60 | bucket 4 | US912828NN61 | 1.000 | 2013/7/15 | 1.69% | 88.22% | 1,685,918 | 88,223,824 | 435 | 15,309 | |
| 61 | bucket 4 | US912828JK78 | 3.125 | 2013/8/31 | 1.22% | 89.44% | 1,217,934 | 89,441,758 | 322 | 15,630 | |
| 62 | bucket 4 | US912828NU05 | 0.750 | 2013/8/15 | 1.72% | 91.16% | 1,720,548 | 91,162,306 | 461 | 16,091 | |
| 68 | bucket 4 | US912828PU86 | 0.500 | 2013/11/15 | 1.51% | 100.00% | 1,510,487 | 100,000,000 | 444 | 18,583 | |

圖 2-1C、2010 年 12 月投資組合

| Index Universe: | | Dec-10 | | | | | | Port Mkt Value | | Port Invt Amt | | Port Invt Amt | |
|-----------------------------|----------|--------------|----------|---------------------|--------------------------------|---------|---------------------------|---------------------|---------------------|-----------------|------------|---------------|--|
| As of Date | | 30-Nov-10 | | | | | | 100,000,000 | | 96,280,000 | | 96,260,000 | |
| Totals: | | 1.931 | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 14 | 17 | 18 | 19 | 20 | 21 | 22 | | | |
| Index Security Descriptions | | | | Scaling | Bucketing & Security Selection | | | | Deriving Par Amount | | | | |
| Bucket | ISIN | Cpn | Maturity | Cum Scaled Index MV | Chosen Security 'X' | Eff Dur | Security Weight in Bucket | Calculate Mkt Value | Calculate Value | Par Initial Amt | to buy | | |
| 1 | Bucket 1 | US912828GA24 | 4.500 | 2011/11/30 | 842,663 | | | | | - | 0 | | |
| 2 | Bucket 1 | US912828MM97 | 0.750 | 2011/11/30 | 3,003,913 | | | | | - | 0 | | |
| 9 | Bucket 1 | US9128277L09 | 4.875 | 2012/2/15 | 13,103,093 | X | 1.17 | 85% | 21,253,963 | 19,880,000 | 19,860,000 | | |
| 10 | Bucket 1 | US912828KC34 | 1.375 | 2012/2/15 | 14,726,190 | X | 1.20 | 15% | 3,695,274 | 3,640,000 | 3,640,000 | | |
| 16 | Bucket 1 | US912828KK59 | 1.375 | 2012/4/15 | 24,119,614 | | | | | - | 0 | | |
| 17 | Bucket 1 | US912828GQ75 | 4.500 | 2012/4/30 | 24,949,237 | | | | | - | 0 | | |
| 18 | Bucket 2 | US912828NB24 | 1.000 | 2012/4/30 | 27,104,030 | | | | | - | 0 | | |
| 19 | Bucket 2 | US912828KP47 | 1.375 | 2012/5/15 | 29,089,269 | | | | | - | 0 | | |
| 24 | Bucket 2 | US912828NS58 | 0.625 | 2012/6/30 | 36,483,028 | X | 1.568 | 32% | 7,703,815 | 7,660,000 | 7,660,000 | | |
| 25 | Bucket 2 | US912828LB42 | 1.500 | 2012/7/15 | 38,213,225 | X | 1.597 | 68% | 16,617,184 | 16,230,000 | 16,230,000 | | |
| 26 | Bucket 2 | US912828GZ74 | 4.625 | 2012/7/31 | 39,028,056 | | | | | - | 0 | | |
| 33 | Bucket 2 | US912828HE37 | 4.250 | 2012/9/30 | 49,270,236 | | | | | - | 0 | | |
| 34 | bucket 3 | US912828NX44 | 0.375 | 2012/9/30 | 51,032,291 | | | | | - | 0 | | |
| 42 | bucket 3 | US912828HM52 | 3.625 | 2012/12/31 | 61,745,399 | | | | | - | 0 | | |
| 43 | bucket 3 | US912828MB33 | 1.125 | 2012/12/15 | 63,689,180 | X | 2.01 | 53% | 14,097,371 | 13,850,000 | 13,850,000 | | |
| 44 | bucket 3 | US912828MG20 | 1.375 | 2013/1/15 | 65,708,405 | X | 2.09 | 47% | 12,279,654 | 12,000,000 | 12,000,000 | | |
| 45 | bucket 3 | US912828HQ66 | 2.875 | 2013/1/31 | 66,499,805 | | | | | - | 0 | | |
| 51 | bucket 3 | US912828MX52 | 1.750 | 2013/4/15 | 75,647,262 | | | | | - | 0 | | |
| 52 | bucket 4 | US912828HY90 | 3.125 | 2013/4/30 | 76,696,020 | | | | | - | 0 | | |
| 59 | bucket 4 | US912828BH22 | 4.250 | 2013/8/15 | 86,537,906 | | | | | - | 0 | | |
| 60 | bucket 4 | US912828NN61 | 1.000 | 2013/7/15 | 88,223,824 | X | 2.58 | 28% | 6,927,316 | 6,830,000 | 6,830,000 | | |
| 61 | bucket 4 | US912828JK78 | 3.125 | 2013/8/31 | 89,441,758 | X | 2.64 | 72% | 17,425,422 | 16,190,000 | 16,190,000 | | |
| 62 | bucket 4 | US912828NU05 | 0.750 | 2013/8/15 | 91,162,306 | | | | | - | 0 | | |
| 68 | bucket 4 | US912828PU86 | 0.500 | 2013/11/15 | 100,000,000 | | | | | - | 0 | | |

