
Operational Risk and Capital Requirements in the European Investment Fund Industry

A REPORT BY
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JANUARY 2003



This study is an independent research project commissioned by FEFSI. The study was written by Bruno Biais, Catherine Casamatta and Jean-Charles Rochet¹. The Foreword has been written by FEFSI.

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BACKGROUND

In view of the on-going discussions on the new Basel Capital Accord, and the preparation of a legislative proposal for a new capital adequacy regime in the European Union, FEFSI is pleased to publish this study on operational risk and capital requirements in the European investment fund industry².

FEFSI commissioned this study to obtain an independent analysis of the merits of capital regulation to control operational risk in investment fund management, and thereby to contribute to the future work of the Basel Committee on Banking Supervision and the European Commission.

This study was written by Bruno Biais, Catherine Casamatta and Jean-Charles Rochet. Each of these authors is professor at the University of Toulouse, and is affiliated with the Institut d'Economie Industrielle (IDEI).

The main empirical findings of the study (“the Toulouse Study”) are derived from data that were collected from 46 European fund management companies. FEFSI is grateful to all these companies for their considerable assistance in providing data to Professor Biais and his colleagues.

FEFSI’S POSITION ON THE REGULATION OF OPERATIONAL RISK

The study, in broad terms, reinforces FEFSI’s position on the regulation of operational risk. The main points of this position can be summarized as follows:

- Risks for asset management firms in general and investment fund management companies in particular are very different from those that banks and other financial institutions face.
- Regulatory requirements applicable to investment funds – notably mandatory holding of investors’ assets by a third-party supervised institution; mandatory risk spreading and management process; governance regulation; multi-level controls ranging from internal audit, compliance procedures, external depositaries/trustees to independent auditors; and the active involvement of regulators in establishing and monitoring regulations – play an important role in reducing operational risk in investment fund management.

² FEFSI (www.fefsi.org), the Fédération Européenne des Fonds et Sociétés d’Investissement, represents the interests of the European investment funds industry. Through its members, the national associations of the 15 EU Member States, the Czech Republic, Hungary, Liechtenstein, Norway, Poland and Switzerland, FEFSI represents some 900 management companies and over 41,000 investment funds with EUR 4.3 trillion of assets at end-December 2002.

- As operational losses result from inadequate or failed internal processes, people and systems or from external events³, the most direct approach to limit operational risk is to implement carefully monitored risk management systems. Maintenance of appropriate internal control systems to limit operational losses should result in lower operational risk charges.
- To the extent that the use of insurance cover as risk mitigation tool creates incentives for institutions to develop sound monitoring and management systems for operational risk, capital regulation should reduce capital requirements for those institutions contracting operational risk insurance. To meet the demands of the investment fund industry, there is a need however to develop a more effective operational risk insurance market in Europe, in particular to cover low frequency, high impact risks.
- The capital requirements to meet operational risk should not have any anti-competition effects that would distort the level playing field in the European financial market, raise barriers to entry and undermine the competitive position of EU financial institutions in the global market place.

CONCLUSION

FEFSI believes that the Toulouse Study will contribute to a better understanding of the level and nature of operational risk in investment fund management and of the merits of alternative forms of investor protection. Concerning the main conclusions of the study, the following comments may be made.

First, the study confirms the importance of the three pillars of the proposed new Basel Capital Accord, i.e. minimum capital requirements (Pillar 1), supervisory review process (Pillar 2) and market discipline (Pillar 3). It underlines in particular the beneficial prudential effects of market forces and supervisory oversight. It also confirms the view that the existing investor protection requirements enforced by the UCITS Directive play an important role in reducing the frequency and severity of operational losses in investment fund management and thereby reduce the need for capital requirements.

Secondly, the study underscores the importance of keeping track of loss data to arrive at a comprehensive assessment of the types and frequency of operational risks faced by fund management companies. In this regard, FEFSI supports the view that reporting requirements are useful to help regulators evaluate the quality of companies' internal control mechanisms and allow for a lower capital requirement for operational risk.

³In accordance with the definition proposed by the Basel Committee and the European Commission.

EXECUTIVE SUMMARY	6
I. INTRODUCTION	7
II. THE FUND MANAGEMENT INDUSTRY	14
II.1 FUND MANAGEMENT COMPANIES	14
II.2 OPERATIONAL RISK	15
II.3 A SURVEY OF EUROPEAN FUND MANAGEMENT COMPANIES	17
II.4 REGULATION AND CAPITAL REQUIREMENTS	23
III. A SIMPLE MODEL OF OPERATIONAL RISK AND CAPITAL	26
III.1 ASSUMPTIONS AND PRELIMINARY RESULTS	26
III.2 ANALYSIS	29
III.3 A SIMPLE CASE	33
IV. CONCLUSION AND POLICY IMPLICATIONS	34
REFERENCES	38
APPENDIX (PROOFS)	40

The goal of this paper is to analyse operational risk in the European investment fund industry.

We collected survey data from 46 European fund management companies. In our sample, the median ratio of total yearly operational losses to assets under management is 0.3 basis points, while the median ratio of capital to assets under management is 27 basis points.

To analyse these issues further, we rely on an agency theoretic model, whereby customers delegate the investment of their monies to fund managers, but are unable to observe the amount of effort exerted by the fund management company to reduce operational risk. The capital of the fund management company enhances its incentives to exert such effort.

While this theoretical analysis shows that capital is useful, it suggests that capital requirements are not, if investors correctly understand the incentive effects of capital. In this case the fund management companies find it in their own interest to hold adequate capital, to attract investors. Thus, market forces lead them to choose the same level of capital as would be imposed by a benevolent and competent regulator. This is in line with our empirical finding that fund management companies hold capital well above regulatory capital requirements.

Taken together, our theoretical and empirical results suggest it would not be socially efficient to impose large capital requirements. Note however that if investors fail to appreciate the link between capital and incentives, some regulatory intervention can be beneficial. While it could involve capital requirements, customers protection can and should also rely on other tools. :

- In the fund management industry depositaries play an important role as asset safe keepers and by monitoring certain obligations faced by the fund managers.
- Disclosure and transparency requirements help investors to more clearly understand and monitor the activities of the fund management companies.
- Oversight by supervisors can ensure that certain control procedures are implemented, which reduces the need for capital as incentive device.
- Finally, insurance could complement this set of tools.

⁴ Many thanks to FEFSI for financial support as well as invaluable help to collect the data. We are also grateful for very helpful conversations with Pierre Bollon, Bernard Delbecque, Steffen Matthias, Carlos Pardo, Julie Patterson, Marc Saluzzi, Rudolf Siebel, Michael Stephenson, and Patrick Zurstrassen. Our research program on fund management also benefitted from the support of Inquire Europe.

I) Introduction

Fund management is an important and growing sector of the financial industry, both in the US and in Europe. One of the economic rationales behind investment funds is that they enable diffuse, small individual investors to mutualise the fixed costs associated with the design and implementation of investment and trading strategies. To reap these benefits, however, investors must delegate the management of their monies to managers, whose actions they do not completely and permanently monitor and observe. This can give rise to agency problems.

Several theoretical and empirical studies of mutual funds in the US have highlighted the agency conflict between investors and fund managers. In particular, managers may follow excessively risky strategies to manipulate the market perception of their abilities (see e.g., Bhattacharya and Pfleiderer, 1985, Starks, 1987, Brown, Harlow and Starks, 1996, Chevalier and Ellison, 1997).

One way to mitigate this agency problem is to limit the discretion of the fund managers, by specifying in the fund prospectus the classes of assets in which they can invest and to what extent. This is effective only if the portfolio allocation decisions of the fund manager are monitored to prevent severe breaches of the investment rules of the fund. This role can be played by the fund management company monitoring the actions of the manager it employs. Breaches of fund rules are only one of the different potential sources of operational losses incurred by fund management companies.

The Basel Committee (2001) defines operational risk as “the risk of losses incurred by the company, in the course of its business, because of inadequate or failed internal processes, people and systems or from external events.” Franks and Mayer (2001) surveyed the European asset management industry. Along with breaches of fund rules, they identified misdealing, settlement problems, and errors in the computation of the net value of the assets as the major sources of operational risk⁵.

The goal of the present study is to analyse operational risk and its regulation in the fund management industry.

⁵ Operational losses due to misdealing arise when the fund management company has incurred trading losses because of errors in the placement of orders. For example a buy order could be mistaken for a sell order, or an order to buy one thousand shares could be mistaken for an order to buy one million shares. Settlement problems can arise for example if the fund management company has already paid for the securities it purchased, but the counterparty failed to deliver them.

We collected data on operational risk from 46 European fund management companies. Our sample is different from that studied by Franks and Mayer (2001), because they focused on asset management while we focus on fund management⁶. Also, Franks and Mayer (2001) obtained data from large firms mainly from the UK, while our dataset mainly comes from continental Europe and includes several rather small firms. Yet, the major sources of operational risk we identify are the same as those found by Franks and Mayer (2001).

We also find that the mean ratio of yearly operational losses to assets under management is equal to 0.96 basis points. The median is only equal to 0.3 basis points, however. This reflects the pronounced skewness of the distribution of losses, which includes a lot of small loss events, along with very few much larger losses. We also provide information on the upper tail of the distribution of losses. Regarding investors' protection, this part of the distribution is the most directly relevant: While small losses are absorbed by the gross profits and the capital of the fund management company, very large losses, exceeding this capital, could generate costs for the investors.

