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Are *UK venture capital* and *private equity valuations* **over-optimistic?**

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Abstract

Private equity and venture capital are, by their very nature, long-term investments. As such, it takes years for investors to see the finalised return on their commitments. In light of this, measures of interim fund performance are largely dependent on fund managers' valuations of as-yet-unrealised investments. Despite this, there has been relatively little work to test the statistical properties of these interim valuations. This paper addresses this gap, using data from the BVCA's annual *Performance Measurement Survey*. We find that interim valuations for both venture capital and buyout funds are typically too conservative in the early years of a fund's life, and that valuations typically normalise after around four to six years. There is no evidence of systematic overvaluation, which would artificially boost interim measures of fund performance.

Keywords: Private equity performance; interim IRRs; bias

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Executive summary

Private equity (PE) and venture capital (VC) commitments are long-term, illiquid forms of investment. In some cases, investors may not begin to receive returns from their investment until five or more years after the initial outlay. As such, the valuation that fund managers place on PE and VC investments at any given time is of critical importance – it is the means by which investors are able to gauge the performance of the fund.

There has been an increasing amount of debate recently around the accuracy with which PE and VC funds value their assets. Since active funds have not come to the end of their lives, some critics claim that the returns that are advertised by PE and VC funds are all paper returns, and are overstated by the fund placing an over-optimistic valuation on those assets.

This paper explores whether overvaluation occurs in practice, using data from BVCA members' funds. The BVCA collects detailed and comprehensive data from its members on their cashflows and valuations. From this, we are able to calculate the internal rate of return (IRR) for each fund for each year of its life. These yearly IRRs are then compared against the final IRR of each fund that has reached the end of its lifetime. In this way, we are able to compare how the valuations of different funds evolve over time – and the greater the difference between the interim IRRs and the final IRR, the greater the over- or understatement of the interim valuation.

Performing this analysis against a comprehensive database of over 150 funds which have reached the end of their lifetime, we find that there is no evidence of systematic overvaluation of assets by these funds. Indeed, we find that in the initial years, the valuations that PE and VC managers place on their assets are more likely to be conservative undervaluations.

This result runs counter to claims that private equity routinely overstates its investments in order to make funds' track records appear more attractive to future investors, and is yet further evidence that private equity firms seek to generate long-term sustainable returns.

1. Introduction

Accurately measuring returns from private equity (PE) investments is a key concern for investors and fund managers alike.[3] Given the unique characteristics of PE as an asset class, in particular the irregular timing of its cashflows both in terms of drawdowns, investments and distributions back to investors, the international benchmark for measuring PE performance is the internal rate of return (IRR). The IRR of a fund is essentially a measure of discounted cashflows over the life of the fund, with the implicit discount rate or IRR being the key indicator of financial returns.

Internal rates of return are very different from the types of buy-and-hold return (BHR) measures used for other asset classes. This means that IRRs and BHRs are not directly comparable. However, techniques do exist for consistently benchmarking PE funds' performance against public equity markets (BVCA, 2010a). And given the international nature of PE investments, currency movements can also play a key role in determining returns (BVCA, 2010b). However, one of the most critical underlying components of an IRR is the net asset valuation (NAV) that is used to calculate interim measures of returns – the value that PE firms put on the unrealised gains from their investments.

Concerns about valuations are not unique to PE, with mark-to-market assumptions in many asset markets coming under scrutiny during the recent credit crisis and global recession. But relatively little work has been done thus far to examine whether PE valuations are biased or not. If PE investors are – deliberately or otherwise – over-optimistic about their valuations, that implies that IRRs may be too high early on in the life of the fund, and hence that investors do not eventually get the same returns that early IRRs promise. However, relatively little work has been done in this area. Cumming and Walz (2009) is one exception, although that study uses disparate data from 39 countries, and finds that accounting and legal differences between those countries can have a significant impact on the accuracy of interim estimates of returns. In an economy such as the United Kingdom, where most PE houses' valuations are independently audited, results may be very different from less developed markets.

[3] Throughout this paper, we use 'private equity' to refer to the whole universe of private equity investments, including both venture capital and buyout investment models.