圖 2-1D、檢視投資組合

| Index Universe: | | Dec-10 | | As of Date | | 30-Nov-10 | | 18,583 | | Port Invt Amt | | Port Invt MV | | | |
|-----------------------------|----------|--------------|----------|------------|---------------------|-------------|-----------------------|---------------------|------------|---------------|-----------------|---------------|------------------------------|-----------------------------|--|
| Totals: | | 1.931 | | 1.858 | | 1.8583 | | 96,260,000 | | 99,989,375 | | | | | |
| 1 | 2 | 3 | 4 | 8 | 14 | 15 | 16 | 22 | 25 | 26 | 27 | 28 | 29 | 30 | |
| Index Security Descriptions | | | | | Scaling | | | Reviewing Portfolio | | | | | | | |
| Bucket | ISIN | Cpn | Maturity | Eff Dur | Cum Scaled Index MV | Index PV01 | Cumulative Index PV01 | Initial Amt to buy | MV | PV01 | Cumulative PV01 | Cumulative MV | Cumulative Uninvested Amount | PV01 Difference (Port- Idx) | |
| 1 | Bucket 1 | US912828GA24 | 4.500 | 2011/11/30 | 0.984 | 842,663 | 83 | 83 | 0 | 0 | 0 | 0 | -842,663 | -82.9 | |
| 2 | Bucket 1 | US912828MM97 | 0.750 | 2011/11/30 | 0.993 | 3,003,913 | 215 | 298 | 0 | 0 | 0 | 0 | -3,003,913 | -297.5 | |
| 9 | Bucket 1 | US9128277L09 | 4.875 | 2012/2/15 | 1.172 | 13,103,093 | 147 | 1,414 | 19,860,000 | 2,488 | 2,488 | 21,232,247 | 8,129,154 | 1074.5 | |
| 10 | Bucket 1 | US912828KC34 | 1.375 | 2012/2/15 | 1.196 | 14,726,190 | 194 | 1,608 | 3,640,000 | 443 | 2,931 | 24,932,469 | 10,206,279 | 1323.0 | |
| 16 | Bucket 1 | US912828KK59 | 1.375 | 2012/4/15 | 1.360 | 24,119,614 | 233 | 2,819 | 0 | 0 | 2,931 | 24,932,469 | 812,855 | 112.5 | |
| 17 | Bucket 1 | US912828GQ75 | 4.500 | 2012/4/30 | 1.379 | 24,949,237 | 114 | 2,933 | 0 | 0 | 2,931 | 24,932,469 | -16,768 | -2.0 | |
| 18 | Bucket 2 | US912828NB24 | 1.000 | 2012/4/30 | 1.403 | 27,104,030 | 302 | 3,235 | 0 | 0 | 2,931 | 24,932,469 | -2,171,561 | -304.3 | |
| 19 | Bucket 2 | US912828KP47 | 1.375 | 2012/5/15 | 1.441 | 29,089,269 | 286 | 3,521 | 0 | 0 | 2,931 | 24,932,469 | -4,156,800 | -590.3 | |
| 24 | Bucket 2 | US912828NS58 | 0.625 | 2012/6/30 | 1.568 | 36,483,028 | 309 | 4,641 | 7,660,000 | 1,208 | 4,139 | 32,639,397 | -3,843,631 | -501.6 | |
| 25 | Bucket 2 | US912828LB42 | 1.500 | 2012/7/15 | 1.597 | 38,213,225 | 276 | 4,917 | 16,230,000 | 2,654 | 6,793 | 49,257,079 | 11,043,854 | 1875.9 | |
| 26 | Bucket 2 | US912828GZ74 | 4.625 | 2012/7/31 | 1.599 | 39,028,056 | 130 | 5,048 | 0 | 0 | 6,793 | 49,257,079 | 10,229,023 | 1745.6 | |
| 33 | Bucket 2 | US912828HE37 | 4.250 | 2012/9/30 | 1.770 | 49,270,236 | 144 | 6,795 | 0 | 0 | 6,793 | 49,257,079 | -13,157 | -1.4 | |
| 34 | bucket 3 | US912828NX44 | 0.375 | 2012/9/30 | 1.824 | 51,032,291 | 321 | 7,116 | 0 | 0 | 6,793 | 49,257,079 | -1,775,212 | -322.8 | |
| 42 | bucket 3 | US912828HM52 | 3.625 | 2012/12/31 | 1.998 | 61,745,399 | 161 | 9,174 | 0 | 0 | 6,793 | 49,257,079 | -12,488,320 | -2381.1 | |
| 43 | bucket 3 | US912828MB33 | 1.125 | 2012/12/15 | 2.010 | 63,689,180 | 391 | 9,565 | 13,850,000 | 2,834 | 9,627 | 63,356,333 | -332,847 | 62.2 | |
| 44 | bucket 3 | US912828MG20 | 1.375 | 2013/1/15 | 2.089 | 65,708,405 | 422 | 9,987 | 12,000,000 | 2,566 | 12,193 | 75,638,724 | 9,930,319 | 2206.2 | |
| 45 | bucket 3 | US912828HQ66 | 2.875 | 2013/1/31 | 2.099 | 66,499,805 | 166 | 10,153 | 0 | 0 | 12,193 | 75,638,724 | 9,138,918 | 2040.0 | |
| 51 | bucket 3 | US912828MX52 | 1.750 | 2013/4/15 | 2.327 | 75,647,262 | 489 | 12,193 | 0 | 0 | 12,193 | 75,638,724 | -8,538 | -0.4 | |
| 52 | bucket 4 | US912828HY90 | 3.125 | 2013/4/30 | 2.338 | 76,696,020 | 245 | 12,439 | 0 | 0 | 12,193 | 75,638,724 | -1,057,296 | -245.6 | |
| 59 | bucket 4 | US912828BH22 | 4.250 | 2013/8/15 | 2.562 | 86,537,906 | 453 | 14,873 | 0 | 0 | 12,193 | 75,638,724 | -10,899,182 | -2680.2 | |
| 60 | bucket 4 | US912828NN61 | 1.000 | 2013/7/15 | 2.583 | 88,223,824 | 435 | 15,309 | 6,830,000 | 1,789 | 13,982 | 82,566,183 | -5,657,642 | -1326.4 | |
| 61 | bucket 4 | US912828JK78 | 3.125 | 2013/8/31 | 2.640 | 89,441,758 | 322 | 15,630 | 16,190,000 | 4,600 | 18,582 | 99,989,375 | 10,547,617 | 2951.8 | |
| 62 | bucket 4 | US912828NU05 | 0.750 | 2013/8/15 | 2.677 | 91,162,306 | 461 | 16,091 | 0 | 0 | 18,582 | 99,989,375 | 8,827,069 | 2491.2 | |
| 68 | bucket 4 | US912828PU86 | 0.500 | 2013/11/15 | 2.939 | 100,000,000 | 444 | 18,583 | 0 | 0 | 18,582 | 99,989,375 | -10,625 | -1.0 | |

第三節、重新調整投資組合 (Rebalancing)

2010 年 11 月 30 日所建立之投資組合，在經過一個月後，Duration 通常會比新指數之 Duration 短，因為 12 月底當指數公司提供 2011 年 1 月新的指數成份後，到期日短於 1 年之債券會被移除，並加入一支新的 3 年期債券，此舉使新指數之 Duration 延長，故在 12 月 31 日經理人必須調整投資組合之 Duration，使其重新與指數相同（或儘量相近）。本例並不要求投資組合與指數每一層之 Duration 皆相同，只要投資組合與指數之整體 Duration 相同（或儘量相近）即可。重新調整投資組合之步驟如下。

一、排序整理 (Sorting) 新指數成份債券

取得 2011 年 1 月之新指數成份債券，及所含債券在 2010 年 12 月 31 日之資料，並將債券依 Effective Duration 由短至長依序排列，見圖 3-1A 之第 8 欄。

二、調整 (Scaling) 指數市值與投資金額相同

將指標指數之市值 US\$ 2,105,681 mil(圖 3-1A 第 11 欄最後一列)，比例縮小至與投資組合市值 US\$ 99,715,725 (詳表 3-1) 相同，重新計算指數中每支債券之 PV01，與指數之累積 PV01，見圖 3-1A 之第 11

至 15 欄。

表 3-1 Panel A 顯示 2010 年 12 月 31 日投資組合調整前，各債券之市值與投資組合總市值（含現金）為 US\$ 99,715,725。

表 3-1、2010 年 12 月 31 日投資組合

| A. Before Rebalancing | | | | | | | | | | |
|-------------------------|--------|--------|----------|--------------|------------|--------|-------|-------------|----------------------|-------------|
| Holdings as of Nov 2010 | | | | | | | | | | |
| CUSIP | Issuer | Coupon | Maturity | M. Dur | Face Value | Price | Accr. | Dirty Price | Market Value | Weight |
| US9128277L09 | UST | 4.875 | 02/15/12 | 1.087 | 19,860,000 | 105.02 | 1.84 | 106.86 | 21,222,569 | 21% |
| US912828KC34 | UST | 1.375 | 02/15/12 | 1.111 | 3,640,000 | 101.12 | 0.52 | 101.64 | 3,699,713 | 4% |
| US912828NS58 | UST | 0.625 | 06/30/12 | 1.488 | 7,660,000 | 100.29 | 0.00 | 100.29 | 7,682,461 | 8% |
| US912828LB42 | UST | 1.500 | 07/15/12 | 1.512 | 16,230,000 | 101.65 | 0.69 | 102.34 | 16,609,869 | 17% |
| US912828MB33 | UST | 1.125 | 12/15/12 | 1.936 | 13,850,000 | 101.02 | 0.05 | 101.07 | 13,998,671 | 14% |
| US912828MG20 | UST | 1.375 | 01/15/13 | 2.004 | 12,000,000 | 101.49 | 0.64 | 102.13 | 12,255,227 | 12% |
| US912828NN61 | UST | 1.000 | 07/15/13 | 2.499 | 6,830,000 | 100.48 | 0.46 | 100.94 | 6,894,411 | 7% |
| US912828JK78 | UST | 3.125 | 08/31/13 | 2.557 | 16,190,000 | 106.05 | 1.06 | 107.12 | 17,342,179 | 17% |
| Cash | | | | | | | | | 10,625 | 0% |
| Total Holdings | | | | 1.775 | | | | | 99,715,725.00 | 100% |

