CHAPTER 3

A New Fixed-Income Fund Performance Attribution Model: An Application to ECB Reserve Management

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3.1 Introduction[1]

Portfolio managers' results can be analyzed from different perspectives. The first approach is used by empirical studies that aim to detect the market-timing ability of portfolio managers when granular data on portfolio composition, benchmark composition, and risk factors are not available. While in principle portfolio holdings would be best suited to infer the (ex-ante) managers' bets, given the data limitations, researchers generally resort to (ex-post) return-based tests, where assumptions have to be made about the relevant benchmark index.

The views expressed in the article are those of the authors and do not involve the responsibility of the Bank.

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According to the literature on fixed-income portfolio management: (1) on average bond fund managers exhibit negative or neutral timing ability (Blake et al. 1993; Elton et al. 1995; Boney et al. 2009); (2) conditional performance adjusted for risk is slightly negative (Lam 1999; Ferson et al. 2006); (3) adjusting for non-linear effects, there is no evidence of positive performance after costs (Chen et al. 2010). The studies that employ measures of bond portfolio holdings show a similar picture with some nuances. In particular, Moneta (2015) finds that, on average, portfolio managers display neutral timing ability, with only a subgroup of funds exhibiting successful timing ability; Cici and Gibson (2012) show that conditional performance adjusted for risk is slightly negative; Huang and Wang (2014) find that fund managers specializing in Treasury securities show better market-timing ability in comparison with managers investing in portfolios including mortgage-backed and agency securities—however, after controlling for public information, ability becomes neutral.

A second approach, more oriented toward practitioners, includes performance attribution studies that seek to identify sources of outperformance based on granular data on the composition and risk exposure of portfolios. Compared with return-based tests, performance attribution models allow for pinpointing the skills of portfolio managers by linking return decomposition to specific portfolio strategies. For example, a manager's ability in terms of duration management could be offset by the lack of skill in spread management, or vice versa. In such cases, the econometric estimate of market-timing ability would be the result of two opposite forces, which might cancel each other in statistical terms. Performance attribution models overcome this problem.

Two main families of performance attribution models have been developed in the literature and in the financial industry: sector-based models and factor-based models. The first group tries to identify the contribution of each strategy via a comparison between the portfolio sector weights and returns, and the benchmark sector weights and returns. These models are usually applied to equity funds and identify three sources of performance variation from the benchmark (see e.g. Brinson et al. 1986): asset allocation, stock selection, and interaction. It is inappropriate to adapt this approach to fixed-income portfolios in order to identify the contributions of typical fixed-income portfolio strategies (e.g. Campisi 2011).

In factor models, the return on each asset is viewed as a function of specific risk factors (duration, convexity, carry, spread component, etc.). As a first step, the exposure to each risk factor is computed for each asset included in the portfolio. By aggregating individual asset exposure to each risk factor, it is possible to build the overall portfolio exposure to each factor vis-à-vis the benchmark. The specific risk factor's contribution to the extra performance is obtained as the interaction between the exposure to a specific risk factor and the measured change in that risk factor. In general, each risk factor can be considered as the constituent of a specific strategy. For instance, the contribution to extra returns coming from portfolio manager exposure to the risk factor 'parallel shift' can be viewed as the contribution of duration positions. These models provide a richer description of the performance contribution than sector models. However, the quality of the results of factor models may be affected by the presence of a non-negligible residual term as a component of the return.

This chapter presents a new performance attribution model to identify the main performance drivers of fixed-income portfolio managers. We develop an alternative approach that tries to preserve the richness of factor models without incurring in the drawback of a large residual term. The approach resembles that of sector models; however, we modify the actual portfolio weights in such a way that they can be viewed as the result of exposures to the risk factors related to specific strategies. The proposed model disentangles the contribution of each strategy in order to detect specific portfolio manager skills: (1) duration contribution, (2) curve contribution, (3) spread contribution, and (4) security selection. The proposed framework thus provides a clear interpretation of results of fixed-income portfolio managers.

As an empirical application of the model, we analyze the performance of a group of foreign exchange reserve managers that carry out the investment of the European Central Bank's (ECB) official reserves in US dollars, worth around USD43 billion,[2] using a new dataset that includes detailed portfolio holdings from 2006 to 2010.

We find that, first, the bond portfolio managers investing the ECB reserves in US dollars on aggregate outperform the active benchmark by around 10 basis points on a yearly basis net of transaction costs. This amounts to EUR39 million per year, which, based also on confidential data available to the authors, is well above management costs. It is worth mentioning that the governance structure of the ECB reserve management framework is based on a three-layer structure: a strategic benchmark, a tactical benchmark, and the actual portfolio managed by the national central banks (NCBs) involved in the active reserve management (see Sect. 3.3 for further details). Also, the tactical layer, implementing security selection strategies at each rebalancing date, allows for active management vis-à-vis the strategic benchmark, thus exploiting sources of excess returns and contributing to the overall alpha generation. If we measure the alpha of the aggregated portfolio vis-à-vis the strategic benchmark, it turns out to be positive and significant at the 1.6% significance level. On the other hand, if we measure the alpha of the aggregated portfolio vis-à-vis the tactical benchmark, it turns out to be positive, but is only significant at the 13% significance level. These two results, taken together, indicate that a component of security selection is absorbed by tactical choices.

Second, we attribute the extra performance to the ECB managers' specific strategies based on our performance attribution model, which employs portfolio holdings as well as the 'true' benchmark holdings. For this, we use weekly return data for the eight portfolios and the benchmark, plus the individual asset holdings. We have a specific interest in time periods shorter than one month, since the active benchmark is revised on a monthly basis. Under the hypothesis that portfolio managers have market-timing and selection skills, these should be revealed at very short time intervals. The analysis shows that, in the period under analysis, in the aggregate the main source of extra performance is related to security selection, followed by spread contribution. This approach also allows us to pinpoint the diversity of different investment styles across managers.

Overall our analysis shows that reserve managers adopt different investment styles and make a diversified use of the risk budget, which presumably results in a high number of independent bets on the aggregate portfolio. Our findings seem consistent with the 'law of active management' (Grinold 1989), according to which a high number of independent bets improves the information ratio of the aggregate portfolio. These results seem noteworthy, in consideration of the tightness of the portfolio contest.

Section 3.2 presents the methodology of the performance attribution model. Section 3.3 shows the main features of the ECB reserve management framework. Section 3.4 reports the empirical results. Section 3.5 concludes.

3.2 The Methodology

In this section, we present the methodological building blocks of the proposed performance attribution model. We develop an approach that tries to preserve the richness of performance attribution factor models without incurring the drawback of a large residual term. The approach resembles that of sector models; however, we modify the actual portfolio weights in such a way that they can be viewed as the result of exposures to the risk factors related to specific strategies. The proposed model disentangles the contribution of each strategy in order to detect specific portfolio manager exposure to (1) duration contribution, (2) curvature contribution, (3) spread contribution, and (4) security selection. The proposed framework thus provides a clear interpretation of results from a portfolio manager's perspective.

The total excess return is described by the following expression:

$$r^p = r_d^p + r_c^p + r_a^p + r_s^p$$

where, r^p is the total portfolio return in excess of the benchmark, r_d^p is the duration contribution, r_c^p is the curve contribution, r_a^p is the spread contribution, and r_s^p is the security selection contribution.