Against this backdrop we analyse the regulation of operational risk in the fund management industry. Regulators in the US emphasize disclosure and market discipline, but do not impose capital requirements. While they also emphasize disclosure and market discipline, European regulators impose capital requirements. The new UCITS Directive (to be enforced in 2004) states that the capital of fund management companies cannot be lower than 125,000 Euros and 25% of previous year's fixed overheads⁷. Furthermore, if its assets under management are above 250 million Euros, it must hold additional capital equal to two basis points of the level of assets under management in excess of 250 million Euros, with a maximum of ten million Euros. The new Basel accord (Basel II), is also concerned with operational risk in the context of the banking industry. This impacts the fund management industry at least through the fund management business conducted by banks. Basel II also emphasizes capital requirements. Yet, it also underscores the role of regulatory supervision, whereby regulators assess internal processes, and market discipline.

This raises a number of issues:

- What is the economic rationale for capital requirements?
- Are capital requirements an effective tool to cope with operational risk?
- If capital requirements are imposed to cope with operational risk, how should they be combined with other regulatory tools?

Equity capital along with other sources of financing such as debt or convertible debt play an important role in the funding of corporations. The seminal analysis of Modigliani and Miller (1958), proved that, when markets are perfect, financial structure is irrelevant:

⁶ Asset management refers to the case where one institutional investor (e.g. a pension fund) mandates a fund manager to invest its monies. Fund management refers to collective investment vehicles, such as UCITS or mutual funds.

⁷ See European Union, 2002.

financing needs can equivalently be satisfied with debt or capital. Since then, a large literature in corporate finance has examined optimal financing with such market imperfections as bankruptcy costs and asymmetric information⁸. This literature emphasizes the possible conflicts of interest between shareholders, debtholders and managers. Financial structure reflects the endeavour of these parties to minimize their conflicts of interest along with other costs, such as those generated in bankruptcies.

While the choice of their capital by corporations is an important issue, it is not in general regulated by the government. Rather it is left to private contracting and market forces. The situation could possibly differ in the case financial institutions, if market forces did not lead to efficient outcomes. Three potential market breakdowns have been identified by the literature⁹.

First, government protection, such as deposit insurance or anticipated bailouts, can generate incentives to take risk, to the extent that it shields financial intermediaries in the event of large losses. To mitigate this problem, financial institutions may have to pledge their own capital. This enhances their sensitivity to losses, and thus mitigates incentives to take excessive risk. This problem is not directly relevant in the context of the fund management industry, however, since no government guarantee is offered.

Second, capital requirements could also be justified when there is systemic risk, i.e., when default by one financial institution has negative external effects for the other institutions, and can endanger the stability of the financial system. This could be the case if the default of one intermediary led to question the entire financial system. This does not seem to be a major risk in the case of fund management companies; so far, contagion has not been observed in that industry.

Third, capital requirements, and more generally the regulation of financial intermediaries, could be justified by the need to protect investors, as stated in the “representation hypothesis” put forward by Dewatripont and Tirole (1994). Investors in funds are diffuse and sometimes unsophisticated. It is not optimal that each one of them pay the relatively large fixed costs necessary to collect and process all the information needed to monitor the quality and reliability of the services offered by fund management companies. Rather, these fixed costs should be paid by a single monitor, representing all the investors. Such can be the role of the regulator. This representative monitor is responsible for investors’ protection. Capital requirements could be one of the tools used in this context.

These remarks underscore that the role of capital for fund management companies is markedly different from its counterpart for standard corporations. In the latter case, capital is useful to minimize agency conflicts between shareholders, debtholders and

⁸ See e.g. Biais and Casamatta, 1999.

⁹ Franks and Mayer (2001) and Calomiris and Herring (2002) offer an interesting discussion of these justifications and their relevance for the fund management industry.

managers. In the former case, as we will show below, capital can be useful to minimize agency conflicts between the managers of the fund management company and its customers. It is important to bear in mind that these investors are not the shareholders of the fund management company. The portfolios they own are not in the balance sheet of the fund management company. In other words the assets owned by the investors are segregated from those of the fund management company, and are held by another entity, the depository. This implies in particular that, to a large extent, the investors are protected from the costs that would be generated by the bankruptcy of the fund management company. Hence, the argument put forward in the case of standard corporations, that capital can reduce the expected direct costs of bankruptcy, does not apply when it comes to the interests of investors in investment funds.

To clarify the role of capital and capital requirements for fund management companies, we construct a simple theoretical model. Customers delegate their investment policy to a fund management company. The latter offers them investment performance in exchange for management fees. In the course of its business the fund management company can incur operational losses. If these losses are lower than the capital of the company, they don't affect investors¹⁰. In contrast, if the fund management company cannot absorb the entire loss, the investors could bear part of the loss that exceeds the capital of the fund management company¹¹.

First consider the case where operational losses are exogenous random events. In this context, there is no need for regulation or capital requirements. If fund management companies maintain capital to cover operational losses, then the cost of this capital is passed on to the investors through the management fees. Hence investors don't benefit from the capital held by the fund management company.

Second, turn to the more realistic case where operational risk depends, to some extent, on the behaviour of the fund management company. The latter can rely on efficient (but costly) control agents and procedures. This enables to monitor i) the investment choices of fund managers to avoid breaches of fund rules, ii) the trading process to avoid misdealing, and iii) the credit worthiness of counterparties and intermediaries to avoid settlement problems. The fund management company can also implement efficient but costly evaluation methods, to avoid mispricing.

If the monitoring effort and control procedures implemented by the fund management company are perfectly and freely observable by the investors, then again capital and a fortiori regulation are not needed. Rationally expecting to what extent they will bear operational risk, customers allocate their monies to the management companies offering the best investment performance, net of management fees and expected operational losses.

¹⁰ In this analysis capital is understood in a broad sense as reflecting capital, *stricto sensu*, as well as the net profits of the fund management company. When these are positive they increase the capital base. In contrast, the capital available to cover operational losses is reduced when the fund management company has also incurred other losses, for example when its fixed costs exceed its (essentially variable) revenues.

¹¹ Note that asset segregation reduces the extent to which investors would bear losses in this case. Indeed, asset segregation implies that the creditors of the fund management company have no claim on customers' assets. Note however that asset segregation does not protect customers from all operational losses. For example consider capital losses due to breaches of fund rules.

In practice, however, investors have very limited information about the monitoring and control systems implemented by fund management companies. In fact, as long as the company can absorb operational losses, investors are not informed of the occurrence or magnitude of these losses. Therefore, it is more realistic to assume there is asymmetric information between investors and fund management companies. This raises a moral hazard problem, as the monitoring and control effort of the fund management company is costly but very imperfectly observable by its customers. To the extent that the largest losses exceed the capital of the fund management company, there is an agency conflict between that company and the investors. In this context, capital is useful to incentivise the fund management company: the greater its capital, the more it stands to lose in case of large operational losses, the greater its incentives to implement efficient (but costly) monitoring and control processes. As long as the capital of the fund management company is lower than the maximum possible amount of losses, the level of monitoring effort chosen by the fund management company is lower than the first best level prevailing when effort is perfectly observable.

This moral hazard situation per se is not sufficient to justify capital requirements, however. Indeed, rational investors correctly understand the incentives effects of capital, and correspondingly the link between capital and effort. Consequently, their willingness to delegate the management of their investments and to pay the management fee, increases with the capital of the management company. To put it in less technical terms, the credibility of the fund management company and its ability to attract customers is enhanced by its capital. The fund management company takes this reaction into account when choosing its capital. We show that, in this context, the profit maximising level of capital, chosen by the fund management company is the level of capital that is socially optimal¹². Thus, market forces lead the fund management company to choose the level which optimally trades off the benefits of greater incentives to monitor and the cost of capital, i.e., the level of capital that would be chosen by a benevolent regulator. Hence, while capital is useful, capital requirements are not. Consistent with the view that fund management companies understand the role of capital, and use it, even when they are not constrained to do so by regulators, we find empirically that actual capital is well above current capital requirements (the median of the ratio of actual to regulatory is 5).

Thus, taken together, our theoretical and empirical results suggest it would not be socially efficient to impose large capital requirements. Note however that if investors' computational capacities are limited, they may be unable to observe the level of capital of the fund management companies, or to analyse how it influences incentives and operational losses. In that case, in line with the "representation hypothesis" (Dewatripont and Tirole, 1994), some regulatory intervention could be called for. Yet, while it could involve capital requirements, customers protection can and should also rely on other tools.

¹² To be more precise it is the second best optimum, i.e., the level of capital that is socially optimal, subject to the informational constraint that the monitoring effort is not observable.

To some extent, the regulator can directly observe the efficiency and reliability of the control systems implemented by the fund management company. Hence, it can ensure that certain control procedures be implemented¹³. This process regulation reduces the moral hazard problem, and thus reduces the need for capital requirements. Thus, it can to some extent substitute for (and prove less costly than) capital requirements. In exchange for less demanding capital requirements, the regulator would require the fund management company to provide clear evidence of rigorous and effective control and compliance systems¹⁴. This could involve providing detailed statistics on loss events, their causes and how they were dealt with, as well as information on the control systems and protocols set up by the management company. It might be efficient in this context to offer a menu of regulatory regimes to fund management companies. Companies finding process regulation relatively less costly could opt for this form of regulation and thus face less demanding capital requirements. Other companies could opt for higher capital requirements, to avoid process regulation.

Depositaries also play an important role in the mitigation of operational risk. The UCITS directive entrusts them with mission of monitoring that funds do not breach law and investment rules. This mechanism is particularly effective as depositaries stand to lose in case of operational losses arising when they did not effectively monitor the fund manager.

In the next section, we present the institutional context of this study, by describing the workings of the fund management industry. In the following section, we present our model and theoretical analysis. The last section concludes and discusses the policy implications of our analysis. Proofs are in the Appendix.