| B. After Rebalancing | | | | | | | | | | |
|-------------------------|--------|--------|----------|--------------|------------|--------|-------|-------------|----------------------|-------------|
| Holdings as of Dec 2010 | | | | | | | | | | |
| CUSIP | Issuer | Coupon | Maturity | M. Dur | Face Value | Price | Accr. | Dirty Price | Market Value | Weight |
| US9128277L09 | UST | 4.875 | 02/15/12 | 1.087 | 15,140,000 | 105.02 | 1.84 | 106.86 | 16,178,736 | 16% |
| US912828KC34 | UST | 1.375 | 02/15/12 | 1.111 | 3,640,000 | 101.12 | 0.52 | 101.64 | 3,699,713 | 4% |
| US912828NS58 | UST | 0.625 | 06/30/12 | 1.488 | 7,660,000 | 100.29 | 0.00 | 100.29 | 7,682,461 | 8% |
| US912828LB42 | UST | 1.500 | 07/15/12 | 1.512 | 16,230,000 | 101.65 | 0.69 | 102.34 | 16,609,869 | 17% |
| US912828MB33 | UST | 1.125 | 12/15/12 | 1.936 | 13,850,000 | 101.02 | 0.05 | 101.07 | 13,998,671 | 14% |
| US912828MG20 | UST | 1.375 | 01/15/13 | 2.004 | 12,000,000 | 101.49 | 0.64 | 102.13 | 12,255,227 | 12% |
| US912828NN61 | UST | 1.000 | 07/15/13 | 2.499 | 6,830,000 | 100.48 | 0.46 | 100.94 | 6,894,411 | 7% |
| US912828JK78 | UST | 3.125 | 08/31/13 | 2.557 | 20,890,000 | 106.05 | 1.06 | 107.12 | 22,376,660 | 22% |
| Cash | | | | | | | | | 19,978 | 0% |
| Total Holdings | | | | 1.849 | | | | | 99,715,725.00 | 100% |

三、選擇欲調整之債券 (Security Selection)

2010 年 12 月 31 日投資組合 Duration 為 1.775 (表 3-1 Panel A)，短於新指數之 1.849 (詳圖 3-1A 第 8 欄最後一列)，若欲延長投資組合 Duration，直覺作法為，在維持投資組合市值 US\$ 99,715,725 下，賣出一些短天期債券、買進一些長天期債券。本例選擇調整投資組合中

最短天期與最長天期兩支債券之金額，並保留現金 US\$ 20,000。

四、求解調整金額 (Determine Par Values)

調整金額之目的，在於使投資組合之 Duration 重新與指數之 Duration 相同 (或儘量相近)，亦即，目標在於使投資組合之 Net PV01 (= 投資組合累積 PV01 - 指數累積 PV01) 等於 0，以數學式表達，在求解下列目標函數：

$$\begin{cases} \text{Net PV01} = 0 & (5) \\ \text{s.t. } 99,715,725 - (MV_1 + MV_2) = 20,000 & (6) \end{cases}$$

此動作可利用 Excel 規劃求解功能 (見圖 3-1B) 進行之。

圖 3-1C 第 18 欄顯示所求出之 Rebalancing 金額，但因美國公債之最小投資面額為 US\$ 10,000，故第 19 欄將 Rebalancing 金額取整數至 10,000 之倍數；第 20 欄顯示調整後各債券之投資面額，再乘上債券市價 (第 10 欄 Dirty Price)，可得出第 21 欄各債券之市值，與總投資市值為 US\$ 99,695,747，而保留現金為 US\$ 19,978 (= \$99,715,725 - \$99,695,747)；第 22 欄最後一列顯示投資組合之累積 PV01 為 US\$ 18,435，第 15 欄最後一列顯示指數之累積 PV01 為 US\$ 18,436，故 Net PV01 = - \$1。

表 3-1 Panel B 摘要整理 2010 年 12 月 31 日投資組合經重新調整

後，各債券之市值，此時，投資組合總市值（含現金）仍為 US\$ 99,715,725，投資組合 Duration 為 1.849，與指數 Duration 相同。

五、檢視 (Reviewing)

此外，可製作風險報告，檢視投資組合與指標指數間之追蹤誤差，計算投資組合風險值等。首先，分別將指數與投資組合之利率風險，配置到幾個主要年期（如 0.25、0.50、2、3 年）上，稱之為 Key Rate Duration Mapping，配置後並不會改變指數與投資組合原來之總風險，方法如下：

- 1、 找出每支債券的 *Duration* 落在那兩個相鄰的主要年期中間，例如 $K1$ 與 $K2$ ，且 $K1 < K2$ 。
- 2、 計算某支債券的利率風險 ($Duration_i$)，有多少比例應配置到短的主要年期 $K1$ 上，即 $Alpha = (Duration_i - K2) / (K1 - K2)$ ，又有多少比例應配置到長的主要年期 $K2$ 上，即 $1 - Alpha$ 。
- 3、 配置到 $K1$ 之風險 (PV01) = $Alpha * K1 * Market Value / 10,000$ ，
配置到 $K2$ 之風險 (PV01) = $(1 - Alpha) * K2 * Market Value / 10,000$ 。

以圖 3-2 Panel A 指數中第一支債券 (US912828MJ68) 為例， $Alpha = 0.62 (= (1.074 - 2) / (0.5 - 2))$ ，配置到 0.5 年期之風險為 US\$ 66 (= $0.62 * 0.5 * \$2,137,300 / 10,000$)，配置到 2 年期之風險為 US\$ 164 (= $(1 - 0.62)$

* 2.0 * \$2,137,300 / 10,000)。依此類推，將指數中每支債券的利率風險配置完畢，則各主要年期：0.5、2.0、3.0 上之累積 PV01 分別為 US\$ 1,070、US\$ 12,254、US\$ 5,111，合計 US\$ 18,436，與指數原始之累積 PV01 同。

同理，以圖 3-2 Panel B 投資組合中第一支債券 (US9128277L09) 為例，Alpha = 0.61 (= (1.087 - 2) / (0.5 - 2))，配置到 0.5 年期之風險為 US\$ 492 (= 0.61 * 0.5 * \$16,178,736 / 10,000)，配置到 2.0 年期之風險為 US\$ 1,266 (= (1-0.61) * 2 * \$16,178,736 / 10,000)。依此類推，將投資組合中每支債券的利率風險配置完畢，則各主要年期：0.5、2.0、3.0 上之累積 PV01 分別為 US\$ 1,033、US\$ 12,616、US\$ 4,786，合計 US\$ 18,435，與投資組合原始之累積 PV01 同。

其次，製作風險報告，表 3-2 摘要比較指數與投資組合之風險輪廓，Key Rate PV01s 顯示各主要年期上之利率風險差異，Total PV01 顯示總利率風險差異為- \$1，至於 Tracking Error 則為 1.21 bps。