The duration contribution r_d^p captures the part of the excess return stemming from portfolio duration exposure different from that of the benchmark. The curve contribution r_c^p provides the result of the portfolio manager's choices in weighting the time buckets[3] differently from the benchmark without taking any duration exposure. The selection contribution r_a^p stems from strategies in weighting asset classes (indexed by *i*; e.g. Treasuries vs Agencies) within a specific time bucket *j* differently from the benchmark. The security selection contribution r_s^p is due to the activity of picking securities within a specific sector.

We start by building a sequence of virtual portfolios the weights of which represent the relevant strategies. As a first step, we build a virtual portfolio A, reflecting all the strategies implemented by the portfolio manager with the exception of security selection choices. By comparing the total return of the actual portfolio with that of portfolio A, we can isolate the security selection contribution r_s^p. Second, we build a virtual portfolio B the weights of which include only the portfolio manager's spread choices. By comparing the benchmark total return with that of the virtual portfolio B, we can thus disentangle the spread contribution r_a^p. Third, starting from the virtual portfolio B, we rearrange the weights in order to build a virtual portfolio C including also the curve exposure. By comparing the virtual portfolio B return with that of portfolio C, we obtain the curve contribution r_c^p. Finally, comparing the portfolio A with portfolio C, we obtain the duration contribution. By construction, this model presents no residual term.

We introduce the following definitions:

w_{ij}^{b} is the weight of sector *i* in time—bucket *j* of the benchmark;
R_{ij}^{b} is the return of sector *i* in time—bucket *j* of the benchmark;
MD_{ij}^{b} is the modified duration of sector *i* in time—bucket *j* in the benchmark;
pd_{ij}^{b} is the partial duration (or duration contribution) of sector *i* in time—bucket *j* in the benchmark; it is obtained as the product of benchmark weight w_{ij}^{b} times the modified duration of sector *i* in time—bucket *j*, MD_{ij}^{b};
w_{ij}^{p} is the weight of sector *i* in time—bucket *j* in the actual portfolio;
R_{ij}^{p} is the return of sector *i* in time—bucket *j* in the portfolio;
MD_{ij}^{p} is the modified duration of sector *i* in time—bucket *j* in the portfolio;
pd_{ij}^{p} is the partial duration of sector *i* in time—bucket *j* in the portfolio; it is obtained as the product between the actual portfolio weight w_{ij}^{p} and the modified duration of sector *i* in time—bucket *j*, MD_{ij}^{p}.

The total excess return of the portfolio is given by:

$$r^{p} = \sum_{i}\sum_{j} w_{ij}^{p} R_{ij}^{p} - \sum_{i}\sum_{j} w_{ij}^{b} R_{ij}^{b} \tag{3.1}$$

First, we build a virtual portfolio A which, by construction, has for each sector *i* in time—bucket *j* the same internal composition, modified duration, and return of the benchmark, while making sure that it has the same sector and time-bucket partial durations as the actual portfolio. This virtual portfolio includes all the choices of the reserve manager with the exception of the security selection component. Therefore, if we subtract the overall return of this portfolio from the overall return of the actual portfolio, we obtain the security selection contribution to the overall extra returns.

We compute the weights of the virtual portfolio as:

$$w_{ij}^{A} = \frac{pd_{ij}^{p}}{MD_{ij}^{b}}$$

Since the sum of the rearranged portfolio weights is not necessarily equal to 100%, we assume that we can use a cash account as an additional asset class in order to finance the position (if the sum of weights is larger than 100%) or to invest the cash (if the sum of weights is lower than 100%). We assume that the return on this cash account is equal to the overnight unsecured rate $r_{O/N}$. The weight of this cash account is equal to:

$$w_{\text{cash}}^{A} = 1 - \sum_{i}\sum_{j} w_{ij}^{A}$$

The overall extra returns can be split into two components.

$$r^{p} = \underbrace{\sum_{i}\sum_{j} w^{p}{}_{ij} R^{p}{}_{ij} - \left(\sum_{i}\sum_{j} w^{A}{}_{ij} R^{b}{}_{ij} + w_{cash}{}^{A} r_{O/N} \right)}_{\text{This term represents the security selection component } r_{s}^{p}} + \underbrace{\sum_{i}\sum_{j} w^{A}{}_{ij} R^{b}{}_{ij} + w_{cash}{}^{A} r_{O/N} - \sum_{i}\sum_{j} w^{b}{}_{ij} R^{b}{}_{ij}}_{\text{This term represents the sum of spread contribution, curve and duration contribution } r_{d}^{p} + r_{c}^{p} + r_{a}^{p}}$$

The asset class selection choices depend on the relative asset weighting (e.g. Treasury vs spread products) within each time bucket in terms of partial duration; the partial duration for each time bucket of the actual portfolio and the benchmark can be expressed by:

$$PD_{j}^{p} = \sum_{i=1} pd_{ij}^{p} \left(\text{portfolio}\right)$$

$$PD_{j}^{b} = \sum_{i=1} pd_{ij}^{b} \left(\text{benchmark}\right)$$

The relative asset class weight α_{ij}^{p} of the actual portfolio in terms of partial duration exposures for each asset class i and time bucket j is:

$$\alpha_{ij}^{p} = \frac{pd_{ij}^{p}}{PD_{j}^{p}}$$

Second, we build the weights of the virtual portfolio B, having the same time-bucket partial duration exposure as the benchmark, expressed by PD_j^b, but an exposure for each asset class i, in relative terms, equal to the one of the actual portfolio, as:

$$w_{ij}^{B} = \frac{PD_j^b \alpha_{ij}^p}{MD_{ij}^b}$$

Starting from Eq. 3.1, we add and subtract the overall return of the virtual portfolio B. As previously discussed with the virtual portfolio A, the sum of the rearranged portfolio weights is not necessarily equal to 100%; therefore, we introduce an additional cash account:

$$w_{\text{cash}}^{B} = 1 - \sum_i \sum_j w_{ij}^{B}$$

Again, we assume that the return of this cash account is equal to the overnight unsecured rate $r_{O/N}$. If we subtract the overall return of the benchmark from the virtual portfolio B return, we obtain the spread contribution to the overall extra returns. The difference between the return of portfolio A and the return of portfolio B represents the sum of the curvature and duration contribution.

$$\left(r_d^p + r_c^p + r_a^p\right) = \underbrace{\left(\sum_i \sum_j w^A{}_{ij} R^b{}_{ij} + w_{cash}{}^A r_{O/N}\right) - \left(\sum_i \sum_j w^B{}_{ij} R^b{}_{ij} + w_{cash}{}^B r_{O/N}\right)} + \underbrace{\left(\sum_i \sum_j w^B{}_{ij} R^b{}_{ij} + w_{cash}{}^B r_{O/N}\right) - \sum_i \sum_j w^b{}_{ij} R^b{}_{ij}}$$

This term represents the sum of curve and duration contribution to the overall extra–performance $r_d^p + r_c^p$

This term represents the spread contribution to the overall extra-performance r_a^p

Third, in order to disentangle the contribution stemming from exposure to curvature, we assume that the duration exposure is targeted through securities included in the time bucket with the highest duration exposure in the same direction (long or short) as the overall exposure. We note that the split among curve and duration is not unique; different assumptions may lead to different results. However, we believe that our choice is the most intuitive and suitable from a portfolio manager's perspective. The attribution of the overall duration exposure to the sector with the largest duration exposure is easier to understand compared to more sophisticated algorithms (for instance, based on principal component analysis), which might spread the duration exposure over different time buckets, sometimes also in a counter-intuitive manner. Therefore, we compute the differential time-bucket exposures (portfolio vs benchmark) in terms of partial duration; for illustrative purposes, assume that

- the portfolio exposure in terms of partial duration for the different time buckets is as given in Table 3.1;
- the benchmark exposure is as given in Table 3.2;
- then the differential exposure would be as given in Table 3.3.

