RANKING, RISK-TAKING AND EFFORT: AN ANALYSIS OF THE ECB'S FOREIGN RESERVES MANAGEMENT

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Abstract

The investment of the ECB reserves in US dollars and yen involves an annual performance assessment of portfolio managers, located in the Eurosystem's national central banks. Employing new data on individual portfolios during 2002-2009, we study this peculiar tournament and show the existence of risk-shifting behaviour by reserve managers related to their year-to-date ranking: interim losers increase relative risk in the second half of the year, in the same way as mutual fund managers. In the dollar case the adjustment to ranking is reduced or offset if reserve managers have achieved a positive interim performance against the benchmark. Yen reserve managers that rank low show a tendency to increase effort, as proxied by portfolio turnover. Those who ranked low in the previous year tend to reduce risk significantly. Since reserve managers should have a comparative advantage over the benchmark within a monthly horizon, possible enhancements to the design of the tournament might involve an increased reward for effort and performance by means of a convex scoring system linked to monthly, rather than annual, performance.

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1. Introduction[1]

This paper aims to make an original contribution on four issues. First, it performs an empirical study on the relationship between ranking, risk-taking and effort in the management of the ECB's foreign reserves. This setting has never been explored before and, in a broad sense, it is representative of the under-researched class of the official foreign exchange reserve portfolios, globally worth over 10 trillion US dollars.[2] Second, our analysis is related to the existing studies on tournaments and risk-shifting in the mutual fund industry, pioneered by Brown, Harlow and Starks (1996). This literature has extensively investigated the management of equity funds, while one study has recently examined corporate bond funds (Adam and Guettler, 2011). We present the first analysis to our knowledge of a tournament involving actively managed high-grade bond portfolios. This feature may fill a gap, since it is not obvious that the risk-shifting hypothesis may extend to an environment where overall risk is much lower compared with equity portfolios and corporate bond portfolios. Our findings may thus have some bearing on managed bond portfolios in the private sector, that account for a large portion of the investment management industry.[3] Third, we examine the effect of ranking on portfolio managers' effort, something that has not been attempted in previous empirical research. Finally, from an agency perspective, we discuss possible improvements in the incentives offered to ECB reserves managers via the ranking system.

The purpose of the ECB's foreign reserves is to finance possible interventions in the foreign exchange market. Based on the Statute of the European System of Central Banks, the stock of these assets is the result of the initial transfer from participating National Central Banks (NCBs) and of the investment operations, as well as of interventions (Scheller, 2006). At the end of 2010 the ECB's official foreign reserve assets were worth around €57 billion, of which €17 billion gold, €0.4 billion SDRs and the remainder in US dollar and Japanese yen assets. The shares of dollar and yen assets were around 76 and 24 per cent respectively.

The investment of the ECB's foreign reserves is based on a central risk management function and a decentralized approach for investment operations involving the NCBs. Until 2005 each NCB used to manage one subportfolio in dollars and one in yen. With a view to improving efficiency, since January 2006 an approach aimed at currency specialization has been introduced, resulting in a smaller number of actual portfolios. In any case, portfolio managers in each currency have been assigned a common

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[2] The figure is as of June 2011; see the IMF COFER statistics.

[3] The 2011 Investment Company Factbook (www.icifactbook.org) reports that the share of net assets in bond and money market funds equals 45 per cent of the US mutual fund industry, or 5.4 trillion dollars out of 11.8 trillion dollars at the end of 2010. High-grade securities are the main asset class in bond funds. One may take 45 per cent as an estimate of the share of bond portfolios in the net assets of mutual funds in the rest of the world, which are worth 12.9 trillion dollars in total (same source as above).

benchmark over time, which has given rise to two investment tournaments. On a monthly basis the performance of the individual portfolios is assessed, also by means of year-to-date performance rankings of managers. Once a year a general report is produced and submitted to the Governing Council of the ECB; the report includes the annual performance ranking of the NCB portfolio managers for each currency. The allocation of mandates may be reviewed periodically if the need arises. The ECB's practice follows a global trend in central bank reserve management, whereby an increased focus on returns is accompanied by stronger internal governance rules, involving a strategic asset allocation process and the definition of the acceptable risk-return balance (Johnson-Calari, Grava and Kobor, 2007; Borio, Galati and Heath, 2008).

The delegated framework and the risk control rules for the management of the ECB's foreign reserves have proven in the field to be financially sound, as documented by the internal reports. These show in particular that for both currencies, in the years 1999-2010, the actual portfolios have outperformed on average the respective benchmarks net of transaction costs, and the move to currency specialization in 2006 has led to an overall improvement in portfolio performance. The framework, inspired by the overarching principles of liquidity and security of the ECB's foreign reserves, provides for them to be managed prudently in a way that maximises their value.

Our interest in risk choices is stimulated by the observation that the actual portfolios make a limited use of the market risk budget. For instance, in 2010 the average utilization rate of the allowed budget for the portfolios was equal to 42 per cent and 17 per cent, respectively for the dollar and the yen. Utilization was generally lower in previous years. The question that we address is as follows: does the current ranking system affect portfolio managers' risk-taking and effort during the year? For this purpose we employ panel regressions on a detailed dataset of monthly performance, risk and turnover for each of the twelve managing NCBs (or pools of NCBs) that were active throughout the years 2002-2009, i.e. in the last four years of the uniform approach (2002-2005) and in the first four years of currency specialization (2006-2009). Key to our setting is the fact that upfront monetary incentives are almost entirely absent and competition among portfolio managers is based on reputational credit.

We find that risk-shifting in response to ranking occurs even in the first half of the year, although it becomes much stronger in the second semester. Dollar managers shift all risk variables and, to a lesser extent, effort if their portfolio is performing below the benchmark, while above-benchmark performers do not adjust on the basis of their ranking. We also detect a strong feedback from past year ranking for dollar managers who are below the benchmark: in the second semester they significantly reduce risk and effort. The inception of currency specialization as from 2006, involving a tighter tournament among a smaller group of reserve managers, has been accompanied by an increase of spread risk-shifting in relation to interim ranking, and by some lessening of the other types of adjustment. In the yen case, interim ranking leads reserve managers to shift mainly spread risk and independently of relative return. The feedback from past year ranking is found for spread risk and effort. Currency specialization has led low-ranking yen managers to increase effort. We interpret the empirical finding that past year losers systematically reduce risk in light of concavity in the reputation function, motivated by a concern for capital preservation, which seems higher among NCB foreign reserve managers than in other portfolio tournaments. As a result, in our environment the manager's (reputational) payoff is kinked, and reminiscent of that of the seller of a put option with an exercise price equal to the value of the benchmark portfolio. This feature, which explains the low usage of the risk budget, may cause a loss of performance.

We then examine the implications of managers' choices for the ultimate goal of the actual portfolios. A story from the sports world vividly illustrates the role of scoring and ranking in contestants' decision making, a subject that has been widely examined in the literature (e.g. Ehrenberg and Bognanno, 1990). Let's assume that our rational stakeholder is a fan of Formula 1 racing. They love tight competitions and the drivers' search for performance during each race. The scoring system assigns 25 points to the race winner, 18 to the second driver, 15 points to the third one, and so on down to 1 point for the tenth position, whereas those who classify below tenth get nil. The final score for the drivers' title as well as the constructors' title is the sum of the points earned during the season. One day the race organizer, in the attempt to raise the interest of the public for Formula 1, proposes a change in the ranking system. Under the new scheme each driver would earn a number of points equal to his own race time. At the end of the season the times/points would be summed up and the driver, or the team, with the lowest overall times/points would win the title. Which scoring system would the rational Formula 1 fan prefer? The answer seems obvious, and we leave it to the reader. We observe that in analytical terms the Formula 1 scoring function is highly convex in the arrival order, whereas the new hypothetical function would be linear in the race times.[4] The scoring/ranking system, together with the level of compensation, can clearly influence the agents' strategies.

An agency implication of the risk-shifting evidence in the literature is that, by focusing attention on relative annual return, the mutual fund industry may effectively be changing managerial incentives from a long-term to a short-term perspective (Brown et al., 1996; van Binsbergen, Brandt and Koijen, 2008). In our setting the analogous finding might lead to the opposite conclusion. Owing to the monthly resetting frequency of the benchmark, the investment horizon which in principle reaps the full benefits of the ECB's management framework is arguably very short, and equal to one month (Cardon and Coche, 2004; Koivu, Monar and Nyholm, 2009). However in practice ECB foreign reserve managers adopt the one-year horizon, over which their performance is eventually assessed and reputation awarded by the Governing Council. Therefore in our case the risk-ranking relationship

[4] The scoring system of Formula 1 has indeed been changed several times in recent years (see www.formula1.com). It should be clear that the example is made for general purposes and has no relationship of substance with the investment tournament for the ECB's foreign reserves. The latter is by construction a highly prudent activity within the broader portfolio management business, whereby the maximum amount of risk that can be taken is capped very low (see section 3.1). From a risk perspective the foreign reserve management tournament is at most like an athletic race, definitely not like a car race.

introduces an annual orientation which may conflict with the length of the efficient investment horizon.

We then examine some implications of agency theory for the efficient design of the tournament (see Stracca, 2006 for a survey of delegated portfolio management models). General results of compensation theory (Lazear and Rosen, 1981; Nalebuff and Stiglitz, 1983) and the model of Dybvig, Farnsworth and Carpenter (2010), which derives optimum incentives when portfolio managers' effort and private signals are not observable, suggest that a convex reputation function might induce a more efficient use of the risk budget. An intertwined issue is the discrepancy between the investment horizon of the portfolios and the assessment horizon. In this perspective, we argue that a tournament applying a convex scoring function over a sequence of twelve monthly performance games would seem superior to the set-up where a concave reputation function is applied to a single performance game lasting for twelve months. The rank order is a possible incentive-compatible instrument for the aggregation of scores in different rounds.

The paper proceeds as follows. Section 2 reviews the literature related to our analysis. Section 3 describes the management framework and the tournament. Section 4 defines the variables and shows summary statistics. Section 5 presents the panel estimates on the effect of ranking on risk-taking and effort for the reserve managers. Section 6 examines more closely individual choices. Section 7 presents the normative discussion. Section 8 contains concluding remarks.

2. Related literature

While the background for this study is illustrated in recent surveys on central bank reserve management (e.g. Borio, Ebbesen, Galati and Heath, 2008; Borio, Galati and Heath, 2008; Johnson-Calari, Grava and Roberts, 2007), our research is directly related to the empirical studies of fund managers' tournaments. Past performance is the main determinant of fund selection, through a convex flow-performance relationship (Gruber, 1996; Chevalier and Ellison, 1997; Sirri and Tufano, 1998); hence fund managers actively pursue the growth of the assets under management, which brings about a rise in the fees. This observation underpins the broad version of the tournament (or risk-shifting) hypothesis, according to which fund managers adjust portfolio composition depending on year-to-date performance. The empirical evidence supports this hypothesis in its narrow-sense version, according to which interim winners lock-in their outperformance and reduce risk, while interim losers increase volatility in the attempt to catch up (Lakonishok, Shleifer and Vishny, 1992; Brown et al., 1996; Chevalier and Ellison, 1997). Performance in the previous years also displays a significant effect on risk positions: the more consistently portfolio managers have been losers (winners) in the past the more (less) likely it is that they will have an above average risk exposure (Brown et al., 1996).