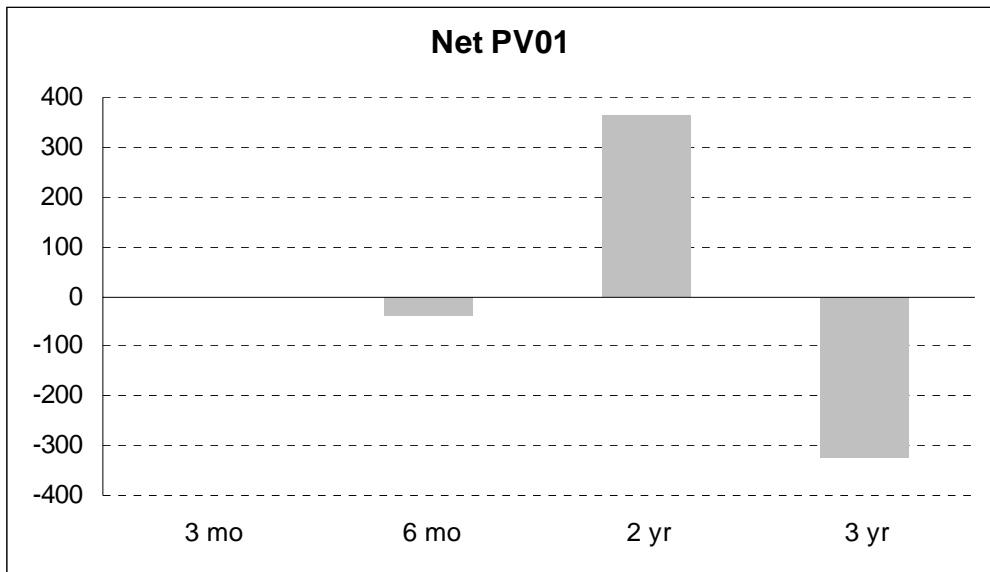
$$TE(\$) = \sqrt{[0 \quad -37 \quad 362 \quad -325] * \begin{bmatrix} 440 & 341 & 188 & -58 \\ 341 & 331 & 238 & -37 \\ 188 & 238 & 359 & -4 \\ -58 & -37 & -4 & 997 \end{bmatrix} * \begin{bmatrix} 0 \\ -37 \\ 362 \\ -325 \end{bmatrix}}$$

$$= \$12,111$$

$$TE (bps) = \$12,111 / \$99,695,747 * 10000$$

表 3-2、風險報告

| | | Benchmark | Portfolio | Net |
|-----------------|--------------|------------|------------|----------|
| | Market Value | 99,715,725 | 99,695,747 | (19,978) |
| | Duration | 1.849 | 1.849 | 0 |
| Key Rate PV01s | 3 mo | - | - | - |
| | 6 mo | 1,070 | 1,033 | (37) |
| | 2 yr | 12,254 | 12,616 | 362 |
| | 3 yr | 5,111 | 4,786 | (325) |
| Key Rate CR01 | 3 mo | - | - | - |
| | 6 mo | - | - | - |
| | 2 yr | - | - | - |
| | 5 yr | - | - | - |
| Total PV01 | | 18,436 | 18,435 | (1) |
| Volatility - \$ | | 292,475 | 292,496 | 12,111 |
| TE - bps | bps | 29.33 | 29.34 | 1.21 |
| VaR - \$ | 99% | (680,398) | (680,447) | (28,173) |
| VaR - bps | 99% | (68) | (68) | (2.8) |



Appendix. 美國公債變異數共變異數矩陣 (Monthly, as of Dec 31, 2011)

| US TREASURY CURVE | | | |
|-------------------|------|------|------|
| 3 mo | 6 mo | 2 yr | 3 yr |
| 440 | 341 | 188 | -58 |
| 341 | 331 | 238 | -37 |
| 188 | 238 | 359 | -4 |
| -58 | -37 | -4 | 997 |

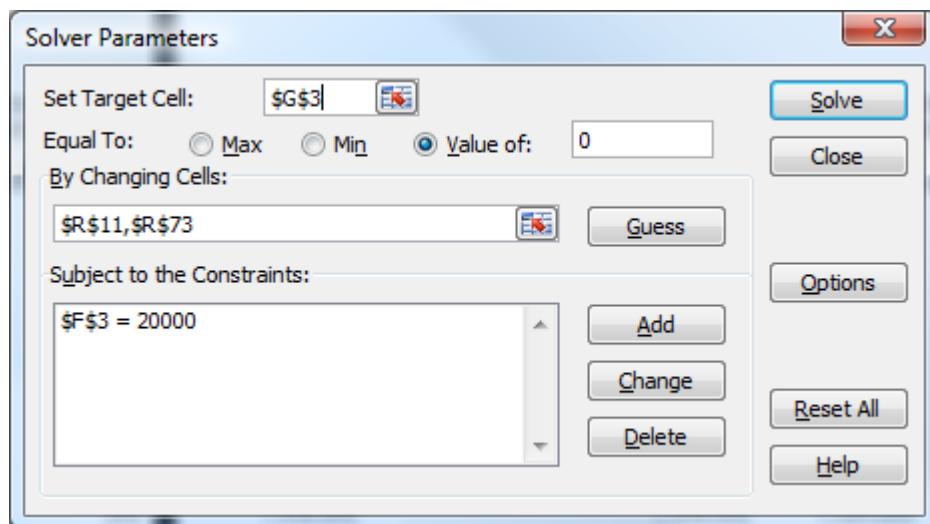
圖 3-1A、BoA-Merrill Lynch 1~3 年期美國公債指數成份 (2011 年 1 月)

| Month-end Date | Benchmark Effective Date | Current Size (incl. Cash) | Total Holdings after Rebal. | Cash after Rebal. | Net PV01 |
|----------------|--------------------------|---------------------------|-----------------------------|-------------------|----------|
| 31-Dec-10 | 01-Jan-11 | 99,715,725 | 99,695,725 | 20,000 | 0 |