Table 3.1 Portfolio

	1–3	*3–5*	*5–7*	*7+*	
Weights	19%	25%	31%	25%	100%
Modified duration	2	4	6	9	5.49
PD	0.38	1	1.86	2.25	5.49

Table 3.2 Benchmark

	1–3	*3–5*	*5–7*	*7+*	
Weights	25%	25%	25%	25%	100%
Modified duration	2	4	6	9	5.25
PD	0.5	1	1.5	2.25	5.25

Table 3.3 Differential exposure

	1–3	*3–5*	*5–7*	*7+*	
PD	–0.12	0	0.36	0	0.24

We identify the time bucket $\bar{j}$ with the largest exposure in the same direction as the overall exposure; in the example, the overall exposure is equal to 0.24 and the bucket with the largest exposure in the same direction as the overall exposure is the 5–7 time bucket.

Starting from the portfolio exposure, we assume that we sell or buy the overall exposure by means of the time bucket identified in the previous step in order to re-instate the benchmark overall exposure; we therefore compute

$$PD_j^{*p} = PD_j^p \forall j \neq \bar{j}$$
$$PD_{\bar{j}}^{*p} = PD_{\bar{j}}^p \pm \text{overall exposure}$$

and, with regard to the time bucket $\bar{j}$, we re-compute the asset class partial durations $pd_{ij}^* = \alpha_{i\bar{j}} PD_{\bar{j}}^p \pm \text{overall exposure}$ in such a way as to preserve the actual portfolio proportion to the overall time-bucket partial duration.

In the example, the partial duration of the 5–7 time bucket is adjusted accordingly (Table 3.4).

Notice that this portfolio has the same overall duration as the benchmark, but a different combination of partial duration exposure among different time buckets; therefore, it conveys only a curve exposure (Table 3.5).

We compute the weight of the virtual portfolio C including only curve and spread exposure in the usual way:

$$w_{ij}^C = \frac{pd_{ij}^*}{MD_{ij}b}$$

also including the cash account

$$w_{\text{cash}}^C = 1 - \sum_i \sum_j w_{ij}^C$$

In the example, considering only the total time-bucket weights and the cash account adjustment, the result is the following (Table 3.6):

Table 3.4 Portfolio adjusted—partial durations

	1–3	*3–5*	*5–7*	*7+*	
Modified duration	2	4	6	9	5.25
PD	0.38	1	1.62	2.25	5.25

Table 3.5 Differential exposure adjusted

	1–3	*3–5*	*5–7*	*7+*	
PD	−0.12	0	0.12	0	0

Table 3.6 Portfolio adjusted—weights

	0–1	*1–3*	*3–5*	*5–7*	*7+*	
Weights	4%	19%	25%	27%	25%	100%
Modified duration	0	2	4	6	9	5.25
PD	0	0.38	1	1.62	2.25	5.25

$$\left(r_d^p + r_c^p\right) = \underbrace{\left(\sum_i \sum_j w^A{}_{ij} R^b{}_{ij} + w_{cash}{}^A r_{O/N}\right) - \left(\sum_i \sum_j w^C{}_{ij} R^b{}_{ij} + w_{cash}{}^C r_{O/N}\right)}_{\text{This term represents the duration contribution component } r_d^p} + \underbrace{\left(\sum_i \sum_j w^C{}_{ij} R^b{}_{ij} + w_{cash}{}^C r_{O/N}\right) - \left(\sum_i \sum_j w^B{}_{ij} R^b{}_{ij} + w_{cash}{}^B r_{O/N}\right)}_{\text{This term can represents the curve contribution } r_c^p}$$

3.3 Main Features of the ECB Reserve Management Framework

Foreign exchange reserves worldwide are worth USD10.9 trillion[4] and are mainly invested in government bonds and other liquid instruments. For comparison, the global net assets of bond- and money-market funds is worth around USD14.5 trillion.[5] While the management and performance of private bond portfolio managers is the subject of a vast empirical literature, relatively little is known about the investment of foreign exchange reserves, owing mainly to confidentiality reasons.

The recent surveys on central bank reserve management mainly deal with strategy issues, such as the use of an ALM approach, and with governance issues (e.g. Borio et al. 2008a, b; Johnson-Calari et al. 2007; Nugée 2012). The composition of US dollar official holdings has been examined in some detail (McCauley and Rigaudy 2011). Not surprisingly, due to the prevalence of institutional reasons for the management of official reserves, their investment performance is rarely the subject of publicly available research (exceptions include Hu 2010; Vesilind and Kuus 2005).

The ECB reserve management framework is based on a three-layer structure: (1) a strategic level, which defines the strategic benchmark; (2) a tactical level, which sets up the tactical benchmark; and (3) the portfolio managers of NCBs involved in the active management of the reserves.

The strategic benchmark addresses the ECB's long-term risk-return preferences, the tactical benchmark seeks to exploit medium-term market movements, and portfolio managers attempt to outperform the tactical benchmark. It is important to highlight that the tactical level also seeks to generate portfolio outperformance by searching for strategies with positive alpha. At each rebalancing date, the tactical level defines a tactical benchmark composition with the goal of outperforming the strategic benchmark. In particular, the tactical layer tries to exploit market and security selection opportunities by deviating from the strategic benchmark within a defined risk budget by choosing a specific composition of eligible asset classes. In turn, portfolio managers try to outperform the tactical layer with active strategies that deviate from the tactical benchmark within specific limits. Consequently, a share of exploitable alpha is absorbed by the tactical level. The ECB sets a common tactical benchmark, thus generating competition among managers (Koivu et al. 2009; Manzanares and Schwartzlose 2009). Every month their individual performance is computed and made known by the ECB to all managers. An annual general report on the investment activities and risks is transmitted to the Governing Council of the ECB, including the individual performance figures and rankings of the NCBs. The assets under management reflect the share of each NCB in the ECB's capital.

The ECB reserves in US dollars must be invested in highly liquid fixed-income instruments. The eligible asset classes and the composition of the strategic benchmark, the tactical benchmark, and the actual portfolios managed by the NCBs reflect the objective of the ECB's foreign reserve portfolio to ensure that, whenever needed, the Eurosystem has a sufficient amount of liquid resources for its foreign exchange policy operations involving non-EU currencies. Indeed, for the ECB's foreign reserves, the portfolio management objective is to maximize returns through prudent portfolio management, subject to the stringent security and liquidity requirements that derive from the portfolio purpose. The eligible investment universe includes government bonds, agencies with government support, BIS instruments, bonds issued by supranational organizations, and deposits. No currency exposure and short selling of securities is allowed within this framework. The portfolio management framework reflects the idea that, within the tight constraints imposed by the framework, portfolio managers can add value to the portfolios over time.