This paper uses BVCA fund-level data from the annual *Performance Measurement Survey (PMS)* to test for bias in UK PE valuations. After first describing our methodological approach, the paper then details the BVCA data underlying this study, before then examining whether there are signs of bias in interim valuations. Initially, these tests are conducted on an unconditional basis – that is, without reference to the underlying state of the economy, which could unexpectedly push valuations and returns either higher or lower. In light of this, we also use a powerful modelling approach to identify unexpected changes in the macroeconomic environment, and then – conditional on these shocks – re-examine our data for signs of bias.

2. Analytical approach

2.1 Background: internal rates of return

Internal rates of return are the international benchmark for measuring PE returns, as they are able to account for the irregular drawdowns and distributions that are one of the hallmarks of a PE fund.[4] The IRR calculation is a relatively simple one, where the return is the implied discount rate such that the net present value of all cashflows over the life of the fund is equal to zero:

$$NPV = \sum_{i=1}^{N} \frac{C_i}{(1+r)^i} = 0 \quad (\mathbf{1})$$

where *NPV* denotes net present value, which is set to zero in order to generate the IRR, C_i denotes cashflow in period *i*, and *r* is the calculated internal rate of return.

However, equation (**1**) only holds where PE funds are implicitly or explicitly closed – where all cash has been returned to investors and where the residual value of the fund is zero. Waiting until a fund is closed before gauging its returns would be unacceptable for PE investors, who are known as Limited Partners (LPs). As a result, during the life of the fund returns are calculated by taking into account the unrealised value of the investments the fund has made, known as the net asset value (NAV). While there are many different methods and concepts for this valuation figure, for the purposes of this section we will consider it as the expected present discounted sum of future cashflows:

$$NAV_i = E_i \sum_{i=j}^{N} \beta^i C_i \quad (\mathbf{2})$$

where β is the discount rate. In principle, the cashflows in equation (**1**) are readily observed – unlike some of the 'accounting' profits on mortgage-backed securities (MBS) prior to the credit crisis, LPs can actually see funds flowing into their bank accounts. However, by

[4] Throughout this paper, we use 'since inception' IRRs as measures of fund returns, as shorter-term measures can be misleading.

definition the forward-looking nature of NAVs means that there is, at the very least, expectational uncertainty around interim IRRs. Combining (**1**) and (**2**) for a typical mid-life investment at period *I*, and assuming that firms discount future cashflows (up to the final period, *N*) on the same basis as part returns, yields:

$$0 = C_0 + \frac{C_1}{1+r} + ... + \frac{C_I}{(1+r)^I} + E_I \frac{C_{I+1}}{(1+r)^{I+1}} + E_I \frac{C_{I+2}}{(1+r)^{I+2}} + ... + E_I \frac{C_N}{(1+r)^N} \qquad \textbf{(3)}$$

$$0 = \sum_{i=0}^{I} \frac{C_i}{(1+r)^i} + E_I \sum_{i=I+1}^{N} \frac{C_i}{(1+r)^i} \qquad \text{for } 0 \le i \le N \qquad \textbf{(4)}$$

$$0 = \sum_{i=0}^{I} \frac{C_i}{(1+r)^i} + NAV_I \qquad \textbf{(5)}$$

As a result, the key uncertainty around interim IRRs – returns for funds that have not yet closed – is the accuracy of the valuation that the PE firm puts on its unrealised investment.

The BVCA, along with the EVCA, AFIC, AIFI and other PE associations, has published international guidelines on how PE firms should value their unrealised assets (IPEV, 2009), details of which can be found in Annex A. But while these guidelines help General Partners (GPs) consider which valuation method is appropriate – for example valuing at cost, using multiples of earnings, or benchmarking against public competitors – the vast majority of valuations will be at least partly subjective. Ultimately, GPs have to make a judgement call about the most appropriate way to value their investments and underlying portfolio companies.

This subjectivity means that these valuations could be wrong, and hence that interim IRRs could be misleading. But it would be incredibly difficult, if not impossible, to verify whether the interim valuations are completely accurate in real time, ie during the life of any given fund. The only way we can get a definitive view on whether valuations are systematically biased is to look at the evolution of valuations and interim IRRs during the life of now-closed funds.

2.2 The role of perfect foresight

In light of this issue, this paper looks at the interim life and performance of now-closed funds in the BVCA's dataset. While these closed funds may have behaved differently from current (live) funds, this is the only sensible approach if we are serious about testing the accuracy of interim valuations. In total, the BVCA has data on over 150 closed funds, as described in Section 3, giving us a large enough sample for our findings to be statistically robust.