¹³ Indeed, under the new UCITS Directive [Article 21(1)] a risk-management process is mandatory.

¹⁴ This is in line with the Advanced Measurement Approach proposed by the Basel Committee, see Basel Committee (2001).

II) The fund management industry

II.1) FUND MANAGEMENT COMPANIES

Investment funds are managed and sold by firms, called sponsors in the US or fund management companies in Europe. Each fund management company typically manages several different funds. The assets included in each fund are not on the balance sheet of the fund management company. They are directly owned by the final investors, purchasing the funds, who own shares in the funds. The gross return on these assets is used to pay fees to the fund management company. Returns net of fees accrue to investors. Consequently, they bear the investment risk – not the fund management company. This is quite different from other financial services firms, such as banks for example, which bear credit, market or transformation risk.

The investment policy of each fund is delineated in a prospectus. The SEC in the US (in application of the 1940 Investment Company Act) and the European Commission in Europe (in line with the UCITS Directive) require that investment funds disclose risk to potential investors through the prospectus. The prospectus outlines the objectives of the fund and the investment constraints placed upon the portfolio manager. It specifies, in particular, the type of assets in which the fund is supposed to invest¹⁵.

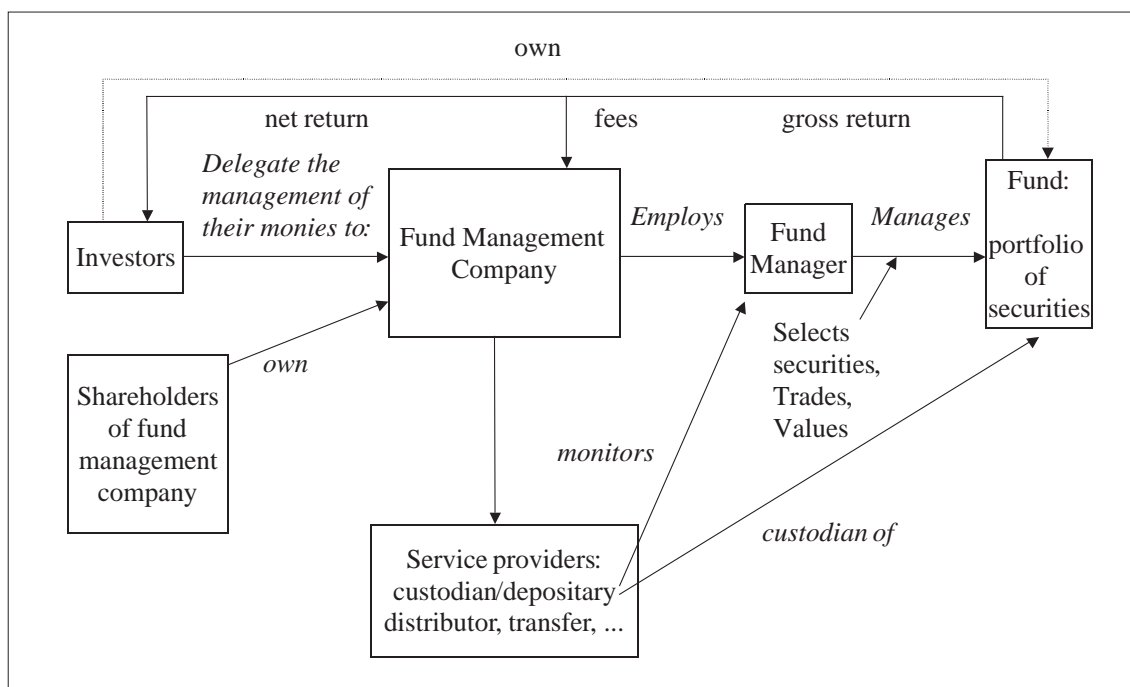
While investors in investment funds delegate the management of their savings to fund management companies, in turn, these organizations can delegate the various tasks associated with fund management to several agents. They employ fund managers, who select the assets to be included in the portfolios, oversee the trading process and the computation of the value of the fund. They contract with service providers, who distribute the funds to investors, keep the assets in custody, and complete transfer operations.

Fund management companies are not allowed to be the custodians of the securities in which their funds invest. Custody is delegated to third parties, often referred to as depositaries, who are responsible for the safekeeping of the fund's assets and the handling of payments. In Europe, according to the UCITS Directive, in addition to their role as custodians, depositaries must also perform other functions. They must, in particular, monitor that funds do not breach law and investment rules, such as those defining the class of assets in which they should invest. The duties of the depositary are defined in a convention.

¹⁵ For example a money market fund can be dedicated to investments in T Bills and Certificates of Deposit, and exclude investment in riskier assets such as long term bonds. Another example is the case of an equity fund dedicated to investments in European equities, which cannot invest in US securities.

In line with the above discussion, Figure 1 summarizes the structure of fund management companies.

Figure 1 : The Working of Investment Funds in Europe



II.2) OPERATIONAL RISK

Operational risk refers to the risk of losses incurred by the company, in the course of its business, because of inadequate or failed internal processes, people and systems. While banks, as all businesses, are exposed to operational risk, default and market movements are also major sources of risk for them. In contrast, in the fund management industry, operational risk is the most significant source of risk, while credit or market risks are either inexistent or much less significant.

Operational losses can be due to operational mistakes, difficulties or possibly carelessness. For example a buy order can be inadvertently confused with a sell order. More generally, errors can arise in the trading process. These errors are referred to as misdealing. Losses can also arise in the settlement process, for example if the counterparty fails to deliver the securities purchased by the fund. Another type of operational risk is referred to as mispricing. Normally the value of the fund must be computed and published every day. The prices of some of the assets owned by the funds may be difficult to obtain, possibly because these assets are very infrequently traded, or

there can be mistakes, e.g., confusing US and Canadian dollars, or forgetting that the share is ex-dividend, or that there has been a stock split. This raises the possibility that the price used to compute the value of the fund be out of line. Yet another type of loss can arise if the fund manager does not follow the investment policy defined in the fund's prospectus. Such deviations, referred to as breaches of investment rules, can reflect negligence or mistakes. In this case they can be of a relatively small magnitude if they are corrected rapidly. Alternatively they can lead to, exceptional, but quite large losses¹⁶.

While large losses are quite infrequent, other types of losses can arise rather frequently, but they are of relatively limited size. The occurrence of small losses, often due to inadvertent mistakes, and of very large losses due to blatantly advertent actions are not entirely independent, however. Well designed and efficiently run control systems rapidly spot or even prevent small deviations, which result in less frequent and more limited small losses, and can potentially avoid large problems. To design and maintain such efficient risk control and compliance systems is costly and time consuming, however. Hence the fund management company, as well as the depositary, face a cost benefit trade-off when deciding what policy to follow in this respect.

Operational losses are primarily covered by the profits of the fund management company, when the latter are large enough. When they exceed profits, operational losses have to be covered by the capital of the fund management company. If the latter is insufficient, then other means of financing can be resorted to, for example the capital of the mother company of the fund management company, or insurance policy. If no such financing means are available, then investors face the risk of bearing these losses.

Franks and Mayer (2001) offer an insightful study of operational risk in the asset management industry, based on a survey of 22 asset managers. To the extent that the asset management business is different from the management of investment funds their results are not directly applicable to the present study, which focuses on funds. They bear some relevance however, because of the common features between the two lines of business. They find that the most frequent sources of operational losses are 1) Breaches of investment guidelines, 2) Misdealing, 3) Settlement Problems, and 4) Mispricing. The largest operational losses arise because of breaches of investment guidelines. Table 1 shows the five largest losses observed in the Franks and Mayer (2001) survey. In all of these cases, the loss was lower than 1 bp relative to assets under management. While the largest of these five losses was greater than one third of the capital of the asset management company, in the four other cases, the loss was lower than 5% of the capital.

¹⁶ Maybe the most severe case of breach of investment rules occurred in 1994 at Morgan Grenfell Asset Management. A top fund managers concentrated investments in high-risk unlisted securities in violation the UCITS directive. Neither the internal risk control and compliance systems of Morgan Grenfell, nor the depositary of the fund spotted these deviations, which ended in very large losses (£ 180 millions).

Table 1: The five largest losses observed in the Franks and Mayer (2001) survey

		Amount (€ Mio)	% of OPEX	Basis point of AUM	% of Actual Capital
1	Misdealing	7.20	17.02	0.94	37.50
2	Breach of client guidelines	3.00	7.50	0.57	4.41
3	Failure to collect	2.60	0.14	0.11	0.16
4	Unit trust mis-pricing	0.30	0.28	0.05	0.29
5	Risk from new business	0.20	0.09	0.04	0.10