Subsequent empirical research has shown that the use of incentive fees magnifies the extent of risk-shifting in an economically significant way (Elton, Gruber and Blake, 2003); risk-shifting may partly be a spurious consequence of survivorship bias (Qiu, 2003) and of returns correlation (Busse, 2001; Goriaev, Nijman and Werker, 2005); and risk-shifting in its narrow version is less pronounced for funds that make an active use of derivative instruments (Koski and Pontiff, 1999). Tournaments take place not only in a given fund segment, but also within families of funds that belong to the same controlling group but offer alternative investment styles (Kempf and Ruenzi, 2008). Tournament behaviour is also detected via risk measures based on portfolio holdings (Schwarz, 2011). The analysis of employment relationships within fund management firms reveals that the amount of risk-taking can also be affected by career concerns, and that the probability of maintaining or improving one's position within the same firm may be concave in performance for younger managers (Chevalier and Ellison, 1999). Compared with compensation incentives, employment concerns may present offsetting effects on risk-taking, and the latter type of incentives may even dominate the former, as in the case of a bear market (Kempf, Ruenzi and Thiele, 2009). In the case of hedge funds, risk-shifting may be influenced by high-water mark provisions, risk of fund closure and the choice of reporting performance to a database (Aragon and Nanda, 2010).

On the theoretical side, a vast literature has modelled mutual fund tournaments and challenged the narrow-sense risk-shifting hypothesis, that losers gamble and winners index (Acker and Duck, 2006; Basak and Makarov, 2011; Basak, Pavlova and Shapiro, 2007; Chen and Pennacchi, 2009; Goriaev, Palomino and Prat, 2001; Taylor, 2003). The degree of risk tolerance affects the risk-ranking relationship and, under risk neutrality, may even cause winners to gamble (Basak and Makarov, 2011). Risk-shifting may also be influenced by general market conditions (as in Acker and Duck, 2006). Very pertinent to our analysis is the result of Goriaev et al. (2001), who study the interplay between relative return objectives and ranking concerns. They show that the introduction of a ranking component in the compensation scheme generates risk-taking incentives for an interim loser in the last period of the tournament. If the weight of ranking in the objective function is relatively large, then the risk-taking incentives of the interim loser increase with the distance to the interim winner. A common thread in this literature is that the relevant measure for decision making is risk relative to the benchmark, rather than portfolio volatility. The empirical tests using relative risk measures are more clearly in favour of the narrow tournament hypothesis (Acker and Duck, 2006; Basak et al., 2007; Chen and Pennacchi, 2009; Goriaev et al., 2001). Ngo and Nguyen (2011) have recently developed a tournament model where competing fund managers make a joint choice on risk levels and effort, and show that when the latter is costly the interim winner exerts higher effort and chooses a lower risk than the interim loser. Based on the notion that the cost of effort is high in bear markets, the empirical test lends support to the risk level predictions but it does not extend to those on the amount of managers' effort.

We depart from previous empirical studies as regards the type of assets under management, the analysis of effort and the testing methodology. On the first aspect, we are aware of only one study of the tournament hypothesis in the case of actively managed bond portfolios, namely Adam and Guettler (2011), whose main focus is on the use of credit default swaps by corporate bond funds in the US. In their case interim underperformers are found to increase the short multi-name CDS positions during the second half of the year, a credit risk-enhancing choice which is consistent with the narrow tournament hypothesis. We look for the first time at portfolios of government and quasi-government securities. Our complementarity to the extant research seems relevant, mainly because the ECB reserve portfolios present a much lower volatility compared with both equity portfolios and corporate bond portfolios; furthermore, on account of their institutional nature, the ECB portfolios offer very narrow risk-taking opportunities vis-à-vis actively managed bond funds in the private industry (see the next section). As a consequence, support for the tournament hypothesis is far from granted in our case. We perform a clinical study on this issue, thanks also to the quality of the data.

Second, until now the empirical study of mutual funds' managerial effort (e.g. Cremers and Petajisto, 2009; Xie, 2011) has tried to explain it in view of fund characteristics and of the time-varying flow-performance relationship, which may cause changes in the marginal utility of effort. We try to measure the amount of managerial effort and seek to advance the analysis by linking it to the incentives created by ranking. For this purpose we use portfolio turnover as a proxy of effort.

In terms of testing methodology, past empirical research has generally examined ex post risk variables sampled yearly using semi-parametric methods. For instance, Brown et al. (1996) employ a standard deviation ratio, given by the fund's volatility after the interim performance assessment date divided by volatility up to that date. With one exception (Chevalier and Ellison, 1997), the studies which employ mutual fund holdings data to measure ex ante changes in risk positions are recent (Kempf et al., 2009; Schwarz, 2011; Adam and Guettler, 2011). Along this strand, we estimate panel regressions on the monthly response to ranking of ex ante risk positions relative to the benchmark, after controlling for a set of market variables.[5] Our risk variables are based on asset holdings and, being unaffected by subsequent market movements, they exactly pin down the intentional changes in risk positions. In particular, since the ECB's foreign reserves are invested in fixed income instruments, we distinguish duration risk, spread risk and curve risk (the use of CDS is not allowed, see below). On account of the closed nature of the tournament, whereby the number of contestants is fixed and the year-to-date performance ranking of each portfolio manager is known to all peers every month, we directly employ the year-to-date rank order as our key explanatory variable.

[5] The use of multivariate panel regressions has a precedent in Kempf and Ruenzi (2008) and Kempf et al. (2009).

3. Set-up

3.1 General framework

The purpose of the ECB’s foreign reserves is to finance possible ECB interventions in the foreign exchange market. Such interventions have occurred twice since the ECB was created, in September and November 2000. The foreign reserve portfolios may also be used to finance the ECB's part of concerted interventions in the foreign exchange market, such as for example the intervention of 18 March 2011 following the tragic events in Japan.

ECB foreign reserves initially comprised transfers of foreign reserve assets to the ECB from the NCBs of the euro-area countries, in proportion to each NCB’s capital share in the ECB (Scheller, 2006, ch. 3). When new countries join the euro area, their NCBs also transfer foreign reserve assets to the ECB, in the same proportion as the other NCBs. Over time, the ECB’s foreign reserves may increase or decrease as a reflection of portfolio returns and of purchases or sales of foreign currency by the ECB. In addition, the ECB may call upon the euro-area NCBs to transfer additional foreign reserve assets if needed.[6]

In order of priority, the high-level objectives of the investment framework are defined as being “liquidity, safety, return”. Three management layers for each currency are envisaged: the *strategic benchmark*, the *tactical benchmark*, and the *investment portfolios*. The strategic benchmark is decided upon by the ECB’s Governing Council on the basis of a proposal put forward by the risk management function of the ECB (detailed information can be found in Koivu, Monar and Nyholm, 2009). The Council then assigns two portfolio management mandates (see ECB, 2006). The first envisages the outperformance of the strategic benchmark by the tactical benchmark, the positions of which are reviewed and possibly changed once a month; this mandate has been given to the ECB’s Investment Committee. The second mandate envisages the outperformance of the tactical benchmark by the actual portfolios managed by the NCBs.[7]

The investment opportunities and risk limits can be summarized as follows (see also Manzanares and Schwartzlose, 2009). There is a positive list of eligible investment instruments for each currency,

[6] Within the Eurosystem, which comprises the ECB and the euro-area NCBs, total foreign reserves amounted to around €591 billion equivalent at the end of 2010, of which around €57 billion were held by the ECB and around €534 billion were held by the NCBs. The purposes of the NCBs’ foreign reserves include: international obligations (e.g. holdings of IMF special drawing rights); optimization of balance sheet structure; and preparedness to transfer additional foreign reserve assets to the ECB if needed. A significant portion of the Eurosystem’s foreign reserves is made up of gold holdings, which accounted for €366 billion equivalent (or 62 per cent) at the end of 2010.

[7] This is in line with various studies that point to the prospects for active management to add return to fixed income portfolios (e.g. Boyd and Mercer, 2010). This approach has benefits beyond the additional returns it generates, in particular in terms of market intelligence; the operational expertise it requires, which is useful not only for investment operations but also for policy operations; and the generation of ideas which can be incorporated in the composition of the benchmark portfolios over time. As a corollary, the portfolio managers must not receive any inside information about monetary and exchange rate policies of the ECB or other central banks or authorities.

including government securities, securities issued by selected supranational institutions and agencies, and BIS instruments. Cash management operations include bank deposits, repos and reverse repos, while some derivative contracts are also allowed, in the form of interest rate and bond futures, interest rate swaps and fully-hedged foreign exchange swaps. With the exception of government securities, each investment class is subject to maximum risk limits of two types: individual issuer limits, in absolute value, and sector limits, as a percentage of portfolio size. These limits are designed to contain credit risk and liquidity risk. Besides, market risk is controlled via a ceiling on the actual portfolios relative VaR (one-day horizon, 99 per cent confidence level) compared with the tactical benchmark and on the tactical benchmarks' relative VaR vis-à-vis the strategic benchmarks. Almost all eligible securities types are included in the benchmarks.

The risk exposure taken by portfolio managers vis-à-vis the tactical benchmark derives from the "signals" they collect in their daily market analysis. The risk of an actively managed bond portfolio can be broadly grouped in three categories. First, portfolio managers may try to outguess the changes in the level of the yield curve, leading to an adjustment of the actual portfolio duration relative to the benchmark duration (duration risk). For instance, if a portfolio manager forecasts a rise in yields (beyond what is already incorporated in the choice of the tactical benchmark), he will shorten the duration of the trading portfolio below that of the benchmark. Second, portfolio managers may form an expectation on the level of the yield spread of credit (i.e. non-government) instruments compared with the treasury yield curve, which would cause an adjustment in the share of credit instruments relative to the benchmark (spread risk). Third, portfolio managers may entertain views on the evolution of specific segments of the yield curve which, other things being equal, would lead to an adjustment of the shares of individual time-buckets compared with the benchmark (curve risk).

The risk controls are implemented through a portfolio management IT system which connects the entire network. The actual portfolios and the benchmarks, constituted by individual securities, are marked-to-market down to each individual component and time bucket in real time, via a continuous link of the IT system with price vendors. Besides, the system computes the so-called duration contribution (i.e. the duration share) of each component of the benchmark and of the portfolios.[8]

Until the end of 2005, each NCB was involved in managing both a US dollar portfolio and a yen portfolio. Since 2006, with a view to achieving efficiency gains, portions of the portfolios are allocated

[8] The duration contribution of a given component of the portfolio is defined as the average duration of that component multiplied by the ratio of the component value over total portfolio value. Hence, the sum of all contributions adds up to the portfolio duration. The IT system enables portfolio managers to evaluate in real time the effect of any transaction on their exposure even before the transaction is made, thus contributing to highly informed risk-taking decisions. For instance, if a dollar portfolio manager wants to increase the share of the credit instruments relative to the benchmark by adding, say, 50 million dollars' worth of an agency bond, he may obtain the absolute and relative changes in the portfolio value, duration, VaR, etc. that would result from the transaction at prevailing market prices, as well as the duration contribution of the credit component before and after the transaction. Likewise, the system can work out the amount of the agency bond that should have to be purchased in order to obtain an increase in the exposure to credit instruments by x duration contribution years.

to each NCB or pool of NCBs that expresses interest in being involved in ECB foreign reserve management. At the end of 2010 there were nine portfolios for the US dollar and six portfolios for the yen. Among these, three portfolios were pools between pairs of NCBs carrying out this activity jointly. The NCBs comprising the analysis, singularly or in pools, are those of Austria, Belgium, Germany, Spain, Finland, France, Greece-Cyprus, Ireland-Malta, Italy, Luxembourg-Slovenia, the Netherlands, and Portugal.[9] For confidentiality reasons, in the analysis that follows each desk of national dealers is indicated by a random code, ranging from M1 to M12.