Some factors make the investment contest of the ECB's reserve managers extremely challenging (Scalia and Sahel 2012). First, while private bond funds often lack formal benchmarks, in our case, the benchmark is tailor-made by the ECB to reflect its risk-return preferences and is actively managed, since the ECB may revise it based on the flow of new information on a monthly basis.[6] Second, the investment set is relatively small and risk limits are quite severe in comparison with the private sector. Third, reserve managers monitor each other's performance and ranking at monthly frequency. In practice, the ECB's reserve managers compete for a handful of basis points of performance in a tight competition. With reduced risk-taking opportunities, the market-timing ability of reserve managers plays a key role in securing extra returns.

In the sample period 2006–2010, the owner of the reserves delegated their investment to a group of managers located at eight NCBs of the Eurosystem, namely those of Belgium, France, Germany, Greece, Ireland, Italy, Luxembourg, and Spain.[7]

In the following section, we show the results of the application of the model of Sect. 3.2 to the aforementioned portfolio managers, treated anonymously and denoted by a random code ranging from M1 to M8.

3.4 Results

We apply the above model to a dataset of portfolio manager performance and positions related to the fixed-income portfolios of US dollar reserves managed by the NCBs.

The net asset value of the ECB US dollar tactical benchmark and aggregate portfolio during 2006–2010 is shown in Fig. 3.1. The return on the portfolio has exceeded the benchmark return in each year, and at the end of the period, the portfolio cumulative return was about 46 basis points above that of the benchmark.

The above figures are net of transaction costs, which are accounted for in the portfolio management system at each trade. The money equivalent

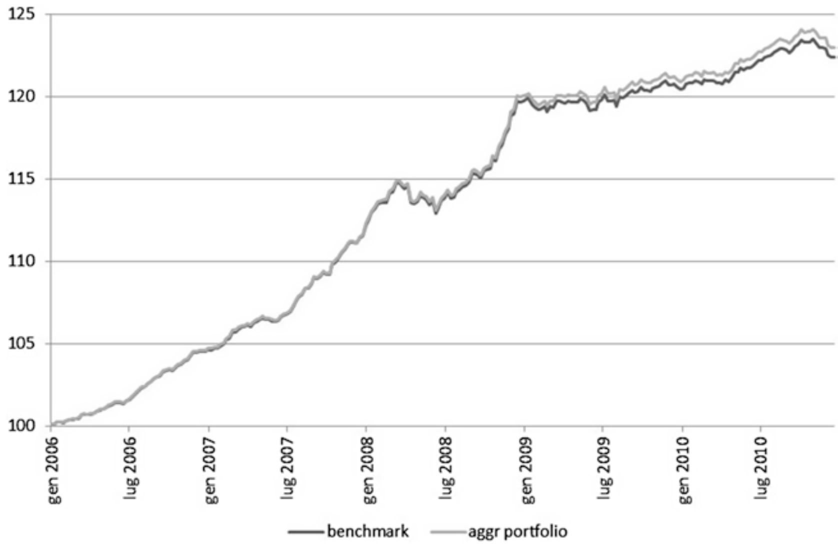

Fig. 3.1 Cumulative returns, ECB's US dollar reserves, 2006–2010: benchmark versus aggregated portfolio. On the y axis, cumulative returns are expressed as an index

of the yearly average extra performance is about EUR39 million. This figure is arguably well above the management costs (staff salaries, IT equipment, overhead) that are involved in the ECB reserve management framework, hence we have a case of positive net outperformance.

Owing to the weekly data frequency, security selection actually reflects not only the activity of 'pure' selection among different bonds, but it captures also the result of all the other positions (duration, curve, and spread) opened and closed in the same week, without altering the weights from one week to another. Furthermore, it includes the component of excess return that comes from the carry of deposits and repo market activity.[8]

We first examine the contribution to the excess return that accrues from duration management (Fig. 3.2).

It is interesting to notice that only one portfolio manager (M8) achieved a non-negligible positive result in duration management, while the other portfolio managers obtained negative results (M3, M4, and M7) or almost nil (M1, M2, M5, and M6).

Portfolio managers also show different styles in the use of risk budget, as can be argued by looking at the average and volatility of duration exposure for each portfolio manager (Fig. 3.3).

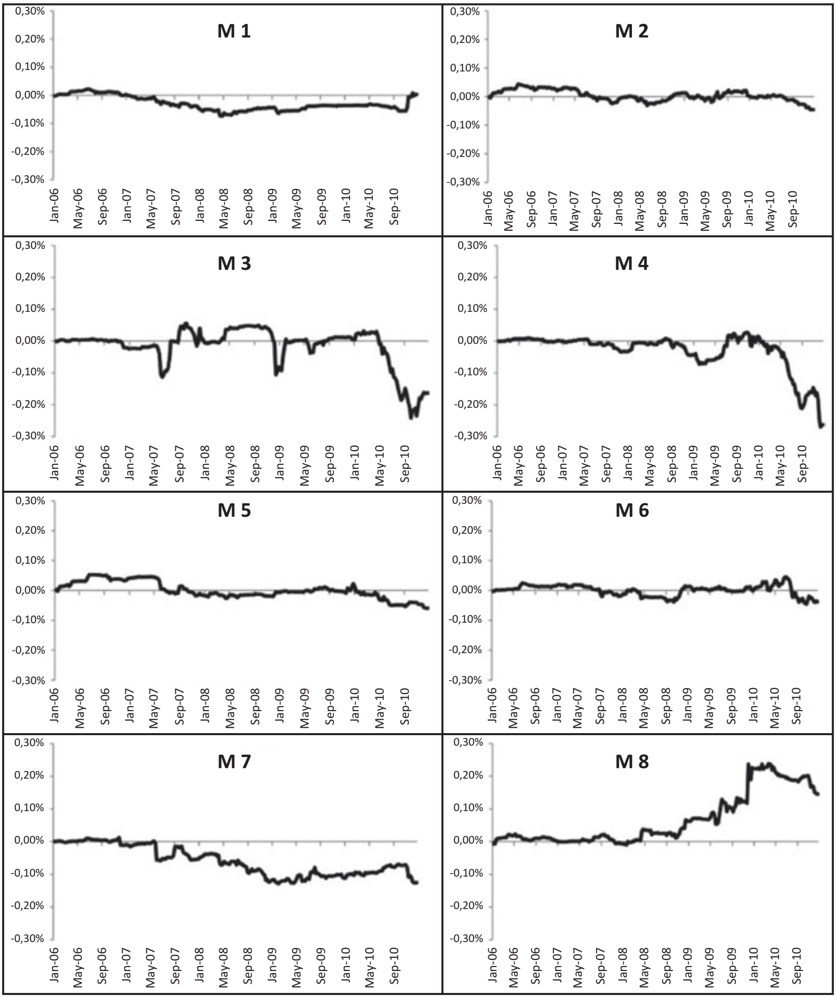

Fig. 3.2 Duration contribution to outperformance

We observe a relatively low exposure to duration bets, with the exception of a couple of portfolio managers (M3 and M4). However, we note that M4 shows a more active duration management only after 2008. The peaks of duration exposure of the other portfolio managers are of the order of 10 basis points only.

