

A recommitment strategy for long term private equity fund investors*

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Abstract

Motivated by the illiquidity of the private equity fund market and the unknown timing of a fund's cash flows ex ante, we design a novel (re)investment strategy for fund investors. New commitments depend on current distributions, uncalled past commitments and the portfolio's investment degree. This dynamic recommitment strategy enables investors to achieve and maintain a constant exposure to private equity funds in line with their strategic asset allocation. Historical simulations show that this strategy is capable of maintaining a stable investment level that is close to the target allocation, while keeping the probability of being overinvested within reasonable bounds. This holds not only for unrestricted portfolios, but also in case investments are limited to funds of a certain type (buy-out or venture capital) and to funds with a specific regional focus (US or Europe). In addition we find that a 30% overcommitment is required to achieve the desired exposure to private equity when starting a new portfolio.

Keywords: Private Equity funds, recommitment strategy, strategic asset allocation, overcommitment

JEL Classification: G11, G23, G24

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1 Introduction

In the rapidly expanding literature on private equity,¹ the role of the private equity fund investor is the least discussed. However, several issues specific to the private equity industry make the role of the investor interesting and warrant investigation. Most importantly, private equity investments are illiquid due to the lack of a well-developed secondary market and due to restrictions on the sale of private equity fund investments, as discussed in Sahlman (1990) and Lerner and Schoar (2004). This makes private equity more suitable for investors with a long investment horizon. Furthermore, private equity investors face a number of agency problems due to information asymmetry between themselves and fund managers, requiring special attention for financing structures and contracts, see Gompers and Lerner (1996) and Lerner and Schoar (2004). Finally, both supply and demand of capital in the private equity market are characterized by pronounced cycles resulting in substantial fluctuations in investment opportunities, returns, and contract arrangements for the investor, see Gompers and Lerner (1996, 1998, 2000).

In this paper, we address another issue that concerns the investor, namely that of achieving and maintaining a desired exposure to private equity, possibly as part of a larger investment portfolio. This is of great practical relevance for institutional investors such as pension funds, insurance companies or endowments, which often aim for a specific private equity exposure as part of their long-term strategic asset allocation. Several complications arise in the investment process, which can be explained by considering the nature of the private equity market. Most investments are made through private equity funds, acting as intermediaries between the investors and entrepreneurs. Initially, the investor commits herself for a certain amount of capital to the private equity fund. These commitments are only gradually invested by the fund, often taking a couple of years before all committed capital is ‘called’ to be actually invested. Hence, in contrast to public equity markets, it is not possible to buy the desired private equity exposure instantaneously, also due to the lack of a well-developed secondary market. In addition, often not all committed capital is eventually invested, such that a higher commitment than the desired strategic allocation may be necessary to achieve the target investment exposure. This so-called

¹See Denis (2004) for a survey.

overcommitment, though, creates the possibility of liquidity problems in the event that the amount of capital that is called for investment exceeds the available capital. It may also result in a breach of investment policy guidelines if these do not allow a larger private equity allocation than the target exposure. Finally, distributions from liquidated investments often occur before all committed capital has been invested, again lowering the effective private equity allocation. In sum, attaining a certain target investment exposure to private equity and maintaining it at that level is not a straightforward task. The central question that arises from the above is: How should private equity fund commitments be made to achieve and to maintain the desired allocation to private equity for a prolonged period? The aim of this paper is to answer this question by designing an appropriate (re)commitment strategy for private equity fund investors. We do not examine the motivation to consider private equity in the strategic asset allocation, but will assume that the decision to include private equity in the portfolio has already been made.

Existing literature on (re)commitment strategies appears to be very scarce. *Cardie et al.* (2000) present a commitment rule stating that investors should commit their complete private equity allocation target every other year, or one half of the allocation each year. A possible drawback of this strategy is that it neglects past portfolio performance when making new commitments. *Nevins et al.* (2004) derive a link between the target for committed capital and the target for invested capital. The resulting commitment strategy rests on the crucial assumption that the rate of investment and the rate of distribution are the same for all private equity funds and constant over time, which is unlikely to hold in practice.

Our recommitment strategy explicitly takes into account characteristics of the private equity portfolio held at each point in time for determining the level of new commitments to be made. These characteristics include the current distributions, the uncalled capital from earlier commitments as well as the current investment degree. Committing the paid out distributions is intuitive, as liquidated investments must be reinvested to keep the allocation at the desired level. Capital that is not called within a certain period of time is recommitted in order to prevent leakage of private equity exposure. The investment degree is used as a multiplier to speed up the adjustment of the investment degree to the desired level as it measures the actual exposure to private equity relative to the sum of the available cash and private equity

investments, that is, the desired exposure.

Our results based on historical simulations using the Thomson Venture Economics database can be summarized as follows. For portfolios diversified across venture capital and buy-out capital and across the US and Europe, we find that our recommitment strategy is capable of maintaining a stable investment degree that is close to the target level, while keeping the probability of liquidity shortfall within reasonable bounds. In addition, we show that the quality of the strategy can be further improved if an investor can use the 3-year future investment degree of the current portfolio to scale up or down his new commitments (instead of the current investment degree). Alternatively, an investor that can permit herself a higher allocation could consider a 20% overcommitment in the recommitment of distributions and uncalled capital. We find that this brings the average portfolio exposure closer to the target, but at the cost of a higher risk of being overexposed. Furthermore we also find that a 30% overcommitment is required to achieve the desired exposure to private equity when starting a new portfolio. Sensitivity analysis shows that our strategy remains successful when the portfolio is restricted to a certain type of private equity capital or to a specific region. Finally, we find that the commitment strategies of Cardie *et al.* (2000) and Nevins *et al.* (2004) both fail to keep the investment degree stable for a prolonged period of time. In particular, the investment degree remains permanently above its target.

The paper proceeds as follows. Section 2 discusses the role of the investor in the private equity market and provides a concise overview of the literature on this topic. Section 3 describes the Thomson Venture Economics data. Section 4 develops the novel recommitment strategies. Section 5 presents the empirical results, while Section 6 concludes.

2 The investor's role in the private equity market

Private equity fund investors include among others pension funds, endowments, insurance companies and banks, although their relative importance varies considerably across countries as pointed out by Mayer *et al.* (2005). These different types of investors are also reported to have different (re)investment styles. For example, Lerner *et al.* (2007) show that corporate pension funds and endowments less likely invest

again in an existing partnership. Moreover they seem to be better at forecasting the performance of follow-on private equity funds.

The supply of private equity capital varies considerably over time. Regulatory factors, in particular capital gains tax rates (Poterba, 1989; Gompers and Lerner, 1998),² state policies such as ERISA in the US (Gompers and Lerner, 1998), and harmonization like the International Financial Reporting Standards (Cumming and Johan, 2005) lead to substantial fluctuations in commitments to private equity. Other factors that are considered to be drivers of capital supply include IPOs, private pension fund levels and labor market rigidities (Jeng and Wells, 2000). Given the illiquidity of investments and the information lag about the state of the market, the supply (and demand) of private equity capital is reported to be sticky in the short run by Gompers and Lerner (2003). This stickiness can result in overshoot of the available capital, which leads to ‘money chasing deals’ as discussed by Gompers and Lerner (2000) and Ljungqvist and Richardson (2003b).

The vast majority of private equity investments takes place through ‘funds’, which usually are structured as limited partnerships. These funds typically have a finite life ranging from 10 to 14 years. The main reason for the existence of such funds is that investing, managing and divesting private equity investments requires a high-level of expertise and experience. In private equity funds, investors bring in capital and serve as limited partners, while the fund’s management brings in expertise and serves as general partner. The general partner’s expertise is recognized by the investor as Cumming *et al.* (2005) show that significantly more capital is allocated to private equity funds that provide financial and strategic advise and management expertise to their investee companies. The main drivers of the success of general partners are the quality of their network (Hochberg *et al.* 2007), specialization (Gompers *et al.* 2006) and experience (Sørensen, 2006). The limited partners have a liability equal to the amount of their commitment and have little or no control of the partnership. The general partner has unlimited liability and takes an active role in the partnership. To mitigate potential issues arising from this lack of control of the investors, private equity funds are governed by a large number of terms and conditions. These (legally) binding rules relate for example to the general partner’s

²Although Gompers and Lerner (1998) also document that the effect of changes in capital gains tax rates mostly appears to occur through the demand for capital.

responsibilities and the economics of a fund such as management fee and the profit sharing (carried interest).³ Gompers and Lerner (1996) give two explanations for the presence of these impressive contractual covenants in the fund agreements: agency problems and the supply and demand conditions in the market. They also show that the costs for the investor (including management fee as well as the carried interest) may shift if there is an unbalance in the capital demand and supply. Lerner and Schoar (2004) show that restrictions on the transfer of fund-ownership are used by young funds and funds with an investment focus in industries with longer investment cycles to attract deep-pockets' investors, that is investors who have a low probability of facing a liquidity shock. This will make fundraising for a follow-on fund easier as these investors have an increased probability to re-participate, which will be a good signal to new potential investors. Although the set-up of the market structure looks more complex than public equity, Axelson *et al.* (2007) show that the financial structure of private equity funds is optimal for three characteristics of the industry: (1) pooling of investments, (2) nonlinear profit sharing with the fund manager to limit governance problems and (3) a financial structure that combines ex-post fundraising and specific deal financing.

We close this section by pointing out that much attention has also been given to the risk and return characteristics of private equity investments. These have been studied (i) at the firm level (Gompers and Lerner, 1998; Cochrane, 2005), (ii) at the fund level (Ljungqvist and Richardson, 2003a; Phalippou and Zollo, 2005; Kaplan and Schoar, 2005) and (iii) at the index level (Moskowitz and Vissing-Jorgenson, 2002; Chen *et al.* 2002; Woodward and Hall, 2003). An important issue here concerns the private equity risk premium, in particular its comparison with the public equity premium. The consensus view seems to be that private equity investments should offer a higher return than public equity, for example due to their illiquid-

³The relationship between private equity fund investors and fund managers has been analyzed from different perspectives, but we should note that the relationship between private equity funds and investee companies has been analyzed much more extensively. This concerns in particular the role of the fund manager as a strategic partner for the investee companies, see Gompers (1995), Hellman and Puri (2002), Kannianen and Keuschnigg (2003) and Cumming *et al.* (2005), among others. The moral hazard and other agency problems in this relationship, which can be controlled by means of financing constructions (e.g. staged financing or management stock options) and financial contracts, see Gompers (1995), Wright and Robbie (1998), Schmidt (2003), Kaplan and Strömberg (2003, 2004), Hsu (2004), Ueda (2004), Wang and Zhou (2004) and Cumming (2005) have also been examined.

ity. However, conclusions from empirical research are mixed. Rather poor returns are reported by Moskowitz and Vissing-Jorgenson (2002) and Phalippou and Zollo (2005b). Kaplan and Schoar (2005) report comparable average returns for private equity and the S&P 500 index, while Ljungqvist and Richardson (2003a) claim that private equity investments outperform the aggregate public equity market by 6-8% per annum, see also Cochrane (2005). More recent studies focus on (explanations for) cross-sectional return differences between private equity funds (Cumming and Walz, 2004; Kaplan and Schoar, 2005) and the drivers of returns (Phalippou and Zollo, 2005). Finally, and of interest for the current paper, risk and return of private equity have been examined from the point of view of strategic asset allocation. Private equity is generally believed to offer attractive diversification opportunities due to low correlations with other asset classes such as public equity and bonds. Chen *et al.* (2002), for example, suggest that a 2-9% target allocation for private equity reduces portfolio risk substantially.⁴

3 Data

We use individual private equity fund data obtained from Thomson Venture Economics (TVE).⁵ Our data set is comparable with Jones and Rhodes-Kropf (2003), Kaplan and Schoar (2005) and Phalippou and Zollo (2005), to which we refer for more information about the way TVE collects the data and potential biases in the database.