\$G\$3: Net PV01 = Portfolio PV01 – Index PV01

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 | 13 | 14 | 15 |
|----------------|-----------------------------|--------------|--------|------------|------------|---------|---------|--------------------|-------------|------------------|----------------|------------|-------------------|---------------|
| | Index Security Descriptions | | | | | | | Index Calculations | | | | | | |
| | Bucket | ISIN | Coupon | Maturity | Par Amount | Price | Accrued | Eff Dur | Dirty price | MV | %Index | Cum Weight | Scaled Index MV | Index PV01 |
| 5 | Bucket 1 | US912828MJ68 | 0.875 | 2012/1/31 | 44,716 | 100.566 | 0.366 | 1.074 | 100.93 | 45,133 | 2.14% | 7% | 2,137,300 | 230 |
| 6 | Bucket 1 | US9128277L09 | 4.875 | 2012/2/15 | 24,780 | 105.020 | 1.841 | 1.087 | 106.86 | 26,480 | 1.26% | 9% | 1,253,982 | 136 |
| 7 | Bucket 1 | US912828KC34 | 1.375 | 2012/2/15 | 33,630 | 101.121 | 0.519 | 1.111 | 101.64 | 34,182 | 1.62% | 10% | 1,618,694 | 180 |
| 8 | Bucket 1 | US912828GK06 | 4.625 | 2012/2/29 | 16,637 | 104.906 | 1.571 | 1.127 | 106.48 | 17,715 | 0.84% | 11% | 838,889 | 95 |
| 14 | Bucket 1 | US912828GQ75 | 4.500 | 2012/4/30 | 16,450 | 105.512 | 0.771 | 1.295 | 106.28 | 17,484 | 0.83% | 21% | 827,943 | 107 |
| 15 | Bucket 1 | US912828NB24 | 1.000 | 2012/4/30 | 44,938 | 100.790 | 0.171 | 1.319 | 100.96 | 45,370 | 2.15% | 23% | 2,148,515 | 283 |
| 20 | Bucket 2 | US912828GW44 | 4.875 | 2012/6/30 | 15,903 | 106.599 | 0.013 | 1.458 | 106.61 | 16,955 | 0.81% | 30% | 802,895 | 117 |
| 21 | Bucket 2 | US912828NS58 | 0.625 | 2012/6/30 | 41,191 | 100.291 | 0.002 | 1.488 | 100.29 | 41,312 | 1.96% | 32% | 1,956,343 | 291 |
| 22 | Bucket 2 | US912828LB42 | 1.500 | 2012/7/15 | 35,592 | 101.648 | 0.693 | 1.512 | 102.34 | 36,425 | 1.73% | 34% | 1,724,929 | 261 |
| 23 | Bucket 2 | US912828GZ74 | 4.625 | 2012/7/31 | 15,804 | 106.573 | 1.935 | 1.514 | 108.51 | 17,149 | 0.81% | 35% | 812,089 | 123 |
| 30 | Bucket 2 | US912828HE37 | 4.250 | 2012/9/30 | 15,874 | 106.517 | 1.086 | 1.686 | 107.60 | 17,081 | 0.81% | 45% | 808,876 | 136 |
| 31 | Bucket 2 | US912828NX44 | 0.375 | 2012/9/30 | 37,129 | 99.753 | 0.096 | 1.739 | 99.85 | 37,073 | 1.76% | 47% | 1,755,600 | 305 |
| 38 | bucket 3 | US912828PV69 | 0.500 | 2012/11/30 | 36,383 | 99.856 | 0.044 | 1.905 | 99.90 | 36,347 | 1.73% | 57% | 1,721,218 | 328 |
| 39 | bucket 3 | US912828MB33 | 1.125 | 2012/12/15 | 40,217 | 101.021 | 0.053 | 1.936 | 101.07 | 40,649 | 1.93% | 58% | 1,924,943 | 373 |
| 40 | bucket 3 | US912828HM52 | 3.625 | 2012/12/31 | 15,657 | 106.044 | 0.010 | 1.946 | 106.05 | 16,605 | 0.79% | 59% | 786,332 | 153 |
| 42 | bucket 3 | US912828MG20 | 1.375 | 2013/1/15 | 41,552 | 101.492 | 0.635 | 2.004 | 102.13 | 42,436 | 2.02% | 63% | 2,009,570 | 403 |
| 43 | bucket 3 | US912828HQ66 | 2.875 | 2013/1/31 | 15,700 | 104.719 | 1.203 | 2.015 | 105.92 | 16,630 | 0.79% | 64% | 787,511 | 159 |
| 49 | bucket 3 | US912828MX52 | 1.750 | 2013/4/15 | 42,928 | 102.289 | 0.375 | 2.243 | 102.66 | 44,072 | 2.09% | 73% | 2,087,036 | 468 |
| 50 | bucket 3 | US912828HY90 | 3.125 | 2013/4/30 | 20,743 | 105.633 | 0.535 | 2.254 | 106.17 | 22,023 | 1.05% | 74% | 1,042,891 | 235 |
| 57 | bucket 4 | US912828BH22 | 4.250 | 2013/8/15 | 33,521 | 108.899 | 1.605 | 2.478 | 110.50 | 37,042 | 1.76% | 84% | 1,754,155 | 435 |
| 58 | bucket 4 | US912828NN61 | 1.000 | 2013/7/15 | 35,010 | 100.481 | 0.462 | 2.499 | 100.94 | 35,340 | 1.68% | 85% | 1,673,554 | 418 |
| 59 | bucket 4 | US912828JK78 | 3.125 | 2013/8/31 | 23,837 | 106.055 | 1.062 | 2.557 | 107.12 | 25,533 | 1.21% | 87% | 1,209,148 | 309 |
| 60 | bucket 4 | US912828NU05 | 0.750 | 2013/8/15 | 36,036 | 99.792 | 0.283 | 2.594 | 100.08 | 36,063 | 1.71% | 88% | 1,707,795 | 443 |
| 67 | bucket 4 | US912828PU86 | 0.500 | 2013/11/15 | 32,853 | 98.687 | 0.065 | 2.856 | 98.75 | 32,443 | 1.54% | 98% | 1,536,359 | 439 |
| 68 | bucket 4 | US912828PL87 | 0.750 | 2013/12/15 | 32,000 | 99.289 | 0.035 | 2.930 | 99.32 | 31,784 | 1.51% | 100% | 1,505,135 | 441 |
| Totals: | | | | | | | | 1.849 | | 2,105,681 | 100.00% | | 99,715,725 | 18,436 |

圖 3-1B、Excel 規劃求解功能



目標儲存格（\$G\$3）內為 Net PV01（見圖 3-1A），等於投資組合累積 PV01 減去指數累積 PV01，Net PV01 之目標值為 0。

圖 3-1C、2010 年 12 月 31 日調整後投資組合

| Month-end Date | Benchmark Effective Date | Current Size (incl. Cash) | Total Holdings after Rebal. | Cash after Rebal. | Net PV01 |
|----------------|--------------------------|---------------------------|-----------------------------|-------------------|----------|
| 31-Dec-10 | 01-Jan-11 | 99,715,725 | 99,695,747 | 19,978 | -1 |