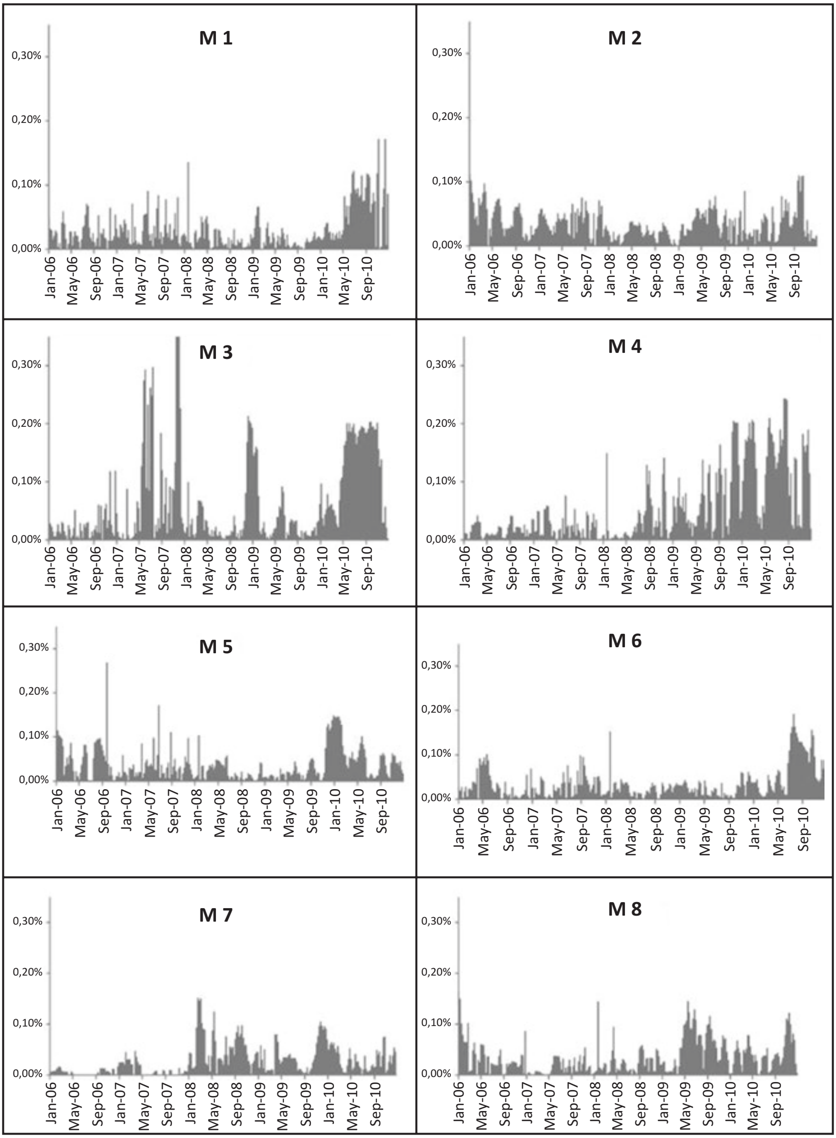

Fig. 3.3 Duration exposure

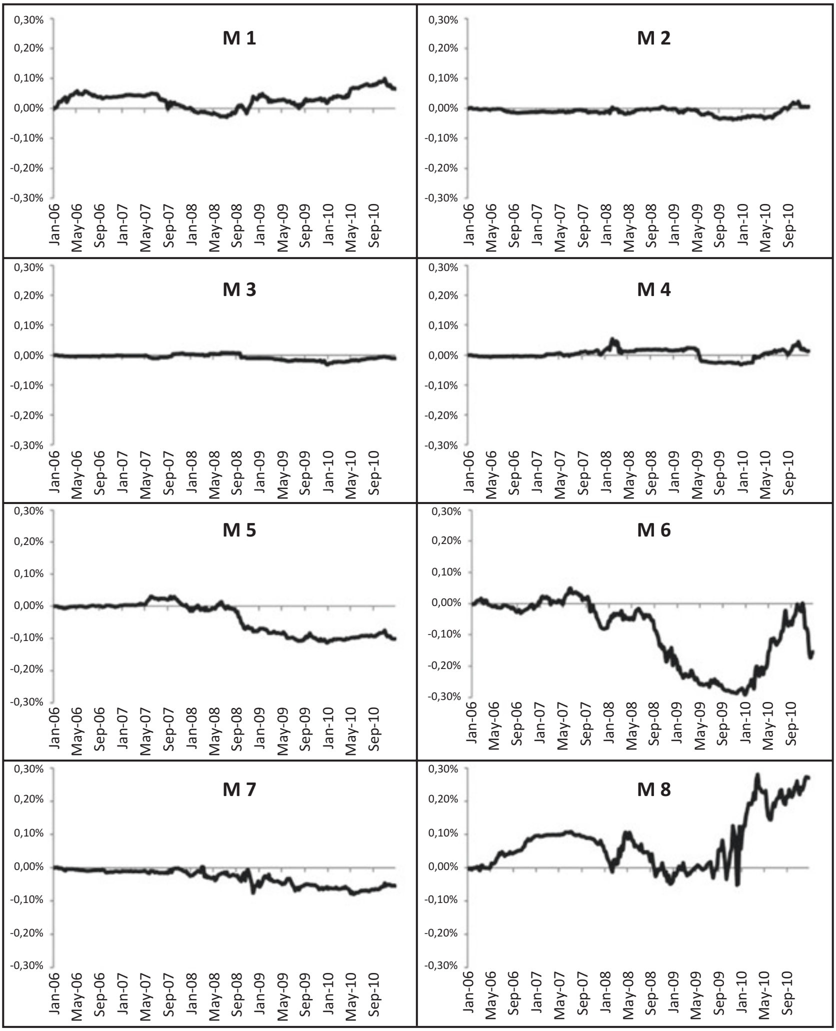

Fig. 3.4 Curvature contribution to outperformance

The curve contribution analysis shows a similar picture. Even in this case, only M8 achieved a sizeable excess return by loading on curvature (Fig. 3.4).