II.3) A SURVEY OF EUROPEAN FUND MANAGEMENT COMPANIES

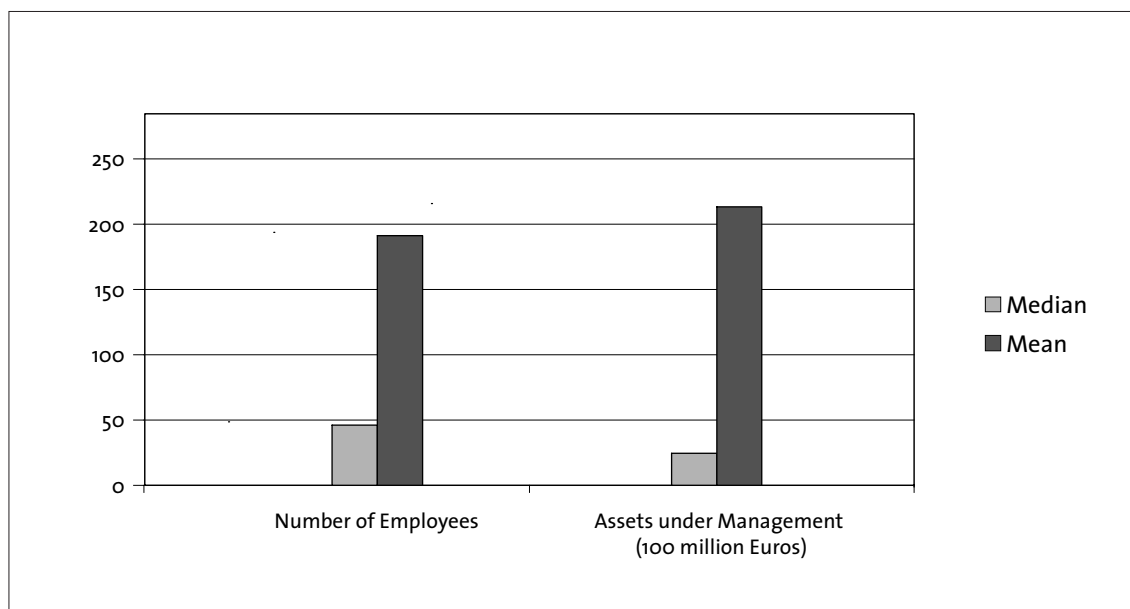
To gather additional information on the fund management industry and operational risk in Europe, we designed a questionnaire which we sent to a large number of companies. We obtained data for one year (2001), from 46 European fund management companies. The geographic structure of the sample is detailed in Table 2. The total Assets under Management of the firms in our sample amount to 900 bio Euros, which represents a little less than one quarter of total Assets under Management in Europe.

Table 2: Geographic structure of our sample

Country or region	Number of firms in our sample
Austria	3
Belgium	1
Eastern Europe (Czech republic, Poland, Hungary)	6
France	15
Germany	3
Italy	1
Luxembourg	4
Netherlands	1
Portugal	1
Scandinavia (Denmark, Norway, Sweden)	10
UK	1

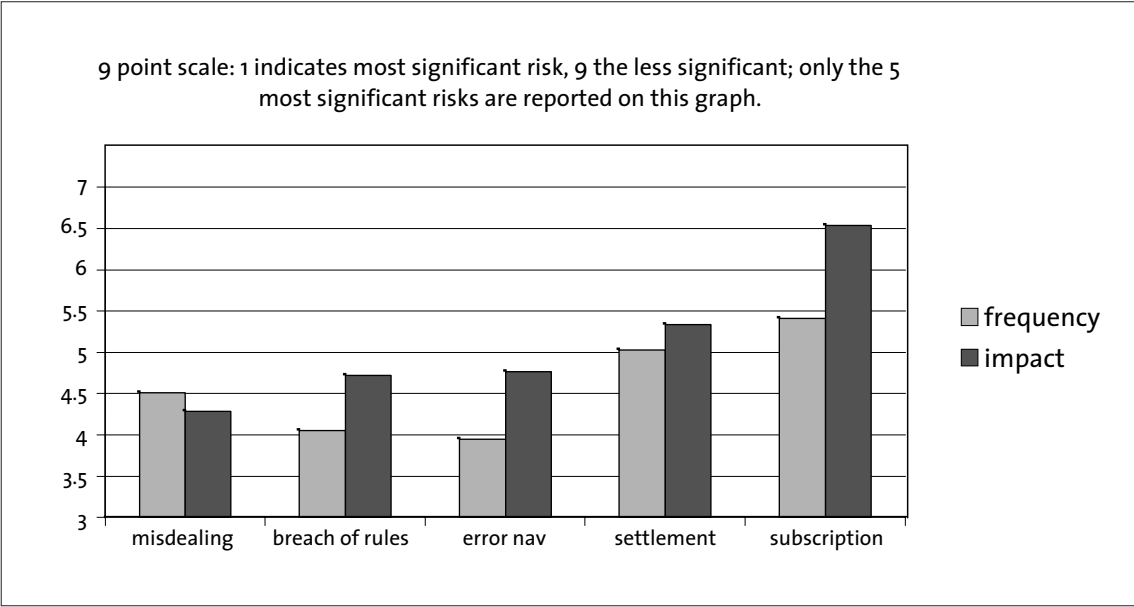
Figure 2 presents descriptive statistics on the size of the fund management companies in our sample. Means are much greater than medians, reflecting skewness in the distribution of firm size. This stems from the presence of a few very large firms and several rather small firms.

Figure 2: Descriptive statistics on the size of the firms in our sample



We asked the firms we surveyed to rank the different types of operational risk, in terms of loss frequency, and in terms of loss size (impact). Figure 3 presents the results, by reporting the average rankings for the categories of risk which emerged as the most significant. The greatest sources of risk are misdealing, breach of fund rules, pricing error and settlement problems. These results are similar to those obtained by Franks & Mayer (2001), which points at the validity of our measures. This similarity arises in spite of two differences between their sample and ours. First, while the Franks and Mayer (2001) sample was in majority composed of UK firms, ours includes mostly continental European firms. Second, while Franks and Mayer (2001) surveyed asset management companies, we focus on fund management. In line with that second difference, we identify a new source of significant risk, which did not appear in the Franks and Mayer (2001) study because it is specific to funds: subscription / redemption mistakes.

Figure 3: Ranking of the sources of operational losses by the firms in our sample

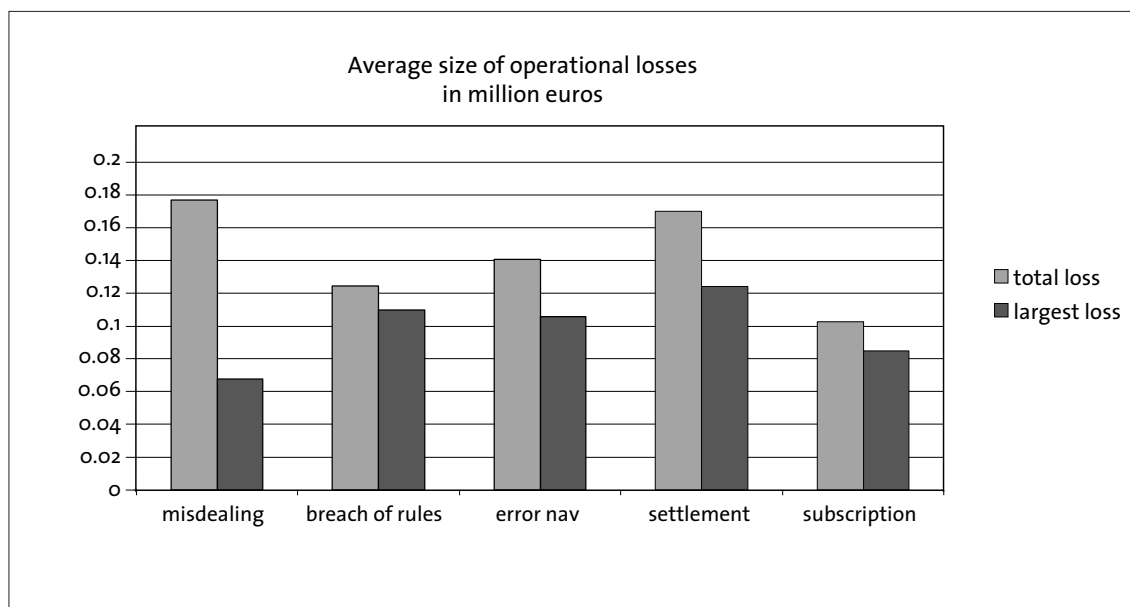


We also asked the fund management companies to provide us with information on the size of the operational losses they incurred. The mean total losses per firm over one year amounts to 0.93 million Euros, but there are very significant differences across countries and firms¹⁷. Relative to the Assets under Management in these firms, we find that the median operational loss amounts to 0.3 basis points while the mean amounts to 0.96 basis point. Again, the difference between the mean and the median reflects skewness in the data. This was to be expected for the distribution of losses, which typically includes a large number of small losses and a small number of large losses.

We also have collected data on loss amounts for the different types of operational risk. Figure 4 depicts the average loss computed across the firms in our sample. The figure depicts the cross sectional average total yearly loss, as well as the cross sectional average of the largest loss event in each firm. The ranking of losses stemming from these quantitative measures is similar to the ranking which emerged from the 9 point scale illustrated in Figure 3 (which points at the validity of our measures). Figure 4 suggests that losses due to misdealing stem from many relatively small errors, while losses due to breach of fund rules stem from fewer but rather larger losses.

¹⁷ The average loss in our sample is of the same order of magnitude as that found by Franks and Mayer (2001): 1.3 million Euros.

Figure 4: Descriptive statistics on the amount of losses for the firms in our sample and the different types of operational risk



In the questionnaire we also asked the respondents if, according to their experience, the management company, the service agent and the distribution agent would bear some responsibility in the case of operational losses. For misdealing, breach of rules and pricing errors more than 80% of the respondents answer that the fund manager bears some responsibility. For settlement problems, more than 60% of the respondents answer that the service agent bears some responsibility. For subscription and redemption mistakes more than 50 % of the respondents answer that the distributor bears some responsibility.

We also asked the respondents to tell us how operational losses would be financed. Internal profits are identified as the primary source of financing. Capital is ranked second. The role of parent firms seems much more limited. Insurance is not frequently used, especially in Eastern Europe (maybe because risk perceived to be high by insurer - consistent with high capitalization of these firms, necessary to cope with this high level of risk).

Since internal profits are generally identified as the primary source of financing for operational losses, it is interesting to compare the respective sizes of these two variables. Descriptive statistics on this comparison are offered in Figure 5¹⁸. For the firms in our sample, in one case out of four, profits were below operational losses. In those cases, it is likely that capital was used to finance losses.

