A recommitment strategy for long term private equity fund investors*

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Abstract

This paper develops a reinvestment strategy for private equity which aims to keep its portfolio weight equal to a desired strategic allocation, while taking into account the illiquid nature of private equity. Historical simulations (1980–2005) show that our dynamic strategy is capable of maintaining a stable investment level that is close to the target. This does not only hold for unrestricted portfolios, but also for investments limited to buy-out or venture capital, a specific region, or management experience. This finding is of great importance for investors, because private equity funds have a finite lifetime and uncertain cash flows.

Keywords: Private equity funds, recommitment strategy, strategic asset allocation, overcommitment
JEL Classification: G11, G23, G24

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I Introduction

Nowadays many institutional investors, such as pension funds, insurance companies and endowments, have included private equity in their strategic asset allocation. The vast majority of these investments takes place indirectly through 'funds', because entering, managing, and exiting direct private equity investments requires a high level of expertise and experience. In private equity funds, investors bring in capital, while the fund's management brings in her expertise (Cumming *et al.*, 2005), experience (Sørensen, 2006), specialization (Gompers *et al.*, in press), and network (Hochberg *et al.*, 2007). Most institutional investors aim for a specific private equity exposure as part of their strategic asset allocation. To the best of our knowledge, prior studies on optimal strategic asset allocation, like Chen *et al.* (2002), ignore the illiquid nature of private equity. The illiquidity is due to the lack of a well-developed secondary market and to restrictions on the sale of private equity fund investments, see Sahlman (1990) and Lerner and Schoar (2004) for a discussion.[1] This makes it difficult to achieve and maintain the desired strategic exposure to private equity. First, the target allocation to private equity cannot be bought instantaneously, like for bonds or public equity. Second, cash pay-outs of the private equity investments can not be reinvested immediately either, while these pay-outs are significant, because private equity funds have a finite lifetime (normally between 10 and 14 years).

Private equity fund investments start with an initial commitment, where the investor commits herself for a certain amount of capital to the fund. These commitments are only gradually invested ('called') by the fund, often taking a couple of years. In addition, often, not even all committed capital is eventually invested. Finally, pay-outs ('distributions') from liquidated investments typically start to occur when a fund is only just a few years old, often already before all committed capital

[1] 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 this set-up of the private equity 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.

has been invested. This again lowers the effective private equity allocation. In sum, attaining a certain target investment exposure to private equity and maintaining it at that level is not straightforward.

The central question that arises from the above is: How much and when should new private equity fund commitments be made to achieve and to maintain the desired strategic allocation for a prolonged period, given that the cash in- and outflows are (highly) uncertain? The aim of this paper is to answer this question by designing an appropriate (re)commitment strategy. At the outset we stress that our focus is on getting passive exposure to private equity and not on designing a strategy that outperforms the market.[2] Furthermore, we do not examine the motivation to include private equity in the strategic asset allocation decision, but we will assume that the decision to pursue a certain private equity exposure has already been made.[3]

Our recommitment strategy makes new commitments to private equity funds every quarter. In addition, the strategy is dynamic in nature by taking into account the characteristics of the current portfolio. The level of the new commitments is determined by the past quarter's distributions in cash, the uninvested capital from earlier commitments as well as the exposure of the current portfolio relative to its target, indicated as 'investment degree' in the remainder of this paper. Committing the paid out cash distributions is intuitive, as these liquidated investments should as soon as possible be reinvested in private equity to keep the allocation at the desired level. Commitments which are not invested within a certain period of time

[2]Lerner *et al.* (2007) report that some institutional investors have been more successful than others at investing in private equity. It would be interesting to examine which factors determine the performance of a private equity investment strategy, but this is not the aim of our paper.

[3]A possible motivation to include private equity in an investment portfolio is provided by its risk and return characteristics. These have been studied extensively (i) at the firm level (Gompers and Lerner, 1998; Cochrane, 2005), (ii) at the fund level (Ljungqvist and Richardson, 2003a; Kaplan and Schoar, 2005; Phalippou and Gottschalg, 2007) and (iii) at the index level (Moskowitz and Vissing-Jorgensen, 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 illiquidity. However, conclusions from empirical research are mixed. Rather poor returns are reported by Moskowitz and Vissing-Jorgensen (2002) and Phalippou and Gottschalg (2007). 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 Gottschalg, 2007).

are recommitted in order to prevent leakage of private equity exposure. Finally, the current investment degree of the existing portfolio is used to either reduce or increase the new commitment to bring the exposure to the desired level.

Our results, based on historical simulations using the Thomson Venture Economics database, can be summarized as follows. Our main finding is that our recommitment strategy is capable of maintaining a stable investment degree that is close to the target allocation, while keeping the probability of being over-exposed within reasonable bounds. This conclusion holds for portfolios diversified across venture capital and buy-out capital and across the US and Europe. In addition, sensitivity analysis shows that our strategy remains equally successful when the portfolio is restricted to a certain type of private equity capital (buy-out or venture capital), to a specific region (US or Europe), or to varying fund manager experience (first-time or follow-on funds). More generally, the principle of our private equity recommitment strategy can easily be expanded to other illiquid asset classes that involve illiquidity and commitments, like direct real estate or infrastructure funds.

In addition, we find that achieving the target exposure is possible only when commitments for the initial portfolio, that is during the first year, are higher than the desired strategic allocation. This so-called '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. Nevertheless our analysis indicates that a 30% overcommitment during the build-up period (in our case one year) is required to achieve the desired exposure to private equity when starting a new portfolio. Furthermore, we show, with perfect foresight, that the quality of the strategy further improves if an investor uses the 3-year future investment degree of the current portfolio to scale up or down new commitments (instead of the current investment degree). Alternatively, an investor that can permit herself a higher allocation could consider overcommitment also when reallocating uncalled capital and distributions. We find that this brings the average portfolio exposure closer to the target, but at the cost of a higher risk of being overexposed. Finally, we compare our novel commitment strategy with the few alternatives that have been put forward previously. Cardie *et al.* (2000) present a commitment rule stating that investors should commit their

complete private equity allocation target every other year, or half of the allocation each year. A possible drawback of this strategy is that it neglects past portfolio developments 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 investments and the rate of distributions are the same for all private equity funds and constant over time, which is unlikely to hold in practice. In our analysis, we find that indeed both these commitment strategies are not capable of keeping 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 II describes the Thomson Venture Economics data. Section III discusses the cash flow dynamics for an investor in private equity funds. Section IV develops the novel recommitment strategies. Section V presents the empirical results, while Section VI concludes.

II Data

We use private equity fund data obtained from Thomson Venture Economics (TVE).[4] Our data set is comparable with Jones *et al.* (2003), Kaplan and Schoar (2005) and Phalippou and Gottschalg (2007), 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 individual 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, performance fees ('carried interest') as well as other costs. 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 or Europe (EU)), the type of investment (venture capital (VC) or buy-out capital (BO)), the fund managers experience ('first-time' or 'follow-on'), and the year of the fund's formation ('vintage year'). The distribution of funds over the different investment types and

[4]Obtained in the period until Q2 2006. We are aware that the Thomson Venture Economics database is backfilled. This backfilling will not distort our results, because we use the only cash flow data and not the returns.

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.