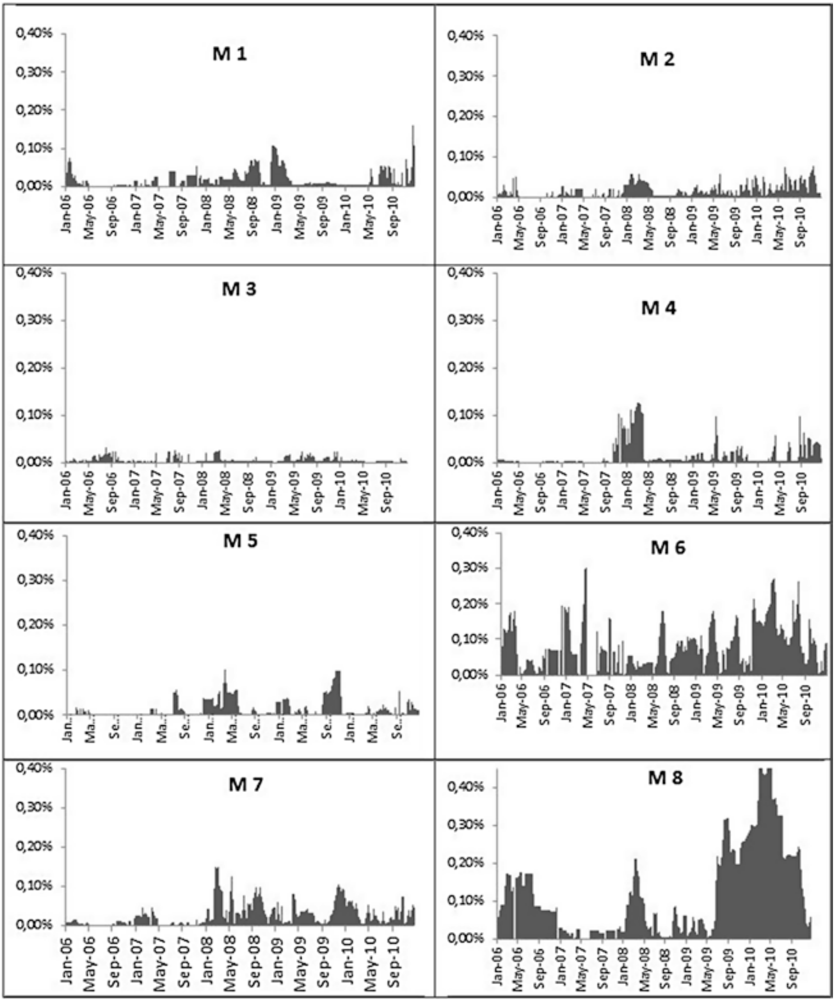

Fig. 3.5 Curvature exposure

M1 shows a slightly positive performance loading on curvature, with the other portfolio managers not taking appreciable curvature risk (M2, M3, and M4) or shorting curvature (M6, M5, and M7). Figure 3.5 illustrates a more diversified use of the risk budget in curve bets than in duration bets. In particular, some portfolio managers seem not to place curve bets (M2 and M3), and other managers take only moderate curve exposures (M1, M4, M5, and M7), while M8 (with exposure peaks at around 50 basis points) and M6 (with maximum exposure at around 30 basis points) show a very active curve management.

Spread exposure proved to be the most important active layer in terms of results and exposures along the sample period. Almost all portfolio managers achieved positive results, with the exception of M8, which was substantially aligned with the benchmark (Fig. 3.6).

In general, an important source of spread-related outperformance is related to the carry component. This component represents the yield pick-up earned by replacing government securities with spread products. The yield pick-up was very high during the financial crisis of 2007–2008, when swap spreads in the two-year tenor peaked at about 165 basis points. However, portfolio managers seem to have achieved these results not only by maintaining a long exposure to spread products, but also by actively trading spreads on both sides, long and short. The best performer in spread management are M1 and M6, which obtained an outperformance of around 40 basis points. M6 also showed an active style, by changing intensity in the usage of the risk budget (Fig. 3.7); M2, M4, M5, and M7 show a result of around 20 basis points, while the other managers obtained a slightly positive outperformance. Again, different styles can be traced: low active spread players (M2, M3, and M4), moderate active spread players (M5, M7), and strong spread players (M6 and M8) can be clearly identified (Fig. 3.7).

The most important source of outperformance proves to be security selection (Fig. 3.8).

The best performer is M6, which achieves an excess return of close to 60 basis points, followed by M7 (around 50 basis points) and M5 (40 basis points); M2 and M4 achieve around 20 basis points, while the results of M1 and M3 are close to zero. The only manager that reports a negative result is M8 (−20 basis points).

All the managers contribute to the outperformance while showing different skills or different ways to pursue returns in excess of the benchmark. Some portfolio managers prove to be more successful in duration bets, while others obtain better results in curve management, or loading on the spread component, or exploiting carry opportunities. Figures 3.3, 3.5, and 3.7 clearly show a different use of the risk budget among portfolio managers and a different attitude in changing it over time.

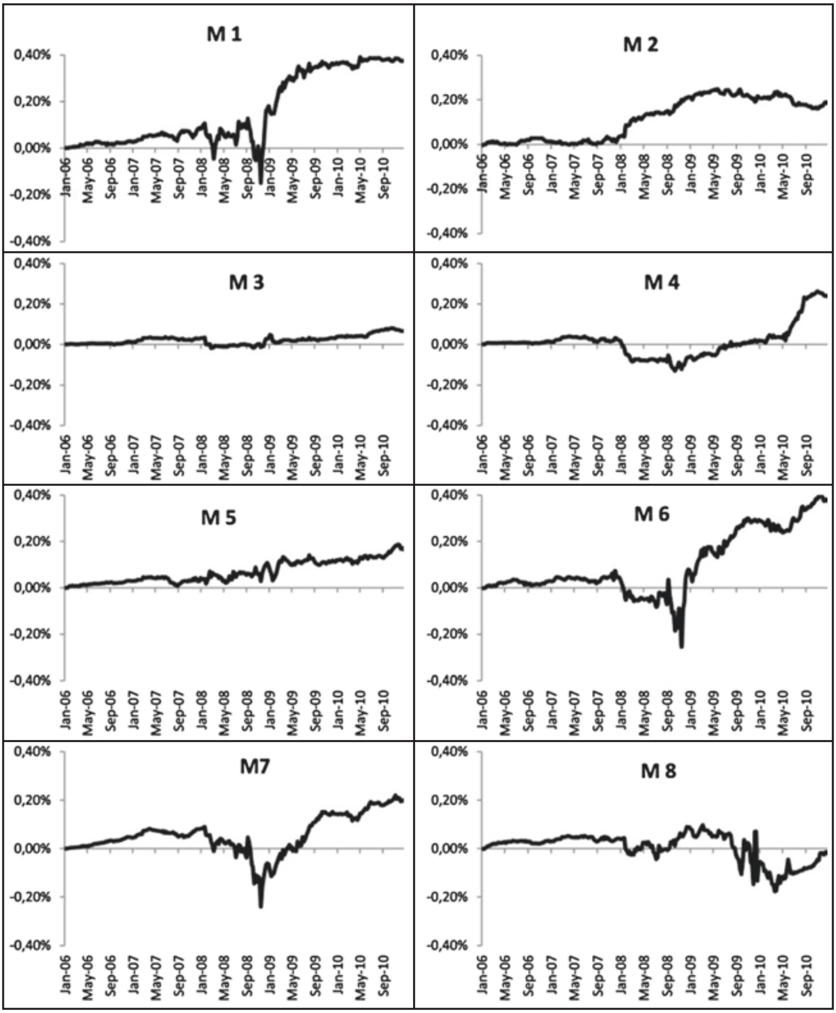

Fig. 3.6 Spread contribution to outperformance

Portfolio managers' also styles prove to be different in terms of some important indicators that may help to better qualify the attitude toward risk and the specific ability of portfolio managers to preserve capital. To illustrate this point, we selected a group of indicators: (1) the information ratio, measuring risk-adjusted performance; (2) the tracking error, giving