¹⁸ We measure profits as the difference between gross income and fixed overheads. This is admittedly crude and could lead to double counting of operational losses if the latter had already been included by the respondent in the fixed overheads.

Figure 5: Profits - total losses (million Euros)
Profits measured as gross income - fixed overheads.

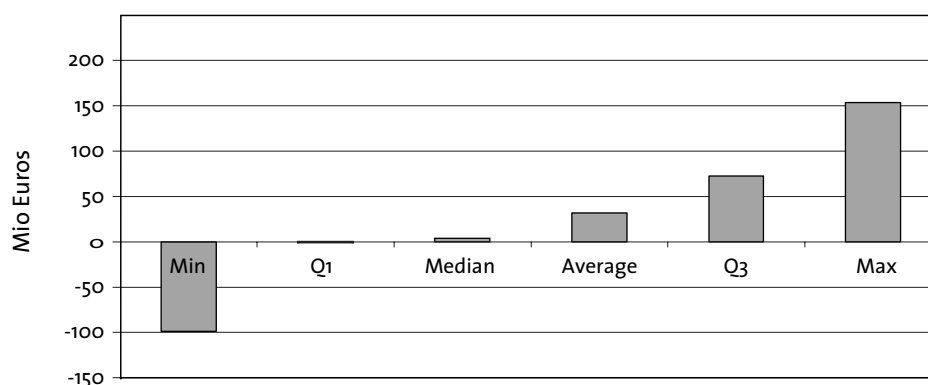
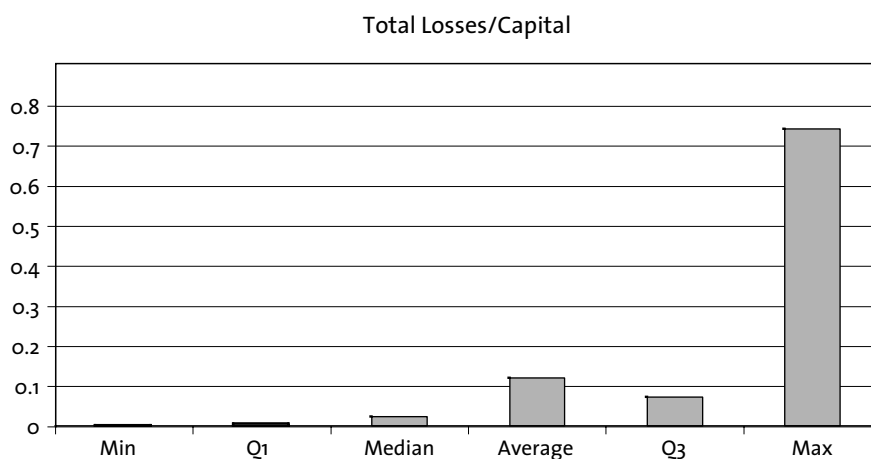


Figure 6 offers information on total losses divided by actual capital. For more than 75% of the fund management companies, operational losses are below 10% of capital. The maximum of the ratio of losses to capital is 74 %.

Figure 6: Total losses/actual capital



The upper tail of the distribution of operational losses is particularly interesting. Investors stand to incur losses due to operational risk only for the largest losses, exceeding the capital of the fund management company (note however that such losses have not been observed in our sample).

Table 3 presents the five largest loss events in our sample ranked in terms of absolute amount. They range between 0.32 and 0.95 million Euros, between 0.14 and 4 basis points of assets under management and between 0.1% and 14.2 % of capital. Comparing the figures of Table 3 to those of Table 1, we observe that the size of the largest loss events is of the same order of magnitude in our sample and in that of Franks and Mayer (2001) (although the figures in Table 1 are a little bit above those of Table 3).

Table 4 offers some information on the five largest loss events in our sample ranked in terms of fraction of assets under management. They range between 0.04 and 0.62 million Euros, between 0.3 and 9.77 basis points of assets under management and between 1.2% and 37 % of capital. By construction the loss amounts, and the corresponding fund management companies corresponding to Table 4, are smaller than those in Table 3.

**Table 3: The five largest loss events in our sample
(ranked in terms of absolute amount)**

Amount (million Euros)	Loss/AuM (basis points)	% capital
0.95	0.14	14.2 %
0.645	0.04	0.1 %
0.624	0.767	4.7 %
0.5	0.28	2.8 %
0.32	4	1.2 %

**Table 4: The five largest loss events in our sample
(ranked in terms of fraction of assets under management)**

Amount (million Euros)	Amount/AuM (in basis points)	% Capital
0.219	9.77	4.4 %
0.32	3.99	1.2 %
0.624	0.767	4.7 %
0.1	0.69	37 %
0.045	0.3	n.a.

It is also interesting to compare operational losses to profits, since the latter are used to cover the losses. Our crude measure of profits is to subtract fixed overheads from gross income. These yearly profits are compared to total yearly losses in Table 5. In 2 cases, profits were lower than losses. Consequently, some of the capital had to be used to finance the loss. In these 2 cases, losses ranged between 2.8% and 7.75% of the capital. Note also that the five companies with the largest ratio of total losses to assets under management are relatively small. This suggests that size matters for operational risk. It is likely that there are fixed costs and economies of scale in the control of this risk.

**Table 5: The five largest total yearly losses in our sample
(ranked in terms of fraction of assets under management)**

Total Loss/Capital	Amount (million Euros)	Total Loss/AuM (basis points)	Total Loss /overheads	Profits - Total loss (million Euros)
7.75 %	0.388	17.31	12.8 %	-1.42
2.8 %	0.74	9.22	12.9 %	-2.495
74 %	0.2	1.38	3 %	n.a
5 %	0.714	0.88	6 %	3.8
Na	0.11	0.71	0.6 %	4.467

II.4) REGULATION AND CAPITAL REQUIREMENTS

In the US, the SEC is in charge of regulating the fund management industry. One of its missions is to enforce the federal legislation relevant for the fund management industry, such as the Investment Company Act of 1940 for example. In Europe, several regulatory institutions coexist, at the national and the international level. For example, while British (resp. French) fund management companies are regulated by the Financial Services Authority (resp. the Commission des Opérations en Bourse), they are also regulated by the European Commission. The main regulatory texts are the European Directives. For the management of investment funds, the most directly relevant Directive is the UCITS Directive¹⁹.

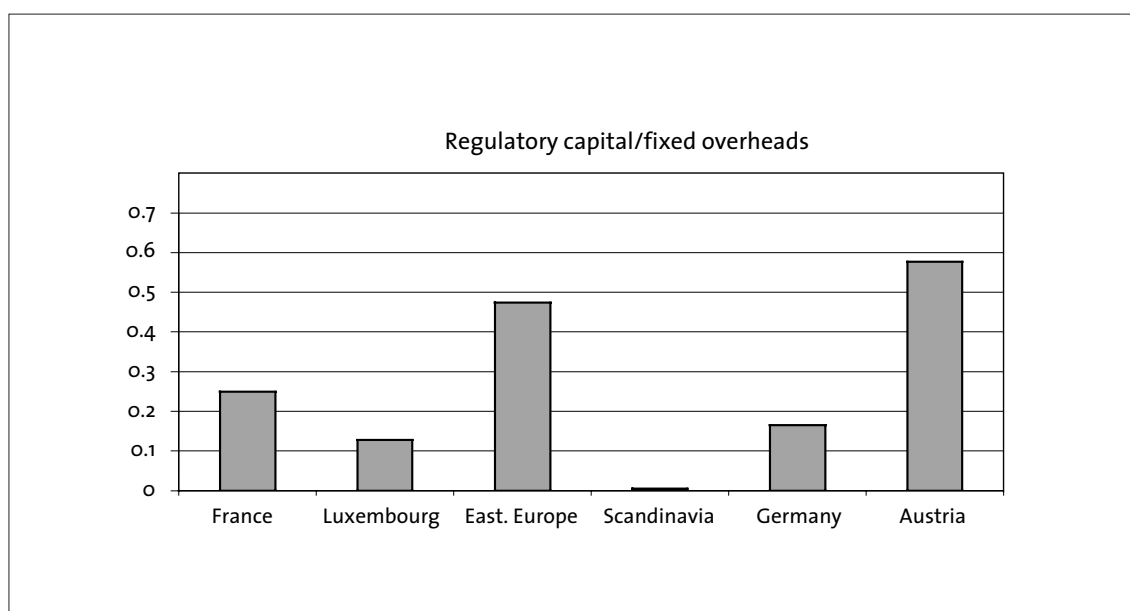
In the US, the regulation of mutual funds emphasizes disclosure and market discipline, and does not impose capital requirements. While it also relies on disclosure and market discipline, the European regulation also imposes capital requirements. For example the new UCITS Directive (to be enforced by 2004) states that the capital of fund management companies cannot be lower than i) 125000 Euros and ii) 25 % of fixed overheads. Furthermore, if its assets under management are above 250 million Euros, it

¹⁹ Our discussion of the European regulatory framework builds directly on the interesting analysis of Zurstrassen (2002).

must hold additional capital equal to two basis points of the level of assets under management in excess of 250 million Euros, with a maximum of ten million Euros²⁰. The UCITS Directive also states that member states may authorise management companies not to provide up to 50% of the additional amount of own funds referred to above if they benefit from a guarantee of the same amount given by a credit institution or an insurance undertaking. In addition the national regulatory authority impose complementary requirements, such as the obligation to hold the capital in riskless assets.