- insert Table 1 about here -

III Descriptive statistics

A Private equity cash flows

Private equity investments start with the investor committing a certain amount of capital to the fund. No capital is exchanged when this decision is made, but from that moment onwards the investor is obligated to provide capital whenever the fund manager asks for it. During a fund's lifetime commitments are irrevocable and the fund manager independently decides on the fund's investments and disinvestments. Investors only control the initial size of their commitments, they do not know in advance when and into which companies their money will be invested. As investment opportunities arise, part of the committed capital will be called by the fund manager. These contributions include the capital that actually is invested but also fees. Private equity funds typically unwind their investments by distributing the proceeds of sold participations to the investors ('limited partners'). Figure 1 shows the average cumulative 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.[5]

- insert Figure 1 about here -

From this figure we observe that it takes several years before the committed capital is invested. Investments are largest in the first year of the fund's lifetime when, on average, 32% of the commitments are invested. After that the pace at which capital is invested gradually decelerates. In the second year after the start of a fund on average 19% of the commitments is called, followed by 15, 10, 7 and 5% capital calls in the next four years. After approximately six years cumulative contributions

[5]The size of a private equity fund is defined as the sum of all the investors' commitments to the fund.

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.

Figure 1 also shows the average value of investments over the fund's lifetime, again expressed as a fraction of total commitments. The 'net asset value' (NAV) of a private equity fund is defined 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.[6] 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, for example, 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 (as mentioned before, the lifetime of a typical private equity fund ranges between 10-14 years). Phalippou and Gottschalg (2007) show that writing off these 'living-dead' investments 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 any cash flows take 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.[7]

The average fund's cash flow characteristics suggest that attaining a desired level of investment exposure to private equity and maintaining it for a prolonged period

[6] Valuing companies in accordance with certain guidelines is increasing though, for example using the International Private Equity and Venture Capital Guidelines developed by the European (EVCA), French (AFIC) and British (BVCA) venture capital associations.

[7] As 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.

is not straightforward. Commitments are only gradually called to be invested and distributions already 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 exposure are shown in Figure 2. This graph shows the portfolio weights of the cash from the initial commitment, the cash from the distributions, and NAV of the actual private equity investments over a fund's lifetime as percentage of the total capital involved. From Figure 2 it is very clear that committed capital does not equal the actual invested capital. The percentage of capital actually invested in private equity reaches its maximum in the fourth year of the fund's lifetime, where it equals not more than 60%. Hence, at that point still only 60% of total capital is actually invested, while 40% is left in cash. At all other times private equity exposure is less than 60%. Obviously this is undesirable for institutional investors.

- insert Figure 2 about here -

B Cash flows over time

As the vast majority of private equity funds has a finite lifetime most managers introduce a new fund every three to four years. All funds that start in a specific year belong to the same 'vintage year'. The summary statistics discussed before mask a great deal of variation in the cash flows and NAV across vintage years. This is borne out by Table 2, which presents the maximum investment degree and its timing (in quarters), as well as the number of funds, for each vintage year in our sample period (1980–2005). 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 peaks in the number of funds occurring at the end of the 1980s and 1990s in Table 2 give an indication of the cyclical pattern in supply and demand for private equity capital. Note in particular

the steep decline in the number of new funds after the collapse of the dot-com bubble in 2001, to just 21 in 2005. Second, we observe that the magnitude of the maximum investment degree varies over time and exhibits a downward trend. 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 23 quarters. It seems that it takes more time to reach to maximum invested degree for funds that started during economic downturns as in 1990–1991 and 2000–2001.

The considerable variation in the timing and height of the maximum investment degree across different vintage years reflects the fluctuations in private equity investment opportunities, documented by Gompers and Lerner (1998), which are due to fluctuations in supply and demand for private equity. The supply of private equity capital has been reported to vary over time due to changes in regulatory factors, in particular capital gains tax rates (Poterba, 1989; Gompers and Lerner, 1998),[8] state policies such as ERISA (Gompers and Lerner, 1998), and harmonization like the International Financial Reporting Standards (Cumming and Johan, 2007) or to labor market rigidities (Jeng and Wells, 2000).

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 84% of the commitments is called after four years while this is 77% for the 1990s. The differences in distributions across vintage years are much larger, ranging from a low of 7% for funds that started in 1982 to a high of 107% for funds dating from 1996. Averaging per decade, we find that the total distributions in the 1980s are almost three times lower (16%) than in the 1990s (41%). Hence, we conclude that the lower maximum investment degrees during the 1990s do not arise because less commitments are actually invested, but are due to the fact that distributions take place earlier.

The considerable variation in the size and timing of the cash flows motivates us to design a dynamic recommitment strategy that takes into account the composition

[8] Although 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.

of the current portfolio when making new commitments to achieve and maintain the desired exposure to private equity.

IV Commitment 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

$$ID_t = \frac{NAV_t}{NAV_t + \text{cash}_t}, \tag{1}$$

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. Recall that all capital calls have to be paid as the commitments made at the start of the fund are irrevocable. 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. First, however, we consider the issue of constructing an initial private equity portfolio to which the recommitment strategies can be applied.

A Setting up the initial portfolio

Implementing a recommitment strategy to maintain a constant exposure to private equity requires an already existing portfolio. In practice, the composition of this portfolio and accompanying characteristics may be given, but this need not necessarily be the case. As discussed in the introduction, a mature private equity portfolio can, in general, not be bought instantaneously, due to the lack of a well-developed secondary market. Hence, the start-up of a private equity portfolio is an interesting problem in its own right. 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 in line with Weidig and Mathonet (2004), who report that a diversified private equity portfolio contains approximately 20 funds. As discussed in Section II, the average maximum investment degree of private equity funds (60%, in year four) is well below one. This suggests that achieving a certain level of private equity investments requires an overcommitment strategy, where commitments exceed the target exposure. For example, for the average fund in our sample a commitment of 167% (that is, 67% overcommitment) would be required to obtain a private equity exposure of 100% in year four.

From Section B we know that cash-flow 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. Based on the findings in Section B, 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 limit liquidity risk and to make sure that we are not overinvested in the 1980s, although a larger overcommitment of about 60% would be preferred for

[9]Normally an investor would spread her 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 funds 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 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.

the portfolios that start in the 1990s.

B Recommitment strategies

Our investor considers three heuristic recommitment strategies to maintain her exposure to private equity at the desired level. 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 II, 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 $t - P$.

Although recommitting uncalled previous commitments as in strategy II should help to improve the average investment degree, it cannot possibly achieve the target exposure completely. The data analysis in Section II reveals that the investment degree for individual funds on average only reaches up to 60% of committed capital as shown in Figure 2. Obviously this applies not only to the commitments made for the initial portfolio in the first year, but also to the capital involved in the recommitment of distributions and uncalled previous commitments. Hence, in order to counter the effects of this underinvesting and maintain the target exposure, overcommitment also seems necessary at the recommitment stage.

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, implementing a strategy with a dynamic overcommitment percentage is not straightforward. Ideally, the overcommitment percentage for new commitments in a given quarter would be based on the actual investment degree that will be attained by funds from the current vintage

year, but in practice this is of course unknown. We argue that the current investment degree of the existing private equity portfolio also provides valuable information regarding the appropriate overcommitment percentage for new commitments. Intuitively, the further this investment degree falls below one, the more aggressive we should recommit capital to new private equity funds in order to bring the exposure back to the target level. Hence, strategy III sets the new commitments at the end of quarter t equal to the distributions received during that quarter and uncalled commitments made P quarters before as in strategy II, but now multiplied with the reciprocal of the investment degree of the current private equity portfolio. Hence, in strategy III the new commitments at the end of quarter t are determined by:

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

where C_t is the amount of new commitments made at the end of quarter t, ID_t is the investment degree of the current private equity portfolio, D_t are the distributions received during quarter t, and UC_{t-P} is the amount of uncalled capital 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).