Net PV01 = Portfolio PV01 – Index PV01 = 18,345 - 18,346

| Index Security Descriptions | | | | | | | | Portfolio Calculations | | | | | | |
|-----------------------------|----------|--------------|----------|--------------|---------------|-------------|------------|------------------------|--------------|-------------------|-------------------|---------------|----------------|-------|
| Bucket | ISIN | Coupon | Maturity | Par Amount | Eff Dur | Dirty price | Index PV01 | Initial Amount | Re-balancing | Rebalance Par Amt | Total Amount | MV | Portfolio PV01 | |
| 5 | Bucket 1 | US912828MJ68 | 0.875 | 2012/1/31 | 44,716 | 1.074 | 100.93 | 230 | 0 | | | 0 | 0 | |
| 6 | Bucket 1 | US9128277L09 | 4.875 | 2012/2/15 | 24,780 | 1.087 | 106.86 | 136 | 19,860,000 | -4,723,966 | -4,720,000 | 15,140,000 | 16,178,736 | 1,759 |
| 7 | Bucket 1 | US912828KC34 | 1.375 | 2012/2/15 | 33,630 | 1.111 | 101.64 | 180 | 3,640,000 | | | 3,640,000 | 3,699,713 | 411 |
| 8 | Bucket 1 | US912828GK06 | 4.625 | 2012/2/29 | 16,637 | 1.127 | 106.48 | 95 | 0 | | | 0 | 0 | 0 |
| 14 | Bucket 1 | US912828GQ75 | 4.500 | 2012/4/30 | 16,450 | 1.295 | 106.28 | 107 | 0 | | | 0 | 0 | 0 |
| 15 | Bucket 1 | US912828NB24 | 1.000 | 2012/4/30 | 44,938 | 1.319 | 100.96 | 283 | 0 | | | 0 | 0 | 0 |
| 20 | Bucket 2 | US912828GW44 | 4.875 | 2012/6/30 | 15,903 | 1.458 | 106.61 | 117 | 0 | | | 0 | 0 | 0 |
| 21 | Bucket 2 | US912828NS58 | 0.625 | 2012/6/30 | 41,191 | 1.488 | 100.29 | 291 | 7,660,000 | | | 7,660,000 | 7,682,461 | 1,143 |
| 22 | Bucket 2 | US912828LB42 | 1.500 | 2012/7/15 | 35,592 | 1.512 | 102.34 | 261 | 16,230,000 | | | 16,230,000 | 16,609,869 | 2,511 |
| 23 | Bucket 2 | US912828GZ74 | 4.625 | 2012/7/31 | 15,804 | 1.514 | 108.51 | 123 | 0 | | | 0 | 0 | 0 |
| 30 | Bucket 2 | US912828HE37 | 4.250 | 2012/9/30 | 15,874 | 1.686 | 107.60 | 136 | 0 | | | 0 | 0 | 0 |
| 31 | Bucket 2 | US912828NX44 | 0.375 | 2012/9/30 | 37,129 | 1.739 | 99.85 | 305 | 0 | | | 0 | 0 | 0 |
| 38 | bucket 3 | US912828PV69 | 0.500 | 2012/11/30 | 36,383 | 1.905 | 99.90 | 328 | 0 | | | 0 | 0 | 0 |
| 39 | bucket 3 | US912828MB33 | 1.125 | 2012/12/15 | 40,217 | 1.936 | 101.07 | 373 | 13,850,000 | | | 13,850,000 | 13,998,671 | 2,710 |
| 40 | bucket 3 | US912828HM52 | 3.625 | 2012/12/31 | 15,657 | 1.946 | 106.05 | 153 | 0 | | | 0 | 0 | 0 |
| 42 | bucket 3 | US912828MG20 | 1.375 | 2013/1/15 | 41,552 | 2.004 | 102.13 | 403 | 12,000,000 | | | 12,000,000 | 12,255,227 | 2,456 |
| 43 | bucket 3 | US912828HQ66 | 2.875 | 2013/1/31 | 15,700 | 2.015 | 105.92 | 159 | 0 | | | 0 | 0 | 0 |
| 49 | bucket 3 | US912828MX52 | 1.750 | 2013/4/15 | 42,928 | 2.243 | 102.66 | 468 | 0 | | | 0 | 0 | 0 |
| 50 | bucket 3 | US912828HY90 | 3.125 | 2013/4/30 | 20,743 | 2.254 | 106.17 | 235 | 0 | | | 0 | 0 | 0 |
| 57 | bucket 4 | US912828BH22 | 4.250 | 2013/8/15 | 33,521 | 2.478 | 110.50 | 435 | 0 | | | 0 | 0 | 0 |
| 58 | bucket 4 | US912828NN61 | 1.000 | 2013/7/15 | 35,010 | 2.499 | 100.94 | 418 | 6,830,000 | | | 6,830,000 | 6,894,411 | 1,723 |
| 59 | bucket 4 | US912828JK78 | 3.125 | 2013/8/31 | 23,837 | 2.557 | 107.12 | 309 | 16,190,000 | 4,703,935 | 4,700,000 | 20,890,000 | 22,376,660 | 5,722 |
| 60 | bucket 4 | US912828NU05 | 0.750 | 2013/8/15 | 36,036 | 2.594 | 100.08 | 443 | 0 | | | 0 | 0 | 0 |
| 67 | bucket 4 | US912828PU86 | 0.500 | 2013/11/15 | 32,853 | 2.856 | 98.75 | 439 | 0 | | | 0 | 0 | 0 |
| 68 | bucket 4 | US912828PL87 | 0.750 | 2013/12/15 | 32,000 | 2.930 | 99.32 | 441 | 0 | | | 0 | 0 | 0 |
| Totals: | | | | 1.849 | 18,436 | | | | | | 99,695,747 | 18,435 | | |

圖 3-2、Key Rate Duration Mapping

| Panel A. Index (as of Dec 31, 2010) | | | | | Key Rate Duration Mapping (as of Dec 31, 2010) | | | | | | | | | |
|-------------------------------------|--------------|-------------------|--------------|---------------|--|--------------|-------------------|--------------|---------------|----------|--------------|---------------|--------------|---------------|
| | CUSIP | MV | Mod Dur | DV01 | Alpha | CUSIP | MV | Mod Dur | DV01 | 0.25 | 0.50 | 2.00 | 3.00 | Total |
| 5 | US912828MJ68 | 2,137,300 | 1.074 | 230 | 0.62 | US912828MJ68 | 2,137,300 | 1.074 | 230 | | 66 | 164 | | 230 |
| 6 | US9128277L09 | 1,253,982 | 1.087 | 136 | 0.61 | US9128277L09 | 1,253,982 | 1.087 | 136 | | 38 | 98 | | 136 |
| 7 | US912828KC34 | 1,618,694 | 1.111 | 180 | 0.59 | US912828KC34 | 1,618,694 | 1.111 | 180 | | 48 | 132 | | 180 |
| 8 | US912828GK06 | 838,889 | 1.127 | 95 | 0.58 | US912828GK06 | 838,889 | 1.127 | 95 | | 24 | 70 | | 95 |
| 14 | US912828GQ75 | 827,943 | 1.295 | 107 | 0.47 | US912828GQ75 | 827,943 | 1.295 | 107 | | 19 | 88 | | 107 |
| 15 | US912828NB24 | 2,148,515 | 1.319 | 283 | 0.45 | US912828NB24 | 2,148,515 | 1.319 | 283 | | 49 | 235 | | 283 |
| 20 | US912828GW44 | 802,895 | 1.458 | 117 | 0.36 | US912828GW44 | 802,895 | 1.458 | 117 | | 15 | 103 | | 117 |
| 21 | US912828NS58 | 1,956,343 | 1.488 | 291 | 0.34 | US912828NS58 | 1,956,343 | 1.488 | 291 | | 33 | 258 | | 291 |
| 22 | US912828LB42 | 1,724,929 | 1.512 | 261 | 0.33 | US912828LB42 | 1,724,929 | 1.512 | 261 | | 28 | 233 | | 261 |
| 23 | US912828GZ74 | 812,089 | 1.514 | 123 | 0.32 | US912828GZ74 | 812,089 | 1.514 | 123 | | 13 | 110 | | 123 |
| 38 | US912828PV69 | 1,721,218 | 1.905 | 328 | 0.06 | US912828PV69 | 1,721,218 | 1.905 | 328 | | 5 | 322 | | 328 |
| 39 | US912828MB33 | 1,924,943 | 1.936 | 373 | 0.04 | US912828MB33 | 1,924,943 | 1.936 | 373 | | 4 | 369 | | 373 |
| 40 | US912828HM52 | 786,332 | 1.946 | 153 | 0.04 | US912828HM52 | 786,332 | 1.946 | 153 | | 1 | 152 | | 153 |
| 42 | US912828MG20 | 2,009,570 | 2.004 | 403 | 1.00 | US912828MG20 | 2,009,570 | 2.004 | 403 | | | 400 | 2 | 403 |
| 43 | US912828HQ66 | 787,511 | 2.015 | 159 | 0.99 | US912828HQ66 | 787,511 | 2.015 | 159 | | | 155 | 4 | 159 |
| 49 | US912828MX52 | 2,087,036 | 2.243 | 468 | 0.76 | US912828MX52 | 2,087,036 | 2.243 | 468 | | | 316 | 152 | 468 |
| 50 | US912828HY90 | 1,042,891 | 2.254 | 235 | 0.75 | US912828HY90 | 1,042,891 | 2.254 | 235 | | | 156 | 79 | 235 |
| 57 | US912828BH22 | 1,754,155 | 2.478 | 435 | 0.52 | US912828BH22 | 1,754,155 | 2.478 | 435 | | | 183 | 252 | 435 |
| 58 | US912828NN61 | 1,673,554 | 2.499 | 418 | 0.50 | US912828NN61 | 1,673,554 | 2.499 | 418 | | | 168 | 251 | 418 |
| 59 | US912828JK78 | 1,209,148 | 2.557 | 309 | 0.44 | US912828JK78 | 1,209,148 | 2.557 | 309 | | | 107 | 202 | 309 |
| 60 | US912828NU05 | 1,707,795 | 2.594 | 443 | 0.41 | US912828NU05 | 1,707,795 | 2.594 | 443 | | | 139 | 304 | 443 |
| 67 | US912828PU86 | 1,536,359 | 2.856 | 439 | 0.14 | US912828PU86 | 1,536,359 | 2.856 | 439 | | | 44 | 395 | 439 |
| 68 | US912828PL87 | 1,505,135 | 2.930 | 441 | 0.07 | US912828PL87 | 1,505,135 | 2.930 | 441 | | | 21 | 420 | 441 |
| | Total | 99,715,725 | 1.849 | 18,436 | | Total | 99,715,725 | 1.849 | 18,436 | - | 1,070 | 12,254 | 5,111 | 18,436 |