One key challenge, however, is how exactly to test whether valuations are correct or not. Net asset valuations will change from year to year as investments are realised and returns are distributed, as well as when GPs draw down as-yet uncalled funds to make new investments. While keeping track of cashflows is relatively simple, accurately gauging what the 'true' valuation of any investment should be is non-trivial, as all non-realised valuations are ultimately subjective in some manner.

Happily, there is an alternative, simpler, approach. In essence, it can be argued that the NAVs that GPs report represent the discounted unrealised returns from the investments they have made, (excluding management fees etc.). In that sense, they are not dissimilar to equity prices, which should reflect the discounted sum of future profits from a company (Panigirtzoglou & Scammell, 2002). Indeed, one of the formal measures in the International Valuation Guidelines is precisely a discounted cashflow basis. It is important to note that, given the very subjective nature of this valuation method, in practice it is generally only used alongside other valuation measures, and should be clearly justified. Nonetheless, the 'discounted future profits' approach allows us to take a different analytical approach.

Suppose, just for argument, that one particular GP had perfect foresight – that is, they knew exactly what would happen to their fund over its entire lifetime. (Let us also suppose that the fund only invested in one company, again for simplicity, as this would be highly unlikely in practice.) In light of their perfect foresight, that GP would know precisely how the enterprise value of the underlying company would evolve over the life of the fund, as well as exactly when drawdowns and distributions would happen. The fund would close with the final sale of the business at a price the GP could accurately forecast, and the return of those funds to LPs. Illustrative examples for enterprise value and net asset valuations in this scenario are shown in Figures 1 and 2.

Figure 1: Illustrative example of enterprise value with perfect foresight

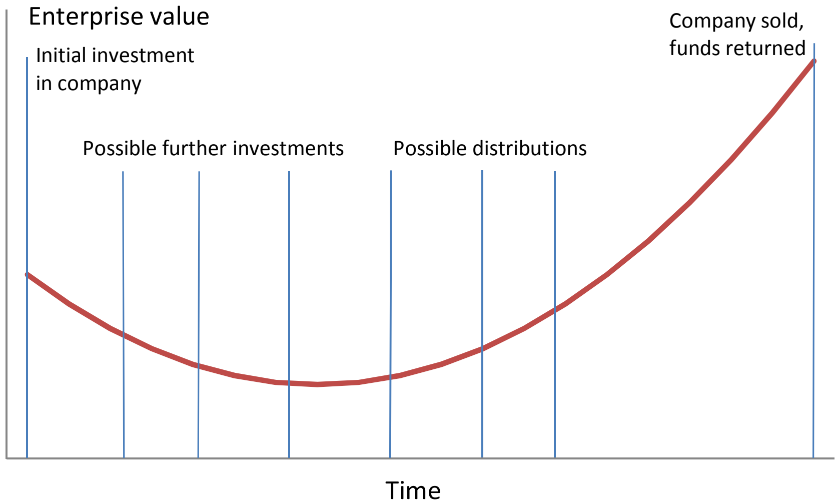
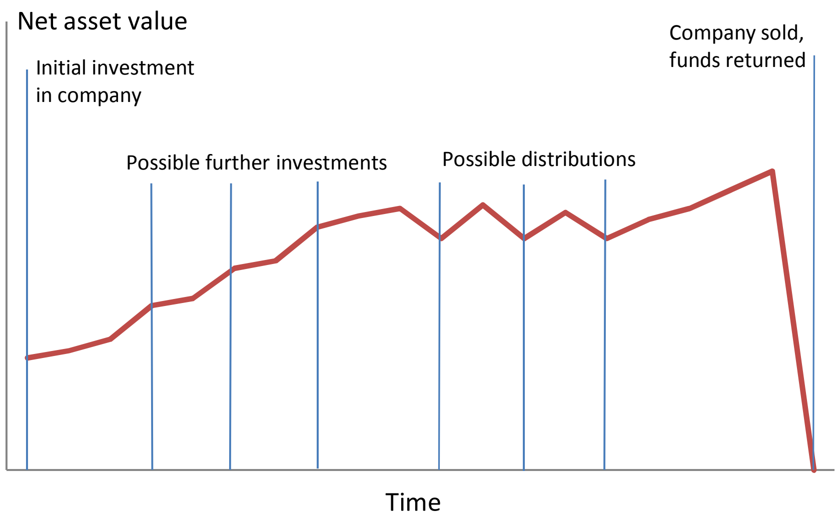


Figure 2: Illustrative example of NAV with perfect foresight



For our GP with perfect foresight, the NAV would evolve over the life of the fund in the usual way. To start with, before any investments had been made, it would be zero, but once the company had been acquired the NAV would reflect discounted future returns. As the fund matured, and those cashflows were realised, the NAV would decline correspondingly.