The TVE database contains information on 2,786 private equity funds over the period 1980Q1-2005Q4, and includes quarterly contributions, distributions and the fund's net asset value (NAV). Reported cash flows are in US dollars and are net of (management) fees as well as carried interest. We make several corrections and adjustments to the data, detailed in the data appendix, after which there are 2,618 funds left for analysis. Several fund characteristics also are available, including the regional focus (US/Europe), the type of investment (venture capital (VC), buy-out

⁴Note that actually the performance and diversification opportunities of private equity make little difference for our analysis, as we assume that our investor has already decided upon which part of her portfolio to invest in private equity. Instead we focus on the strategy that she can use to achieve and maintain this exposure.

⁵Obtained in the period until Q2 2006

capital (BO), mezzanine finance and fund-of-funds), and the vintage year. The distribution of funds over the different investment types and regions is shown in Table 1. Close to two-thirds of all funds are venture capital funds, while about 60 percent are US-oriented funds. The number of funds per vintage year is shown in the second column of Table 2 with peaks occurring at the end of the 1980s and 1990s, demonstrating the pronounced cycles in the demand for private equity capital.

- insert Table 1 about here -

As investment opportunities arise, part of the committed capital will be called by the fund manager and invested in investee companies. All cash flows from the investor to the fund are indicated as ‘contributions’ and include investment costs but also fees. Private equity funds typically unwind their investments by distributing the proceeds of sold participations to the investors or ‘limited partners’. The capital that flows from the private equity fund to the limited partners is referred to as ‘distributions’. Figure 1 shows the average cash flows (contributions and distributions) over the lifetime of the funds in our data set. We scale these cash flows by the total commitment to the fund to make the individual fund statistics comparable and independent of the fund size.⁶ From this figure we observe that the pace at which capital is called gradually decelerates. In the first year after the start of a fund on average 32% of the commitments is called, followed by 19, 15, 10, 7 and 5% capital calls in the next five years. After approximately six years cumulative contributions level off. Note that on average only about 90% of total commitments is eventually called by the private equity fund. The average cumulative distributions show a typical S-shape. Starting after two years, distributions are made at an accelerating pace up to seven or eight years, followed by a steady decline until eventually cumulative distributions level off at around 1.5 times the total commitments after 12 years.

- insert Figure 1 about here -

Figure 1 also shows the average NAV over the fund’s lifetime, again expressed as a fraction of total commitments. The NAV of a private equity fund is defined

⁶The size of a private equity fund is defined as the sum of all the investors’ commitments to the fund.

as the sum of the NAVs of the individual investee companies. These NAVs are based on the fund manager's subjective valuation, as private equity investments are not evaluated by the market and the fund manager is not subject to standardized reporting guidelines.⁷ Generally, a manager keeps the NAV at investment cost during the first years of an investment. After a while valuations are updated with additional information from comparable listed companies or from a new financing round. Due to the pattern of contributions and distributions, NAV builds up quickly during the first few years of the fund's lifetime, reaches its maximum between four and six years, and then gradually drops off again over the remaining years. It appears that the average NAV does not decrease completely to zero even after 15 years. This occurs because some funds keep a residual value, although not showing any signs of activity (the lifetime of a typical private equity fund ranges between 10-14 years). Phalippou and Zollo (2005) show that this effect substantially lowers the average private equity returns. Following Ljungqvist and Richardson (2003b), who suggest that these residual values are unreliable, we set the NAV equal to zero after 12 years if there are no signs of activity at that point or after the last activity if this takes place in year 13 or later. The effect of this write-off rule is observable in the NAV at the end of year 12 in Figure 1.⁸

4 Commitment strategies

4.1 (Over)Commitment strategies

The average fund's cash flow characteristics discussed in the previous section suggest that attaining a desired level of investment exposure to private equity and maintaining it for a prolonged period is not a straightforward task. Commitments are only gradually called to be invested and distributions occur before all committed capital has been invested, while in practice of course the timing of these cash flows is typically unknown ex ante. The impact of these dynamics on private equity investment

⁷Though, valuing companies in accordance with certain guidelines is increasing. An example are the International Private Equity and Venture Capital Guidelines developed by the European (EVCA), French (AFIC) and British (BVCA) venture capital associations.

⁸As we focus on cash-flows and not on returns this adjustment has little impact on our analysis. Results including the residual NAV values, which are available upon request, are qualitatively similar.

exposure are shown in Figure 2. This figure shows the weights of the cash from the initial commitment, the cash from the distributions, and the net asset value (NAV) of the actual private equity investments over a fund's lifetime as percentage of the total capital involved. The central statistic in this paper is the investment degree, which is defined as the ratio of the fund's NAV to the sum of the NAV and cash, where cash is the sum of uncalled commitments and cumulative distributions. From Figure 2 we observe that the average maximum investment degree for all the funds in our data-set is reached between three and four years, and is slightly below 0.6. This means that at maximum 60% of total capital will actually be invested in private equity and that we hold at least 40% cash. The fact that the maximum investment degree is well below one suggests that achieving a certain level of private equity investments requires an overcommitment strategy, where more commitments are made than the amount of the initially available capital.

- insert Figure 2 about here -

There is considerable variation in the timing and height of the maximum investment degree across the different vintage years, reflecting the fluctuations in private equity investment opportunities documented by Gompers and Lerner (1998). As the vast majority of funds has a limited lifetime new funds are introduced each year. Table 2 displays the number of funds, the mean and standard deviation of the maximum investment degree and its timing (in quarters) for the vintage years in our sample. The results for vintage years 2001–2005 have to be treated with caution, because the average investment degree of these funds is still increasing. As a result both the magnitude and timing of its maximum cannot be determined with certainty yet.

- insert Table 2 about here -

First of all, the number of funds per vintage year illustrates the growth in private equity: from 22 funds that started in 1980 to 301 in 2000. The cyclical pattern in demand for private equity capital can also be observed in Table 2, with peaks in the number of funds occurring at the end of the 1980s and 1990s. Note in particular the steep decline in the number of new funds in the data set after the collapse of the internet bubble in 2001, to just 21 in 2005. Second, we observe that the average

maximum investment degree exhibits a downward trend over time. At the beginning of the 1980s it amounted to about 80%, while funds at the end of the 1990s only achieved a maximum investment degree of around 60%. Furthermore, the time it takes to reach the maximum investment degree varies substantially, between 11 and 20 quarters, where it seems that it takes more time in economic downturns as in 1990–1991 and 2000–2001.

The cyclical nature of the cash flows is further illustrated in the last two columns of Table 2. These columns show the cumulative contributions and distributions after 16 quarters. The sharp contrast between the maximum investment ratios in the 1980s and 1990s is less pronounced in the contributions. During the 1980s on average 83% of the commitments is called after 4 years while this is 74% for the 1990s. The differences in distributions across vintage years are much larger, ranging from a low of 3% for funds that started in 1983 to a high of 95% for funds dating from 1996. Averaging across decades, we find that the total distributions in the 1980s are three times lower (12%) than in the 1990s (36%). Hence, the lower maximum investment ratios during the 1990s do not arise because less commitments are actually invested, but are due to the fact that distributions take place earlier. In sum, Table 2 demonstrates that, although overcommitment seems necessary to achieve full exposure, fluctuations in the rate of distributions lead to considerable variation in timing and size of the maximum investment degrees across vintage years, such that applying a constant overcommitment percentage seems unsuitable.

4.2 Recommitment strategies

Our hypothetical investor aims to achieve and maintain a certain target allocation to private equity. Although in practice this may be part of a larger investment portfolio, here we simplify the problem by focusing on the private equity part only. Thus the investor constructs a 100% private equity portfolio. The main objective is to keep the investment degree as close as possible to one, where the investment degree (ID_t) is defined as

$$ID_t = \frac{NAV_t}{NAV_t + \text{cash}_t}, \quad (1)$$

where NAV_t is the sum of the NAVs of the private equity investments held at the end of quarter t , and cash_t is the amount of cash or uninvested capital, computed

as cash_{t-1} minus the sum of all contributions made in quarter t plus the sum of all distributions received during quarter t . Hence, the objective of keeping the investment degree as close as possible to one can be rephrased as keeping the amount of cash as close as possible to zero. An important consideration is that at the same time liquidity shortfall should be avoided as much as possible. Liquidity shortfall occurs at the moment required investments exceed the amount of available capital such that cash becomes negative and the investment degree larger than one. This could lead to liquidity problems if the investor does not have enough cash or credit lines available to fulfill the capital call or lead to a breach of the investment guidelines if a higher private equity allocation is not allowed in a more diversified portfolio setting.

The investment problem as described above is difficult, if not impossible to solve analytically. Hence, our investor considers three heuristic recommitment strategies. Strategy I simply states that distributions received during quarter t are (re)committed to new private equity funds at the same time. The advantage of this strategy is that the possibility of liquidity shortfall is avoided altogether. However, given that committed capital will be called only gradually over a number of years after the initial commitment, the effective investment degree may be expected to fall below one. In addition, this strategy implicitly assumes that all committed capital will eventually be called. However, as seen in Section 3, this is not the case as on average private equity funds call only 90% of committed capital. This results in ‘leakage’, that is uncalled commitments remaining within the portfolio as cash and accumulating over time. For this reason strategy II extends strategy I by setting commitments at the end of quarter t equal to the sum of the current distributions and uncalled capital from the commitments made P quarters ago, at $t - P$. A possible drawback of strategy II is that the adjustment of the investment degree to the target level of one is rather slow. Hence, strategy III sets the new commitments at time t equal to the current distributions and uncalled commitments as in strategy II, but now multiplied with the reciprocal of the investment degree of the current private equity portfolio at time t . This multiplier will accelerate the adjustment of the investment ratio to one. In sum, in strategy III the new commitments at time t are determined

by:

$$C_t = \frac{1}{ID_t} (D_t + UC_{t-P}), \quad (2)$$

where C_t is the amount of new commitments at time t , ID_t is the investment degree of the current private equity portfolio at time t , D_t are the distributions at time t , and UC_{t-P} is the amount of uncalled capital at time t of commitments made P quarters ago.