C Implementation

We evaluate the performance of the three recommitment strategies by means of historical simulation using the TVE database. Hence, we form initial portfolios for vintage years from 1980 up to and including 2000, and apply the recommitment strategies for the remainder of the sample period. 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. Reinvestment strategies when limited to a certain type of funds or to a specific region are analysed in Section B below.

Second, after the portfolio construction period in the first year, 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, again 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.

V 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 and money needs to be borrowed to fulfill capital calls). When computing these statistics, we discard the first three years of the portfolio's life, in order to avoid any influence of the initial portfolio formation period.

A Main results

Panel (a) in Figure 3 shows how the average investment degree evolves over 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 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 applied 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.

As discussed in the previous section, it seems necessary to apply overcommitment at the recommitment stage as well to achieve an investment degree that is closer to the target value of one. Using the investment degree of the existing portfolio for setting the overcommitment percentage for the current recommitments as in strategy III appears to be quite effective, because it increases the investment degree and lowers the variation of the average investment degrees of the different vintage years. 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 the year 2000, driven by the large distributions made

during the dot-com bubble in that year. Due to the overcommitment effect, however, the investment degree quickly increases again in subsequent years.

- insert Figure 4 about here -

From Gompers and Lerner (1998, 2000), Kaplan and Schoar (2005) and Gompers *et al.* (in press) we learn that both capital flows and returns in the private equity market are cyclical. For example, the venture capital market experienced a boom in 1981–1983 and in 1998–2000 when investments grew dramatically in personal computer hardware manufacturers, and in internet and telecommunication companies, respectively. The question rises to what extent our recommitment strategy is cyclical in nature. This may be the case for several reasons. First, we might invest aggressively when the market becomes overvalued, because we will receive more distributions than normal that will be invested again. Second, it might be that we make larger commitments at times when investments are difficult to find due to our dynamic overcommitment, while simultaneously the uncalled commitments might be relatively large, resulting in additional recommitments after 6 years. This can lead to an undesirable accumulation of new commitments.

The detailed picture of the cash flows involved in strategy III, provided by panel (b) of Figure 3 for the 1980 portfolios, leads us to the answer to this question. First, on average the distributions 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] The new commitments do show some cyclicality in, for example, the year 2000. Nevertheless, the stability of the actual contributions illustrates that the cyclicality of our strategy is limited. Second we observe a rise in the commitments in year 7 due to the recommitments of the uncalled capital of the initial portfolio. We do not see this effect occurring again at a later stage, showing that by then the portfolios mature and do not become cyclical in nature.

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. The potential cyclical behavior of our portfolio is small and not a major

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

issue because our aim is to get a passive exposure to the private equity market that includes investments in over- and undervalued periods.

B Portfolio restrictions

B.1 Investment focus

So far we considered unrestricted portfolios, not imposing any limitations on the investment focus or accessibility. Here we examine the performance of our strategy when restrictions are imposed on the type of funds (VC or BO) or the investment region (US or Europe). Panel (a) in Figure 5 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 the number of buyout capital funds were very limited. Table 4 shows the corresponding summary statistics for all vintage years.

- insert Figure 5 and Table 4 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 5, panel (a) 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 dot-com bubble in 2000 and 2001. In those years 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 an increased 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.

B.2 Fund access

Typically, first-time funds are not in the position to turn away new investors, while established private equity fund managers may restrict access to their follow-on funds. Access to follow-on funds is in fact often limited to the shareholders that already participate in a current fund. As a result fund investors are required to invest some part of their assets in first-time funds from new managers. It has been documented that expected returns on first-time funds are lower on average than expected returns on follow-on funds, see Kaplan and Schoar (2005). Therefore, we examine the applicability of our strategy restricting the sample either to first-time funds or to follow-on funds. Our sample holds 1,529 (58%) follow-on funds and 1,089 (42%) first-time funds. Panel (b) in Figure 5 shows the average investment degree for the unrestricted portfolios as well as the portfolios consisting of first-time and follow-on funds only for vintage year 1986. The last two columns in Table 4 show the corresponding summary statistics for all vintage years.

The average investment degree for follow-on funds (0.83) portfolios is similar to the unrestricted portfolios (0.85), while the average investment degree for first-time fund portfolios (0.92) is higher. From Figure 5, panel (b) it can be seen that the average investment degrees for unrestricted and first-time portfolios deviate most, with the difference being most clear during the dot-com bubble in 2000–2001. During this period many first-time venture capital funds were raised. Second the volatility of the investment degree of the follow-on fund portfolios (8 percent) is similar to the total sample (9 percent), while the investment degree of the first-time fund portfolios is more volatile (12 percent).

Given that the results for first-time and follow-on portfolios resemble the results for unrestricted portfolios, we conclude that our strategy III can also be applied successfully to such private equity funds with different degrees of accessibility.

C More aggressive overcommitment

The analysis so far has demonstrated that making use of overcommitment with a dynamic percentage based on the investment degree of the current private equity portfolio leads to a successful recommitment strategy with stable performance. Nevertheless, the resulting private equity exposure is still below the target level by 15%

on average as the average investment degree is equal to 0.85. This finding can be understood intuitively from (2), which shows that new commitments become equal to current distributions and uncalled capital that was committed six years before. The slow and incomplete calls for capital then put downward pressure on the investment degree in subsequent quarters, as discussed before. Obviously, the average investment degree can be brought further up by more aggressive overcommitment, but this necessarily comes at a greater risk of liquidity shortfall. In this section we examine the balance between these two aspects, by reconsidering our strategy III, but now increasing the overcommitment with a constant percentage OC equal to $10, 20, \ldots, 50$ percent in each quarter:

$$C_t = \frac{1 + OC}{ID_t} \left(D_t + UC_{t-P} \right) \tag{3}$$

Panel (a) in Figure 6 shows the average investment degrees resulting from these strategies for the 1980 portfolios, with summary statistics provided for all vintage years in Table 5. Inflating the overcommitment percentage appears to be successful, in the sense that the average investment degree moves closer to the target level of one as OC increases. The increase in the investment degree that we observe for 1980 in Figure 6 is also prevalent for the other vintage years, see Table 5. The average investment degree goes up from 0.85 for strategy III with dynamic overcommitment only, to 0.89, 0.92, 0.95, 0.98 and 1.01 with additional fixed overcommitment equal to $10, \ldots, 50\%$. Unfortunately, the accompanying increase in the probability of being overinvested is substantial. 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% for strategy III without additional overcommitment. Hence, it seems that a more aggressive overcommitment strategy is suitable only when liquidity shortfall is not a serious problem for our institutional 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% additional 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 6 shows the average investment degrees resulting from strategy III including a 20% fixed 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 6 and Table 5 about here -

D Using the future investment degree

Using the current investment degree of the existing private equaty portfolio to determine the overcommitment percentage in quarter t, as in strategy III according to (2), might be sub-optimal because part of the previously committed but yet uncalled capital will be invested in the near future. Using the current investment degree might lead to an overestimate of the required commitments in quarter t. On the other hand, distributions from the current investments will likely continue in the future such that we may be underestimating the required overcommitment percentage. The results in Section A suggest that this second effect dominates.

The performance of the recommitment strategy may be improved by using 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 De 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 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 $t + Q$ for determining the overcommitment percentage to be applied 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 $4, 8, \ldots, 20$:[11]

[11] We 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 $t + Q$.

$$C_t = \frac{1}{ID_{t+Q}} \left(D_t + UC_{t-P}\right) \tag{4}$$

The average investment degrees resulting from these strategies for the 1980 portfolios are shown in panel (a) in Figure 7. 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 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 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 6. 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 7 shows the average investment degrees resulting from strategy III including 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 have matured.