Considering the experience so far with ECB foreign reserve management, the efficiency of the strategic benchmark can be confirmed ex post by comparing its returns with the returns of simpler investment strategies presenting similar risk, like investing in bills or short-term bonds. For example, strategies consisting of rolling over investments in three-month or six-month Treasury bills or two-year Treasury notes would have achieved average yearly returns of 2.75, 2.98 and 3.30 per cent respectively over the period from January 1999 to December 2010, while the ECB's US dollar strategic benchmark returns (calculated in the same manner) were 3.96 per cent over the same period. For the Japanese yen, the roll-over of investments in six-month or twelve-month Japanese government bills or two-year government bonds would have achieved average yearly returns of 0.19, 0.23 and 0.43 per cent respectively, while the ECB's Japanese yen strategic benchmark returns were 0.40 per cent. The objective of outperforming the strategic benchmark can thus be considered as rather challenging. In terms of actual investment performance, Table 1 shows the returns achieved by the actual portfolios compared with the strategic benchmarks. These excess returns have been positive in eleven out of twelve years for the US dollar portfolio and nine out of twelve years for the yen portfolio. Of the average yearly excess return of 12 basis points on both portfolios combined, around three quarters reflected the investment decisions made at the level of the actual portfolios by NCBs.

3.2 The tournament

The stylized facts about the foreign reserve management tournament are as follows. The objective of the actual portfolios is to outperform the tactical benchmark, and the assessment horizon for practical purposes is the calendar year, corresponding to the horizon for reporting to the Governing Council. Since the distribution of reserves reflects the NCBs' capital share, the flow-performance relationship and the ensuing incentive structure of the private sector do not apply. The only type of global reward consists in good or bad reputation at the Governing Council level as a consequence of national performance and/or ranking in the previous year. The best portfolio managers obtain praise, from the ECB and from home; those who lag behind at the very least provoke a few raised eyebrows.

[9] The NCB of Slovakia, which became a portfolio manager for the ECB's foreign reserves upon entry into the Eurosystem in January 2009, has not been included in the analysis owing to the limited historical sample.

Other types of reward in relation to performance are left to the discretion of individual NCBs. A survey among them has shown that in the sample period only two out of twelve envisaged a bonus related to the achievement of an annual *ranking* target set by the board, and the bonus was relatively small compared with base salary. In one case the NCB board set a performance target, although without attaching a bonus. Four NCBs, including the ones that paid a bonus, foresaw other forms of discretionary reward related to performance and/or ranking, mainly in terms of career development. Broadly speaking, in the medium term consistent achievement or losses reveal the portfolio manager's skills and contribute to positive or negative career development, and thus indirectly to monetary reward. These employment incentives generally punish poor results less severely than in the private sector, in the sense that employment relationships at NCBs are quite often tenured. However, although with different modalities compared with the mutual fund market, peer pressure and competition are clearly at work in the management of the ECB's reserves as well. In one aspect the ECB reserve management tournament is even more testing than the mutual fund tournament. Whereas in the latter case the number of competitors is usually in the hundreds, in the ECB's case the number of players is below ten, implying very close scrutiny.

In the majority of cases in which specific internal targets are not set, anecdotal evidence gathered from NCB portfolio managers indicates that they perceive a concave award of reputational credit over the final ranking: the negative reward for performing badly is larger in absolute terms than that for performing well, a feature which generates risk aversion over annual portfolio performance relative to the benchmark return. This shape for the reputation function is usually explained by portfolio managers with capital preservation concerns which, although already reflected in the choice of a prudential strategic benchmark with narrow deviation bands, permeates the culture of foreign reserves dealers and of their management. At the NCB level, in some cases the mandate to dealers can be described by the precept "first and foremost outperform the benchmark, then try to rank well".[10]

We conjecture that the incentives offered to reserve managers during the year and their rational reaction to performance ranking may be in accordance with the tournament hypothesis, and we set out to test this hypothesis.

4. Data

We seek to describe the managers' choice variables along two dimensions: risk and effort. We therefore construct monthly time series of the type $x_{i,t,c}$, where the generic variable x is observed over manager i = 1,…, 12 and month t, ranging from January 2002 to December 2009. Each variable refers to a currency portfolio c = USD, JPY. In the years 2002-2005 all twelve NCBs, or pools thereof,

[10] These concerns may have similar effects compared with the private sector, where career-enhancement incentives may be concave in performance (Chevalier and Ellison, 1999).

used to run a dollar portfolio and a yen portfolio. During 2006-2009 our sample includes eight dollar portfolio managers and six yen portfolio managers (two NCBs manage both currencies). For each of them we exploit the availability of detailed data from the aforementioned portfolio management IT system of the ECB. To capture the different dimensions of risk we construct three variables:

Duration risk: this variable measures the duration exposure of the portfolio relative to the benchmark. It is defined as the absolute difference in years between the modified duration of the portfolio and that of the tactical benchmark, both observed on the last day of the month.

Spread risk: this measures the spread exposure of the portfolio relative to the benchmark and is defined as the absolute difference between the duration contribution of the spread instruments (deposits, BIS, supranationals, agencies) in the portfolio and that of the tactical benchmark, in years, at month end.[11]

Curve risk: this variable measures the curve exposure of the portfolio relative to the benchmark, net of *Duration risk*. It is defined as the sum of the absolute differences between the duration contribution of each time bucket in the portfolio and the corresponding value for the benchmark, minus *Duration risk*, in years, at month end.

Effort is proxied by the following variable:

Turnover: the ratio between monthly portfolio turnover and portfolio size, covering all transactions (cash management, securities, and derivatives).

We note that our risk variables might also be viewed as proxies of (unobservable) effort, since they are computed as the sum of absolute differences in portfolio shares compared with the benchmark. For a fund manager, departing from the passive replication of the benchmark involves not only a conscious act of risk-taking but also hard work in terms of market analysis, price capture, security transactions, back office work, etc. This reasoning has recently induced Cremers and Petajisto (2009) to propose the "active share" measure of managerial efforts for equity mutual funds, which is basically the same approach used in the calculation of our variables *Duration risk*, *Spread risk* and *Curve risk*. In our case, since each of the three risk variables exactly matches one key dimension of risk in bond portfolio management, we prefer to think of our three variables as primarily risk measures. To the extent that the active share notion is more generally valid, there is clearly a positive association between risk and

[11] A numerical example may help. In December 2002 the duration of the dollar portfolio held by Manager 1 (or M1) was equal to 2.06 years, against 2.03 years for the corresponding tactical benchmark. Hence, the *Duration risk* of M1 was equal to 0.03 years. In the same month the spread instruments in M1's portfolio had a duration contribution of 0.80 years, against a value of 0.45 for the tactical benchmark, i.e. the portfolio was overweighted in spread instruments. M1's *Spread risk* was thus equal to 0.35 years. Incidentally, this is also the maximum of that variable for M1 in the sample period (see Table 2).

effort, and our subsequent inference on risk-taking may also be indicative of patterns in managerial effort, in addition to what we derive from the study of *Turnover*.

Our key explanatory variables are:

Rank: the year-to-date return ranking among all portfolios in the same currency.[12] The raw ranking ranges between 1 (best interim performer) and 12 (worst interim performer) in the years before currency specialization, i.e. from 2002 to 2005, and from 1 to 8 (6) in the years 2006-2009 for the dollar (respectively the yen). For homogeneity, *Rank* is normalized to vary between 1 and 8 (6 for the yen) through the whole sample period. In the regressions we use the lagged value, i.e. $Rank_{-1}$, which is strictly predetermined relative to the endogenous variables, and made known to all reserve managers in the first week of the month following the reference month.

Last year rank: the final rank among reserve managers over the previous calendar year, normalized like *Rank.* This variable, which is constant for each manager during the year, measures the effect of the last completed tournament over current choices.

Based on the previous discussion, we advance the hypothesis that lagged *Rank* will directly affect managers' effort and risk-taking, along its three dimensions (duration, spread, and curve). For simplicity we conjecture a linear relationship between *Rank* and each dependent variable: those who rank in the lower half of the distribution (i.e. with larger values of *Rank*) from the beginning of the year to the previous month will increase risk and effort linearly. Conversely, those who rank in the top half of the distribution will reduce risk and effort.

Last year rank might have a positive effect on risk and effort, as found in the mutual fund sector. However, if our anecdotal conjecture on the asymmetric reward function of portfolio managers is indeed at work, we could also see risk averse behaviour on the part of past losers, and *Last year rank* would display a negative effect on risk.

Consistently with the literature, we hypothesize that risk-shifting will be more pronounced in the second half of the year, when the time to the end result becomes shorter. Besides, we try to ascertain whether risk-shifting in the second semester is affected by the portfolio return being above or below the benchmark return, since it could be argued that a low ranking manager might feel less pressure to gamble if his cumulated portfolio performance is positive.

Our regression strategy is as follows: first, we use ranking variables that measure the undifferentiated effect, if any, over the year (lagged *Rank* and, respectively, *Last year rank*); second, we measure the

[12] We consistently use the term performance to mean the difference between portfolio return and benchmark return, which can have positive or negative values. By construction, our monthly ranking variables based on performance are identical to those which would have been obtained based on absolute return, since the benchmark return is the same across portfolios.

differential effect of the same ranking variables in the second semester; third, limiting ourselves to the second semester, we measure the differential effect of the same variables when the portfolio manager has achieved a positive performance. Then we construct the following variables:

H2 rank: the interaction between lagged *Rank* and an indicator variable equal to 1 from July to December and 0 otherwise. The regression coefficient measures the incremental effect, if any, of *Rank* in the second semester.

H2 above bmk: the interaction between *H2 rank* and an indicator variable equal to 1 if the cumulated performance in relation to the benchmark up until the previous month is positive. The regression coefficient measures the incremental effect, if any, of the portfolio return being above the benchmark return. In the second semester the total risk-shifting effect is given by the sum of the base effect of *Rank* plus the incremental effect of *H2 rank* (for all) plus the effect of *H2 above bmk* (for positive performers only).

H2 last year: is equal to *Last year rank* from July to December, and 0 otherwise. Analogously to *H2 rank*, this variable captures the presence of the incremental effect of *Last year rank* in the second semester.

H2 last above: the interaction between *H2 last year* and the positive performance indicator variable. In the second semester total risk-shifting related to last year's ranking is the sum of the base effect plus the incremental effect of *H2 last year* (for all) plus the effect of *H2 last above* (for positive performers in the current year).

We also employ some control variables, aiming to characterize the state of the market in a parsimonious way. By construction they are manager-invariant:

Term spread: the slope of the yield curve. It is defined as the difference between 10-year and 2-year government bond yields, in percentage points, at month end. We will use the lagged value, $\textit{Term spread}_{-1}$.

Ted spread: the difference between the 3-month Libor rate and the 3-month T-bill rate, in percentage points, at month end. This variable measures the credit risk in the economy for the dollar case. We will use $\textit{Ted spread}_{-1}$.

OIS spread: the difference between the 3-month Libor rate and the 3-month overnight indexed swap rate, in percentage points, at month end. Like *Ted spread*, it measures credit risk in the case of the yen. We use $\textit{OIS spread}_{-1}$.

Bond volatility: the annualized historical volatility of the price of 10-year government futures contracts, for current delivery, taken over the last sixty working days, in percentage points, at month end. This variable is a proxy of market volatility at the long end of the curve. Like *Term spread*, this variable is available for both currencies. We use its lagged value.

The choice of the control variables reflects their role as key market indicators for portfolio decisions, the widespread use by market practitioners and their availability throughout the sample period. The source of these variables is Bloomberg.

Table 2 shows summary statistics on the dependent variables in the dollar case. The random codes for the managing NCBs or NCB pools are consistent throughout the sample period. Therefore, since eight NCBs or NCB pools have continued to manage a dollar portfolio after currency specialization, in their case we collect explanatory variables in both regimes (96 monthly observations). The remaining four NCBs have withdrawn from the dollar as from 2006, and we thus collect the variables only until 2005 (48 observations).

We note inter alia that manager 10, who was active until 2005, always kept a neutral duration position (*Duration risk*=0 on average) and a small spread risk exposure. Manager 5 maintained on average a nil spread exposure. Among the moderate duration risk and spread risk-takers we also note manager 12. Manager 8 is the one who likes taking risks most, showing relatively high values for average *Duration risk* (0.07 years), *Spread risk* (0.21 years) and *Curve risk* (0.59 years), although he achieves this with a low value of *Turnover* (0.49, i.e. 49 per cent of portfolio size).