An important choice to be made in strategies II and III obviously is the ‘lag-time’ P . In the empirical analysis below we set $P = 24$ quarters, based on the observation that for the average private equity fund, the cumulative contributions level off after approximately six years as shown in Figure 1, also see Ljungqvist and Richardson (2003b). Finally, we remark that an alternative way to counter the effects of leakage may be applying overcommitment at the recommitment stage. This is analysed in more detail in Section 5.2.

4.3 Implementation

We evaluate the performance of the three recommitment strategies by means of historical simulation using the TVE database. Several implementation issues are worth mentioning. First, we impose no restrictions on the portfolio of private equity funds concerning the type of funds (venture capital or buy-out capital), the investment region (US or Europe), the maximum number of funds invested in or the maximum portfolio weights. The only restriction is that the commitments must be sufficiently diversified. The performance of the reinvestment strategies when limited to a certain type of funds or to a specific region is analysed in Section 5.4 below.

Second, implementing the recommitment strategies requires an already existing private equity fund-of-funds portfolio. In practice, the composition of this portfolio and accompanying characteristics are given. Here we construct the initial portfolio over a one year period by making equal commitments to 16 randomly selected private equity funds with the same vintage year (4 new commitments per quarter).⁹ This is

⁹Normally an investor would spread his initial commitments over 2 – 3 years to benefit from vintage year diversification, while a limited number of investors tries to buy an existing portfolio in the secondary market. The secondary market is no open market and not very deep because many fund put restrictions on the transfer of fund-ownership (Lerner and Schoar, 2004). In order to examine the relevance of this issue, we also conduct the empirical analysis discussed in the next section with initial portfolios built up in two or three years. Doing so, the investment degrees differ

in line with Weidig and Mathonet (2004), who report that a diversified private equity portfolio contains around 20 funds. As discussed in Section 3, characteristics of private equity funds evolve over time. In particular, the maximum investment degree has declined due to more rapid distributions, while the timing of this maximum also varies. Hence, we assess the performance of the recommitment strategies over time by forming initial portfolios for all vintage years for the period 1980 – 2000. Based on the findings in Section 4.1 a 30% overcommitment is applied to set-up the initial portfolio and achieve an investment degree close to one. We choose this overcommitment percentage to make sure that we are not overinvested in the 1980s and to limit liquidity risk, although a larger overcommitment of about 60% would be preferred for the portfolios that start in the 1990s.

Third, after the portfolio construction period, the different recommitment strategies are applied for the remainder of the sample period as described before. For assigning the new commitments to be made in a particular quarter, four funds with the relevant vintage year are drawn randomly from the TVE data set, independent of the region (EU or US) or investment type (venture capital or buy-out). The new commitment will be equally assigned to each of the four random funds from the concerning vintage year.

Finally, throughout we assume no return on cash because our portfolio would be part of a larger portfolio. In order to avoid dependence of the results on the particular initial portfolio that is constructed and on the funds selected for the recommitments, we simulate 1,000 portfolios and average the results for evaluation.

5 Results

We evaluate the quality of the recommitment strategies by considering various properties of the investment degree, in particular its mean, standard deviation and probability of liquidity shortfall (that is, the probability that the investment degree exceeds one). All these statistics are computed using observations after the portfolio is three years old, in order to avoid any influence of the initial portfolio formation period.

during the first few years as the portfolio gets invested more slowly. After about five years, all portfolios converge, showing that the construction of the initial portfolio does not seem to affect the quality of the recommitment strategies after the portfolio matures. Detailed results are available upon request.

5.1 Main results

Panel (a) in Figure 3 shows how the average investment degree evolves over calendar time when applying strategies I–III for the 1,000 private equity portfolios with vintage year 1980. Summary statistics for all vintage years are given in Table 3. When applying strategy I, which sets current commitments equal to current distributions, the investment degree remains well below the target level of one. This does not come as a surprise as committed capital is not called instantaneously, such that the portfolio always contains a certain amount of cash. In fact, the average investment degree comes very close to the target level of one between two and three years after formation due to the overcommitment in the initial portfolio. This, however, is followed by a decline to a considerably lower level, such that the average investment degree per vintage year varies between 0.65 and 0.81 for the years 1996 and 1999, respectively, with an average across all vintage years of 0.73. Also note that, although it would seem that an investment degree in excess of one cannot occur for this strategy by construction, we do observe a positive probability of liquidity shortfall for most vintage years. This is due to the overcommitment during the formation of the initial portfolio.

- insert Figure 3 and Table 3 about here -

The first recommitment strategy suffers from two problems that result in an average investment degree below the target level of one. First, not all committed capital is called instantaneously but with a delay that can extend to several years. Second, part of the committed capital is never called at all. The results from the second recommitment strategy suggest that the first problem is the most important one. Strategy II aims to remedy the second problem by increasing the commitments at time t with uncalled capital from the commitments made at $t - P$, where we set $P = 24$ for reasons discussed before. The results show that this increases the average investment degree, but only by a small amount, from 0.73 to 0.75. From panel (a) in Figure 3 it is clear that the improvement starts approximately six years after the initial portfolio formation, as expected.

Several possibilities exist to mitigate the problem of delayed investment of (re)committed capital. Introducing a multiplier based on the current investment degree for setting

the current commitments as in strategy III appears to be quite effective. Table 3 shows that the average investment degree rises to 0.85, well above the level attained with strategies I and II. Not surprisingly, this comes at the cost of a higher risk of being overinvested, although the increase in the probability of liquidity shortfall is quite modest from 5% to 9%. We also note that the range of the average investment degree across the different vintage years is much smaller, between 0.82 and 0.88. This is confirmed by Figure 4, showing the investment degree for selected vintage years (1981, 1986, 1991, 1996, 2001). We observe that the average investment degree behaves similarly once the portfolios mature. For example, for all vintage years the investment degree declines in 2000 driven by the large distributions made during the internet-bubble in that year. Due to the multiplier effect, however, the investment degree quickly increases again in subsequent years.

- insert Figure 4 about here -

A detailed picture of the cash flows involved in strategy III is provided by panel (b) of Figure 3 for the 1980 portfolios. The distributions, on average, amount to 5% of the total portfolio value per quarter, while the actual investments (contributions) are slightly lower but much more constant than the distributions. These orders of magnitude are fairly stable across vintage years.¹⁰ From this graph we also observe that distributions in 2000 clearly were far above average, amounting to 10% of the portfolio value per quarter. The rise in the commitments in year 7 due to the recommitments of the uncalled commitments of the initial portfolio can also be seen. We do not see this effect happening again after 12 or 18 years, showing that by then the portfolios have matured.

The bottom line of our results so far is that strategy III is very well able to bring the investment degree close to the target level with an acceptable risk of being overinvested. For the investors with more appetite for risk we examine next whether overcommitment can bring the investment degree further up.

5.2 Overcommitment

The data analysis in Section 3 reveals that on average only 90 percent of committed capital eventually is called by private equity funds. This suggests that overcom-

¹⁰Detailed results for other vintage years are available upon request.

mitment for the recommitment of distributions may be necessary to maintain the target exposure, in addition to the overcommitment already applied for the initial portfolio. This also follows from the average investment degree for individual funds in Figure 2, which shows that this only reaches up to 60% of committed capital. An important but difficult choice to be made is the overcommitment percentage to be applied. As shown in Table 2, the average maximum investment degree varies substantially across vintage years, suggesting that a constant overcommitment percentage is not appropriate. On the other hand, the actual maximum investment degree that will be attained by funds from a particular vintage year is of course unknown upfront, making it difficult to implement a strategy with a dynamic overcommitment percentage. Hence we reconsider our strategy III, but now applying a constant overcommitment of 10, 20, \dots , 50 percent in each quarter.

Panel (a) in Figure 5 shows the average investment degrees resulting from these strategies for the 1980 portfolios, with summary statistics provided for all vintage years in Table 4. Applying overcommitment when recommitting distributions and uncalled capital appears to be successful, in the sense that the average investment degree moves closer to the target level of one. The increase in the investment degree that we observe for 1980 in Figure 5 is also prevalent for the other vintage years, see Table 4. The average investment degree goes up from 0.85 for strategy III with no overcommitment to 0.89, 0.92, 0.95, 0.98 and 1.01 with overcommitment equal to 10, \dots , 50%. Unfortunately, but not surprisingly, this is accompanied by a substantial increase in the probability of being overinvested. In fact, this probability rises faster than the average investment degree, and becomes equal to 16, 24, 33, 41 and 49%, while it is only 9% without overcommitment. Hence, it seems that an overcommitment strategy is suitable only when liquidity shortfall is not a serious problem for the investor. This may be the case when private equity is part of a larger investment portfolio that also includes public equity, which can be sold (temporarily) to provide the capital necessary for the private equity investments. For these investors it seems that a 20% overcommitment is optimal as this brings the average investment ratio to 0.92 while the probability of being overinvested is 24%. Panel (b) in Figure 5 shows the average investment degrees resulting from strategy III including a 20% overcommitment for different vintage years. From this graph it is clear that the average investment degrees are close to one. Again we

observe that the investment degree develops similarly for different vintage years after the portfolios have matured. All portfolios show a decline in the investment degree in 2000 and a sharp increase in the years afterwards.