Figure 7 depicts the current average ratio of regulatory capital to fixed overheads for the different countries in our sample. The figure points at differences between the regulations currently prevailing in the different countries. The current level of required capital is greater in Austria, Germany and Eastern Europe, while Scandinavia appears much less regulated (note that the Scandinavian average excludes Denmark where there are no capital requirements). Higher levels of required capital in Eastern Europe can reflect higher perceived risks, and the need to spur investors' confidence.

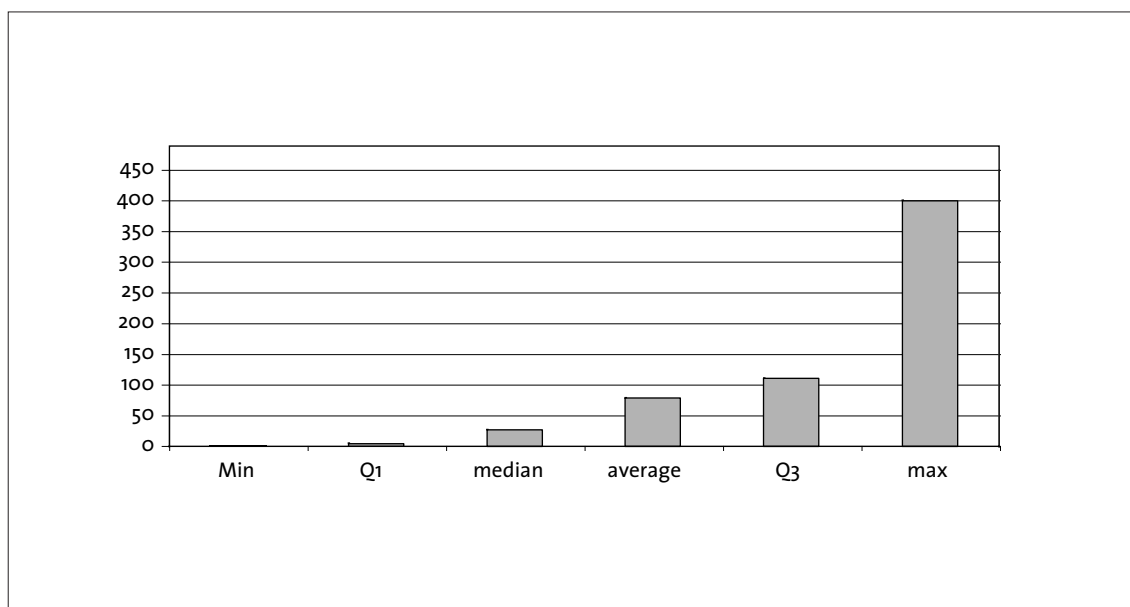
Figure 7: The ratio of regulatory capital to fixed overheads in our sample



²⁰ The UCITS Directive is strictly more demanding than the Investment Services Directive.

Figure 8 offers descriptive statistics on the ratio of actual capital to Assets under Management for the firms in our sample. For the majority of firms, the ratio of capital to Assets under Management is above 25 basis points. But there is considerable variation across countries.

Figure 8: Descriptive statistics on the ratio of actual capital to assets under management for the firms in our sample



III) A simple model of operational risk and capital

To provide a rigorous framework for our analysis, we have built a simple theoretical model of the workings of fund management companies. We have kept this model as simple as possible, and endeavoured to tailor it to the central the issues at stake in this paper: operational risk and capital requirements²¹. The goal is to shed light on the causes of operational risk, highlighting in particular incentives and agency issues, and clarifying the role of capital. Readers who would find our theoretical modelling too technical can skip the present section and directly go to its policy implications, presented in Section IV.

Like the theoretical models surveyed above, the present one is set in the context of the agency paradigm. As in the literature we base our analysis of the assumption that all agents, i.e., in our case the fund managers and the investors, are rational. For simplicity we focus on the risk neutral case. The main difference between the present model and those offered by previous literature are that: i) we explicitly model operational risk, and ii) we model capital and analyse its role.

III.1) ASSUMPTIONS AND PRELIMINARY RESULTS

Fund performance, operational risk and capital

Suppose investors have the choice between investing in the market portfolio, or in a investment fund. For simplicity, normalize the amount of their investment to one unit. If there are no operational losses, investment in the investment fund generates excess performance a , supposed positive. For simplicity but without impact on our qualitative results, we assume it is constant. Random losses can occur however. This random variable is denoted L . To avoid or reduce the magnitude of losses, the fund management company can exert effort and devote resources to control, compliance services and monitoring. Denote e the corresponding effort, and $c(e)$ its cost. The probability that losses are greater than a certain threshold s , for a given level of effort e is denoted:

$$G(s,e) = \text{Proba}(L > s | e).$$

²¹ In a companion paper (Biais, Casamatta and Rochet, 2002), we analyse the strategy of the fund managers and their control by the fund management company, focusing mainly on one type of operational risk: breaches of investment rules.

This probability is equal to one minus the cumulative distribution function of losses. We assume it is decreasing in the level of monitoring and control (e).

For a given level of capital (K), the fund management company bears operational losses up to that level. Hence, for a given operational loss L , the fund management company bears $\text{Min}(L, K)$. The corresponding expected losses for the fund management company are:

$$P(K, e) = E(\text{Min}(L, K)).$$

The expectation is taken by integrating over the possible loss realizations L between their minimum level 0 and their maximum possible level, denoted M , with respect to the density function of losses: $g(L, e)$ (the opposite of the derivative with respect to L of the probability function $G(L, e)$). This leads to our first lemma:

Lemma 1: *i) The expected losses borne by the fund management company are increasing in its capital. ii) They are decreasing in its monitoring and control effort level. iii) Furthermore, the greater the capital of the fund management company, the greater the reduction in expected losses induced by an increase in effort.*

The first part of the lemma (i) simply reflects that the level of capital sets the maximum amount the fund management company can be liable for. The second part of the lemma (ii) directly stems from the fact that effort reduces the probability of large losses. The third part of the lemma (iii) reflects that greater capital leads to greater sensitivity to losses, and thus greater benefits from the reduction in losses brought about by monitoring.

Value at risk

The probability G is the inverse of the value at risk. Consider for example the value at risk at the $\epsilon=0.5\%$ level, i.e., the threshold such that losses exceed this level only 0.5% of the cases:

$$V(\epsilon = 0.5\%, e).$$

This value at risk is written as a function of the monitoring effort of the fund management company. Better monitoring reduces the value at risk, just like it reduces the probability of large losses. Formally, the link between the probability G and the value at risk V is:

$$V(\varepsilon, e) = s \quad \Leftrightarrow \quad G(s, e) = \varepsilon.$$

To write the expected loss in terms of value at risk (V) change variables. Then:

$$P(K, e) = E(\text{Min}[V, K]),$$

where the expectation is taken by integrating between 0 and 1 over the different levels of value at risk (ε) and the value at risk at each point in the integral is evaluated as: $V(\varepsilon, e)$.

The extensive form of the game

The fund management company seeks to maximize its expected profits. The latter are equal to the fees paid by the investors (denoted F), minus the cost of capital, and the potential cost of covering operational losses. For simplicity we take the other costs (wages and other overheads) to be constant. They are denoted H . The extensive form of the game is the following:

- At time 1: The fund management company chooses its level of capital: K . For simplicity, the cost capital is assumed to be linear and is denoted: βK .
- At time 2: The fund management company offers a investment fund contract (specifying F) to the investors, and the investors accept it or not.
- At time 3: If investors have accepted the contract, the management company manages the fund, and in particular chooses the level of effort e .
- At time 4: Losses are realized. Losses smaller than K are covered by the management company. Losses greater than K are covered by the management company up to K and by the investors for the remaining amount.
- At time 5: The investors receive the realized return (α), net of the fees of the management company (F), and in the case of large losses bear the part of the loss not covered by the management company ($L-K$).

We assume that monitoring effort is not observable. This raises moral hazard issues. The investors are in the situation of the principal, delegating to the fund management company (the agent) the task of monitoring and controlling operational risk. To the extent that the fund management company does not bear the entirety of this risk, there is a conflict of interest between the principal and the agent.

III.2) ANALYSIS

We solve this game by backward induction: First we determine the level of effort optimally chosen by the fund management company at time 3, then we compute the level of fees set at time 2, finally we compute the optimal level of capital set at time 1.

Monitoring and control at time 1

At the monitoring stage, the program of the fund management company is:

$$\text{Max}_e [T - \beta K - H] - P(K, e) - c(e).$$

The first term (in brackets) is equal to the fees received by the fund management company, net of the cost of capital and the overheads. The second term is equal to the cost of covering operational losses (up to K). The last term is equal to the cost of control. After simple manipulations, we obtain our first proposition:

Proposition 1: *The level of effort of the fund management company is increasing in its capital.*

The monitoring effort is increasing in the level of capital pledged by the fund management company. Financial responsibility enhances the incentives of the fund management company to exert effort and devote costly resources to control and avoidance of operational losses. In line with Proposition 1, we denote the level of effort chosen by the fund management company as a function of its capital: $e^*(K)$.

Remember that value at risk is decreasing in effort, since the probability of large losses $G(L, e)$ is decreasing in effort and the value at risk is the inverse of this probability. Combining this with the result that effort is increasing in capital (as stated in Proposition 1), we obtain the following corollary:

Corollary 1: *The value at risk of the fund management company is decreasing in its capital.*

The corollary directly reflects the incentive effects of capital.

A first best benchmark

To provide a benchmark, consider the first best case where there is no agency conflict between the fund management company and the investors, because monitoring effort is perfectly observable and contractible. Obviously this situation is not realistic. It provides a useful benchmark, however, to which the outcome obtaining in the more realistic case can be compared.