| Panel B. Portfolio Holdings (as of Dec 31, 2011) | | | | | | | Interest Rate Risk Mapping (as of Dec 31, 2011) | | | | | | |
|--|--------|-----------|----------|------------|-------------|-------------------|---|---------------|----------|--------------|---------------|--------------|---------------|
| Issue | Coupon | Maturity | Duration | Face Amt | Dirty Price | Market Value | Alpha | DV01 | 0.25 | 0.50 | 2.00 | 3.00 | Total |
| US9128277L09 | 4.875 | 15-Feb-12 | 1.087 | 15,140,000 | 106.86 | 16,178,736 | 0.61 | 1,759 | | 492 | 1,266 | | 1,759 |
| US912828KC34 | 1.375 | 15-Feb-12 | 1.111 | 3,640,000 | 101.64 | 3,699,713 | 0.59 | 411 | | 110 | 301 | | 411 |
| US912828NS58 | 0.625 | 30-Jun-12 | 1.488 | 7,660,000 | 100.29 | 7,682,461 | 0.34 | 1,143 | | 131 | 1,012 | | 1,143 |
| US912828LB42 | 1.500 | 15-Jul-12 | 1.512 | 16,230,000 | 102.34 | 16,609,869 | 0.33 | 2,511 | | 270 | 2,241 | | 2,511 |
| US912828MB33 | 1.125 | 15-Dec-12 | 1.936 | 13,850,000 | 101.07 | 13,998,671 | 0.04 | 2,710 | | 30 | 2,680 | | 2,710 |
| US912828MG20 | 1.375 | 15-Jan-13 | 2.004 | 12,000,000 | 102.13 | 12,255,227 | 1.00 | 2,456 | | | 2,441 | 15 | 2,456 |
| US912828NN61 | 1.000 | 15-Jul-13 | 2.499 | 6,830,000 | 100.94 | 6,894,411 | 0.50 | 1,723 | | | 691 | 1,032 | 1,723 |
| US912828JK78 | 3.125 | 31-Aug-13 | 2.557 | 20,890,000 | 107.12 | 22,376,660 | 0.44 | 5,722 | | | 1,983 | 3,739 | 5,722 |
| Cash | - | | | | | | | - | | | - | - | - |
| Total | | | | | | 99,695,747 | | 18,435 | - | 1,033 | 12,616 | 4,786 | 18,435 |

第四節、 績效評估 (Performance Measurement)

實務上，在重新調整投資組合前，可先評估投資組合於 12 月份之績效表現，以做為 12 月 31 日實際調整投資組合之參考。表 4-1 Panel A 顯示 2010 年 11 月 30 日所建立之投資組合，加權平均息票率為 2.325%，比指數之加權平均息票率 1.931%略高（詳圖 2-1A 第 3 欄），總市值為 US\$ 100,000,000。

2010 年 12 月份公債價格下跌，表 4-1 Panel B 顯示 2010 年 12 月 31 日投資組合總市值降為 US\$ 99,811,556，損失 US\$ 188,444，總報酬率為-0.188%。將之拆解為利息收入與價格報酬兩部份，則（一）投資組合含現金 US\$ 10,625 與其一個月孳息 US\$ 1.662，共 US\$ 10,627 收入；另第 3 支債券在 12 月 31 日付息 US\$ 23,938；第 5 支債券在 12 月 15 日付息 US\$ 77,906，與其半個月孳息 US\$ 6.29，共 US\$ 77,913 收入；合計利息收入為 US\$ 879,987，較 11 月底之 US\$ 699,465 高出 US\$ 180,521，故利息報酬率為 0.181%，而（二）價格報酬率則為-0.369%（= -0.188% - 0.181%）。

表 4-1、2010 年 12 月份投資組合績效表現

Panel A. Nov 30, 2010

| | 1 | 2 | 3 | 4 | 5 | 9 | 10 | 11 | 12 | 13 |
|----------------|--------------|------------|------------|----------|----------|------------|----------------|--------------------|-------------|----------|
| | | | | 11/30/10 | 11/30/10 | | | | | 11/30/10 |
| CUSIP | Coupon | Maturity | Par Amt | Price | Accrual | Clean MV | Accrual | Dirty MV | Weight | |
| 1 US9128277L09 | 4.875 | 2012/2/15 | 19,860,000 | 105.48 | 1.43 | 20,948,109 | 284,138 | 21,232,247 | 21% | |
| 2 US912828KC34 | 1.375 | 2012/2/15 | 3,640,000 | 101.25 | 0.40 | 3,685,533 | 14,689 | 3,700,221 | 4% | |
| 3 US912828NS58 | 0.625 | 2012/6/30 | 7,660,000 | 100.35 | 0.26 | 7,686,894 | 20,035 | 7,706,929 | 8% | |
| 4 US912828LB42 | 1.500 | 2012/7/15 | 16,230,000 | 101.82 | 0.57 | 16,525,727 | 91,955 | 16,617,682 | 17% | |
| 5 US912828MB33 | 1.125 | 2012/12/15 | 13,850,000 | 101.28 | 0.52 | 14,027,307 | 71,946 | 14,099,253 | 14% | |
| 6 US912828MG20 | 1.375 | 2013/1/15 | 12,000,000 | 101.83 | 0.52 | 12,220,068 | 62,323 | 12,282,391 | 12% | |
| 7 US912828NN61 | 1.000 | 2013/7/15 | 6,830,000 | 101.05 | 0.38 | 6,901,660 | 25,798 | 6,927,459 | 7% | |
| 8 US912828JK78 | 3.125 | 2013/8/31 | 16,190,000 | 106.82 | 0.79 | 17,294,611 | 128,581 | 17,423,192 | 17% | |
| Cash | 0.182 | | 10,625 | 100.00 | - | 10,625 | - | 10,625 | 0% | |
| Total | 2.325 | | | | | | 699,465 | 100,000,000 | 100% | |

Panel B. Dec 31, 2010

| | 1 | 2 | 3 | 4 | 5 | 6 | 9 | 10 | 11 | 12 |
|----------------------------|--------|------------|------------|----------|-------------|---------|------------|----------------|-------------------|----|
| | | | | 11/30/10 | 12/31/10 | Last | | | Accrual Int + | |
| CUSIP | Coupon | Maturity | Par Amt | Price | Coupon Date | Accrual | Clean MV | Cpn Payment | Dirty MV | |
| 1 US9128277L09 | 4.875 | 2012/2/15 | 19,860,000 | 105.02 | 2010/8/15 | 1.828 | 20,856,873 | 363,066 | 21,219,939 | |
| 2 US912828KC34 | 1.375 | 2012/2/15 | 3,640,000 | 101.12 | 2010/8/15 | 0.516 | 3,680,808 | 18,769 | 3,699,577 | |
| 3 US912828NS58 | 0.625 | 2012/6/30 | 7,660,000 | 100.29 | 2010/12/31 | - | 7,682,329 | - | 7,682,329 | |
| 4 US912828LB42 | 1.500 | 2012/7/15 | 16,230,000 | 101.65 | 2010/7/15 | 0.689 | 16,497,405 | 111,802 | 16,609,207 | |
| 5 US912828MB33 | 1.125 | 2012/12/15 | 13,850,000 | 101.02 | 2010/12/15 | 0.049 | 13,991,394 | 6,849 | 13,998,243 | |
| 6 US912828MG20 | 1.375 | 2013/1/15 | 12,000,000 | 101.49 | 2010/7/15 | 0.631 | 12,179,004 | 75,774 | 12,254,778 | |
| 7 US912828NN61 | 1.000 | 2013/7/15 | 6,830,000 | 100.48 | 2010/7/15 | 0.459 | 6,862,859 | 31,366 | 6,894,225 | |
| 8 US912828JK78 | 3.125 | 2013/8/31 | 16,190,000 | 106.05 | 2010/8/31 | 1.053 | 17,170,272 | 170,509 | 17,340,782 | |
| Cash | 0.182 | | 10,625 | 100.00 | | 10,625 | 10,625 | 1.662 | 10,627 | |
| 3 3rd Coupon Payment | | | | 100.00 | | 23,938 | 23,938 | - | 23,938 | |
| 5 5th Coupon Payment | | | | 100.00 | | 77,906 | 77,906 | 6.291 | 77,913 | |
| Total | | | | | | | | 879,987 | 99,811,556 | |
| Monthly Change (\$) | | | | | | | | 180,521 | -188,444 | |
| Monthly Change (%) | | | | | | | | 0.181% | -0.188% | |