- insert Figure 5 and Table 4 about here -

5.3 Using the future investment degree

Using the current investment degree to scale up the commitments in quarter t , as in strategy III according to (2), is sub-optimal. As part of the committed but uncalled capital will be invested in the near future, using the current investment degree leads to an overestimate of the required commitments in quarter t . Instead, it may be better to use the future investment degree of the current portfolio to set the current commitments. Implementing this in practice requires a cash flow prediction model, see Takahashi and Alexander (2002) and Malherbe (2004) for examples. The performance of the recommitment strategies is then, to a considerable extent, determined by the quality of these forecasting models. In order to focus on the (relative) merits of our recommitment strategy as such, we use perfect foresight instead. Obviously this implies that our results have to be treated with caution, as they may be overly optimistic about the ability of the strategies to achieve the goal of a full and constant exposure to private equity. On the other hand, we do not aim to select private equity funds having a pattern of commitments that matches the pattern of distributions from the portfolio as closely as possible. Instead, funds are selected randomly. Hence, we consider strategy III but now applying the actual investment degree of the current portfolio in quarter $t + Q$ to scale the new commitments to be made in quarter t . That is, we replace the current investment degree ID_t in (2) by ID_{t+Q} , where we consider values of Q equal to 4, 8, \dots , 20.¹¹

The average investment degrees resulting from these strategies for the 1980 portfolios are shown in panel (a) in Figure 6. Clearly, applying the future investment degree in the recommitment strategy becomes effective only five years after inception of the portfolio as the investment degrees do not differ much during the first

¹¹We stress that ID_{t+Q} is the investment degree in quarter $t + Q$ of the private equity portfolio held in quarter t , that is, we do not use information about new commitments made between t and $t + Q$.

years. It also appears that looking ahead too far into the future, that is, four and five years, results in being overinvested. This is probably caused by the fact that the investment degree of the current portfolio will be quite low after four and five years, such that the multiplier increases and the level of new commitments becomes too high. On the other hand, the investment degree does not rise that much if we use the investment degree for one or two years ahead. This leads us to conclude that our strategy can benefit most from a cash flow forecasting model with a three year horizon. This conclusion is confirmed by the summary statistics for the other vintage years shown in Table 5. Using a three year horizon in our recommitment strategy leads to an increase of the average investment degree to 0.92 and a probability of being overinvested of 23%. Panel (b) in Figure 6 shows the average investment degrees resulting from strategy III including a three-year perfect foresight for different vintage years. From this graph it is clear that the investment degrees are close to 1. Again we observe that the investment degree develops similarly for different vintage years after the portfolios are mature, but the pattern is different from the constant overcommitment in the previous section. Finally, we note that using the future investment degree leads to comparable results as the overcommitment discussed in the previous section. The main difference is that scaling our recommitments based on the future investment degree actually comes down to a dynamic overcommitment strategy, while the use of a constant overcommitment obviously is not and could be too rigid during times when distributions are extremely small or large.

- insert Figure 6 and Table 5 about here -

In sum, an investor who has a cash flow prediction model at her disposal can improve our recommitment strategy by using the expected future investment degree of the current portfolio as a scaling factor to determine the new commitments. It is advisable to employ investment degree forecasts for an horizon of three years.

5.4 Portfolio restrictions

So far we considered unrestricted portfolios, not imposing any limitations on the type of funds (VC or BO) or the investment region (US or Europe). Here we examine the performance of our strategy when such restrictions are imposed. Figure 7 shows the average investment degree for the unrestricted portfolios as well as the portfolios

consisting of VC, BO, US or European funds only for vintage year 1986. Before 1986 the number of European funds as well as buyout capital funds was very limited. Table 6 shows the corresponding summary statistics for all vintage years.

- insert Figure 7 and Table 6 about here -

The average investment degree for BO (0.87) and VC (0.86) portfolios are similar to the unrestricted portfolios (0.85), while the probability of liquidity shortfall is marginally higher than the unrestricted strategy. The strategies only differ in the volatility of the investment degree, which is equal to 7.9 and 21.2 percent for BO and VC portfolios, respectively. From Figure 7 it can be seen that the average investment degrees for unrestricted and VC portfolios are most similar. This close resemblance can be explained by the distribution of funds over the two investment types: VC-funds constitute two-thirds of the TVE data set. The difference in investment degree between VC and BO portfolios is particularly clear during the internet-bubble in 2000 and 2001. In this period venture capital funds made historically large distributions while the buy-out distributions were less extreme.

The results for US portfolios closely resemble those for the unrestricted portfolios, although the average investment degree for all vintage years is slightly lower (0.82). The average for European portfolios (0.92) is closer to 1, but at the cost of a larger probability of liquidity shortfall.

Given that the results for VC and BO portfolios as well as the US and Europe portfolios resemble the results for unrestricted portfolios, we conclude that our strategy III can also be applied successfully to such specialised private equity portfolios.

5.5 Existing commitment strategies

5.5.1 CCK-rule

The literature on (re)commitment strategies in private equity is very scarce; in fact only two relevant papers were found. Cardie *et al.* (2000) suggest a commitment rule (denoted as CCK-rule), which states that an investor should commit her entire private equity allocation target to new investments every other year or one half of the target each year. Although frequently making new private equity commitments is certainly necessary to maintain the desired exposure, the CCK-rule seems somewhat

naive. In particular, it fails to take into account the development of the existing private equity investments in the portfolio when making new commitments.

Here we examine the first variant of the CCK-rule, setting new commitments equal to the private equity target times the current market value of the portfolio (the sum of the portfolio's NAV and cash) every other year. The number of funds that is selected (randomly) in each round of commitments is set equal to 16 and the target is set at 100 percent. The average investment degree over 1,000 simulated portfolios is shown in panel (a) of Figure 8 for vintage years 1981, 1986, 1991, 1996, and 2001. Clearly, the private equity investment degrees are not kept constant at 100 percent over time. Instead, they remain permanently and substantially above target and fluctuate wildly. It is clear that the CCK-rule does not succeed in keeping the investment degree constant at the allocation target. Not taking into account the characteristics of the current portfolio results in a high and volatile investment degree.

- insert Figure 8 about here -

5.5.2 NCM-rule

Nevins *et al.* (2004) derive the following expression for the target level of committed capital C^* , given a strategic asset allocation target on invested capital I^* :

$$C^* = I^* \left[1 + \frac{1}{r_{IN}} \{ (1 - I^*) (r_L - r_I) + r_{DI} \} \right] \quad (3)$$

where r_L and r_I correspond to the expected rate of return on the liquid (non-private equity) and illiquid (private equity) parts of the overall asset portfolio, respectively, r_{DI} is the rate at which distributions are paid from the private equity investments (expressed as a percentage of the value of invested capital (NAV)) and r_{IN} is the rate at which capital commitments are invested, expressed as percentage of remaining (not (yet) invested) commitments. The resulting commitment strategy, denoted as the NCM-rule, states that an investor should make new commitments when actual committed capital falls below its target C^* , equal to the difference between the two.

The NCM-rule rests on two crucial assumptions. First, investors make commitments according to the computed allocation target for committed capital. Second, the expected returns r_L and r_I as well as the rate of distributions and investments

r_{DI} and r_{IN} in (3) are assumed to be constant over time and across private equity funds.¹² When these two assumptions hold, the ratio of committed capital to invested capital converges to a steady-state level. However, especially the second part of the second assumption is unrealistic. As discussed in Section 3, the rates of distributions and investments vary over time, while in addition they likely vary across private equity funds according to characteristics such as size and investment orientation (Ljungqvist and Richardson, 2003b). Of course this dependence will diminish if multiple private equity funds are combined in a portfolio (or fund-of-funds), but it will not disappear completely given that the number of included funds is typically fairly small (up to 20, say).

For a 100 percent allocation target for private equity ($I^* = 1$), the NCM-rule reduces to

$$C^* = 1 + \frac{r_{DI}}{r_{IN}}. \quad (4)$$

In case r_{DI} is large, more capital needs to be committed to compensate for the reduction in investment degree due to the large distributions. If r_{IN} is small, more capital is required for new commitments, because existing commitments are called relatively slowly. For computing r_{DI} and r_{IN} Nevins *et al.* (2004) suggest using information on capital calls and distributions from liquidated funds only. Based upon the 536 liquidated funds in our TVE database, r_{DI} is equal to 24.36 percent and r_{IN} is equal to 20.36 percent. With these figures, the target for committed capital as determined according to (4) is equal to 2.19, which is equivalent to 119 percent overcommitment. Nevins *et al.* (2004) find a target of committed capital of 17 percent for a target exposure of 10 percent, or 70 percent overcommitment. We find a percentage in the same order of magnitude if we only take into account capital calls during the first six years of the fund's lifetime for estimating r_{IN} , when nearly all committed capital is called.

The NCM-rule is assessed using the same framework as before. Investors make new commitments if the amount of actual committed capital falls short of its target (219 percent), equal to the difference between the two. The average investment degree over 1,000 simulated portfolios is shown in panel (b) of Figure 8 for the vintage years 1981, 1986, 1991, 1996, and 2001. Clearly, the the private equity

¹²This assumption is reflected in the way Nevins *et al.* (2004) estimate r_{DI} and r_{IN} , namely by aggregating the characteristics of the liquidated funds of their dataset on a life cycle basis.

investment degrees are not kept constant at 100 percent over time. For example, the 1981 portfolio starts substantially above target in the 1980s and falls back to 0.5 in the mid-1990s. In contrast to our strategy III the NCM-portfolios do not converge to the same investment degree as they mature. The wide range in the investment ratios for mature portfolios can for example be seen in 2005, where the degrees range between 0.69 for the 1981 portfolio and 1.15 for the 1996 portfolio. This illustrates that the NCM strategy is not able to deal with the dynamics of a specific portfolio. Finally, we remark that excessive commitments are made in 2000 due to the difference between the actual amount of committed capital and its target, and the value of the total portfolio (NAV + cash). This could be caused by differences in sample period used to estimate r_{DI} and r_{IN} , as Nevins *et al.* (2004) only consider liquidated funds for vintage years between 1980 and 2000.

We conclude that the NCM-strategy fails to keep the private equity fund-of-funds investment degree constant at one for a prolonged period. This is most likely due to the fact that the assumption of constants rates of distribution and investment do not hold in practice.

6 Conclusion

This paper provides a (re)commitment strategy for long term investors, such as insurance companies, pension funds or endowments, which aim to have a constant private equity exposure in their strategic asset allocation. Our recommitment strategy explicitly takes into account characteristics of the existing private equity portfolio for determining the level of new commitments. Commitments in a particular quarter are set equal to current distributions plus uncalled capital from commitments made six years ago, divided by the investment degree of the current portfolio. The reason for recommitting uncalled capital is to prevent ‘leakage’ of capital due to the fact that on average 10 percent of the commitments are not invested. The investment degree is used as a multiplier to speed up the adjustment of the investment degree to the desired level, to counter the fact that committed capital is actually invested only gradually, with a delay that can extend to several years.