In algebraic terms, the changing value of the fund over time can be represented by the transition of equation (**3**) from period *I* to period (*I +1*):

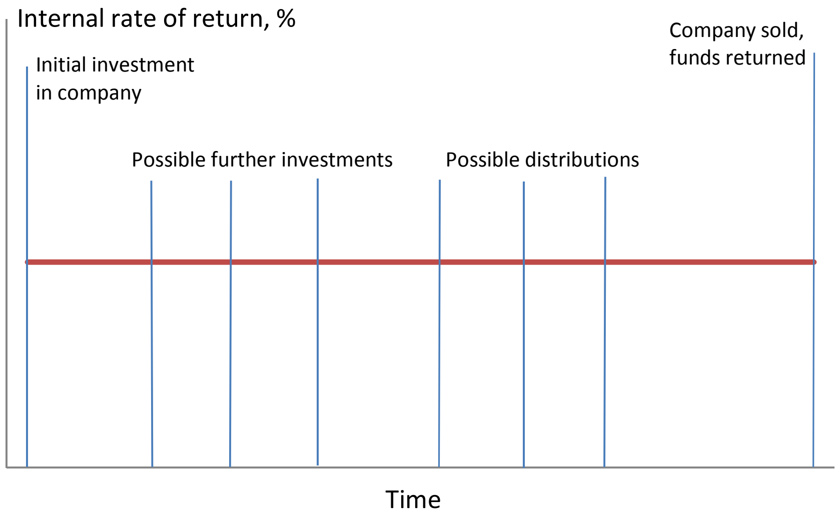
$$0 = C_0 + \frac{C_1}{1+r} + \ldots + \frac{C_I}{(1+r)^I} + E_I \frac{C_{I+1}}{(1+r)^{I+1}} + E_I \frac{C_{I+2}}{(1+r)^{I+2}} + \ldots + E_I \frac{C_N}{(1+r)^N} \qquad \textbf{(3)}$$

$$0 = C_0 + \frac{C_1}{1+r_b} + \ldots + \frac{C_I}{(1+r_b)^I} + \frac{C_{I+1}}{(1+r_b)^{I+1}} + E_{I+1} \frac{C_{I+2}}{(1+r_b)^{I+2}} + \ldots + E_{I+1} \frac{C_N}{(1+r_b)^N} \qquad \textbf{(6)}$$

Comparing (**3**) with (**6**), the only change in the IRR between period *I* and period *(I+1)* has to reflect either the expectational error in period (*I+1*) when the cashflow is observed, or changes in expectations of future cashflows from periods (*I+2*) onwards. However, under our assumption of perfect foresight, by definition all expectational errors are zero – and hence the IRR would be constant throughout the life of the investment.

This means that while enterprise values and NAVs will (and should) vary over time with perfect foresight, as the investment moves through its life-cycle, measured returns are a different matter. For our perfect foresight GP, the interim IRR at all points during the life of the fund should equal the final IRR. Because the GP knows when they will make investments (and how large those will be), as well as exactly when cash will be returned to investors, including proceeds from the final sale of the businesses, the interim IRRs they report should always equal the final realised IRR once the fund closes. Even before the GP has finished its planned drawdowns, they know exactly what the final return from the fund will be. Over the life of the fund, the time series of the reported IRR will be a flat line, equal to the final realised rate of return (Figure 3).

Figure 3: Illustrative time profile for IRR under perfect foresight



2.3 Back to reality – testing for bias

In practice, of course, perfect foresight is unrealistic. General Partners will make mistakes in valuing their investments, and changes in the underlying micro- or macroeconomic situation will also affect the portfolio company's performance. But perfect foresight does point towards a simple way of testing whether valuations are unbiased or not: we can simply look at how interim IRRs evolve over time, and how they converge to their eventual realised (or final) IRRs. This approach has been used to test for bias in other economic fields, such as inflation expectations (see for example Pacquet, 1992) and real-time data (Castle & Ellis, 2002). In order to use this approach, we must necessarily examine funds that are now closed, ie where we observe the final, realised IRRs. And, as with any backward-looking exercise of this type, it is important to bear in mind that the past evolution of valuations and returns may differ from the behaviour of current (live) funds and valuations.