第五節、 績效報告 (Reporting)

最後，製作績效報告，向董事會呈報 2010 年 12 月份複製指標指數之結果。例如，表 5-1 說明 2010 年 12 月份投資組合追蹤指數之結果：

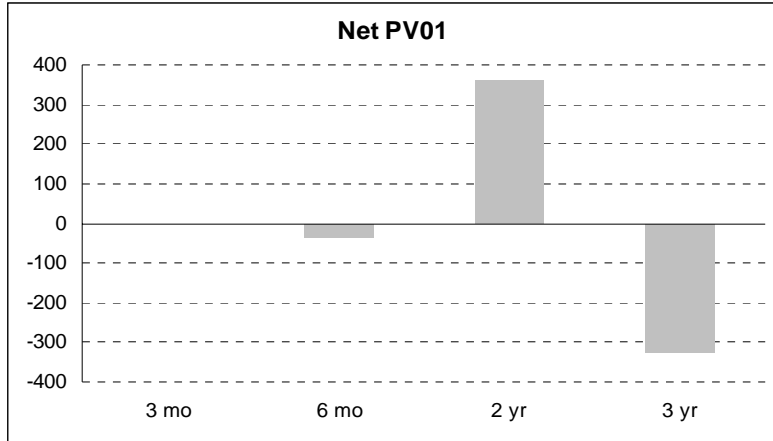
- 1、 利息報酬方面 (Panel A)：因投資組合比指數之加權平均息票率略高，故有正的 (2.444 bps) 追蹤誤差。
- 2、 價格報酬方面 (Panel A)：有負的 (-2.637 bps) 追蹤誤差，檢視風險報告可知，投資組合對 2 年期與 3 年期之 Key Rate Duration 相當敏感 (Panel B)，致 2~3 年期債券之價格損失稍大 (Panel C)，因此 2010 年 12 月 31 日重新調整投資組合之重點，宜進一步降低此兩 Buckets 之 Net PV01。

表 5-1、績效報告

Panel A. 追蹤誤差

| | Portfolio (%) | Index (%) | Excess (BPS) |
|----------------|---------------|-----------|--------------|
| Price Return | -0.369% | -0.343% | -2.637 |
| Accrual+Coupon | 0.181% | 0.156% | 2.444 |
| Total Return | -0.188% | -0.187% | -0.193 |

Panel B. 風險報告



Panel C. 投資組合價格報酬

| | 1 | 2 | 3 | 4 | 5 | 14 |
|----------------|--------|------------|------------------|----------------|-----------------|----|
| CUSIP | Coupon | Maturity | 11/30/10 Par Amt | 12/31/10 Price | Clean MV Change | |
| 1 US9128277L09 | 4.875 | 2012/2/15 | 19,860,000 | 105.02 | -91,236 | |
| 2 US912828KC34 | 1.375 | 2012/2/15 | 3,640,000 | 101.12 | -4,725 | |
| 3 US912828NS58 | 0.625 | 2012/6/30 | 7,660,000 | 100.29 | -4,565 | |
| 4 US912828LB42 | 1.500 | 2012/7/15 | 16,230,000 | 101.65 | -28,321 | |
| 5 US912828MB33 | 1.125 | 2012/12/15 | 13,850,000 | 101.02 | -35,913 | |
| 6 US912828MG20 | 1.375 | 2013/1/15 | 12,000,000 | 101.49 | -41,064 | |
| 7 US912828NN61 | 1.000 | 2013/7/15 | 6,830,000 | 100.48 | -38,801 | |
| 8 US912828JK78 | 3.125 | 2013/8/31 | 16,190,000 | 106.05 | -124,339 | |

Appendix. Index Performance

```

mlprd2 Index
MERRILL LYNCH INDICES
Rates of Return

From: 11/30/10 To: 12/31/10 Inception Date
Currency LOC Percent Hedged Total Return: 12/31/75
Price Return: 1/31/78

6102 U.S. Treasuries, 1-3 Yrs

Total Return Index Price Return Index
Index Value 11/30/10 12/31/10 11/30/10 12/31/10
Periodic Return -0.187 -0.342
Annualized Return -2.174 -3.958
    
```

第六節、結論與未來發展方向

分層取樣法之優點為：複製的步驟與流程透明，且成本低。缺點為：主要依賴人力之主觀判斷，來進行分層取樣及重新調整投資組合，但不確定所建立之投資組合是否為最佳組合，或許需試驗多次才能找到使事前追蹤誤差最小的組合。以 BoA-Merrill Lynch 1 至 3 年期美國公債指數為例，包含 68 支公債，尚可用人力複製，若應用到 1 至 10 年期美國公債指數，包含 161 支公債時，可以想見勞力密集之程度。

最適化求解法之優點為：在給定投資目標（事前追蹤誤差最小）與相關限制條件下，最適化求解軟體可有效率地找出最佳投資組合，並產生風險與績效報告（韓國央行採用 Barclays POINT 系統）。缺點為：軟體成本高，且求解方法主要依賴歷史債券價格、及變異數與共變變異數等資料，找出的投資組合不保證能應付未來極端情況。

本研討會係為複製指標指數技巧之入門課程，有些實際執行層面的問題並未深入討論，諸如：

- 1、 如何應用到 1 至 10 年期美國公債指數：若採取將指數分段成 1~3 年（68 支）、3~5 年（36 支）、5~7 年（37 支）、及 7~10 年（20 支）四個子指數，再分批複製的方式進行，即使每一段皆找到最佳投資組合（假設每段選出 8 支債券），合起來（四段共有 32 支債券）是否為最佳投資組合？

- 2、 以 On-the-run 債券複製是否較佳：若每個月皆以 2、3、5、7、10 年期 on-the-run 債券來複製 1 至 10 年期美國公債指數，則其餘 off-the-run 債券之績效如何複製？或者說，隨著時間經過，當年的 on-the-run 債券變成現在指數裡的 off-the-run 債券，而現在 Rebalancing 時又只調整現在 on-the-run 債券之金額，則其餘 off-the-run 債券之績效如何複製？
- 3、 如何應用到 MBS 指數：上述第 2 點問題在複製 MBS 指數時特別明顯，使用 current coupon TBA 只能追蹤 MBS generic index 中（例如 ML 之 MG1S）新產生的 pools，但整體指數總共包含 92 個不同 coupon、不同 vintage 的 pools，如何複製這些 seasoned pools 之績效，尤其是 large seasoned pools 不見得能在市場上買到¹。

上述問題留待後續研究。

¹ Dynkin, Konstantinovsky and Phelps (2001)發現，使用 Large Pool-Only (at least \$5 bil outstanding) 策略複製 Lehman MBS Index 之事後追蹤誤差，明顯小於使用 TBA-Only 策略，但困難處在於 large seasoned pools 不易買到。

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