The performance of the recommitment strategy is assessed by means of historical simulations using the Thomson Venture Economics database. We consider portfolios

composed of investments in 16 private equity funds diversified across venture capital and buy-out capital and across the US and Europe, where a 30% overcommitment is used to initialize the portfolio. We find that our recommitment strategy is capable of maintaining a stable investment degree that is close to the target level, while keeping the probability of liquidity shortfall within reasonable bounds. We show that the quality of the strategy can be improved if an investor can use the three-year future investment degree of the current portfolio to scale up or down his new commitments. An investor that can permit herself a higher allocation could consider a 20% overcommitment in the recommitment as this will bring the portfolio exposure more close to the target, but at the cost of a higher risk of being overexposed. Furthermore, sensitivity analysis shows that our strategy remains successful when the portfolio is restricted to a certain type of private equity capital or to a specific region. In addition, we find that the commitment strategies of Cardie *et al.* (2000) and Nevins *et al.* (2004) both fail to keep the investment degree stable for a prolonged period of time. In particular, the investment degree remains permanently above its target.

Further research could consider the use of more accurate intermediate valuations of the portfolio investments. Driessen *et al.* (2007) present a methodology to estimate the intermediate net asset values by estimating the CAPM beta on the fund's cash flows when the fund is matured. We expect that the average exposure to private equity over time will not be affected much, but that the volatility of the investment degree will rise because the value of private equity investments will become more volatile. Furthermore, our current strategy is limited to 100% private equity, but it can be expanded in a straightforward manner to private equity in a broader strategic asset allocation with e.g. public equity, bonds and hedge funds, taking into account the returns on these asset classes. Finally more research on cash flow prediction, see Takahashi and Alexander (2002) and Ljungqvist and Richardson (2003b), is necessary to make the recommitment strategy based on the future investment degree operational.

Data Appendix

The data set obtained from Thomson Venture Economics contains information on 2,786 private equity funds over the period 1980Q1-2005Q4, and includes the regional focus (US/Europe), the type of investment (venture capital, buy-out capital, mezzanine finance and fund-of-funds), the vintage year, quarterly contributions and distributions, and quarterly information on the net asset value (NAV). Reported cash flows are given in US dollars and are net of (management) fees as well as carried interest. In total 168 funds are excluded on the following grounds:

1. Total commitments: The fund's cash flows and NAVs are expressed relative to its total commitment, which makes funds of different sizes comparable. One fund reports a zero commitment and has been excluded from the data set.
2. Geographic orientation: 1 fund was included in both the European and US sample. The double counting has been excluded and the fund is characterized as 'global'.
3. Type of investment: Mezzanine funds (65 funds) are removed, since their structures differ from private equity funds. As this research focuses on private equity fund investors, data on fund-of-funds (direct investing (13 funds) and secondaries (7 funds)) are excluded as well.
4. Missing observations: Two funds report cash flows equal to zero over the entire period and are therefore excluded.
5. Visual inspection: 71 funds are removed on visual inspection of the data.

The Thomson Venture Economics database reports a fund's contributions, distributions and estimated NAVs. The contributions and distributions, if any, are assumed to take place at the end of the month and information on the NAVs is given on a quarterly basis. The following adjustments were made to these cash flow variables:

1. 157 funds report negative contributions, which have been changed to distributions.
2. Negative distributions of 14 funds have been adjusted by subtracting them from the fund's earlier distributions.
3. 8 funds report a negative NAV. As the NAVs of funds are highly unlikely to become negative, these funds have been removed.

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Table 1: Distribution of private equity funds across investment types and regions

Investment type	Region			Total
	US	Europe	Global	
Venture capital	1090	591	–	1681
Buy-out capital	535	401	1	937
Total	1625	992	1	2618

Note: The table reports the number of funds for each region (US, Europe, and world) and type (Buy-out or Venture capital) combination.

Table 2: Timing and magnitude of maximum investment degree across vintage years

Vintage year	# funds in VY	Maximum investment degree			Optimal overcom.	$CC_{t=4y}$	$CD_{t=4y}$
		Mean	StdDev	Timing			
1980	22	0.78	0.062	Q11	28%	0.86	0.28
1981	24	0.81	0.048	Q15	23%	0.85	0.05
1982	29	0.81	0.093	Q16	24%	0.82	0.03
1983	63	0.87	0.098	Q15	15%	0.94	0.14
1984	82	0.76	0.070	Q17	32%	0.86	0.14
1985	76	0.85	0.136	Q18	18%	0.92	0.11
1986	70	0.68	0.050	Q16	47%	0.79	0.14
1987	116	0.69	0.056	Q19	45%	0.77	0.12
1988	95	0.74	0.058	Q20	35%	0.77	0.08
1989	114	0.67	0.058	Q18	49%	0.70	0.06
1990	67	0.73	0.122	Q20	36%	0.83	0.16
1991	61	0.52	0.065	Q20	93%	0.56	0.11
1992	58	0.66	0.058	Q15	52%	0.75	0.16
1993	94	0.56	0.064	Q15	80%	0.66	0.27
1994	105	0.59	0.063	Q16	71%	0.71	0.26
1995	111	0.57	0.092	Q19	74%	0.76	0.40
1996	104	0.60	0.092	Q15	66%	0.85	0.95
1997	180	0.64	0.071	Q13	55%	0.79	0.65
1998	213	0.63	0.081	Q10	59%	0.80	0.55
1999	248	0.57	0.074	Q13	77%	0.72	0.14
2000	301	0.56	0.112	Q21	79%	0.66	0.11
2001*	172	0.49	0.078	Q20	-	-	-
2002*	86	0.38	0.071	Q16	-	-	-
2003*	60	0.50	0.138	Q12	-	-	-
2004*	46	0.33	0.092	Q8	-	-	-
2005*	21	0.14	0.048	Q4	-	-	-
Av.80s	69	0.77	0.073	Q17	32%	0.83	0.12
Av.90s	124	0.61	0.078	Q16	66%	0.74	0.36

Note: The table reports the number of funds, mean, standard deviation, timing in quarters of the maximum investment degree (measured as a fraction of total commitments), the optimal overcommitment ratio to reach a maximum investment degree of 100% and the cumulative contributions and distributions after 4 years across vintage years. The average maximum investment degrees and timing for vintage years 2001-2005 are unreliable as the maximum and its timing cannot be determined with certainty yet. Vintage year statistics are based on 1,000 simulations of portfolios. In each simulation 16 private equity funds are randomly selected within the same vintage year and equally weighted to constitute the initial portfolio.

Table 3: Summary statistics of the investment degree in recommitment strategies I – III across vintage years

Vintage year	Strategy I		Strategy II		Strategy III	
	Mean	StdDev	Mean	StdDev	Mean	StdDev
1980	0.74	0.05	0.77	0.05	0.86	0.05
1981	0.73	0.05	0.77	0.05	0.87	0.06
1982	0.75	0.07	0.81	0.06	0.88	0.07
1983	0.77	0.07	0.80	0.07	0.88	0.07
1984	0.79	0.07	0.80	0.07	0.88	0.07
1985	0.78	0.09	0.80	0.09	0.88	0.09
1986	0.73	0.05	0.76	0.05	0.85	0.06
1987	0.72	0.06	0.75	0.06	0.85	0.07
1988	0.73	0.06	0.75	0.06	0.85	0.07
1989	0.71	0.07	0.73	0.07	0.83	0.07
1990	0.74	0.09	0.75	0.09	0.85	0.09
1991	0.66	0.06	0.71	0.07	0.83	0.07
1992	0.70	0.06	0.71	0.06	0.82	0.07
1993	0.69	0.08	0.72	0.09	0.84	0.10
1994	0.72	0.06	0.75	0.07	0.84	0.07
1995	0.69	0.10	0.70	0.10	0.84	0.12
1996	0.65	0.08	0.66	0.08	0.86	0.16
1997	0.74	0.09	0.76	0.09	0.85	0.08
1998	0.77	0.12	0.77	0.12	0.87	0.10
1999	0.81	0.11	0.82	0.11	0.86	0.09
2000	0.78	0.18	0.77	0.18	0.82	0.19
Average	0.73	0.08	0.75	0.08	0.85	0.09

Note: The table shows properties of the investment degree for private equity portfolios maintained using commitment strategy I, II and III. Strategy I sets current commitments equal to current distributions, Strategy II sets current commitments equal to current distributions plus uncalled commitments and Strategy III sets current commitments equal to current distributions plus uncalled commitments divided by the investment degree. Reported are the mean, standard deviation (StdDev) and the fraction of observations with an investment degree higher than 1 ($P_{(ID>1)}$). Vintage year statistics are based on 1,000 simulations of portfolios. In each simulation 16 private equity funds are randomly selected within the same vintage year and equally weighted to constitute the initial portfolio. The results for vintage years 2001-2005 are not reported as these portfolios are too immature to illustrate the effectiveness of the strategies.

Table 4: Summary statistics of the investment degree in recommitment strategies with overcommitment across vintage years

Vintage year	Mean					$P_{(ID>1)}$				
	10%	20%	30%	40%	50%	10%	20%	30%	40%	50%
1980	0.90	0.94	0.97	1.01	1.05	0.16	0.30	0.42	0.52	0.62
1981	0.91	0.94	0.98	1.01	1.04	0.16	0.26	0.39	0.52	0.64
1982	0.92	0.95	0.99	1.02	1.05	0.21	0.32	0.45	0.56	0.67
1983	0.91	0.95	0.98	1.02	1.05	0.20	0.30	0.40	0.51	0.62
1984	0.92	0.95	0.98	1.02	1.05	0.26	0.35	0.45	0.54	0.63
1985	0.92	0.95	0.98	1.01	1.05	0.22	0.30	0.38	0.47	0.56
1986	0.89	0.92	0.96	0.99	1.02	0.08	0.18	0.28	0.39	0.51
1987	0.88	0.92	0.95	0.98	1.01	0.12	0.20	0.29	0.36	0.44
1988	0.88	0.92	0.95	0.98	1.01	0.14	0.22	0.30	0.38	0.45
1989	0.86	0.90	0.93	0.96	0.99	0.08	0.16	0.24	0.31	0.37
1990	0.89	0.92	0.95	0.98	1.02	0.16	0.25	0.33	0.41	0.47
1991	0.86	0.90	0.93	0.96	1.00	0.14	0.23	0.33	0.39	0.45
1992	0.86	0.89	0.92	0.96	0.99	0.07	0.15	0.24	0.32	0.39
1993	0.87	0.90	0.94	0.97	1.00	0.15	0.25	0.33	0.40	0.45
1994	0.88	0.91	0.95	0.98	1.01	0.13	0.23	0.34	0.41	0.46
1995	0.89	0.93	0.97	1.00	1.04	0.17	0.26	0.37	0.45	0.52
1996	0.91	0.97	1.00	1.06	1.11	0.27	0.40	0.46	0.54	0.61
1997	0.89	0.92	0.95	0.99	1.03	0.15	0.25	0.35	0.47	0.54
1998	0.91	0.93	0.96	0.98	1.00	0.16	0.24	0.30	0.38	0.45
1999	0.87	0.89	0.91	0.92	0.93	0.11	0.13	0.19	0.22	0.27
2000	0.82	0.83	0.83	0.84	0.83	0.11	0.12	0.12	0.13	0.13
Average	0.89	0.92	0.95	0.98	1.01	0.16	0.24	0.33	0.41	0.49

Note: The table shows properties of the investment degree for private equity portfolios where the current commitments are set equal to current distributions plus uncalled commitments divided by the investment degree multiplied by varying levels of overcommitment (10, 20, 30, 40 and 50%). Reported are the mean and the fraction of observations with an investment degree higher than 1 ($P_{(ID>1)}$). Vintage year statistics are based on 1,000 simulations of portfolios. In each simulation 16 private equity funds are randomly selected within the same vintage year and equally weighted to constitute the initial portfolio. The results for vintage years 2001-2005 are not reported as these portfolios are too immature to illustrate the effectiveness of the strategies.