The key point here is that while valuations will frequently be wrong – there is no such thing as perfect foresight – we want to test whether they are *systematically* wrong. If we observe that some interim IRRs are too low, and rise over time, but others are too high and decline, that would be consistent not with systematic bias but with general uncertainty and the subjective nature of valuations. If, in contrast, we saw all interim fund IRRs decline towards lower final IRRs, that would indicate that GPs were being too optimistic in their valuations.

As well as plotting and interrogating the data, we can also employ the usual statistical tests for bias.

This interrogation of our data will be carried out not just on our population of IRRs as a whole, as we can also split our sample between VC and buyout funds. Given that variations in returns from VC are likely to be greater than for buyouts – we might expect the former to exhibit higher potential returns but also increased risk of business failure – we might observe greater fluctuation of VC IRRs over time, compared with buyouts.

A final refinement in our approach is to take account of macroeconomic shocks. We have just been through the deepest recession that most people in advanced economies can remember, which no one accurately forecast. In light of such a large shock, it is likely that cashflows, valuations and underlying company performance may have been affected. And even though the recent recession will not have affected previously closed funds in our data, past economic shocks could also have affected performance, for instance when economic growth was stronger than had been expected.

In light of these factors, we also decided to account for these economic shocks using a powerful macroeconomic model known as a factor-augmented vector autoregression (FAVAR). This is described in more detail in Section 5. Essentially, once we have identified these economic shocks, we can then adjust the observed interim IRRs to take account of the impact the economic shocks may have had, and then test for bias in the usual way.

3. Our dataset

The BVCA's performance data is based on information collected for the years 1980 to 2009, and covers all independent UK-based PE funds that are managed by members of the BVCA and raise money from third-party investors.[5] Data is collected in the form of detailed cashflows that record individual drawdowns and distributions from each fund, as well as end of year fund valuations. It is important to note that, as we have recognised above, the drawdown and distribution figures represent actual drawdowns and distributions made by each fund – realised cashflows to and from investors – and only the end-year valuations are unrealised and therefore subject to uncertainty and a subjective judgement on the part of the fund manager.

Participation in the survey is a condition of membership for all UK-based BVCA member firms who raise funds from third party investors. As such, the coverage of our dataset is comprehensive, and is not subject to reporting bias from, for example, poorly performing funds choosing not to participate. BVCA members account for the vast majority of UK private equity firms, making the BVCA's dataset the most comprehensive and accurate database on the UK private equity market.

From these figures, we are able to compute yearly since-inception IRRs for each fund that provides data to the BVCA. In order to examine how closely these interim IRRs (and hence the valuations that underpin them) match up to the final (realised) IRRs, we need to look at the evolution of these yearly since-inception IRRs over time, compared with the IRR when the fund has exited all investments and distributed all capital to investors. At this point, the valuation of the fund should be zero and the final IRR is therefore observable, made up of realised drawdowns and distributions. By comparing this final IRR with the interim IRRs, we are able to observe whether the early valuations of investment portfolios match final returns, as the only unobserved variable in these interim IRR calculations is the end-year valuation of the portfolio by the PE fund manager.

The dataset we use in this paper is drawn from the BVCA's full fund performance data, and includes all funds where the valuation of the portfolio has reached zero for two consecutive years. We have chosen two consecutive years of zero valuation in order to ensure that we

[5] Captive funds are therefore excluded. The *PMS* also excludes mezzanine and infrastructure funds.

do not include any 'false positive' funds, where the IRR falls to zero due to write downs but subsequently regains some lost value. We also included the criteria that there should be no further drawdowns or distributions from the fund.

When analysing data for the whole population of funds, we also excluded those IRRs that were generated within one month of the first drawdown. In some instances these valuations looked unusual, given the short time frame since the initial investment, and could hence potentially produce misleading results. In total, our population included 154 funds, with vintages ranging from 1980 through to 2005, and the bulk having a vintage in the mid-late 1980s or early 1990 (Table A). Our population therefore includes a number of funds from the relatively early years of PE and VC in the United Kingdom. This is unavoidable, as only by looking at funds which have reached the end of their lifetime are we able to calculate the difference between interim and final IRRs, and therefore look at the evolution of IRRs and valuations over time.