Table 3 provides analogous statistics for the yen portfolios. In this case we collect explanatory variables for six NCBs throughout the sample period, while for the remainder we only have data for the uniform approach period of 2002-2005. Interestingly, we observe that a large number of reserve managers does not take spread risk positions: some of them left the tournament as from 2006 (M1, M3, M4, M5), while others are still active under currency specialization (M2, M10, M11, M12). On average the yen managers show lower *Turnover* values compared with the dollar managers. The traders with an average turnover ratio above unity are M4 and M8, who left in 2006, plus M6 and M9, who are still in the game.

A general remark on these statistics is that *Turnover*, our effort proxy, varies widely among reserve managers, particularly in the dollar case. One reason may be related to the dispersion in the absolute size of the portfolios. Smaller portfolios are more flexible to manage because they involve a lower absolute transaction size to achieve any given relative risk position. Besides, some managers may actively use futures contracts or liquidity management operations, involving a higher gross turnover.

The summary statistics on the USD control variables between 2002 and 2009 are listed in Table 4, while Table 5 gives the corresponding figures for the yen market. The dollar market variables show higher average values and greater dispersion compared with the yen variables.

5. The effect of ranking

We recall our key question: does ranking in its twofold characterization (year-to-date and from previous year) affect risk-taking and effort at the individual level? For this purpose we adopt a stepwise approach. In this section we present the results of the following regressions starting with the dollar (the currency subscript is omitted for simplicity):

$$\begin{aligned} Y_{i,t} = \alpha &+ \beta_1 \; \textit{Term spread}_{-1,t} + \beta_2 \; \textit{Ted spread}_{-1,t} + \beta_3 \; \textit{Bond volatility}_{-1,t} \\ &+ \gamma_1 \; \textit{Rank}_{-1,i,t} + \gamma_2 \; \textit{H2 rank}_{-1,i,t} + \gamma_3 \; \textit{H2 above bmk}_{-1,i,t} \\ &+ \delta_1 \; \textit{Last year rank}_{i,t} + \delta_2 \; \textit{H2 last year}_{i,t} + \delta_3 \; \textit{H2 last above}_{i,t} + u_i + \varepsilon_{i,t} \end{aligned} \tag{1}$$

where the dependent variable *Y* is represented alternatively by *Duration risk*, *Spread risk*, *Curve risk*, *Turnover*. We use panel regression estimates with fixed effects, measured by the u_i term. This specification involves a number of simplifying assumptions. In particular, all relationships among the explanatory variables and the dependent variables are assumed to be linear. The presence of individual effects is captured by u_i: risk-taking and effort between any two portfolio managers *i* and *j* may differ only by a constant shift factor equal to $(u_i - u_j)$, and over time all managers are assumed to react in the same way to changes in the explanatory variables.

The dependent variables are extremely volatile and complex to model, reflecting a number of factors and idiosyncratic preferences that are difficult to capture with the available explanatory variables. Not surprisingly, the R-squared values that we obtain are rather low. Nonetheless, for our hypothesis testing we rely on the coefficients t-statistics computed with robust standard errors.

Table 6 presents the results of equation (1) for the dollar portfolios where the dependent variable is *Duration risk*. The first column section lists the results for the entire sample period. It shows a highly significant constant term equal to 0.07 years and the negative effect of both the term spread and the Ted spread on duration risk. The base effect of ranking (γ_1) is nil. Risk-shifting however takes place in the second semester, as revealed by a positive and highly significant value of γ_2, equal to 0.006. This implies that, other things being equal, the reserve manager with the lowest interim ranking (*H2 rank*=8) displays a greater value of duration risk compared with the average rank (*H2 rank*=4.5) by (0.006*3.5=) 0.021 years. Interestingly, the value of γ_3 equal to -0.006 shows that risk-shifting is entirely offset if the portfolio manager has achieved a positive performance. This reveals that risk-shifting takes place asymmetrically around the value of the benchmark return. The reserve managers who achieve a positive interim performance do not adjust duration risk; those that remain below the benchmark shift duration risk in line with their ranking position in the second half of the year.

Turning to the effect of past year ranking, we find an insignificant base coefficient δ_1. Risk-shifting materializes in the second half of the year, when the value of δ_2, highly significant and equal to -0.006, shows that losers in the previous tournament reduce duration risk, as could be conjectured on the basis of the managers' anecdotal evidence. Again, we find an asymmetry around the benchmark return: the value of δ_3, equal to 0.005, reveals an almost full offset of the past ranking effect for reserve managers who are currently above the benchmark return.

We also ran equation (1) separately during the uniform management period and the currency specialization period. The results for duration risk are reported in Table 6 in the second and third column section respectively. In the uniform management period the market variables are no longer significant, while the risk-shifting coefficients are smaller and show the same patterns as in the regression for the entire sample: asymmetric duration risk-shifting occurs as a response to current ranking $(\gamma_2 > 0,\ \gamma_3 < 0,\quad \gamma_3 = -\gamma_2)$ as well as to past year ranking $(\delta_2 < 0,\ \delta_3 > 0,\quad \delta_2 = -\delta_3)$. In the currency specialization period duration risk responds negatively to the term spread and to the Ted spread, while most of the risk-shifting effects are no longer significant. The only significant effect is related to *Last year rank*, the base variable which covers the whole year, with $\delta_1 = -0.008$. While in the years 2002-2005 the effect of past ranking on current duration risk was found in the second semester only, during 2006-2009 the reserve managers' concern about their past score is more pervasive: it weighs on duration risk choices all year round, and independently of the level of performance.

The estimates of equation (1) as applied to *Spread* in the dollar portfolios are reported in Table 7. In the full sample period we note that spread risk varies inversely with the Ted spread and directly with bond futures volatility. The base effect of *Rank* is equal to -0.009. In the second semester, the estimate of γ_2 turns positive as expected and is equal to 0.023, while we observe again the offset of $\gamma_3 = -0.020$. In the second half of the year the total effect of cumulated ranking is given by $(\gamma_1 + \gamma_{2_2} + \gamma_3 =) - 0.006$ for positive performers, and by $(\gamma_1 + \gamma_2 =) + 0.014$ for negative performers. This is evidence of spread risk-shifting also by the reserve managers who are ranking well (to the extent that this is associated with positive performance), and not only by those performing below the benchmark, as in the case of duration risk. Past year ranking has a low base effect $(\delta_1 = 0.003)$ with a moderate significance level. In the second semester negative performers shift risk $(\delta_1 + \delta_2 = -0.015)$, whereas positive performers practically do not $(\delta_1 + \delta_2 \quad + \delta_3 = +0.001)$.

In the uniform management period we find broadly similar results compared with the full sample regression: both interim ranking and past year ranking show an impact on current spread risk choices, with the same patterns as described above. It is interesting to note that in the currency specialization period the number of significant ranking coefficients diminishes, and the effect of interim ranking for negative performers in the second semester becomes greater (0.010 as opposed to 0.005).

Table 8 presents the results of equation (1) as applied to *Curve risk*. This is affected negatively by the term spread and the Ted spread, and positively by bond futures volatility. Risk-shifting related to interim ranking occurs mainly for negative performers in the second semester $(\gamma_1 + \gamma_2 = 0.068)$; it is practically nil for positive performers, while it reverses $(\gamma_1 = -0.009)$ in the first semester. In the second part of the year we observe the usual negative effect of past year ranking on curve risk, which is strong for negative performers (-0.065) and much smaller for positive performers $(\delta_2 + \delta_3 = -0.006)$.

The comparison between the two subperiods reveals that currency specialization brings about a marked reduction in the extent of curve risk-shifting related to interim ranking. In particular, in the second semester negative performers have a cumulative effect equal to +0.062 in the first subperiod and to +0.036 in the second subperiod. The corresponding effect for positive performers diminishes in absolute terms, from -0.007 to -0.002. These patterns are the opposite of those found for spread risk.

Table 9 gives the results for *Turnover*. This variable responds inversely to the size of the term spread and to bond volatility. We detect a significant value of γ_3, equal to -0.157: in the second semester low ranking reserve managers reduce turnover, to the extent that they have achieved positive performance. Past year ranking has an inverse effect on turnover $(\delta_2 = -0.156)$; however this effect is more than compensated for if the manager has achieved a positive performance $(\delta_2 + \delta_3 = 0.048)$. The latter finding seems consistent with the notion that, once reserve managers have achieved a positive performance, they deploy an extra effort, e.g. in security selection, to improve their ranking position. The coefficient estimates for the two subperiods reveal the presence of ranking-related adjustments in turnover only under the uniform management regime.

To obtain a clearer picture of adjustment patterns under the two regimes, Table 10 reports summary evidence on the ranking-related effects on risk and turnover estimated for the second semester. We observe that some types of risk-shifting diminish under currency specialization, while others become greater. In the first group we can include the adjustment of curve risk following the interim ranking results, and of spread risk and curve risk following past year ranking.[13] We also notice that the adjustment of turnover to either type of ranking loses significance under currency specialization. The second group includes the adjustment of spread risk to the interim ranking results and that of duration risk to past year ranking. The first of these effects may partly be related to the increase in size and

[13] Strictly speaking, in the subperiod 2002-2005 the lowest ranking manager has a *Rank* (or *Last year rank*) equal to 8, while the highest ranking manager, owing to normalization, has a value equal to (1/12 x 8=) 0.67. This introduces an upward bias in the size of the coefficient estimates of the first subperiod.

volatility of credit spreads in the years 2006-2009 compared with the first subperiod. Overall currency specialization is associated with a reduction in the extent of risk-shifting for the dollar reserve managers. However risk-shifting is still present.

The evidence so far lends support to the view that the ECB's reserve managers strategically adjust their risk-taking and, to a lesser extent, turnover to changes in their relative ranking, both from the previous year and year-to-date. While enhanced risk-taking by the interim losers in the second semester is in line with the tournament hypothesis, the finding that low performance in the previous annual tournament causes a reduction in risk exposure can be attributed to the emergence of risk aversion - a phenomenon that seems to be absent in the mutual funds market, where the tournament is much less rigid and where losing the yearly tournament twice in a row is probably perceived as less damaging by portfolio managers.

Next we turn to the group of estimates for the yen portfolios, presented in the same sequence as for the dollar. Table 11 gives the results for *Duration risk*. In the entire sample period this variable responds positively to the term spread and the OIS spread. Interim ranking has an opposite, although small, effect on duration risk $(\gamma_1 = -0.004)$. No other types of risk adjustment are found. In the uniform management period we find that risk-shifting reverses sign in the second semester $(\gamma_1 + \gamma_2 = 0.003)$, and that past year ranking displays a negative effect on duration risk. Under currency specialization we are left with a single coefficient, with mild significance, and the "wrong" sign $(\gamma_2 = -0.012)$.

The results for *Spread risk* are given in Table 12. In this case low performers do increase risk positions, and more so in the second part of the year $(\gamma_1 + \gamma_2 = 0.014)$. Past year losers reduce spread risk in the second semester. These patterns are present in the uniform management period but disappear with currency specialization.

Table 13 shows the estimates for *Curve risk*. While in the entire period there is no evidence of risk-shifting, in the first subperiod we find the "familiar" tournament effects: low interim ranking causes an increase in risk-taking, which becomes more pronounced in the second semester $(\gamma_1 + \gamma_2 = 0.045)$; however this phenomenon is almost fully offset by reserve managers with positive performance $(\gamma_1 + \gamma_2 + \gamma_3 = 0.005)$. In the same subperiod, past year ranking displays a negative effect on risk-taking throughout the year $(\delta_1 = -0.012)$. Under currency specialization we notice a significant coefficient on the variable *H2 rank*, although with an unusual negative sign.

The results for turnover are shown in Table 14. In the full sample the only significant coefficients are $\gamma_3 = -0.098$ and $\delta_1 = -0.032$, presenting familiar signs. In the uniform management period there is no evidence of turnover adjustment, while under currency specialization we notice a significant value of γ_1, equal to 0.063 and showing that interim low ranking causes an increase in effort.