Table 5: Summary statistics of the investment degree in recommitment strategies that include the future investment degree across vintage years

Vintage year	Mean					$P_{(ID>1)}$				
	+4Q	+8Q	+12Q	+16Q	+20Q	+4Q	+8Q	+12Q	+16Q	+20Q
1980	0.89	0.93	0.98	1.06	1.16	0.10	0.21	0.43	0.79	0.93
1981	0.90	0.94	0.99	1.07	1.18	0.14	0.21	0.47	0.84	0.95
1982	0.91	0.95	1.00	1.08	1.19	0.17	0.25	0.49	0.82	0.91
1983	0.91	0.94	1.00	1.07	1.18	0.18	0.24	0.44	0.79	0.96
1984	0.91	0.94	0.99	1.06	1.15	0.21	0.26	0.43	0.76	0.92
1985	0.91	0.95	1.00	1.07	1.16	0.20	0.25	0.41	0.71	0.90
1986	0.88	0.90	0.95	1.02	1.10	0.04	0.06	0.20	0.54	0.73
1987	0.87	0.90	0.94	1.01	1.09	0.08	0.10	0.21	0.50	0.74
1988	0.87	0.90	0.95	1.01	1.09	0.10	0.13	0.26	0.51	0.75
1989	0.85	0.88	0.91	0.97	1.04	0.06	0.08	0.17	0.36	0.53
1990	0.88	0.91	0.94	1.00	1.08	0.13	0.17	0.28	0.47	0.63
1991	0.83	0.84	0.86	0.89	0.93	0.07	0.08	0.15	0.31	0.40
1992	0.85	0.87	0.90	0.96	1.03	0.04	0.05	0.14	0.33	0.49
1993	0.84	0.85	0.86	0.90	0.95	0.01	0.08	0.09	0.22	0.38
1994	0.85	0.85	0.87	0.89	0.91	0.05	0.05	0.07	0.14	0.25
1995	0.86	0.87	0.89	0.93	0.98	0.11	0.11	0.13	0.25	0.40
1996	0.88	0.89	0.89	0.92	0.95	0.18	0.18	0.13	0.21	0.29
1997	0.86	0.87	0.86	0.85	0.84	0.08	0.08	0.05	0.04	0.02
1998	0.87	0.87	0.86	0.85	-	0.09	0.07	0.07	0.08	-
1999	0.84	0.83	0.81	-	-	0.07	0.04	0.02	-	-
2000	0.78	0.73	-	-	-	0.07	0.07	-	-	-
Average	0.87	0.89	0.92	0.98	1.06	0.10	0.13	0.23	0.46	0.62

Note: The table shows properties of the investment degree for private equity portfolios where the current commitments are set equal to current distributions plus uncalled commitments divided by the future investment degree (+4, +8, +12, +16 and +20 quarters perfect foresight). Reported are the mean and the fraction of observations with an investment degree higher than 1 ($P_{(ID>1)}$). Vintage year statistics are based on 1,000 simulations of portfolios. In each simulation 16 private equity funds are randomly selected within the same vintage year and equally weighted to constitute the initial portfolio. The results for vintage years 2001-2005 are not reported as these portfolios are too immature to illustrate the effectiveness of the strategies.

Table 6: Summary statistics of the investment degree in recommitment strategies for restricted portfolios

Vintage year	Mean				$P_{(ID>1)}$			
	EU	US	BO	VC	EU	US	BO	VC
1980	NA	0.84	NA	0.86	NA	0.02	NA	0.09
1981	NA	0.86	NA	0.86	NA	0.11	NA	0.10
1982	NA	0.88	NA	0.89	NA	0.18	NA	0.19
1983	NA	0.86	NA	0.88	NA	0.12	NA	0.20
1984	NA	0.85	NA	0.87	NA	0.13	NA	0.20
1985	1.04	0.84	NA	0.89	0.47	0.13	NA	0.21
1986	0.89	0.84	0.86	0.86	0.09	0.04	0.03	0.10
1987	0.90	0.83	0.89	0.85	0.22	0.09	0.10	0.12
1988	0.92	0.82	0.89	0.84	0.22	0.09	0.13	0.10
1989	0.88	0.81	0.88	0.82	0.17	0.02	0.12	0.04
1990	0.93	0.80	0.91	0.82	0.26	0.03	0.18	0.06
1991	0.91	0.82	0.87	0.83	0.39	0.07	0.22	0.06
1992	0.85	0.80	0.85	0.82	0.08	0.01	0.05	0.04
1993	0.93	0.79	0.89	0.82	0.40	0.01	0.12	0.08
1994	0.89	0.82	0.86	0.85	0.20	0.00	0.07	0.06
1995	0.97	0.79	0.87	0.84	0.38	0.03	0.05	0.11
1996	0.99	0.81	0.92	0.88	0.41	0.06	0.25	0.22
1997	0.92	0.80	0.89	0.85	0.23	0.01	0.12	0.09
1998	0.94	0.82	0.85	0.89	0.24	0.03	0.03	0.18
1999	0.89	0.84	0.84	0.87	0.14	0.05	0.04	0.13
2000	0.92	0.74	0.73	0.86	0.23	0.01	0.00	0.18
Average	0.92	0.82	0.87	0.86	0.26	0.06	0.10	0.12

Note: The table shows properties of the investment degree for private equity portfolios where the current commitments are set equal to current distributions plus uncalled commitments divided by the investment degree using European, US, venture capital or buy-out capital funds. Reported are the mean and the fraction of observations with an investment degree higher than 1 ($P_{(ID>1)}$). Vintage year statistics are based on 1,000 simulations of portfolios. In each simulation 16 private equity funds are randomly selected within the same vintage year and equally weighted to constitute the initial portfolio. The results for vintage years 2001-2005 are not reported as these portfolios are too immature to illustrate the effectiveness of the strategies, while the first 4 years for Europe and 5 years for buy-out are missing because not enough funds are available.

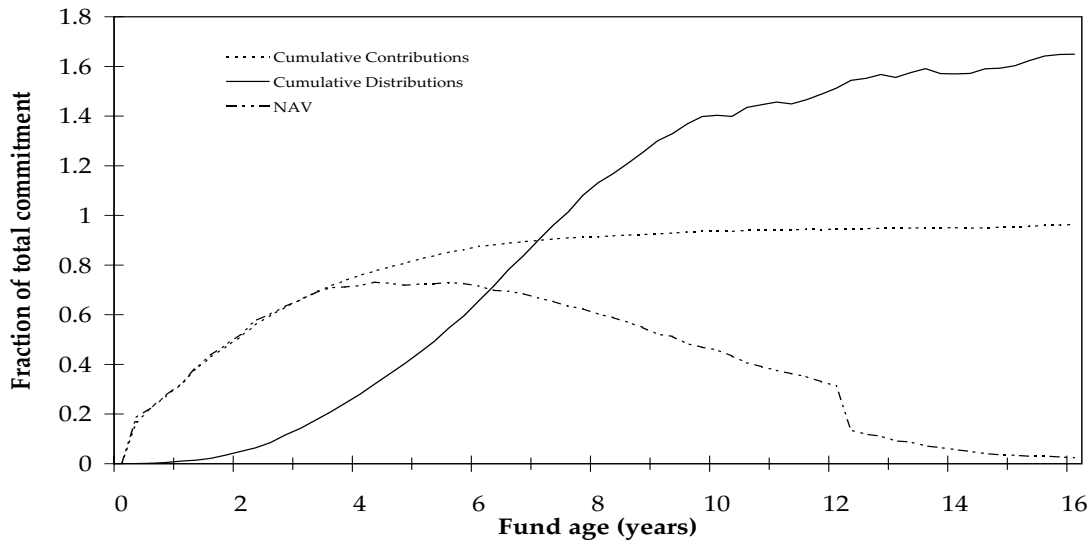


Figure 1: Average cumulative contributions, average cumulative distributions and average NAVs of individual private equity funds, 1980Q1-2005Q4.