- insert Figure 7 and Table 6 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 to determine the appropriate overcommitment percentage. It is advisable to employ investment degree forecasts for an horizon of three years.

E Existing commitment strategies

E.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 does not 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 annual number of funds that is selected (randomly) in each round of new 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 -

E.2 NCM-rule

Nevins *et al.* (2004)'s 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. For a 100 percent allocation target for private equity, the target level of committed capital according to the the NCM-rule is defined as:

$$C^* = 1 + \frac{r_{DI}}{r_{IN}}, \tag{5}$$

where 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. In case r_{DI} is large, more capital

needs to be committed to compensate for the reduction in investment degree due to 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, and find that 70 percent overcommitment as a result.[12]

The NCM-rule rests on two crucial assumptions. First, investors make commitments according to the computed allocation target for committed capital. Second, the rate of distributions and investments r_{DI} and r_{IN} in (5) are assumed to be constant over time and across private equity funds.[13] 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 seems to be unrealistic. As discussed in Section II, 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).

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 (170 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 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

[12]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 (5) is equal to 2.19, which is equivalent to 119 percent overcommitment. We find a percentage in the same order of magnitude as the 70 percent reported by Nevins *et al.* (2004) 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.

[13]This 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.

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 is not capable to keep the private equity 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.

VI Conclusion

This paper provides a (re)commitment strategy for long term institutional investors, such as insurance companies, pension funds or endowments, which aim to have a constant private equity exposure in their strategic asset allocation. Investors need this strategy because private equity is illiquid such that it, in general, cannot be bought instantaneously in the primary or secondary market. Given the high level of expertise and experience required for investing, managing and divesting of private equity, most investments take place through private equity funds. Our heuristic recommitment strategy makes new fund commitments every quarter and 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, with an dynamice overcommitment percentage determined 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 to determine an overcommitment percentage to counter the fact that committed capital is actually invested only gradually, with a delay that can extend to several years, with distributions already starting to occur before all commitments are called.

The recommitment strategy is evaluated 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. Furthermore we use a 30% overcommitment to initialize the portfolio in the first year. 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 being overexposed within reasonable bounds. Sensitivity analyses show that our strategy remains successful when the portfolio is restricted to a certain type of private equity capital, to a specific region or to fund managers with varying experience. Furthermore, 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 her new commitments. An investor that can permit herself a higher allocation could consider more aggressive overcommitment as this will bring the portfolio exposure closer to the target, but at the cost of a higher risk of being overexposed. In addition, we find that the commitment strategies of Cardie *et al.* (2000) and Nevins *et al.* (2004) are both not capable to keep the investment degree stable for a prolonged period of time. In particular, the investment degree remains permanently above its target.

The concept of our private equity recommitment strategy can be expanded further to other illiquid asset classes that involve commitments, like some specific real estate funds or infrastructure funds. Further research could also 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

	Region			
Investment type	US	Europe	Global	Total
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 vintage year	Maximum investment degree			
		Mean	Timing	$CC_{t=4y}$	$CD_{t=4y}$
1980	22	0.72	Q10	0.83	0.32
1981	24	0.85	Q14	0.90	0.09
1982	29	0.85	Q13	0.88	0.07
1983	63	0.83	Q13	0.92	0.23
1984	82	0.77	Q16	0.87	0.13
1985	76	0.75	Q9	0.92	0.26
1986	70	0.71	Q15	0.83	0.16
1987	116	0.68	Q18	0.78	0.14
1988	95	0.67	Q18	0.74	0.11
1989	114	0.66	Q17	0.74	0.11
1990	67	0.67	Q18	0.78	0.18
1991	61	0.55	Q17	0.63	0.15
1992	58	0.69	Q13	0.82	0.35
1993	94	0.57	Q12	0.75	0.43
1994	105	0.62	Q14	0.77	0.29
1995	111	0.61	Q17	0.77	0.38
1996	104	0.62	Q14	0.81	1.07
1997	180	0.64	Q12	0.81	0.73
1998	213	0.65	Q9	0.81	0.40
1999	248	0.57	Q12	0.75	0.12
2000	301	0.55	Q23	0.65	0.11
2001*	172	0.54	Q20	0.59	0.13
2002*	86	0.39	Q16	0.49	0.11
2003*	60	0.61	Q12	-	
2004*	46	0.36	Q8	-	
2005*	21	0.15	Q4	-	
Av. 80s	69	0.75	Q14	0.84	0.16
Av. 90s	124	0.62	Q14	0.77	0.41

Note: For each vintage year from 1980 to 2005, the table reports the number of funds, the magnitude and timing (in quarters) of the maximum investment degree and the cumulative contributions and distributions after 4 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 the average distributions, contributions and NAV for all funds that were started during that year.

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

Vintage	Strategy I			Strategy II			Strategy III		
year	Mean	StdDev	$P_{(ID>1)}$	Mean	StdDev	$P_{(ID>1)}$	Mean	StdDev	$P_{(ID>1)}$
1980	0.74	0.05	2%	0.77	0.05	3%	0.86	0.05	5%
1981	0.73	0.05	9%	0.77	0.05	9%	0.87	0.06	10%
1982	0.75	0.07	10%	0.81	0.06	12%	0.88	0.07	13%
1983	0.77	0.07	13%	0.80	0.07	13%	0.88	0.07	14%
1984	0.79	0.07	16%	0.80	0.07	16%	0.88	0.07	19%
1985	0.78	0.09	16%	0.80	0.09	16%	0.88	0.09	17%
1986	0.73	0.05	1%	0.76	0.05	1%	0.85	0.06	3%
1987	0.72	0.06	3%	0.75	0.06	4%	0.85	0.07	7%
1988	0.73	0.06	6%	0.75	0.06	6%	0.85	0.07	9%
1989	0.71	0.07	1%	0.73	0.07	1%	0.83	0.07	3%
1990	0.74	0.09	8%	0.75	0.09	7%	0.85	0.09	10%
1991	0.66	0.06	0%	0.71	0.07	0%	0.83	0.07	5%
1992	0.70	0.06	0%	0.71	0.06	0%	0.82	0.07	2%
1993	0.69	0.08	0%	0.72	0.09	0%	0.84	0.10	6%
1994	0.72	0.06	0%	0.75	0.07	0%	0.84	0.07	4%
1995	0.69	0.10	1%	0.70	0.10	0%	0.84	0.12	8%
1996	0.65	0.08	0%	0.66	0.08	0%	0.86	0.16	15%
1997	0.74	0.09	1%	0.76	0.09	1%	0.85	0.08	6%
1998	0.77	0.12	2%	0.77	0.12	3%	0.87	0.10	9%
1999	0.81	0.11	5%	0.82	0.11	5%	0.86	0.09	8%
2000	0.78	0.18	9%	0.77	0.18	8%	0.82	0.19	12%
Average	0.73	0.08	5%	0.75	0.08	5%	0.85	0.09	9%

Note: The table shows properties of the investment degree for private equity portfolios maintained using recommitment strategies 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 simulated portfolios. In each simulation, the initial portfolio is composed of 16 randomly selected funds from the relevant vintage year. Quarterly recommitments in subsequent years are equally distributed among four randomly selected new funds from that year. The first three years of the portfolios' life are not included in the investment degree statistics. 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 for restricted portfolios