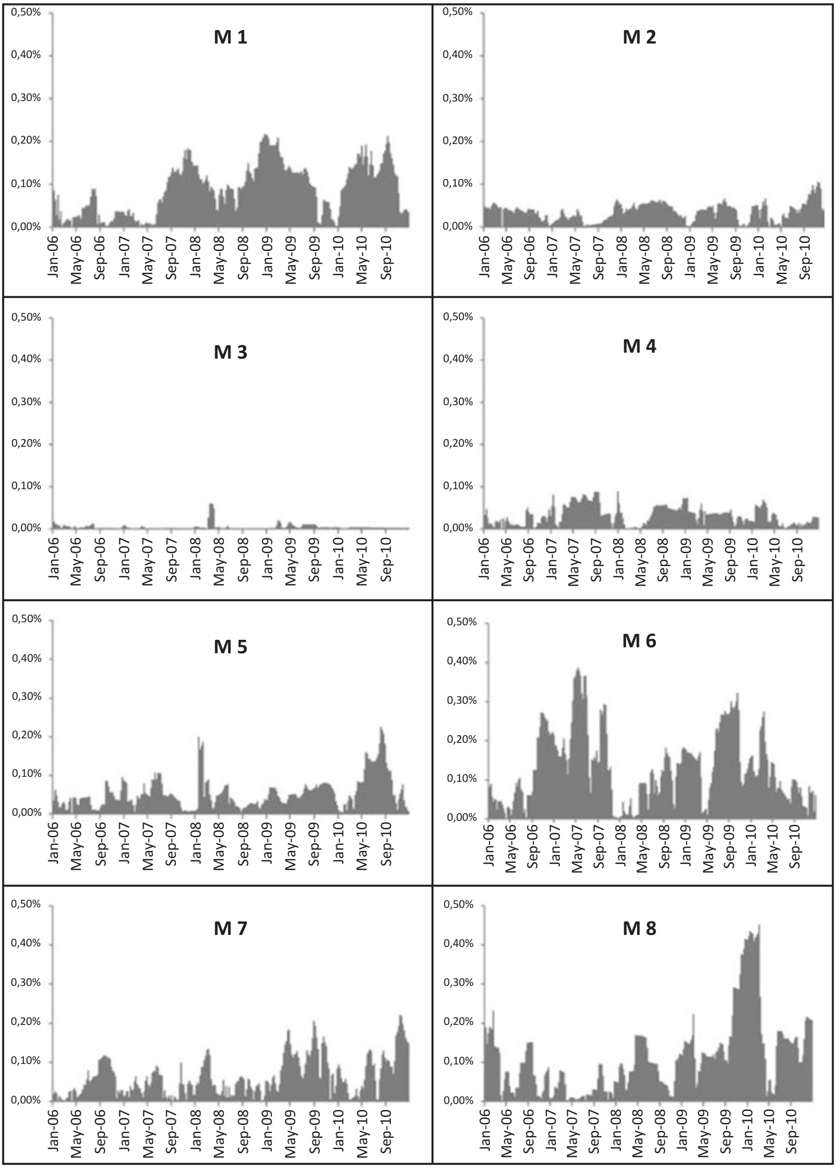

Fig. 3.7 Spread exposure

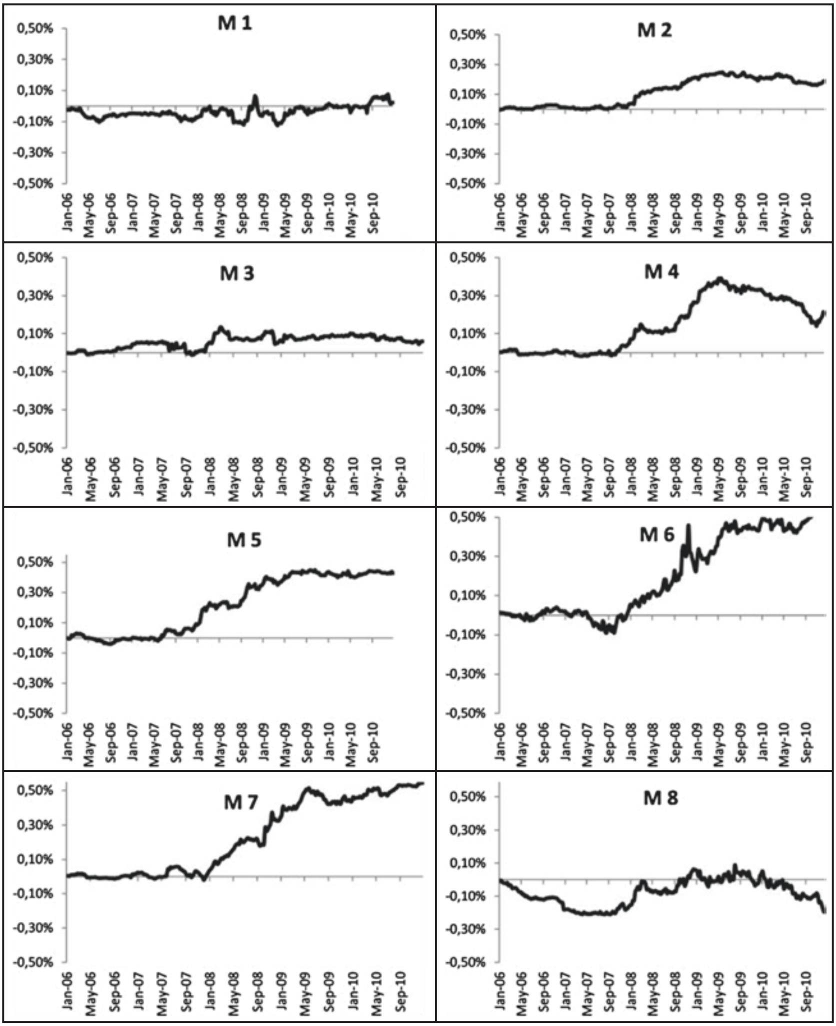

Fig. 3.8 Security selection contribution to outperformance

the dispersion of extra returns; (3) the hit ratio, that is, the percentage of winning bets over total bets; and (4) the max drawdown, measuring the largest cumulative loss from peak to trough over a period of time.

The ranking across these performance qualifiers sheds some light on the preferences of portfolio managers toward returns (high information ratio) or capital preservation (low drawdown risk). The hit ratio helps understand if the extra returns reflect a combination of a large number of winning bets (with low profits) and a small number of losing bets (with a higher loss) or a combination of a few winning bets (with high profits) with many losing bets (with low losses). The tracking error provides a useful indication about the confidence interval of returns around the mean, which may help distinguish whether the results depend on solid skills.

Tables 3.7 through 3.10 show a low degree of overlap among the ranking of portfolio managers across performance qualifiers and active layers,

Table 3.7 Duration exposure synthetic indicators

	M1	*M2*	*M3*	*M4*	*M5*	*M6*	*M7*	*M8*
Duration								
Information ratio (yearly basis)	0.02	−0.30	−0.35	−0.87	−0.36	−0.20	−0.56	0.40
Ranking	2	4	5	8	6	3	7	1
Tracking error (yearly basis)	0.03%	0.03%	0.10%	0.06%	0.03%	0.04%	0.05%	0.08%
Ranking	1	2	8	6	3	4	5	7
Hit ratio	45%	51%	49%	48%	47%	50%	56%	49%
Ranking	8	2	4	6	7	3	1	4
Max drawdown	−0.09%	−0.09%	−0.30%	−0.30%	−0.11%	−0.09%	−0.14%	−0.09%
Ranking	4	1	8	7	5	2	6	3

Table 3.8 Curve exposure synthetic indicators

	M1	*M2*	*M3*	*M4*	*M5*	*M6*	*M7*	*M8*
Curve								
Information ratio (yearly basis)	0.35	0.05	−0.18	0.09	−0.71	−0.33	−0.27	0.36
Ranking	2	4	5	3	8	7	6	1
Tracking error (yearly basis)	0.04%	0.02%	0.01%	0.03%	0.03%	0.10%	0.04%	0.15%
Ranking	5	2	1	4	3	7	6	8
Hit ratio	51%	53%	51%	50%	48%	49%	49%	54%
Ranking	3	2	3	5	8	7	6	1
Max drawdown	−0.09%	−0.04%	−0.04%	−0.09%	−0.14%	−0.34%	−0.08%	−0.18%
Ranking	5	2	1	4	6	8	3	7

thus supporting the idea of heterogeneous investment styles. The time horizon for active bets chosen by portfolio managers qualifies the investment style, discriminating between portfolio managers that prefer a low number of bets with a longer time horizon from those oriented toward a higher number of bets with a shorter time horizon.