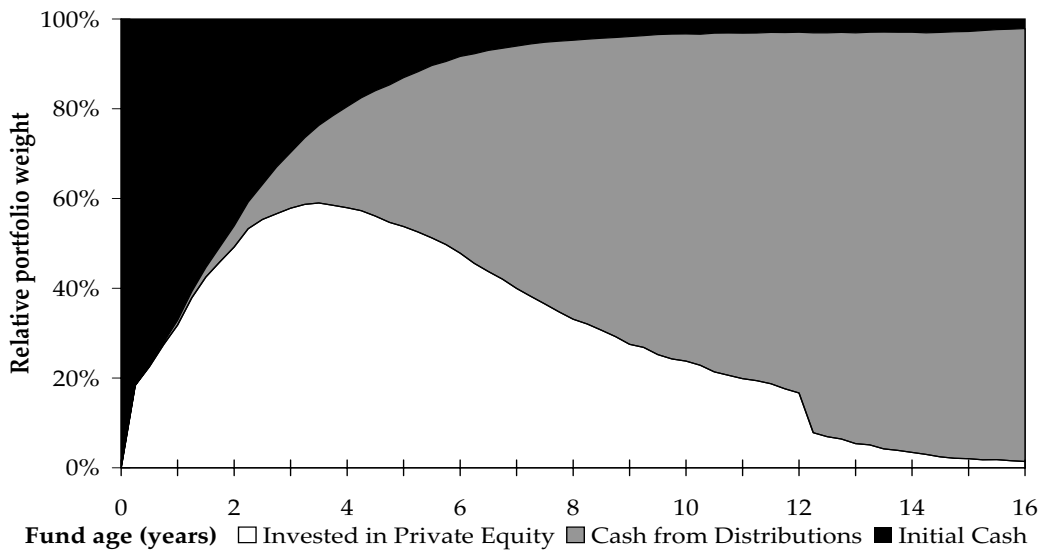
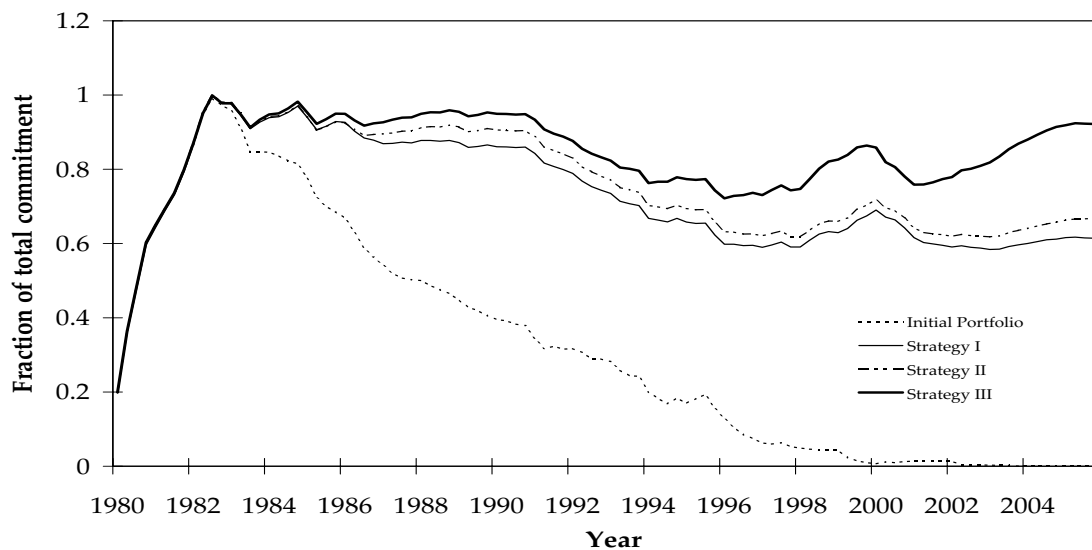
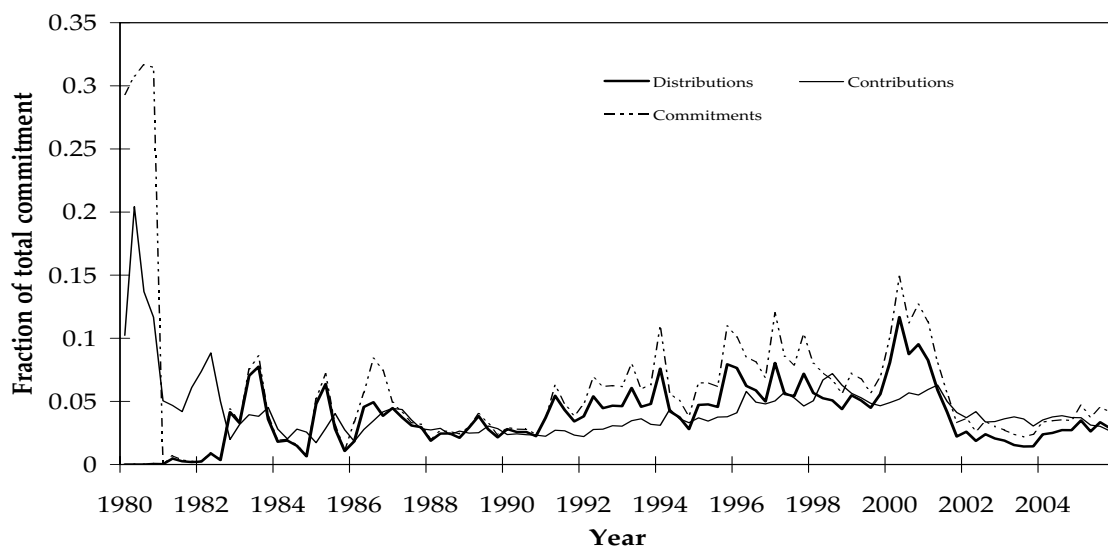


Figure 2: Cash versus actual private equity fund investment.

Note: This figure shows the average relative portfolio weight of the available cash at start (100), cash from the distributions and the value of the actual private equity investment (NAV), 1980Q1-2005Q4.



(a) Initial portfolio and strategy I–III for 1980



(b) Average (re)commitments and cash flows using strategy III for 1980

Figure 3: Average investment degree of private equity fund portfolios constructed using overcommitment only and strategy I–III for vintage year 1980 and (re) commitments and cash flows of strategy III for vintage year 1980.

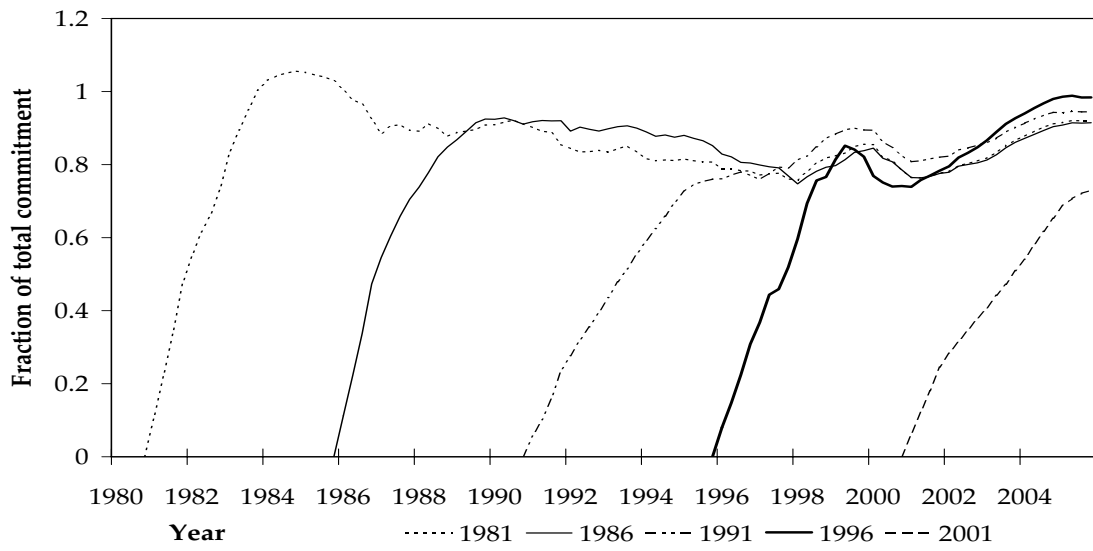
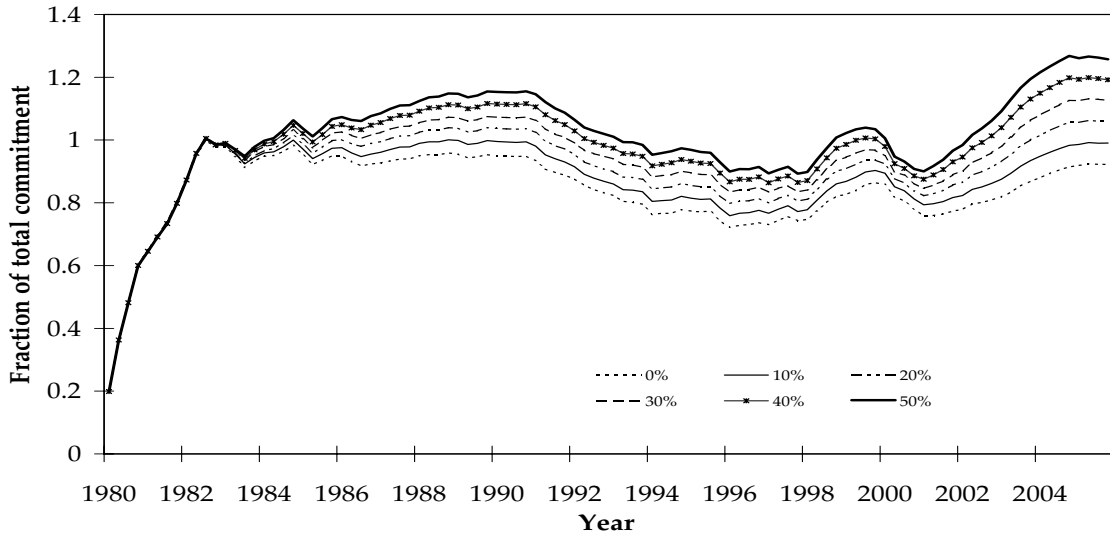
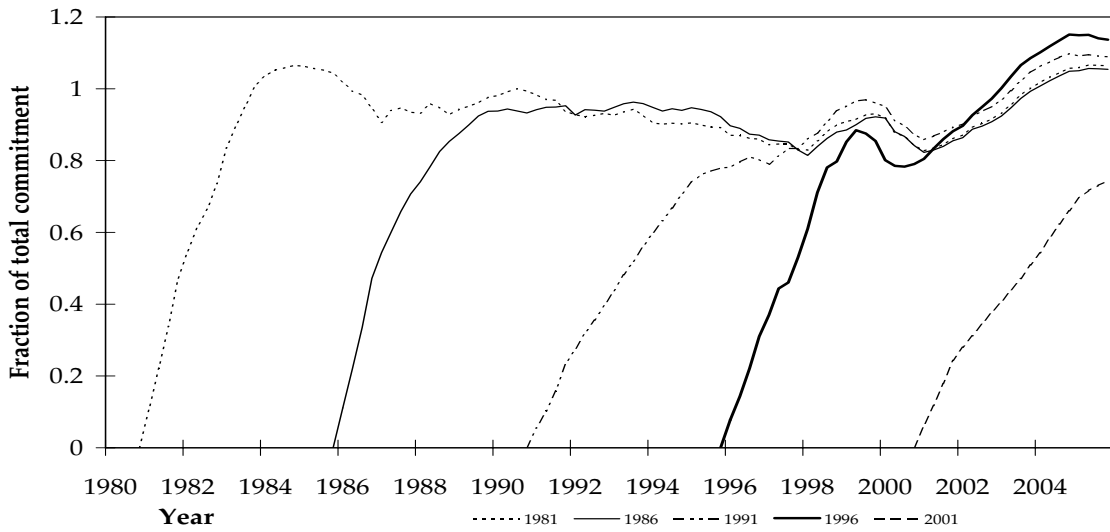


Figure 4: Average investment degree of private equity fund portfolios constructed using strategy III for vintage years 1981, 1986, 1991, 1996, 2001.