Vintage	Investment focus				Fund access	
year	EU	US	BO	VC	FO	FT
1980	NA	0.84	NA	0.86	NA	NA
1981	NA	0.86	NA	0.86	NA	NA
1982	NA	0.88	NA	0.89	NA	NA
1983	NA	0.86	NA	0.88	0.84	0.95
1984	NA	0.85	NA	0.87	0.85	0.94
1985	1.04	0.84	NA	0.89	0.88	0.91
1986	0.89	0.84	0.86	0.86	0.83	0.89
1987	0.90	0.83	0.89	0.85	0.83	0.89
1988	0.92	0.82	0.89	0.84	0.82	0.91
1989	0.88	0.81	0.88	0.82	0.82	0.87
1990	0.93	0.80	0.91	0.82	0.80	0.92
1991	0.91	0.82	0.87	0.83	0.82	0.90
1992	0.85	0.80	0.85	0.82	0.80	0.86
1993	0.93	0.79	0.89	0.82	0.81	0.90
1994	0.89	0.82	0.86	0.85	0.82	0.91
1995	0.97	0.79	0.87	0.84	0.81	0.95
1996	0.99	0.81	0.92	0.88	0.83	1.04
1997	0.92	0.80	0.89	0.85	0.81	0.95
1998	0.94	0.82	0.85	0.89	0.85	0.94
1999	0.89	0.84	0.84	0.87	0.88	0.84
2000	0.92	0.74	0.73	0.86	0.76	0.92
Average	0.92	0.82	0.87	0.86	0.83	0.92

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, for specific portfolios only consisting of European, US, venture capital, buy-out capital, follow-on or first time funds. Reported is the mean investment degree based on 1,000 simulated portfolios (excluding the first three years of the portfolios' life). In each simulation, the initial portfolio is composed of 16 randomly selected funds from the relevant vintage year. Quarterly recommitments in subsequent years are equally distributed among four randomly selected new funds from that year. 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.

Table 5: Summary statistics of the investment degree in recommitment strategies with additional fixed overcommitment across vintage years

Vintage	Mean					$P_{(ID>1)}$				
year	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 additional fixed overcommitment (10, 20, 30, 40 and 50%). Reported are the mean investment degree and the fraction of observations with an investment degree higher than 1 ($P_{(ID>1)}$). Vintage year statistics are based on 1,000 simulated portfolios (excluding the first three years of the portfolios' life). In each simulation, the initial portfolio is composed of 16 randomly selected funds from the relevant vintage year. Quarterly recommitments in subsequent years are equally distributed among four randomly selected new funds from that year. 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 that include the future investment degree across vintage years

Vintage	Mean					$P_{(ID>1)}$				
year	$+4Q$	$+8Q$	$+12Q$	$+16Q$	$+20Q$	$+4Q$	$+8Q$	$+12Q$	$+16Q$	$+20Q$
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 investment degree and the fraction of observations with an investment degree higher than 1 ($P_{(ID>1)}$). Vintage year statistics are based on 1,000 simulated portfolios (excluding the first three years of the portfolios' life). In each simulation, the initial portfolio is composed of 16 randomly selected funds from the relevant vintage year. Quarterly recommitments in subsequent years are equally distributed among four randomly selected new funds from that year. The results for vintage years 2001-2005 are not reported as these portfolios are too immature to illustrate the effectiveness of the strategies.

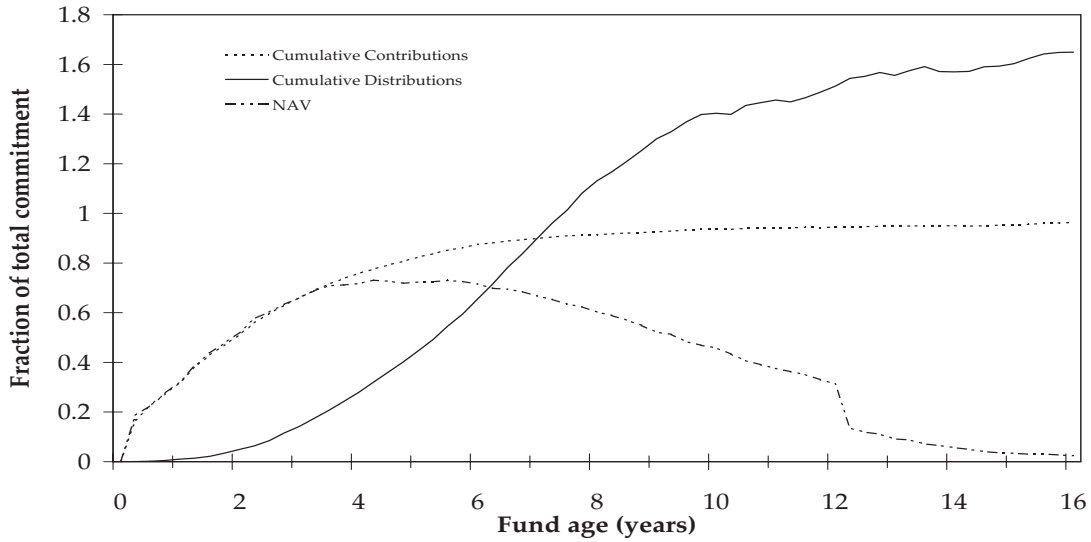


Figure 1: Average cumulative contributions, average cumulative distributions and average NAVs of individual private equity funds, 1980Q1-2005Q4.