Table 15 reports summary evidence on the effects of ranking on yen portfolio risk and turnover in the second semester. The picture differs somewhat from the dollar case. We do not have a plausible explanation for the switch in the sign of the effect of interim ranking on duration risk and curve risk in the currency specialization years. We notice however that in those years the shifting of spread risk looses significance and that reserve managers adjust turnover to interim ranking instead. The effect of past year ranking disappears for three variables out of four.

6. Individual effects

In our stepwise test approach, we move on to release some of the assumptions used so far. In this section we allow for the possibility that individual effects appear not only as a constant component over time, but also via different reactions to the ranking variables. For this purpose the panel regressions are transformed as follows:

$$
\begin{aligned}
Y_{i,t} &= \alpha + \beta_1\, Term\ spread_{-1,t} + \beta_2\, Ted\ spread_{-1,t} + \beta_3\, Bond\ volatility_{-1,t} \\
&+ \sum_{j=1}^{J} \gamma_1^j\, Rank_{-1,i,t} \cdot D_{i,t}^j + \sum_{j=1}^{J} \gamma_2^j\, H2\, rank_{-1,i,t} \cdot D_{i,t}^j + \sum_{j=1}^{J} \gamma_3^j\, H2\, above\ bmk_{-1,i,t} \cdot D_{i,t}^j \\
&+ \sum_{j=1}^{J} \delta_1^j\, Last\ year\ rank_{i,t} \cdot D_{i,t}^j + \sum_{j=1}^{J} \delta_2^j\, H2\, last\ year_{i,t} \cdot D_{i,t}^j + \sum_{j=1}^{J} \delta_3^j\, H2\, last\ above_{i,t} \cdot D_{i,t}^j + u_i + \varepsilon_{i,t}
\end{aligned} \tag{2}
$$

where the dummy variables $D_{i,t}^j$ are manager specific, and range over (*j*, *t*, *c*) with value 1 in the months *t* when manager *j* is active in currency *c*, and 0 otherwise (the currency subscript is omitted for simplicity). As before, the dependent variable *Y* is represented alternatively by *Duration risk*, *Spread risk*, *Curve risk*, *Turnover*. We set out to test the hypothesis that reserve managers adjust risk positions and effort individually in a systematic way as a function of year-to-date ranking and past year ranking, allowing for the possibility that they modify their response in the second semester, and that they do so asymmetrically conditional upon achieving positive performance. This regression approach comes at the cost of a much larger number of coefficients to estimate, which inevitably reduces the efficiency of the estimates, since a large fraction of individual effects does not exist in practice and this amplifies the standard errors of the "true" effects.[14] The t-statistic, even if downward biased, continues to provide a reliable instrument for hypothesis testing.

The listing of the results of the eight regressions would be overly detailed. Therefore in Appendix Tables 1 and 2, respectively for the dollar and the yen, we provide evidence only on the γ and δ coefficients from equation (2) that turned out to be significant in the two distinct subperiods, ignoring for simplicity the results covering the entire sample, the effects of the market variables, the constant α and all the insignificant coefficient estimates. To enhance readability we compiled in Table 16 a selection of the results for the dollar (from Appendix Table 1), where we omitted the four portfolio managers who have no longer been active in that currency since 2006. While we note that two dollar managers (M4 and M5, from Appendix Table 1) present no significant ranking effect, Table 16 shows a wide variety of individual effects for the remaining six dollar managers. One extreme of moderation in this group is represented by M11 who, under currency specialization, reduces spread risk in response to a low past year ranking. At the other extreme we observe M8, who appears as a systematic risk- and turnover-adjuster. This reserve manager displays recognizable effects: low interim ranking causes an increase in spread risk and curve risk in the second semester; interestingly, these effects become greater under currency specialization. However turnover is reduced after low year-to-date ranking. With two exceptions, this reserve manager reacts in the same fashion independently of whether his return is above or below the benchmark. Looking back at the entire group of eight dollar managers who were active before and after currency specialization, and considering the four dependent variables, we have 32 combinations. As shown in Table 16, we have estimated the presence of one or more significant individual effects, related to either definition of ranking, in 11 cases out of 32, or 34 per cent. We recall that this figure is, if anything, biased downwards by the regression approach and by the choice to present the results for the subperiods.[15]

Table 17 provides the individual effects for the yen, using the same simplified format as in Table 16. We observe an even greater range of estimates. As was the case with the aggregate results of Tables 11-14, some of these individual effects can be interpreted less clearly than those for the dollar. Managers M11 and M12 generally display regular patterns across the four dependent variables (interim ranking displays a positive coefficient, past year ranking has a negative coefficient), and in a number of cases they react asymmetrically depending on their position relative to the benchmark return. In the entire group of six yen managers who were active before and after currency specialization, and considering the four dependent variables, we have 24 combinations. Out of these,

[14] The alternative of dropping the insignificant variables and re-estimating the equations would be very cumbersome.

[15] Owing to the large number of coefficients, we do not go through the standard procedure from general to particular, whereby subsequent regression rounds leave out the variables that did not turn out to be significant at the previous stage.

we have estimated the presence of one or more individual effects in 16 cases, corresponding to 67 per cent of the total combinations.

To conduct robustness checks of our results, we also performed regressions (1) and (2) under alternative, milder assumptions. In particular, we ran separate regressions over reserve managers of both large and small portfolios.[16] These showed that those managing a large or a small portfolio behave differently, whereas they tend to display similar reactions within-group. This phenomenon may partly be explained by closer scrutiny among the next of kin, and by the different flexibility afforded by small versus large portfolios. In achieving the same risk positions and turnover, reserve managers of small portfolios clearly benefit from the fact that the absolute size of the transactions involved is also small.

Although showing different nuances and changes over time/individual effects, the robustness checks point to the same general conclusion: both aggregate regressions of type (1) and individual effect regressions of type (2) reveal that ranking has a systematic impact on risk-taking and effort, as proxied by turnover.[17]

7. Normative considerations

The previous empirical analysis raises two issues concerning the reserve management framework: the assessment horizon for portfolio choices and the structure of reputational reward.

Recognising that investment opportunities and risk premia are time-varying, and that bond returns are to some extent predictable,[18] once a year the top investment layer revises the strategic benchmark by means of a dynamic optimization process. The resulting benchmark is thus of the "active" type, since it exploits the conditional return distribution based on the available information set and has an investment horizon of twelve months.[19] The tactical layer in turn exploits any update in the conditional

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[16] The results are available from the authors upon request.

[17] In separate regressions we also estimated the effect of the risk variables and of effort on contemporaneous performance. One might argue that outperforming a (fixed-income) benchmark portfolio, dynamically reviewed every month, is no easy task (see e.g. Chen, Ferson and Peters, 2010) and as such there could not be any systematic reward to risk and effort. Outperformance would materialize occasionally as the outcome of fortunate market timing and security selection, and risk-shifting would do little harm. Indeed, we find some cases in which portfolio managers display positive and significant effects of risk exposure and effort on performance. In other instances we find negative and significant values of the regression coefficients. The latter are an unfortunate indication that higher risk is not necessarily associated with higher return, which is of course nothing new in finance. We leave a full-blown test of causality between risk decisions and performance as a subject for future research. The performance consequences of risk-shifting in the case of US mutual funds have been analysed recently by Huang, Sialm and Zhang (2011).

[18] See for example Cochrane and Piazzesi (2005).

[19] Van Binsbergen, Brandt and Koijen (2008) discuss the use of an unconditional ("passive") benchmark jointly with strategic asset allocation decisions in a decentralized investment management framework. The appropriate length of the investment horizon in foreign exchange reserve management is discussed by Johnson-Calari et al., 2007.

return distribution on a monthly basis. Third comes the actual portfolio, which adds the knowledge of day-by-day market developments. While the ECB's guidelines state that the objective of the tactical benchmark is to outperform the strategic benchmark within an investment horizon of three months, the mandate of the actual portfolios is not explicit over their assessment horizon. On the one hand, the link with the accounting results and general market practice support the present choice of the annual horizon, implicit in the reporting frequency to the Governing Council. On the other hand, it might be argued that owing to specialization motives, the horizon of the actual portfolios should be shorter than that of the tactical benchmark. By using superior short-term analysis skills and information which is not taken into account at the tactical level, a short-term orientation of the third layer of management would maximize the probability to add outperformance and make an efficient use of the risk budget (Cardon and Coche, 2004; Koivu, Monar and Nyholm, 2009). In this perspective, it could be argued that the appropriate horizon for the assessment of actual portfolios is one month. In principle the hypothesis that the portfolio horizon is three months, as for the tactical benchmark, cannot be discarded altogether. However we observe that, by analogy with the relationship between the strategic horizon (twelve months) and the tactical horizon (three months), the appropriate horizon going one step down should be shorter. To sum up, the one-month horizon would seem superior to the one year horizon on two grounds: specialization and internal consistency.

In the presence of stochastic returns, typically portfolio choice problems seek to specify an objective function for the owner of the funds, where the degree of risk tolerance plays a crucial role in finding the balance between risk and return. This also applies to our framework, in which the ECB's long-term risk/return preferences are incorporated in the strategic benchmark, while the medium-term preferences against the background of market conditions steer the tactical benchmark. Thus the two benchmarks reflect and reveal the preferences of the decision-making bodies, and tight risk limits are assigned to the portfolios.

Should risk and return then be further traded-off at the portfolio level? If the objective of each portfolio were to outperform the tactical benchmark within a one-month horizon, then risk concerns by the portfolio managers should be confined to the effect of within-month volatility of asset returns, which may induce managers to time the market and to perform security selection in the day-by-day investment process. In this conceptual framework there is no role for strategic risk-shifting based on ranking and/or performance during the year or in the previous year.

The second normative issue is related to the design of compensation. Within the current practice, which basically involves the award of reputational credit, an implicit feature of the tournament consists in the concavity of the reward to annual performance, related to capital preservation concerns. These induce a degree of risk aversion at the portfolio management level which may go against the pursuit of return. Finding the right balance between risk and return in the investment of foreign reserves is the task of the general rules of the framework, which we do not call into question. However we can point out some arguments for reviewing the award of reputation.

A standard result in the design of optimal labour contracts is that a worker's incentives to invest in effort increase with the spread between winning and losing prizes; therefore the principal would want to increase the spread to induce greater investment and generate higher output, subject to participation and cost constraints (Lazear and Rosen, 1981; Nalebuff and Stiglitz, 1983). In a delegated investment setting, Dybvig, Farnsworth and Carpenter (2010) have recently studied the portfolio manager's optimal compensation under the hypothesis that she exerts a costly effort to influence the quality of a private signal about future market prices.[20] If effort is not observable, the incentive-compatible contract gives the manager a payoff proportional to the investor's payoff plus a fraction of the excess return of the portfolio over a passive benchmark. If neither the effort nor the signal are observable, then excess return strategies would tend to make the portfolio manager overly conservative. Thus in this case the optimal contract is one that rewards the manager for trading more aggressively on the basis of "extreme" information.

The implication for our framework, where portfolio managers' private signals and effort are largely unobservable, is that the reward function should include a prize for positive performance. Furthermore, to limit excessive prudence and indexing behaviour, the shape of reward should possibly be convex. This would elicit effort towards market timing and security selection at the level of the actual portfolios.

Under the assumptions that i) the portfolio horizon should maintain a short-term orientation and ii) an incentive-compatible reputational reward should be assigned to portfolio managers, we ask the question: can the design of performance ranking help towards those two objectives? If this were the case, the framework could attain an efficiency improvement even without changing its policy principles.