In the first best benchmark, the socially optimal level of monitoring effort and the level of capital are chosen to maximize the sum of the expected profits of the fund management company and of the investors:

$$\alpha - [\beta K + H + c(e)] - P(M, e). \quad (2)$$

The first term is the performance increase obtained thanks to the fund manager, the second term (in brackets) is the cost of managing the investments, and the third term is the total expected operational losses.

Obviously, in that case, capital is useless, and it is optimal to set it to 0. The next corollary compares the level of effort arising in that case is compared to its counterpart when effort is not observable.

Corollary 2: *The level of effort chosen by the fund management company when there is an agency conflict with investors and its capital is $K < M$ ($e^*(K)$), is lower than the first best level of effort ($e^*(M)$).*

The corollary emphasizes that because of the agency conflict between the investors and the fund management company, there is underprovision of effort relative to the first best.

Fees set at time 2

We now return to the second best case (where there is an agency conflict between the investors and the fund management company). The maximum fee investors are willing to pay is:

$$F = \alpha - [P(M, e^*(K)) - P(K, e^*(K))] - U.$$

The first term is the investment performance the investors can expect from the fund. The second term (in brackets) is the fraction of operational losses the investors will bear. The third term, U , is the investors' reservation level, corresponding for example to what they can obtain with another fund management company. For example, if the fund

management company is in a monopoly situation, $U=0$. On the other hand if the fund management company is competitive, U is set such that the expected profit of the company is 0.

When accepting this level of fees, investors rationally anticipate the subsequent level of monitoring effort ($e^*(K)$). This gives rise to the following result:

Corollary 3: *The greater the capital of the fund management company, the greater the fees investors are willing to pay.*

The corollary states that the credibility of the fund management company, i.e., its ability to attract customers and collect fees, is increasing in its level of capital.

Capital chosen at time 1

At time 1, the program of the fund management company is the following:

$$\text{Max}_K [F - \beta K - H] - P(K, e^*(K)) - c(e^*(K)).$$

At this point, the fund management company rationally anticipates the level of the fees which will be accepted by the investors at time 2:

$$F = \alpha - [P(M, e^*(K)) - P(K, e^*(K))] - U,$$

as well as the level of monitoring effort to be exerted at time 3: $e^*(K)$. Substituting F and simplifying the program of the fund management company is:

$$\text{Max}_K \alpha - H - c(e^*(K)) - P(M, e^*(K)) - \beta K. \quad (3)$$

Note that the direct impact of capital on fees and on the expected losses borne by the fund management company cancel out. The cost of covering the losses incurred by the investors up to K , directly translates in the fee level. Capital remains in the objective for two reasons: On the one hand, obviously, increasing capital raises the cost of capital, and consequently reduces the profitability of the fund management company. On the other hand, K matters also through its impact on the incentives of the fund management company to engage in monitoring and control. Increasing the level of capital increases the level (and cost) of effort. This in turn reduces expected operational losses.

This is an important implication of our theoretical analysis, which we state as our next proposition:

Proposition 2: *If operational risk was totally exogenous, covering operational losses by the capital of the fund management company would bring no value to the investors. With moral hazard however, the capital of the fund management company matters, because it enhances the incentives of the fund management company to exert effort to reduce this risk.*

The proposition is directly in line with the Modigliani and Miller (1958) theorem, which asserts that, in absence of such imperfections as moral hazard, value is not affected by capital structure.

Further note that the reservation level of the investors: U , does not impact the solution of the maximization problem. This result is stated as our next proposition:

Proposition 3: *The effort level chosen by the management company is not affected by its competitive situation.*

Finally note the objective in equation (3) is formally similar to that in equation (2) (which corresponded to the first best). The only difference is that in (3) only capital (K) can be chosen, while in (2) the level of effort e could be chosen. In the second best problem (3), effort can be influenced only via the incentive effect of capital K , stated in Proposition 1. Thus, K is chosen to optimally trade off its benefits in terms of incentives and its cost: the cost of capital and its indirect effect on the cost of effort. More precisely, the first order condition of program (3) is:

$$[S_0^K \{-\delta G(s, e^*(K))/\delta e^*(K)\} ds] [\delta e^*(K)/\delta K] = \beta + c'(e^*(K)) [\delta e^*(K)/\delta K].$$

The left-hand side reflects the marginal benefit of an increase in capital in terms of monitoring incentives. The right-hand side reflects the cost of capital, and the cost of effort. Because capital is costly, in general this first order condition does not lead to set $K=M$. Consequently the level of effort is lower than in the first best. Note however that the objective in program (3) is the sum of the utility of the investor and that of the fund management company. Consequently, this is the objective which a benevolent regulator would maximise. This yields another important implication of our analysis, which we state in the next proposition:

Proposition 4: *In spite of agency conflicts, as long as investors are rational, the level of capital chosen by the fund management company to maximize its expected profits is equal to the second best optimal level, that would be selected by a benevolent regulator, maximising utilitarian social welfare.*

III.3) A SIMPLE CASE

To illustrate this analysis consider the simple case where the investment fund can totally avoid operational losses, with probability p , or incur some losses, with the complementary probability. When there are some operational losses, they can be minor, with probability e , or severe with the complementary probability. Minor losses are denoted ℓ , while large losses are denoted Λ . For simplicity, the control cost, $c(e)$, is assumed quadratic in the probability of small losses i.e., there is a constant c such that: $c(e) = (c/2) e^2$.

It is plausible to assume that small losses are lower than the capital of the fund management company, i.e.: $\ell < K$. We also assume that very large losses exceed this capital, i.e.: $\Lambda > K$. In the context of this simple model our fifth proposition characterizes the level of capital chosen by the fund management company.

Proposition 5: *The level of capital chosen by the fund management company is increasing in the size of the large losses, as well as in the probability of operational losses, and decreasing in the cost of monitoring and the cost of capital.*

Thus, the amount of capital held depends upon the cost of capital relative to the cost of effort in avoiding losses.

IV) Conclusion and policy implications

To study operational risk and the role of capital and capital requirements in the fund management industry, we have collected data and analysed a simple model.

In our sample, the main sources of operational risk are misdealing, breaches of fund rules and errors in the computation of net asset values. The distribution of operational losses is very skewed, with frequent small losses and infrequent large losses. Median yearly operational losses in our sample amount to 0.3 basis points of assets under management. Our empirical analysis includes a study of the largest operational losses in our sample. The largest losses exceed the profits of the companies, and the maximum of the ratio of these losses to capital is 74%.

In our simple model, customers delegate their investment policy to a fund management company, which offers them investment performance in exchange for management fees. The fund management company can incur operational losses. The capital of fund management companies can be used to cover these operational losses (at least partially). However, the expected value of this coverage is factored in the fees paid by the investors to the fund management company. The greater the cost of capital for fund management companies, the greater the corresponding increase in fees.

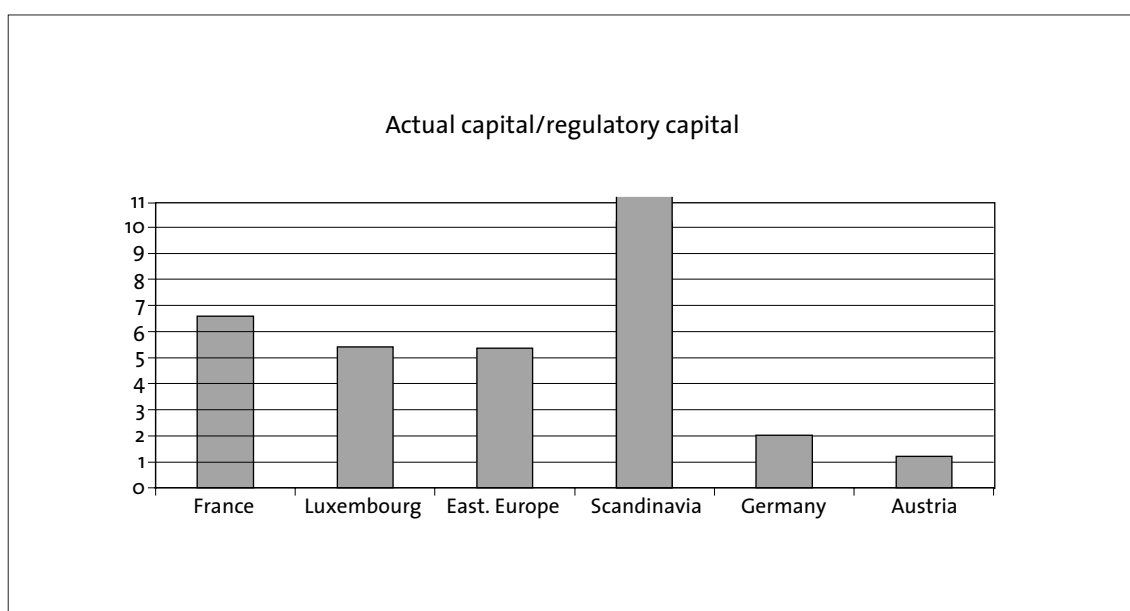
Thus, if operational losses are exogenous random events, investors don't benefit from the capital held by the fund management company. With asymmetric information, however, capital plays an indirect role in investors' protection. Investors delegate to fund management companies the monitoring and controlling of operational risk. To the extent that this activity is imperfectly observable, this creates a moral hazard problem. Capital can increase the fund management company's incentives to monitor and control operational risk. The greater the capital of the fund management company, the more it stands to lose in case of severe operational losses, the greater its incentives to avoid such losses, the more the fund management company monitors and controls operational risk. Thus, capital plays a beneficial role by aligning the incentives of the principal (the investor) and those of the agent (the fund management company²²). Correspondingly it helps reducing operational losses.