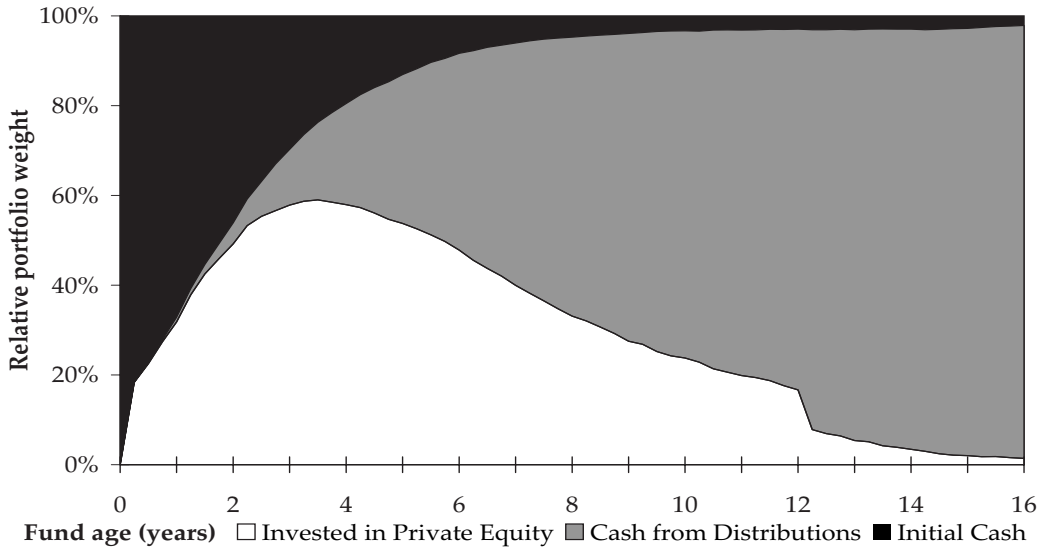
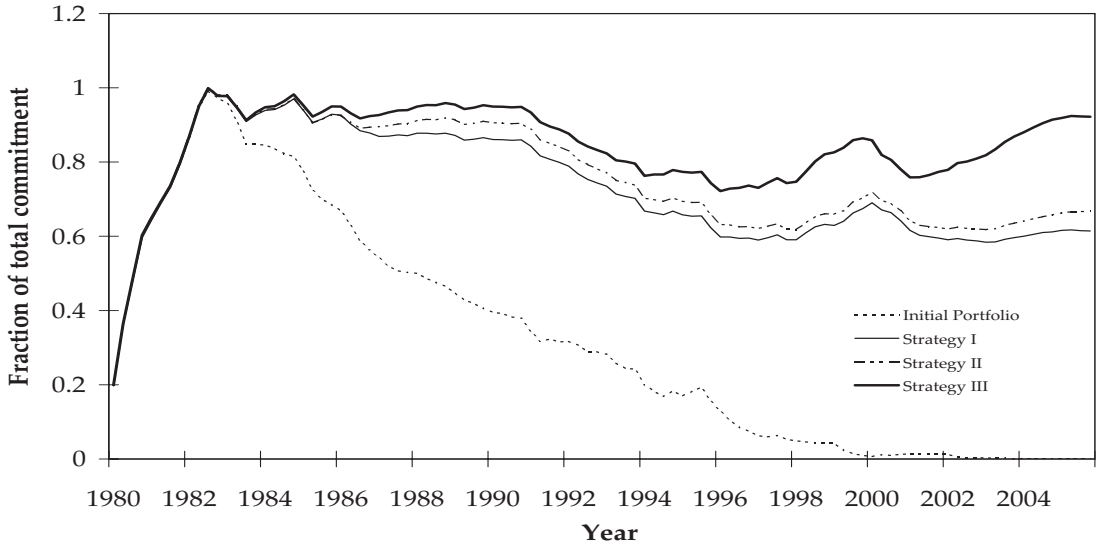
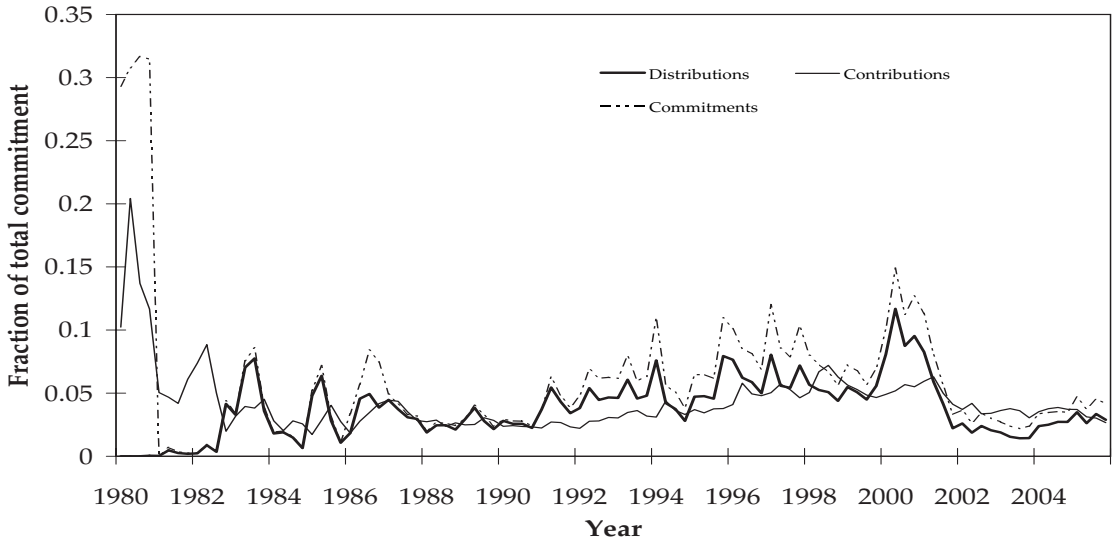


Figure 2: Cash versus actual private equity fund investment.

Note: This figure shows the average relative portfolio weight of the available cash at start (100), cash from the dis 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 maintained with recommitment strategies I–III for vintage year 1980 (panel (a)) and (re) commitments and cash flows of strategy III for vintage year 1980 (panel (b)).

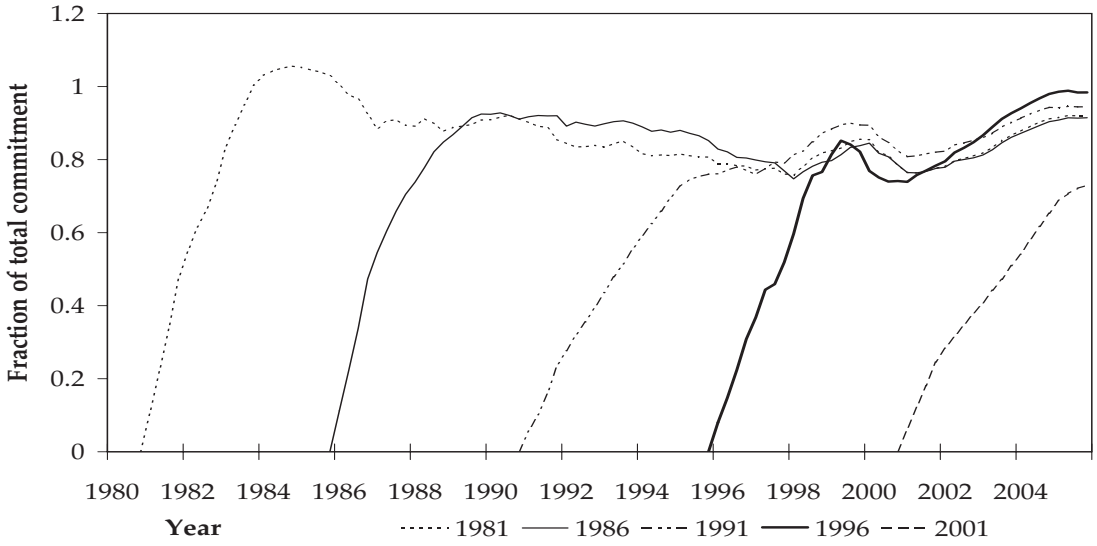
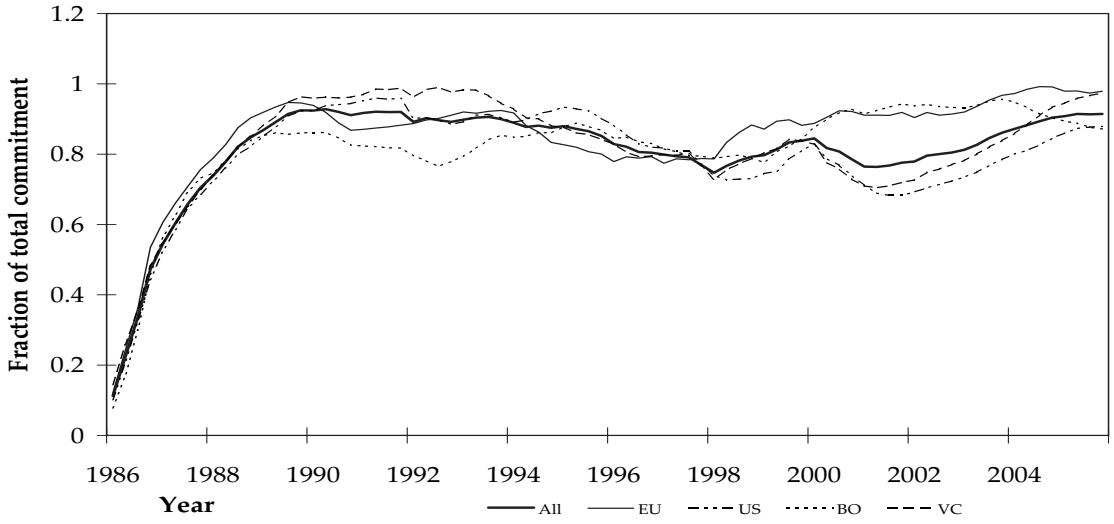
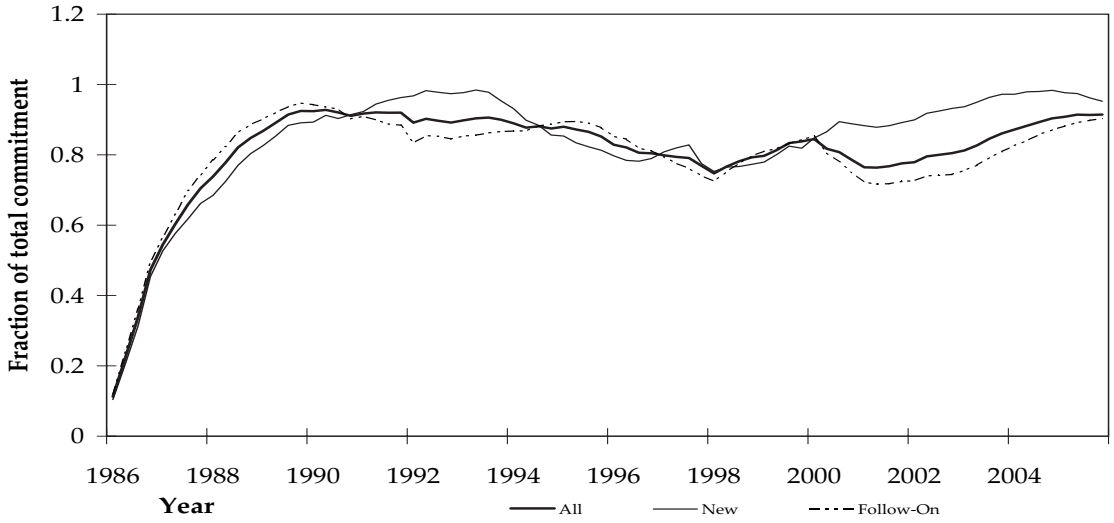