In its simplest version the scoring formula is $SCORE_i = \sum_{t=1}^{T} f\left(outcome_{i,t}\right)$, that is the final score of contestant i in the tournament is computed over a suitable horizon T as the sum of a function evaluated at each round t. In the reserve management tournament the arguments are the individual's positive outcomes (portfolio outperformance) or negative outcomes (underperformance) in each round. The current formula adopts a cardinal and linear function $f(\cdot)$, which returns a value in the same measurement unit (basis points). There is only one round t coinciding with T (one year) or twelve monthly rounds (which is equivalent) with time additive scores. Letting $R_{i,t}$ and $R_{b,t}$ denote the

[20] The inclusion in the model of security returns with a spanning of market states overcomes the irrelevance result (Stoughton, 1993; Admati and Pfleiderer, 1997), according to which benchmarking does not provide the right incentives and leads to underinvestment of effort.

return on portfolio i and, respectively, on the benchmark, negative performance $\left(\min\left\lfloor R_{i,t} - R_{b,t}, 0\right\rfloor\right)$ weighs as much as positive performance $\left(\max\left\lfloor R_{i,t} - R_{b,t}, 0\right\rfloor\right)$ at each monthly round.

There are in principle several alternatives to the present system. We limit ourselves to a qualitative sketch of the "ideal" ranking mechanism, which could aim at fulfilling four objectives:

a) align the timeframe of investment decisions with the horizon preferred by the owner (*time coherence*);

b) eliminate or limit the correlation of portfolio decisions with the past (*forward orientation*);

c) reduce the tendency of interim winners to view themselves as final winners too early during the year (*effort*);

d) encourage the intermediate performers, as well as the losers, to make the best use of their risk budgets (*risk-taking*).

For simplicity we present two possible options. They would keep the monthly observation frequency and the yearly assessment horizon T as at present.

Option 1 – Each round t lasts one month. The function $f(\cdot)$ remains cardinal but it presents a convex kink, by assigning a score of 0 to underperformance (the negative outcome).

Option 2 - Each round lasts one month as before. The function $f(\cdot)$ is ordinal and mildly convex. The positive outcomes are defined as the top $N/2$ performance values, N being the number of portfolio managers (if not an integer, $N/2$ might be rounded down). The first dollar (yen) manager would obtain (the integer part of) $N/2$ points, the second would get $N/2$-1, …, down to zero for the portfolio managers with the lower N/2 performances. Alternatively, the positive outcomes might be defined as the top $N/2$ conditional on achieving outperformance.

The two options present an increasing order of reward to effort and risk-taking. The system currently in use does not seem to promote time coherence and forward orientation by the managers. By ignoring all negative performance months, Option 1 would break the intertemporal substitutability of outcomes, thus eliciting greater time coherence, effort and risk-taking. Option 2, by adopting the ordinal function, would introduce an additional incentive to risk-taking and the pursuit of a better performance. For example, the top scorer would get one more point compared with the second one, no matter how close the latter is. This option could make a contribution to all four objectives.

8. Conclusions

We have presented the main features of the investment framework for the ECB's foreign reserves and provided empirical evidence on the relationships among portfolio risk choices, managerial effort and relative performance. A peculiar tournament takes place among reserve managers, who are located at different national central banks and share a common benchmark. We have empirically found that the tournament hypothesis extensively studied in the literature on the mutual fund industry holds also in our case. Interim losers increase relative risk in the second half of the year in an attempt to catch up, while interim winners in some cases reduce risk and tend to follow more closely the benchmark to lock-in their gains. We also found that the impact of ranking may be asymmetric, depending on whether the reserve manager has achieved a positive performance against the benchmark. In a number of cases those that are outperforming the benchmark lessen the extent of risk adjustment, consistently with the managers' narrative according to which outperforming the benchmark is the primary objective for most of them, while ranking takes only second place.

Effort, as proxied by turnover, is significantly affected by ranking, particularly in the yen case and since the move to currency specialization. More generally, to the extent that the act of risk-taking involves more hard work, as suggested in the literature, our risk-shifting evidence reinforces the conclusion that reserve managers shift effort on the basis of ranking as well.

The finding that past year losers reduce risk seems an original feature of the ECB's reserve management tournament. We have discussed this evidence in relation to a reward function of reputational nature over annual performance, described by some portfolio managers as being concave.

Our results, showing for the first time evidence of strategic risk-shifting in a high-grade bond portfolio contest, offer proof of the pervasiveness of tournament incentives even in an environment which features low volatility and contained risk budgets. This may have implications also for the private sector, where bond portfolios benefit from greater risk-taking opportunities. Future research could thus further explore the tournament behaviour of bond mutual funds, in view of their importance in the global financial market.

In the ECB foreign reserves case, our exploratory analysis of the appropriate horizon for investment decisions and the structure of reward suggests that a review of the ranking system might better align the incentives offered to portfolio managers with the ECB's preferences. A new solution could increase the reputational reward for effort and performance via a convex scoring system linked to monthly, rather than annual, results.

With a view to aligning incentives and preferences, more innovative changes could be considered. These would however involve some revision of the general principles of the investment framework, which is beyond the scope of this paper.

Although the delegated setting of the ECB is unique, there are very important similarities with the practices of other monetary authorities, in terms of investment objectives, eligible asset classes, risk control principles, etc. By examining the ECB's case, we have shown in detail how one member in the community of foreign exchange reserve managers acts to fulfil its institutional duties.

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Table 1: Performance of ECB foreign reserve management

	USD	JPY	Total
1999	28	-7	24
2000	10	2	9
2001	6	0.4	5
2002	-4	9	-3
2003	6	-1	5
2004	0.2	-7	-1
2005	19	2	16
2006	11	4	10
2007	5	0.1	4
2008	41	22	37
2009	28	8	23
2010	10	8	9
Average	13.3	3.4	11.6

Returns over benchmark, basis points.

Table 2: USD dependent variables - Summary statistics

	Variable	Obs	Mean	Std. dev.	Min	Max
M1	*Duration risk*	96	0.04	0.09	0.00	0.76
	Spread risk		0.11	0.09	0.00	0.35
	Curve risk		0.30	0.22	0.04	1.43
	Turnover		2.80	1.85	0.51	8.92
M2	*Duration risk*	48	0.03	0.03	0.00	0.12
	Spread risk		0.17	0.09	0.03	0.39
	Curve risk		0.30	0.10	0.10	0.56
	Turnover		3.92	1.76	1.27	8.04
M3	*Duration risk*	96	0.06	0.06	0.00	0.34
	Spread risk		0.04	0.03	0.00	0.14
	Curve risk		0.13	0.08	0.02	0.41
	Turnover		2.89	1.83	0.36	7.91
M4	*Duration risk*	96	0.02	0.03	0.00	0.20
	Spread risk		0.04	0.03	0.00	0.15
	Curve risk		0.06	0.06	0.00	0.25
	Turnover		3.45	1.50	0.95	13.19
M5	*Duration risk*	96	0.04	0.06	0.00	0.31
	Spread risk		0.00	0.01	0.00	0.06
	Curve risk		0.06	0.10	0.00	0.53
	Turnover		2.66	1.00	0.29	4.20
M6	*Duration risk*	48	0.08	0.08	0.00	0.25
	Spread risk		0.10	0.12	0.00	0.43
	Curve risk		0.41	0.47	0.00	1.90
	Turnover		8.26	4.52	1.77	18.19
M7	*Duration risk*	96	0.03	0.03	0.00	0.16
	Spread risk		0.06	0.05	0.00	0.21
	Curve risk		0.20	0.10	0.04	0.43
	Turnover		4.82	2.39	0.40	13.36
M8	*Duration risk*	96	0.07	0.08	0.00	0.24
	Spread risk		0.21	0.26	0.00	1.28
	Curve risk		0.59	0.52	0.02	2.51
	Turnover		0.49	0.84	0.00	4.78
M9	*Duration risk*	96	0.05	0.08	0.00	0.46
	Spread risk		0.04	0.04	0.00	0.20
	Curve risk		0.16	0.13	0.01	0.69
	Turnover		5.55	2.48	1.12	11.81
M10	*Duration risk*	48	0.00	0.00	0.00	0.02
	Spread risk		0.01	0.02	0.00	0.06
	Curve risk		0.05	0.05	0.00	0.20
	Turnover		1.56	0.59	0.38	3.17
M11	*Duration risk*	96	0.05	0.06	0.00	0.27
	Spread risk		0.05	0.04	0.00	0.18
	Curve risk		0.15	0.10	0.01	0.52
	Turnover		2.71	1.13	0.39	5.21
M12	*Duration risk*	48	0.02	0.01	0.00	0.06
	Spread risk		0.04	0.03	0.00	0.15
	Curve risk		0.18	0.10	0.04	0.52
	Turnover		4.19	1.67	1.03	7.69

Duration risk , *Spread risk* and *Curve risk* are in duration contribution years. *Turnover* is a ratio over portfolio size

Table 3: JPY dependent variables - Summary statistics

	Variable	Obs	Mean	Std. dev.	Min	Max
M1	*Duration risk*	48	0.08	0.08	0.00	0.39
	Spread risk		0.00	0.00	0.00	0.01
	Curve risk		0.24	0.16	0.07	0.82
	Turnover		0.53	0.54	0.00	2.31
M2	*Duration risk*	96	0.12	0.09	0.00	0.32
	Spread risk		0.00	0.00	0.00	0.00
	Curve risk		0.41	0.20	0.05	1.02
	Turnover		0.61	0.45	0.02	3.13
M3	*Duration risk*	48	0.06	0.04	0.01	0.17
	Spread risk		0.00	0.00	0.00	0.00
	Curve risk		0.12	0.07	0.02	0.32
	Turnover		0.36	0.33	0.00	1.25
M4	*Duration risk*	48	0.04	0.03	0.00	0.13
	Spread risk		0.00	0.00	0.00	0.00
	Curve risk		0.07	0.06	0.00	0.31
	Turnover		1.45	1.96	0.04	7.57
M5	*Duration risk*	48	0.08	0.06	0.00	0.24
	Spread risk		0.00	0.00	0.00	0.00
	Curve risk		0.28	0.19	0.03	0.76
	Turnover		0.76	0.66	0.06	3.17
M6	*Duration risk*	96	0.12	0.07	0.01	0.33
	Spread risk		0.02	0.04	0.00	0.23
	Curve risk		0.51	0.36	0.11	1.60
	Turnover		1.57	1.28	0.02	7.79
M7	*Duration risk*	48	0.15	0.07	0.00	0.25
	Spread risk		0.01	0.04	0.00	0.23
	Curve risk		0.30	0.14	0.05	0.63
	Turnover		0.29	0.39	0.01	2.59
M8	*Duration risk*	48	0.11	0.08	0.00	0.28
	Spread risk		0.18	0.25	0.00	0.68
	Curve risk		0.68	0.37	0.25	1.57
	Turnover		1.51	2.30	0.00	10.84
M9	*Duration risk*	96	0.07	0.05	0.00	0.21
	Spread risk		0.02	0.04	0.00	0.17
	Curve risk		0.22	0.15	0.00	0.58
	Turnover		1.01	0.94	0.05	4.55
M10	*Duration risk*	96	0.06	0.06	0.00	0.18
	Spread risk		0.00	0.00	0.00	0.00
	Curve risk		0.17	0.16	0.00	0.64
	Turnover		0.34	0.34	0.00	2.31
M11	*Duration risk*	96	0.07	0.06	0.00	0.25
	Spread risk		0.00	0.00	0.00	0.00
	Curve risk		0.19	0.13	0.00	0.57
	Turnover		0.53	0.52	0.01	4.12
M12	*Duration risk*	96	0.11	0.08	0.00	0.27
	Spread risk		0.00	0.01	0.00	0.05
	Curve risk		0.43	0.42	0.03	1.70
	Turnover		0.49	0.44	0.00	1.65

Duration risk , *Spread risk* and *Curve risk* are in duration contribution years. *Turnover* is a ratio over portfolio size

Table 4: USD market variables - Summary statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Term spread	96	1.35	0.95	-0.15	2.70
Ted spread		0.53	0.55	0.12	3.14
Bond volatility		6.92	2.52	3.00	14.10

All variables are in percentage points.