Finally, Table 3.11 shows the average time horizon, in terms of weeks, for each single strategy across portfolio managers.[9] Portfolio managers are more resilient in changing positions of spread trades. This is in line with the idea that managers seek to fully exploit the carry component of spread

Table 3.9 Spread exposure synthetic indicators

	M1	*M2*	*M3*	*M4*	*M5*	*M6*	*M7*	*M8*
Spread								
Information ratio (yearly basis)	0.55	0.47	0.40	0.77	0.57	0.50	0.36	−0.01
Ranking	3	5	6	1	2	4	7	8
Tracking error (yearly basis)	0.14%	0.03%	0.03%	0.06%	0.06%	0.16%	0.12%	0.18%
Ranking	6	1	2	4	3	7	5	8
Hit ratio	57%	61%	57%	54%	55%	55%	61%	53%
Ranking	3	2	4	7	6	5	1	8
Max drawdown	−0.28%	−0.07%	−0.06%	−0.17%	−0.08%	−0.33%	−0.33%	−0.27%
Ranking	6	2	1	4	3	7	8	5

Table 3.10 Security selection indicators

	M1	*M2*	*M3*	*M4*	*M5*	*M6*	*M7*	*M8*
Security selection								
Information ratio (yearly basis)	0.04	0.77	0.18	0.68	1.13	0.76	1.21	−0.32
Ranking	7	3	6	5	2	4	1	8
Tracking error (yearly basis)	0.11%	0.05%	0.07%	0.07%	0.08%	0.16%	0.09%	0.13%
Ranking	6	1	2	3	4	8	5	7
Hit ratio	52%	55%	60%	51%	55%	55%	54%	44%
Ranking	6	2	1	7	2	2	5	8
Max drawdown	−0.19%	−0.09%	−0.09%	−0.25%	−0.07%	−0.23%	−0.09%	−0.28%
Ranking	5	3	2	7	1	6	4	8

Table 3.11 Active positions—average time horizon (weeks)

	M1	*M2*	*M3*	*M4*	*M5*	*M6*	*M7*	*M8*
Duration	4	10	5	5	6	6	6	6
Curve	11	6	4	6	7	10	7	9
Spread	24	13	2	15	24	22	13	18

products, which involves a preference for long spread positions and a bias toward a longer time horizon of spread strategies. The average holding period for curve strategies is shorter, and it ranges between four and eight weeks, showing mixed preferences in terms of holding period among portfolio managers. The time horizon for duration strategies is even shorter than that of curve strategies. The duration positions show a time horizon of slightly over one month, thus indicating that the monthly rebalancing represents a kind of 'catalyst' for duration bets.

These results confirm the idea that portfolio managers adopt different investment styles. The more diversified the investment styles of portfolio managers are, according to each active layer, the more likely it is that, in the aggregate portfolio, a higher number of independent bets are carried out. According to the 'law of active management' (Grinold 1989), other things being equal, the higher the number of independent bets, the higher the information ratio of the aggregated portfolio. In particular, the information ratio is defined as:

$$\mathrm{IR} = \mathrm{IC}^{*} \sqrt{BR}$$

where IC is the information coefficient, a measure of the level of skill, or the ability to forecast each asset residual return. It is defined as the correlation between the forecasts and the returns; *BR* represents breadth, or the number of independent bets in the managed portfolio. According to this formula, one way to improve the information ratio might be given by an increase in the number of independent bets, assuming a comparable level of skills. More independent positions among portfolio managers in terms of duration, curve, and timing may actually lead to a decrease in the absolute and relative risk of the aggregated portfolio, while the aggregate return can be expected to increase, hence improving the risk-return profile of the aggregate portfolio.

3.5 Conclusions

We develop a simple performance attribution model that has some advantages in comparison with existing factor models: it identifies the contribution of the key portfolio managers' strategies, it offers a clear interpretation of results from a portfolio manager's perspective, and it presents no residual term.

Applying our methodology to the managers of the ECB's foreign reserves, we find that among the active layers (duration, curve, and spread), the spread contribution seems the most relevant. Curve and duration bets, with some exceptions, have generally provided modest value addition. The analysis of the use of risk budget and the ranking across 'performance qualifiers' supports the view that portfolio managers adopt diversified investment styles. This may explain the non-negligible result of the aggregate reserve portfolio, averaging 10 basis points on an annual basis net of transaction costs. The more diversified the investment styles are, the more likely it is that portfolio managers place independent bets, which in turn may positively affect the risk-adjusted return of the aggregate portfolio.

Notes

1. Helpful comments by Christophe Beuve, Narayan Bulusu, Gioia Cellai, Francesco Daini, Maurizio Ghirga, Giuseppe Grande, Johannes Kramer, Philippe Muller, Franco Panfili, Tommaso Perez, Dario Ottaviani, Antonio Rossetti, Andrea Santorelli, Roberto Violi, and seminar participants at the Sixth BIS-World Bank-Bank of Canada Public Investors' Conference in Washington, ECB and Banca d'Italia are gratefully acknowledged.
2. At the end of 2010.
3. Bonds included in the benchmark can be grouped in pre-defined buckets, so called 'time buckets', according to their maturities (just for illustrative purposes, bonds with maturity ranging from zero to one year can be included in an hypothetical time bucket '0–1 year', and so on).
4. At first quarter 2017 (IMF COFER statistics: http://data.imf.org/?sk=E6A5F467-C14B-4AA8-9F6D-5A09EC4E62A4)
5. At first quarter 2017 (International Investment Funds Association: https://www.iifa.ca/files/1503579002_IIFA%20-%20Worldwide%20Open-End%20Fund%20Report%20-%20Q1%202017.pdf).
6. 'Virtual' trades for rebalancing the tactical benchmark are carried out at actual trading prices (including transaction costs).

7. The ECB's official reserves include also assets denominated in Japanese yen and gold. The other Euro-system NCBs were involved in the active management of the yen reserve portfolio. We refer to each central bank's desk involved in the management of the ECB reserves as a 'portfolio manager'. In practice, a small team usually works on the ECB reserves desk, comprising, for example, one manager and one or two dealers, in some cases devoting part of their work time to the ECB reserves and the remainder to the management of the foreign exchange portfolio owned by the NCB.
8. The extra return that comes from the carry of deposits is included in the security selection and not in the spread contribution, because deposit instruments are not classified as spread products.
9. The average time horizon is obtained by counting the number of inversions of sign of partial duration exposures related to each single strategy.

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