Figure 4: Average investment degree of private equity fund portfolios maintained with recommitment strategy III for vintage years 1981, 1986, 1991, 1996, 2001.

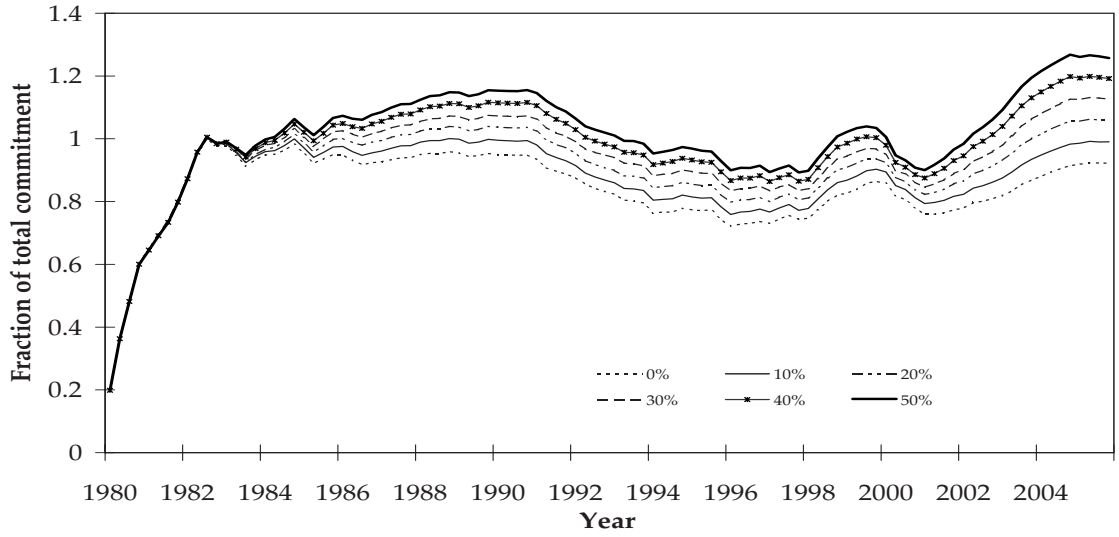


(a) Investment focus restriction

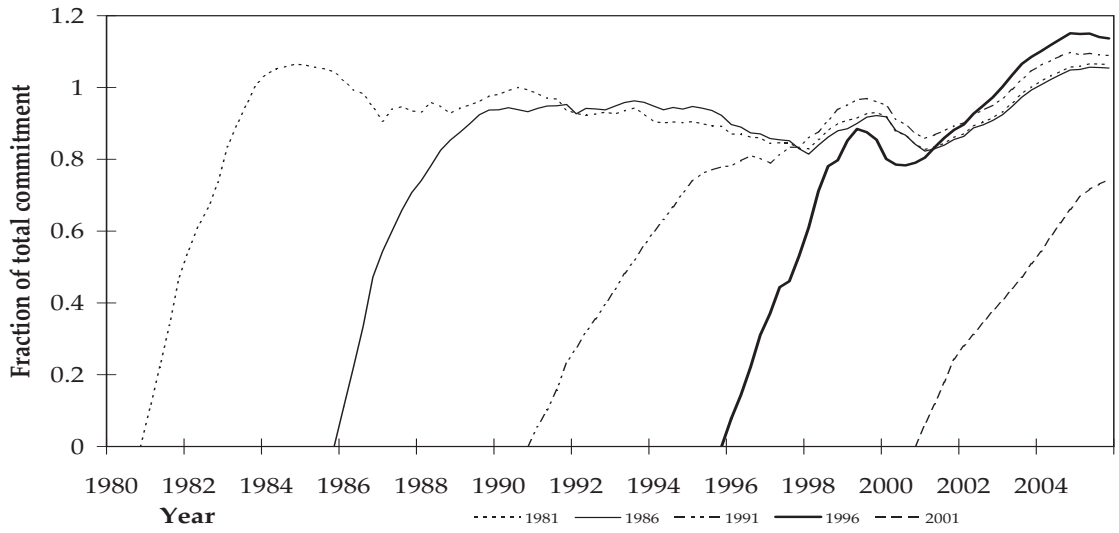


(b) Fund access restriction

Figure 5: Average investment degree of private equity fund portfolios maintained with recommitment strategy III for vintage year 1986 using all or only European (EU), US, buy-out (BO), or venture capital (VC) funds (panel (a)), or only new (first time) and follow-on funds (panel (b)).