Table 5: JPY market variables - Summary statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Term spread	96	1.05	0.24	0.49	1.64
OIS spread		0.17	0.18	0.02	0.73
Bond volatility		3.81	1.32	1.40	7.60

All variables are in percentage points.

Table 6: Duration risk - USD portfolios

	entire sample 2002-2009	uniform approach 2002-2005	currency specialization 2006-2009
Term spread $_{-1}$	-0.014 ***	-0.008	-0.019 **
	(0.004)	(0.005)	(0.008)
Ted spread $_{-1}$	-0.015 ***	0.016	-0.019 **
	(0.005)	(0.034)	(0.008)
Bond volatility $_{-1}$	0.001	0.002	0.002
	(0.002)	(0.002)	(0.003)
Rank $_{-1}$	0.000	-0.002 *	0.000
	(0.001)	(0.001)	(0.002)
H2 rank	0.006 ***	0.004 **	0.001
	(0.002)	(0.002)	(0.004)
H2 above bmk	-0.006 ***	-0.004 *	-0.001
	(0.002)	(0.002)	(0.004)
Last year rank	-0.001	0.001	-0.008 ***
	(0.001)	(0.001)	(0.002)
H2 last year	-0.006 ***	-0.004 **	-0.001
	(0.002)	(0.002)	(0.004)
H2 last above	0.005 ***	0.004 **	0.001
	(0.002)	(0.002)	(0.004)
constant	0.066 ***	0.040 **	0.105 ***
	(0.009)	(0.018)	(0.017)
obs	948	564	384
groups	12	12	8
R^2	0.050	0.028	0.109

Fixed effects estimates of equation (1) as applied to *Duration risk* . Robust standard errors in parentheses. * denotes significance at 10% level, ** at 5%, *** at 1%.

Table 7: Spread risk - USD portfolios

	entire sample 2002-2009	uniform approach 2002-2005	currency specialization 2006-2009
Term spread $_{-1}$	0.007	-0.004	0.005
	(0.006)	(0.012)	(0.006)
Ted spread $_{-1}$	-0.024 ***	-0.187 **	-0.013 **
	(0.008)	(0.081)	(0.006)
Bond volatility $_{-1}$	0.005 *	0.005	0.002
	(0.003)	(0.005)	(0.002)
Rank $_{-1}$	-0.009 ***	-0.015 ***	-0.001
	(0.002)	(0.003)	(0.002)
H2 rank	0.023 ***	0.020 ***	0.010 ***
	(0.003)	(0.005)	(0.003)
H2 above bmk	-0.020 ***	-0.014 ***	-0.008 ***
	(0.003)	(0.006)	(0.003)
Last year rank	0.003 *	0.003	-0.001
	(0.002)	(0.002)	(0.001)
H2 last year	-0.018 ***	-0.015 ***	-0.007 **
	(0.003)	(0.004)	(0.003)
H2 last above	0.016 ***	0.012 ***	0.004
	(0.003)	(0.004)	(0.003)
constant	0.062 ***	0.136 ***	0.056 ***
	(0.015)	(0.042)	(0.012)
obs	948	564	384
groups	12	12	8
R^2	0.102	0.116	0.110

Fixed effects estimates of equation (1) as applied to *Spread risk* . Robust standard errors in parentheses. * denotes significance at 10% level, ** at 5%, *** at 1%.

Table 8: Curve risk - USD portfolios

	entire sample 2002-2009	uniform approach 2002-2005	currency specialization 2006-2009
Term spread $_{-1}$	-0.028 **	-0.056 **	-0.003
	(0.014)	(0.025)	(0.017)
Ted spread $_{-1}$	-0.045 **	-0.387 **	-0.035 **
	(0.018)	(0.170)	(0.017)
Bond volatility $_{-1}$	0.016 ***	0.028 ***	0.001
	(0.006)	(0.010)	(0.006)
Rank $_{-1}$	-0.009 **	-0.015 ***	-0.009 *
	(0.004)	(0.006)	(0.005)
H2 rank	0.077 ***	0.077 ***	0.045 ***
	(0.007)	(0.010)	(0.008)
H2 above bmk	-0.069 ***	-0.069 ***	-0.038 ***
	(0.008)	(0.012)	(0.009)
Last year rank	0.003	0.001	-0.008 *
	(0.003)	(0.005)	(0.004)
H2 last year	-0.065 ***	-0.064 ***	-0.033 ***
	(0.007)	(0.009)	(0.009)
H2 last above	0.059 ***	0.059 ***	0.027 ***
	(0.007)	(0.009)	(0.009)
constant	0.169 ***	0.245 ***	0.308 ***
	(0.033)	(0.089)	(0.036)
obs	948	564	384
groups	12	12	8
R^2	0.137	0.159	0.142

Fixed effects estimates of equation (1) as applied to *Curve risk* . Robust standard errors in parentheses. * denotes significance at 10% level, ** at 5%, *** at 1%.

Table 9: Turnover - USD portfolios

	entire sample 2002-2009	uniform approach 2002-2005	currency specialization 2006-2009
Term spread $_{-1}$	-0.244 *	-0.277	-0.581 ***
	(0.126)	(0.202)	(0.199)
Ted spread $_{-1}$	-0.234	-0.065	-0.074
	(0.163)	(1.373)	(0.196)
Bond volatility $_{-1}$	-0.125 **	-0.106	-0.071
	(0.053)	(0.082)	(0.072)
Rank $_{-1}$	-0.019	-0.101 **	-0.006
	(0.037)	(0.046)	(0.057)
H2 rank	0.100	-0.028	0.105
	(0.063)	(0.082)	(0.097)
H2 above bmk	-0.157 **	-0.036	-0.125
	(0.069)	(0.094)	(0.101)
Last year rank	-0.004	-0.080 **	-0.073
	(0.030)	(0.039)	(0.052)
H2 last year	-0.156 ***	-0.087	-0.077
	(0.059)	(0.070)	(0.109)
H2 last above	0.204 ***	0.142 *	0.104
	(0.061)	(0.074)	(0.110)
constant	4.860 ***	5.902 ***	4.474 ***
	(0.295)	(0.722)	(0.416)
obs	948	564	384
groups	12	12	8
R^2	0.087	0.084	0.180

Fixed effects estimates of equation (1) as applied to *Turnover* . Robust standard errors in parentheses. * denotes significance at 10% level, ** at 5%, *** at 1%.

Table 10: Ranking effects in second semester - USD portfolios

			Duration risk		*Spread risk*		*Curve risk*		*Turnover*	
			2002-2005	2006-2009	2002-2005	2006-2009	2002-2005	2006-2009	2002-2005	2006-2009
Rank	Negative performers	$\gamma1+\gamma2$	0.002	0	0.005	0.010	0.062	0.036	-0.101	0
	Positive performers	$\gamma1+\gamma2+\gamma3$	-0.002	0	-0.009	0.002	-0.007	-0.002	-0.101	0
Last year rank	Negative performers	$\delta1+\delta2$	-0.004	-0.008	-0.015	-0.007	-0.064	-0.041	-0.080	0
	Positive performers	$\delta1+\delta2+\delta3$	0	-0.008	-0.003	0	-0.005	-0.014	0.062	0

Sum of significant coefficients from equation (1), at 10% level or better.

Table 11: Duration risk - JPY portfolios

	entire sample 2002-2009		uniform approach 2002-2005		currency specialization 2006-2009	
Term spread $_{-1}$	0.029	**	0.030	**	0.089	***
	(0.011)		(0.014)		(0.030)	
Ted spread $_{-1}$	0.050	**	-1.126	***	0.149	***
	(0.020)		(0.309)		(0.029)	
Bond volatility $_{-1}$	0.000		-0.003		0.008	**
	(0.002)		(0.002)		(0.004)	
Rank $_{-1}$	-0.004	**	-0.004	*	0.001	
	(0.002)		(0.002)		(0.003)	
H2 rank	0.002		0.007	*	-0.012	*
	(0.003)		(0.004)		(0.007)	
H2 above bmk	-0.004		-0.006		0.003	
	(0.003)		(0.004)		(0.008)	
Last year rank	0.001		0.001		-0.003	
	(0.001)		(0.001)		(0.004)	
H2 last year	-0.003		-0.006	***	0.007	
	(0.002)		(0.002)		(0.007)	
H2 last above	0.001		0.003		-0.006	
	(0.002)		(0.002)		(0.008)	
constant	0.072	***	0.134	***	-0.058	
	(0.015)		(0.018)		(0.037)	
obs	852		564		288	
groups	12		12		6	
R^2	0.037		0.057		0.199	

Fixed effects estimates of equation (1) as applied to *Duration risk* . Robust standard errors in parentheses. * denotes significance at 10% level, ** at 5%, *** at 1%.

Table 12: Spread risk - JPY portfolios

	entire sample 2002-2009		uniform approach 2002-2005		currency specialization 2006-2009	
Term spread $_{-1}$	-0.029	***	-0.025		-0.016	
	(0.010)		(0.016)		(0.011)	
Ted spread $_{-1}$	-0.030		-0.540		-0.005	
	(0.018)		(0.343)		(0.011)	
Bond volatility $_{-1}$	-0.001		-0.002		-0.001	
	(0.002)		(0.003)		(0.001)	
Rank $_{-1}$	0.009	***	0.015	***	0.000	
	(0.002)		(0.002)		(0.001)	
H2 rank	0.005	*	0.008	*	0.000	
	(0.003)		(0.004)		(0.003)	
H2 above bmk	-0.002		-0.004		-0.001	
	(0.003)		(0.005)		(0.003)	
Last year rank	0.002	*	0.003	**	0.000	
	(0.001)		(0.002)		(0.002)	
H2 last year	-0.004	*	-0.006	**	-0.001	
	(0.002)		(0.003)		(0.003)	
H2 last above	0.001		0.003		0.000	
	(0.002)		(0.003)		(0.003)	
constant	0.019		0.014		0.029	**
	(0.014)		(0.020)		(0.014)	
obs	852		564		288	
groups	12		12		6	
R^2	0.084		0.147		0.014	

Fixed effects estimates of equation (1) as applied to *Spread risk* . Robust standard errors in parentheses. * denotes significance at 10% level, ** at 5%, *** at 1%.

Table 13: Curve risk - JPY portfolios

	entire sample 2002-2009	uniform approach 2002-2005	currency specialization 2006-2009
Term spread $_{-1}$	-0.001	-0.127 ***	0.425 ***
	(0.041)	(0.045)	(0.081)
Ted spread $_{-1}$	0.132 *	-1.910 *	0.631 ***
	(0.072)	(0.996)	(0.079)
Bond volatility $_{-1}$	-0.030 ***	-0.014 *	-0.038 ***
	(0.007)	(0.008)	(0.010)
Rank $_{-1}$	0.002	0.015 **	0.012
	(0.007)	(0.007)	(0.009)
H2 rank	0.009	0.030 **	-0.040 **
	(0.011)	(0.012)	(0.020)
H2 above bmk	-0.013	-0.040 ***	0.027
	(0.012)	(0.013)	(0.023)
Last year rank	-0.004	-0.012 ***	-0.013
	(0.005)	(0.004)	(0.011)
H2 last year	0.000	-0.011	0.034 *
	(0.008)	(0.007)	(0.020)
H2 last above	-0.009	0.009	-0.031
	(0.008)	(0.008)	(0.022)
constant	0.428 ***	0.622 ***	-0.101
	(0.054)	(0.057)	(0.100)
obs	852	564	288
groups	12	12	6
R^2	0.050	0.157	0.238

Fixed effects estimates of equation (1) as applied to *Curve risk* . Robust standard errors in parentheses. * denotes significance at 10% level, ** at 5%, *** at 1%.