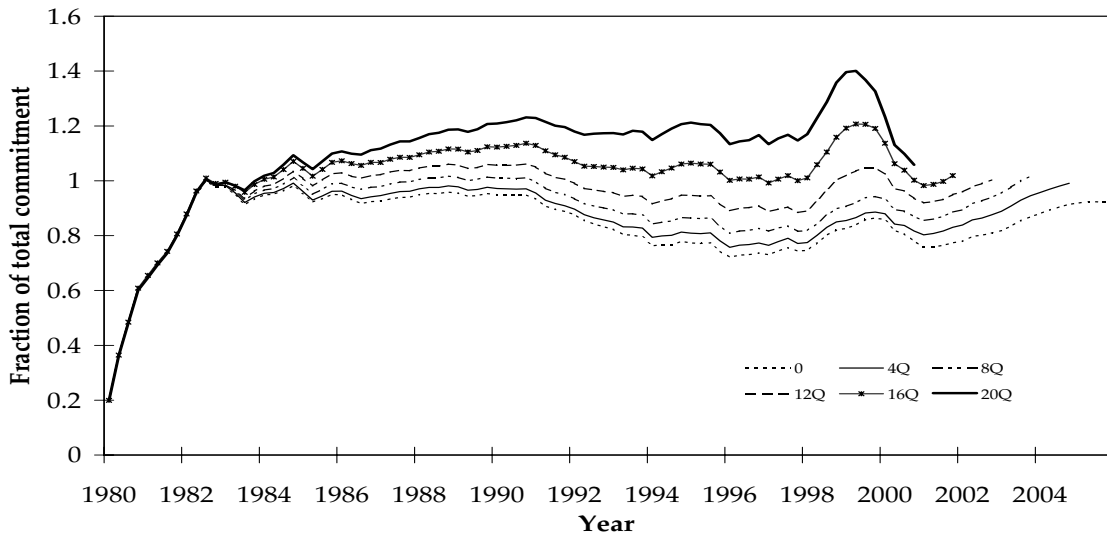


(a) Strategy III with varying overcommitment (0, 10, ..., 50%) for vintage year 1980

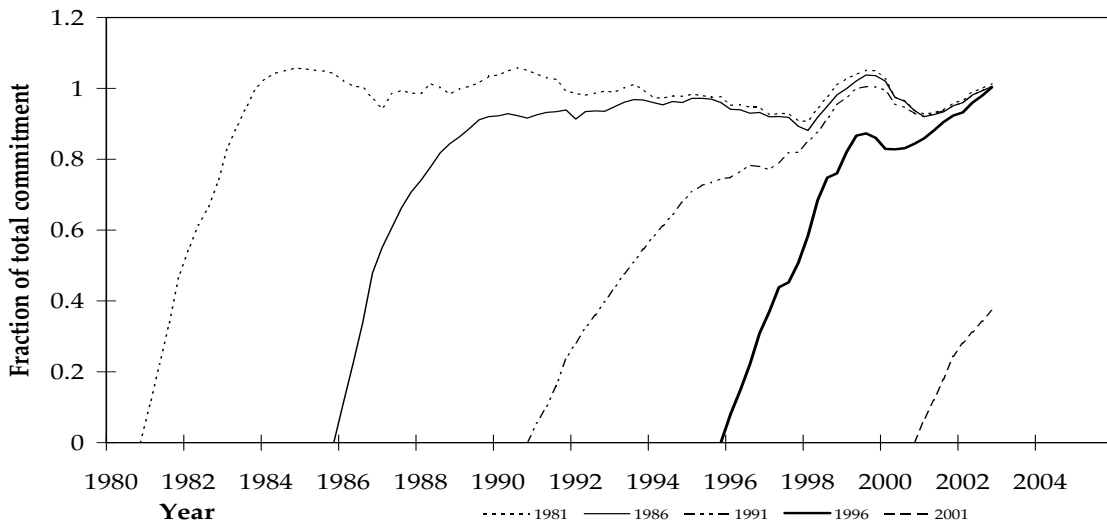


(b) Strategy III with 20% overcommitment for vintage years 1981, 1986, 1991, 1996 and 2001

Figure 5: Average investment degree of private equity fund portfolios constructed using strategy III with varying degrees of overcommitment for vintage year 1980 (a) and 20% overcommitment for vintage years 1981, 1986, 1991, 1996 and 2001 (b).



(a) Vintage year 1980



(b) Vintage years 1981, 1986, 1991, 1996, and 2001

Figure 6: Average investment degree of private equity fund portfolios constructed using strategy III with varying perfect foresight in the investment degree degrees for vintage year 1980 (a) and three-year perfect foresight for vintage years 1981, 1986, 1991, 1996, and 2001 (b).

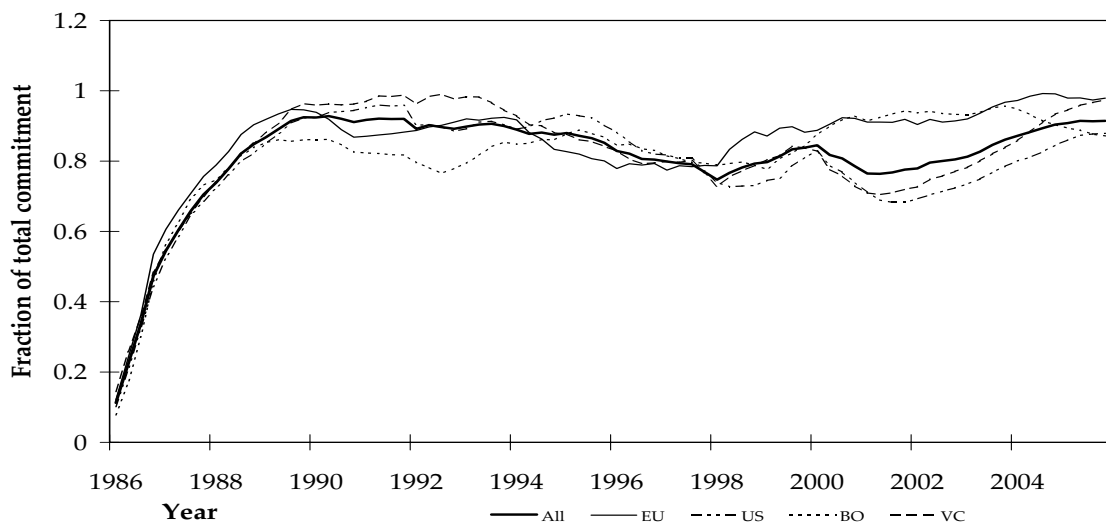
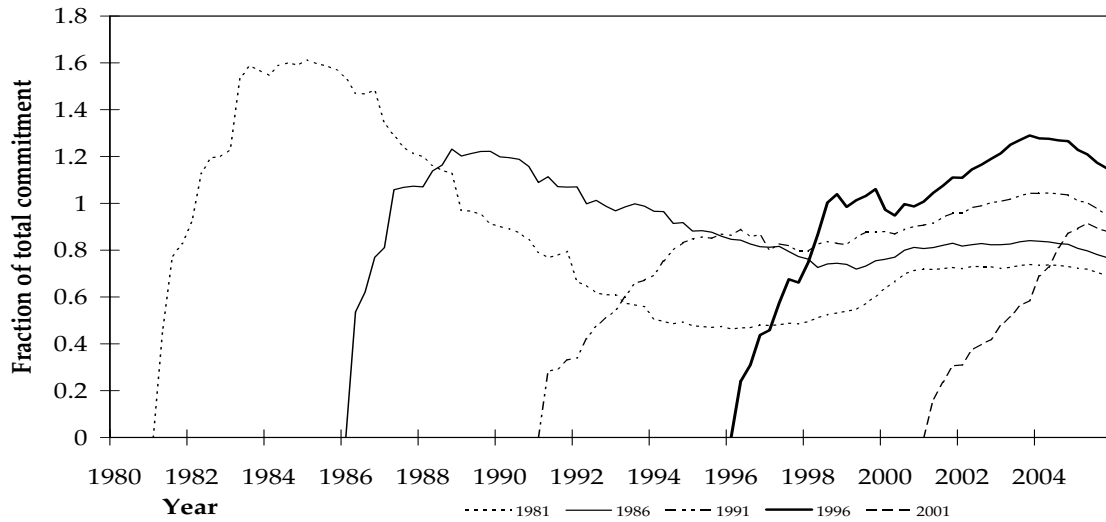
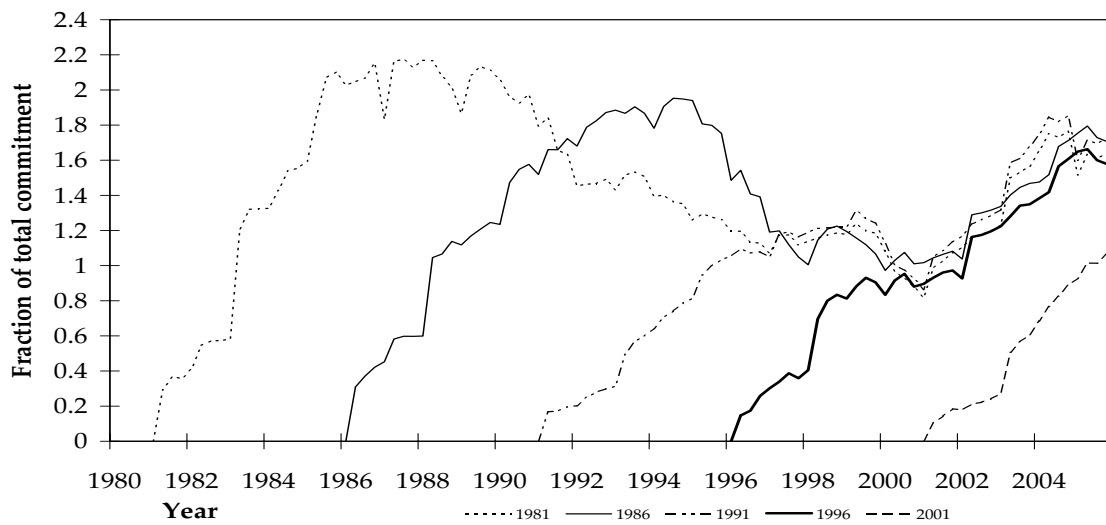


Figure 7: Average investment degree of private equity fund portfolios constructed using strategy III for vintage year 1986 using all or only buy-out, venture capital, US and European funds.



(a) CCK-rule



(b) NCM-rule

Figure 8: Average investment degree of private equity fund portfolios constructed using (a) the CCK-rule and (b) the NCM-rule for vintage years 1981, 1986, 1991, 1996, and 2001.