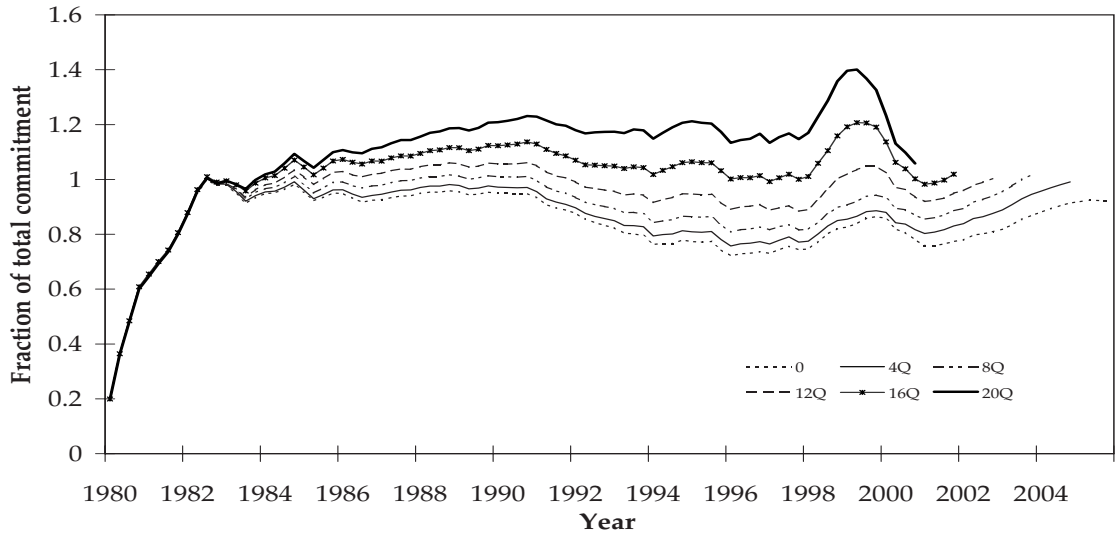


(a) Strategy III with varying additional overcommitment $(0, 10, \ldots, 50\%)$ for vintage year 1980

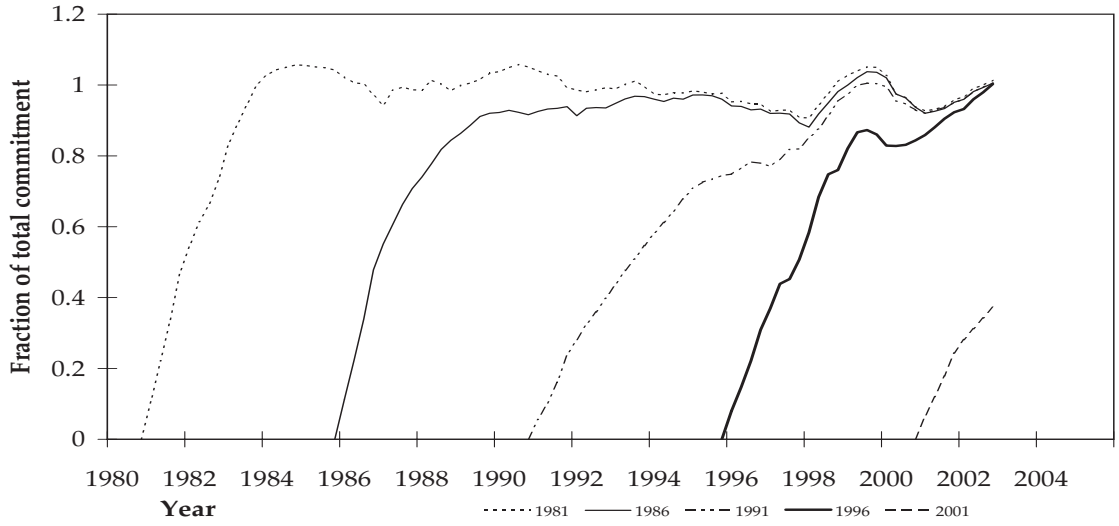


(b) Strategy III with 20% additional overcommitment for vintage years 1981, 1986, 1991, 1996 and 2001

Figure 6: Average investment degree of private equity fund portfolios maintained with recommitment strategy III with varying degrees of additional fixed overcommitment for vintage year 1980 (a) and 20% overcommitment for vintage years 1981, 1986, 1991, 1996 and 2001 (b).

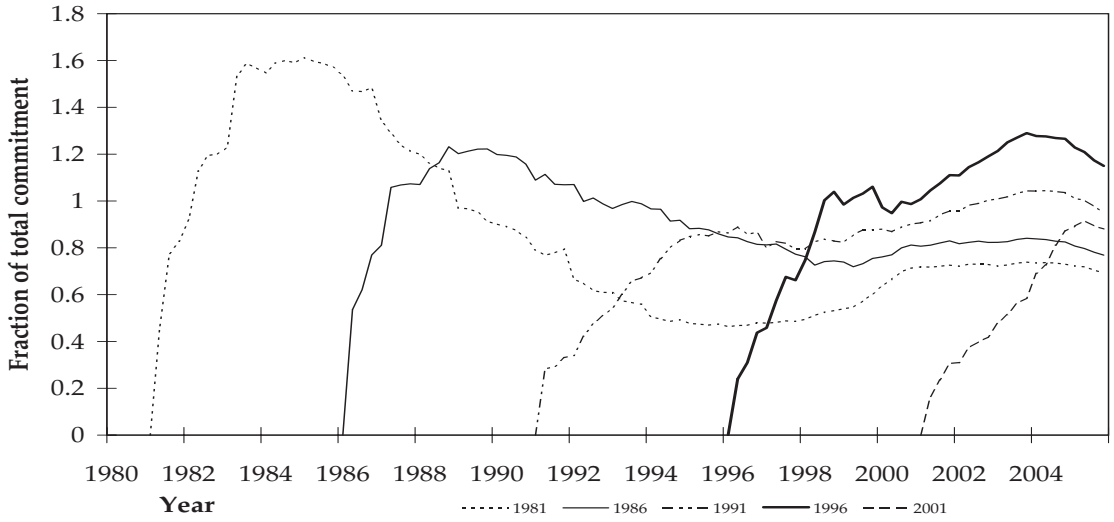


(a) Vintage year 1980

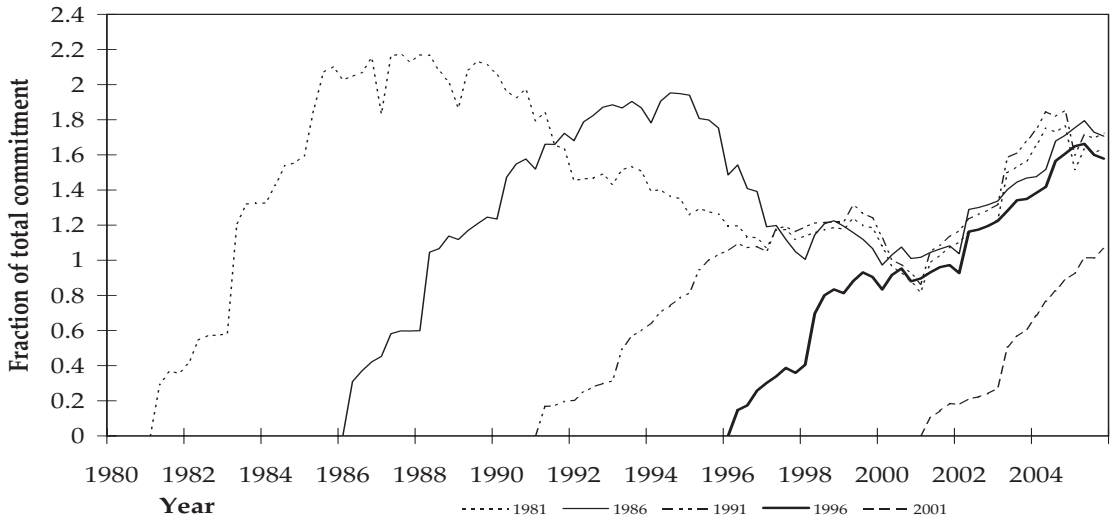


(b) Vintage years 1981, 1986, 1991, 1996, and 2001

Figure 7: Average investment degree of private equity fund portfolios maintained with recommitment strategy III with perfect foresight concerning the future investment degree at varying horizons for vintage year 1980 (panel (a)) and three-year perfect foresight for vintage years 1981, 1986, 1991, 1996, and 2001 (panel (b)).



(a) CCK-rule



(b) NCM-rule

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