Table 14: Turnover - JPY portfolios

	entire sample 2002-2009	uniform approach 2002-2005	currency specialization 2006-2009
Term spread $_{-1}$	-0.690 ***	-0.297	-0.917 ***
	(0.163)	(0.243)	(0.251)
Ted spread $_{-1}$	-0.505 *	-7.614	-1.488 ***
	(0.288)	(5.353)	(0.246)
Bond volatility $_{-1}$	-0.016	-0.063	0.042
	(0.029)	(0.041)	(0.031)
Rank $_{-1}$	-0.007	-0.039	0.063 **
	(0.027)	(0.038)	(0.028)
H2 rank	0.052	0.043	-0.012
	(0.045)	(0.066)	(0.061)
H2 above bmk	-0.098 **	-0.068	-0.055
	(0.049)	(0.072)	(0.071)
Last year rank	-0.032 *	-0.016	-0.013
	(0.018)	(0.024)	(0.034)
H2 last year	-0.035	-0.028	0.007
	(0.030)	(0.039)	(0.062)
H2 last above	0.046	0.020	0.024
	(0.032)	(0.041)	(0.069)
constant	1.858 ***	1.868 ***	1.851 ***
	(0.215)	(0.308)	(0.311)
obs	852	564	288
groups	12	12	6
R^2	0.045	0.037	0.167

Fixed effects estimates of equation (1) as applied to *Turnover* . Robust standard errors in in parentheses. * denotes significance at 10% level, ** at 5%, *** at 1%.

Table 15: Ranking effects in second semester - JPY portfolios

			Duration risk		*Spread risk*		*Curve risk*		*Turnover*	
			2002-2005	2006-2009	2002-2005	2006-2009	2002-2005	2006-2009	2002-2005	2006-2009
Rank	Negative performers	$\gamma1+\gamma2$	0.003	-0.012	0.023	0	0.045	-0.040	0	0.063
	Positive performers	$\gamma1+\gamma2+\gamma3$	0.003	-0.012	0.023	0	0.005	-0.040	0	0.063
Last year rank	Negative performers	$\delta1+\delta2$	-0.006	0	-0.003	0	-0.012	0.034	0	0
	Positive performers	$\delta1+\delta2+\delta3$	-0.006	0	-0.003	0	-0.012	0.034	0	0

Sum of significant coefficients from equation (1), at 10% level or better.

Table 16: Individual ranking effects in second semester - USD portfolios

			Duration risk		*Spread risk*		*Curve risk*		*Turnover*	
			2002-2005	2006-2009	2002-2005	2006-2009	2002-2005	2006-2009	2002-2005	2006-2009
M1	*Rank*	Negative pfm				-0.004				
		Positive pfm			-0.062	-0.004				
	Last year rank	Negative pfm				-0.011		-0.033		
		Positive pfm			0.069	-0.011		-0.033		
M3	*Rank*	Negative pfm	-0.009	0.019						
		Positive pfm	-0.009	0.019						
	Last year rank	Negative pfm								
		Positive pfm								
M7	*Rank*	Negative pfm								1.740
		Positive pfm								-0.014
	Last year rank	Negative pfm							0.438	-0.657
		Positive pfm							0.438	1.194
M8	*Rank*	Negative pfm	0		0.008	0.012	0.016	0.085	-0.209	
		Positive pfm	0		0.008	0.027	0.016	0.085	-0.209	
	Last year rank	Negative pfm	-0.009		-0.027	-0.013	-0.096	-0.047	-0.141	
		Positive pfm	-0.009		0.028	-0.030	-0.096	-0.047	-0.141	
M9	*Rank*	Negative pfm								
		Positive pfm								
	Last year rank	Negative pfm		-0.016					-0.439	-0.379
		Positive pfm		-0.016					-0.439	-0.379
M11	*Rank*	Negative pfm								
		Positive pfm								
	Last year rank	Negative pfm				-0.013				
		Positive pfm				-0.013				

Selection by portfolio manager of estimates from Appendix Table 1, conditional on keeping the USD under currency specialization and showing at least one significant coefficient across risk variables and regimes, at 10% level or better.

Table 17: Individual ranking effects in second semester - JPY portfolios

			Duration risk		*Spread risk*		*Curve risk*		*Turnover*	
			2002-2005	2006-2009	2002-2005	2006-2009	2002-2005	2006-2009	2002-2005	2006-2009
M2	*Rank*	Negative pfm	-0.017					0.054		
		Positive pfm	-0.017							
	Last year rank	Negative pfm		-0.085						
		Positive pfm		-0.085						
M6	*Rank*	Negative pfm	-0.020					-0.040	-0.351	0.202
		Positive pfm	-0.020					0.357	-0.351	0.202
	Last year rank	Negative pfm	0.022						0.213	
		Positive pfm	0.022					-0.567	0.213	
M9	*Rank*	Negative pfm	-0.026						-0.823	
		Positive pfm	-0.026						-0.823	
	Last year rank	Negative pfm	-0.014			0.049				0.669
		Positive pfm	-0.014			0.049				0.669
M10	*Rank*	Negative pfm					-0.066			
		Positive pfm					0.037			
	Last year rank	Negative pfm		-0.035				-0.011		
		Positive pfm		-0.035			-0.057	-0.011		
M11	*Rank*	Negative pfm		0.033			0.057			-0.244
		Positive pfm	-0.028	0.033			-0.017			-0.244
	Last year rank	Negative pfm	-0.027				-0.053			
		Positive pfm	-0.002				0.015			
M12	*Rank*	Negative pfm	0.023	0.064			0.127			0.141
		Positive pfm	0.023	0.005			-0.098			0.141
	Last year rank	Negative pfm	0.030	-0.079			-0.251			
		Positive pfm	0.030	-0.002			-0.139			

Selection by portfolio manager of estimates from Appendix Table 2, conditional on keeping the JPY under currency specialization and showing at least one significant coefficient across risk variables and regimes, at 10% level or better.

Appendix Table 1: Individual effects - USD portfolios

		curr	*Duration risk*		*Spread risk*		*Curve risk*		*Turnover*	
		spec	2002-2005	2006-2009	2002-2005	2006-2009	2002-2005	2006-2009	2002-2005	2006-2009
Rank	M1	yes				0.026 ***				
	M2				-0.015 **				-0.287 **	
	M3	yes	-0.009 *	0.019 **						
	M4	yes								
	M5	yes								
	M6		-0.007 **		-0.031 ***		-0.058 ***		-0.671 ***	
	M7	yes								
	M8	yes	-0.015 ***		-0.049 ***	-0.009 **	-0.091 ***		-0.209 *	
	M9	yes								
	M10									
	M11	yes								
	M12									
H2 rank	M1	yes				-0.030 ***				
	M2									
	M3	yes								
	M4	yes								
	M5	yes								
	M6						0.065 ***			
	M7	yes								1.740 **
	M8	yes	0.015 ***		0.057 ***	0.022 ***	0.107 ***	0.085 ***		
	M9	yes								
	M10									
	M11	yes								
	M12									
H2 above bmk	M1	yes			-0.062 **					
	M2									
	M3	yes								
	M4	yes								
	M5	yes								
	M6								0.513 *	
	M7	yes								-1.754 *
	M8	yes				0.015 **				
	M9	yes								
	M10									
	M11	yes								
	M12									
Last year rank	M1	yes				-0.036 ***		-0.033 *		
	M2				-0.024 **				-0.292 *	
	M3	yes	0.017 ***							
	M4	yes								
	M5	yes								
	M6		-0.006 **						-0.212 **	
	M7	yes							0.438 *	1.224 ***
	M8	yes	0.006 ***		0.021 ***				-0.141 *	
	M9	yes		-0.016 **					-0.439 ***	-0.379 **
	M10									
	M11	yes								
	M12								0.284 *	
H2 last year	M1	yes				0.025 ***				
	M2									
	M3	yes								
	M4	yes								
	M5	yes								
	M6						-0.043 **			
	M7	yes								-1.882 *
	M8	yes	-0.015 ***		-0.048 ***	-0.013 ***	-0.096 ***	-0.047 ***		
	M9	yes								
	M10									
	M11	yes				-0.013 *				
	M12									
H2 last above	M1	yes			0.069 *					
	M2									
	M3	yes								
	M4	yes								
	M5	yes								
	M6									
	M7	yes								1.851 *
	M8	yes			0.055 **	-0.016 ***				
	M9	yes								
	M10									
	M11	yes								
	M12									
R^2			0.173	0.165	0.335	0.403	0.300	0.307	0.265	0.306

Fixed effects estimates of equation (2). The coefficients of the market variables and the constant are omitted for simplicity. The "curr spec" column indicates whether the portfolio manager kept a USD portfolio under currency specialization. * denotes significance at the 10% level, ** at 5%, *** at 1%.

Appendix Table 2: Individual effects - JPY portfolios

		curr spec	Duration risk 2002-2005	Duration risk 2006-2009	Spread risk 2002-2005	Spread risk 2006-2009	Curve risk 2002-2005	Curve risk 2006-2009	Turnover 2002-2005	Turnover 2006-2009
Rank	M1									
	M2	yes	-0.017 *					0.054 **		
	M3									
	M4								-0.883 ***	
	M5		0.020 ***							
	M6	yes	-0.020 ***						-0.351 ***	0.202 ***
	M7									
	M8		-0.016 ***		0.066 ***		0.060 ***		0.459 ***	
	M9	yes	-0.026 *						-0.823 ***	
	M10	yes								
	M11	yes		0.033 ***			0.057 **			-0.244 **
	M12	yes					-0.082 ***			0.141 **
H2 rank	M1						-0.152 ***			
	M2	yes								
	M3									
	M4									
	M5									
	M6	yes						-0.040 *		
	M7		0.036 ***							
	M8		0.031 ***		0.027 ***		0.087 ***			
	M9	yes								
	M10	yes					-0.066 *			
	M11	yes								
	M12	yes	0.023 *	0.064 ***			0.209 ***			
H2 above bmk	M1						0.137 **			
	M2	yes								
	M3									
	M4									
	M5									
	M6	yes						0.396 ***		
	M7									
	M8		-0.030 **		-0.087 ***		-0.234 ***		-0.496 **	
	M9	yes								
	M10	yes					0.103 ***			
	M11	yes	-0.028 *				-0.074 *			
	M12	yes		-0.060 **			-0.225 ***			
Last year rank	M1		-0.017 **				-0.043 **			
	M2	yes		-0.085 **						
	M3									
	M4						0.028 *		-0.172 **	
	M5		-0.016 ***						-0.225 **	
	M6	yes	0.022 ***						0.213 *	
	M7		0.012 ***							
	M8		0.011 ***				-0.021 **			
	M9	yes	-0.014 *			0.049 ***				0.669 ***
	M10	yes		-0.035 ***				-0.111 ***		
	M11	yes					-0.053 ***			
	M12	yes	-0.013 **				-0.135 ***			
H2 last year	M1						0.117 ***			
	M2	yes								
	M3									
	M4									
	M5									
	M6	yes								
	M7		-0.024 ***							
	M8		-0.020 ***		-0.035 ***		-0.056 ***			
	M9	yes								
	M10	yes								
	M11	yes	-0.027 *							
	M12	yes	-0.017 **	-0.079 ***			-0.117 ***			
H2 last above	M1						-0.100 ***			
	M2	yes								
	M3									
	M4								0.508 *	
	M5									
	M6	yes						-0.567 ***		
	M7		0.013 *							
	M8				0.032 ***		0.070 ***			
	M9	yes								
	M10	yes					-0.057 ***			
	M11	yes	0.025 *				0.068 *			
	M12	yes		0.077 ***			0.112 ***			
R^2			0.288	0.401	0.519	0.127	0.530	0.3755	0.360	0.282

Fixed effects estimates of equation (2). The coefficients of the market variables and the constant are omitted for simplicity. The "curr spec" column indicates whether the portfolio manager kept a JPY portfolio under currency specialization. * denotes significance at the 10% level, ** at 5%, *** at 1%.