If investors correctly understand the link between capital and incentives, they are willing to entrust the fund management company with the management of their monies only if it is adequately capitalized. In that sense, capital is necessary for fund management companies to be credible. Thus, to attract customers, the fund management company finds it in its own interest to hold adequate capital.

²² Of course, in practice other factors might incentivize fund management companies to exert effort to avoid operational losses. These factors include the desire maintain one's reputation, or to keep one's job.

Figure 9 depicts the average ratio of actual capital to regulatory capital for the different countries in our sample. For most countries actual capital far exceeds required capital. For France, Luxembourg and Eastern Europe actual capital is between 5 and seven times as large as required capital²³. That actual capital is well above current capital requirements is consistent with the view that market forces lead fund management companies to hold capital, even when they are not constrained to do so by regulators.

Figure 9: Descriptive statistics on the ratio of actual capital to regulatory capital for the firms in our sample



Our analysis underscores that market imperfections such as asymmetric information and agency conflicts are not sufficient to justify regulatory intervention. In fact, in our simple model, market forces lead fund management companies to hold the (second best) optimal level of capital. Capital requirements are useless in this context.

This result does not hold, however, if investors have bounded rationality or are imperfectly informed, which prevents them from correctly appreciating the link between capital and incentives. Our theoretical analysis shows that the socially optimal level of capital is decreasing in the cost of capital of the fund management companies, and increasing in the magnitude of operational losses and the cost of monitoring and controlling operational risk. Estimating these parameters is difficult and costly. It is not optimal that each individual investor incurs this fixed cost. It is more economical that a single entity engages in costly information acquisition, for the benefit of all investors. Such can be the task of the regulator.

²³ The maximum value of the ratio (22) is attained for Scandinavia (this figure is not reported on the graph, to improve legibility for the other countries). This reflects the very low level of required capital in Scandinavia. Symmetrically, relatively low values of the ratio in Austria and Germany are related to relatively high values of required capital.

This is in line with the representation hypothesis, put forward by Dewatripont and Tirole (1997). The view that regulatory intervention can be called for because contracting by individual investors is imperfect is also consistent with the description of its mission offered by the SEC. It states that the regulation of the fund management industry in the US is based on the view that individual investors lack the necessary skill and information (Division of Investment Management, 1992, pages 272-273). Similarly, the European Union Directives regulating the fund management industry emphasize investors' protection.

While regulation could involve some capital requirements, it could and should also rely on other tools. Disclosure and transparency requirements can help investors to more clearly understand and monitor the services and activities of fund management company. For example, the UCITS Directive requires general disclosure on the internal control mechanisms in the annual report of the fund management company. Another vehicle for disclosure, emphasized by the UCITS Directive in Europe and the SEC in the US, is the fund's prospectus, which outlines the investment policy and objectives of the fund and the investment constraints placed upon the portfolio manager.

Furthermore, while capital can be useful to provide incentives when the fund management company's monitoring activities are not observable, it is less necessary when the regulator can elicit clear evidence of rigorous control and compliance systems. This is in the spirit of process regulation. Since this regulation can be expensive, as it requires labour intensive compliance departments, it could make sense to offer a menu of regulatory regimes. Companies finding process regulation relatively less costly could opt for it to benefit from less demanding capital requirements. Alternatively, fund management companies could accept higher capital requirements, to benefit from arm's length regulation.

This is in the spirit of the regulatory approach taken in Basel II, which offers three alternative regulatory regimes. The basic approach involves relatively large capital requirements. At the other extreme of the spectrum, the advanced measurement approach, allows for lower capital requirements but requires that the financial institution offer a reliable estimate of its operational risk exposure. The Basel Committee demands that this risk measure capture the impact of infrequent, but potentially severe risks events, i.e., the upper tail of the distribution of operational losses.

As mentioned above, a justification for regulatory intervention could be that the regulator would incur the fixed cost of monitoring the fund management companies, on behalf of the diffuse population of investors. An alternative way to reap these economies of scale would be to delegate the control of the fund management company to private agents, instead of a regulator. Depositaries play an important role in this respect. According to the UCITS directive, they must monitor that funds do not breach law and investment rules. This complements the monitoring role of the fund management

company, and thus contributes to reducing operational risk. The effectiveness of this mechanism is enhanced when the depositary stands to lose in case of operational losses arising when they did not effectively monitor the fund manager. In this case, the depositary may have to bear part of the operational loss. Also, the regulatory authority can impose penalties on depositaries when they have not fulfilled their task.²⁴

Also, while this is not frequent currently, insurance companies could insure fund management companies against operational risk. Correspondingly, the moral hazard risk analysed in the present paper would be transferred to the insurance company. In this context, it would be in the interest of the latter to monitor the fund management company, and check that it implements efficient risk control systems. The insurance company would have every incentive to design the optimal combination of monitoring and contracting clauses, such that the fund management company would implement effective control of operational risk. Indeed, the UCITS Directive allows member states to reduce capital requirements for fund management companies which purchased insurance. An interesting topic of further research would be to study the interaction between different institutions (insurance companies, depositaries, and fund management companies) monitoring and mitigating operational risk.

²⁴ Examples of such penalties, imposed by the Commission des Opérations en Bourse in France, are presented in Commission des Opérations en Bourse, 2001.

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PROOF OF LEMMA 1:

$P(K,e) = \int_0^M \text{Min}(s,K) g(s,e) ds = \int_0^K s g(s,e) ds + \int_K^M K g(s,e) ds = \int_0^K s g(s,e) ds + G(K,e).$
Integrating by part and simplifying,

$$P(K,e) = \int_0^K G(s,e) ds.$$

QED

PROOF OF PROPOSITION 1:

The program of the fund management company is simply to choose the level of effort, e , to minimize expected costs:

$$\text{Min}_e P(K,e) + c(e).$$

The first order condition is:

$$\delta P(K,e) / \delta e + c'(e) = 0, \quad (1)$$

where $\delta P(K,e) / \delta e$ denotes the derivative of the function $P(K,e)$ with respect to its second argument. The second order condition is:

$$\delta^2 P(K,e) / \delta e + c''(e) > 0,$$

where $\delta^2 P(K,e) / \delta e$ denotes the second derivative of the function $P(K,e)$ with respect to its second argument. Suppose the second order condition holds so that the first order condition pins the optimal level of effort, denoted e^* .

Denote $Y(e,K)$ the function to be minimised by the fund management company when choosing its optimal level of effort.

$$Y(e,K) = P(K,e) + c(e) = \int_0^K G(s,e) ds + c(e).$$

Assuming the second order condition holds, this function is convex, and the optimal level of effort chosen for the level of capital K_1 is given by the first order condition:

$$\delta P(K_1, e) / \delta e + c'(e) = 0 \Leftrightarrow \int_0^{K_1} [\delta G(s, e) / \delta e] ds + c'(e) = 0.$$

Now consider the optimal choice of effort for a larger level of capital: $K_2 > K_1$. Since Y is convex in e , the optimal level of effort chosen for capital K_2 is greater than for capital K_1 if the derivative of $Y(K_2, e)$ evaluated at the optimal level of effort for K_1 : $e^*(K_1)$ is negative. This is the case since:

$$\begin{aligned} \delta P(K_2, e^*(K_1)) / \delta e + c'(e^*(K_1)) &= \int_0^{K_2} [\delta G(s, e^*(K_1)) / \delta e] ds + c'(e^*(K_1)) \\ &= \int_0^{K_1} [\delta G(s, e^*(K_1)) / \delta e] ds + c'(e^*(K_1)) + \int_{K_1}^{K_2} [\delta G(s, e^*(K_1)) / \delta e] ds \\ &= \int_{K_1}^{K_2} [\delta G(s, e^*(K_1)) / \delta e] ds < 0. \end{aligned}$$

QED

PROOF OF COROLLARY 2:

The first order condition with respect to e is:

$$\delta P(M, e) / \delta e + c'(e) = 0,$$

and the corresponding first best level of effort is: $e^*(M)$. Note that this first order condition differs from its counterpart in (1) only because the maximum possible level of losses M is taken into account in the expected losses $P(M, e)$, rather than capital (K) . This, and Proposition 1, directly imply the corollary.

QED

PROOF OF COROLLARY 3:

$$F = \alpha - [P(M, e^*(K)) - P(K, e^*(K))] - U = \alpha - [S_0^M G(s, e^*(K)) ds - S_0^K G(s, e^*(K)) \\ - [S_K^M G(s, e^*(K)) ds] - U$$

Hence:

$$\delta F / \delta K = -G(K, e^*(K)) + S_K^M [(\delta G(s, e^*(K)) / \delta e) (\delta e^*(K) / \delta K)] ds$$

Consequently:

$$\delta F / \delta K < 0.$$

QED

PROOF OF PROPOSITION 5:

In this simple case the objective of the fund management company is:

$$\text{Max}_e [F - \beta K - H] - (1 - \pi) \{eL + (1 - e)K\} - (c/2)(e^2)$$

For simplicity, assume the rent of the investors is equal to 0:

$$\alpha - F - (1 - \pi)(1 - e)(L - K) = 0,$$

i.e., the excess return earned on the fund just covers the fees charged by the investment fund and the losses incurred by the investors in case of large operational losses.

The expected profit of the fund management company is:

$$\text{Max}_K [F - \beta K - H] - (1 - \pi) \{e \ell + (1 - e) K\} - (c/2)(e^2).$$

Substituting the values F and of e (as a function of K) and simplifying, the program of the fund management company becomes:

$$\text{Max}_K [(1 - \pi)^2/c](K - \ell) [(L - \ell) - (K - \ell)] - \beta K.$$

The first order condition yields the optimal level of capital: $K = L - \beta c / [(1 - \pi)^2]$.

QED