Table A: Number of funds by vintage year

Vintage	Funds	Vintage	Funds	Vintage	Funds
1980	1	1989	14	1998	5
1981	3	1990	10	1999	2
1982	1	1991	13	2000	3
1983	2	1992	6	2001	1
1984	6	1993	6	2002	1
1985	13	1994	13	2003	1
1986	7	1995	5	2004	1
1987	11	1996	7	2005	2
1988	16	1997	4	**Total**	**154**

We also split our data between venture and buyout funds. This breakdown has been carried out by reference to fund manager self-definition, supplemented where necessary by data from ThomsonOne. The breakdown of fund type by year of vintage is shown in Table B. These sample sizes are large enough to be robust in testing whether there is systemic bias in the reporting of valuations, even when split into VC and buyout transactions.

Table B: Fund type by vintage year (a)

Buyout funds		Venture funds	
Vintage	**Funds**	**Vintage**	**Funds**
1980		1980	1
1981	1	1981	2
1982		1982	1
1983		1983	2
1984	3	1984	3
1985	5	1985	8
1986	3	1986	4
1987	5	1987	6
1988	7	1988	9
1989	7	1989	7
1990	6	1990	3
1991	7	1991	5
1992	5	1992	1
1993	3	1993	2
1994	8	1994	4
1995	3	1995	2
1996	7	1996	
1997	2	1997	2
1998	5	1998	
1999	2	1999	
2000	2	2000	1
2001	1	2001	
2002	1	2002	
2003	1	2003	
2004		2004	1
2005		2005	2
Total	**84**	**Total**	**66**

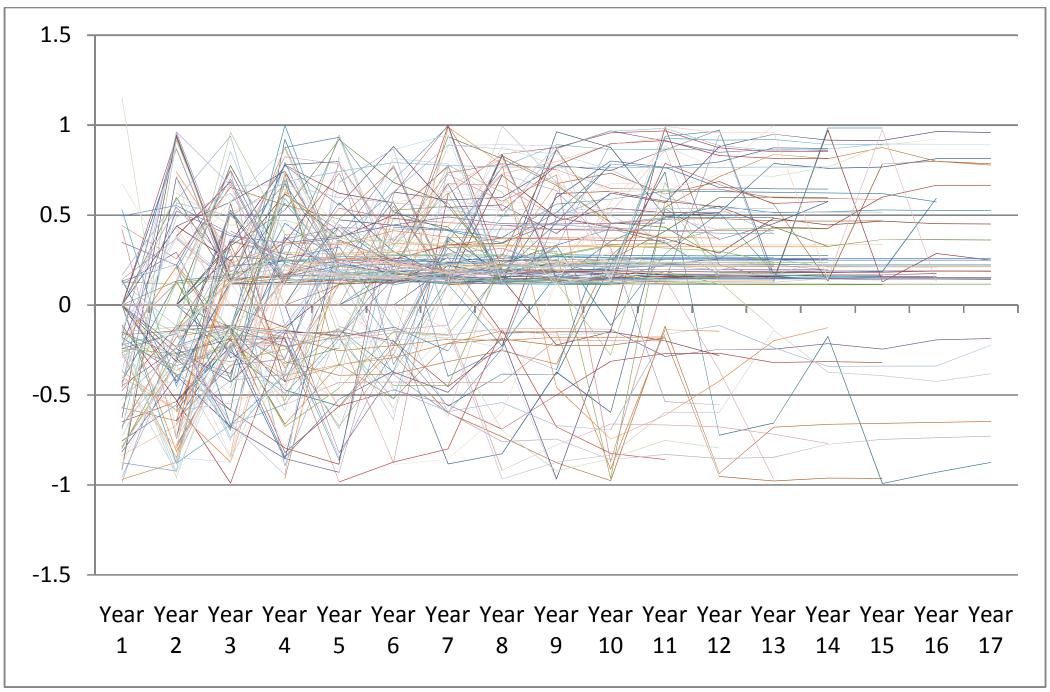
(a) Note that totals do not sum to total number of funds due to some funds being undefinable

4. Testing for unconditional bias in interim IRRs

4.1 Aggregate results

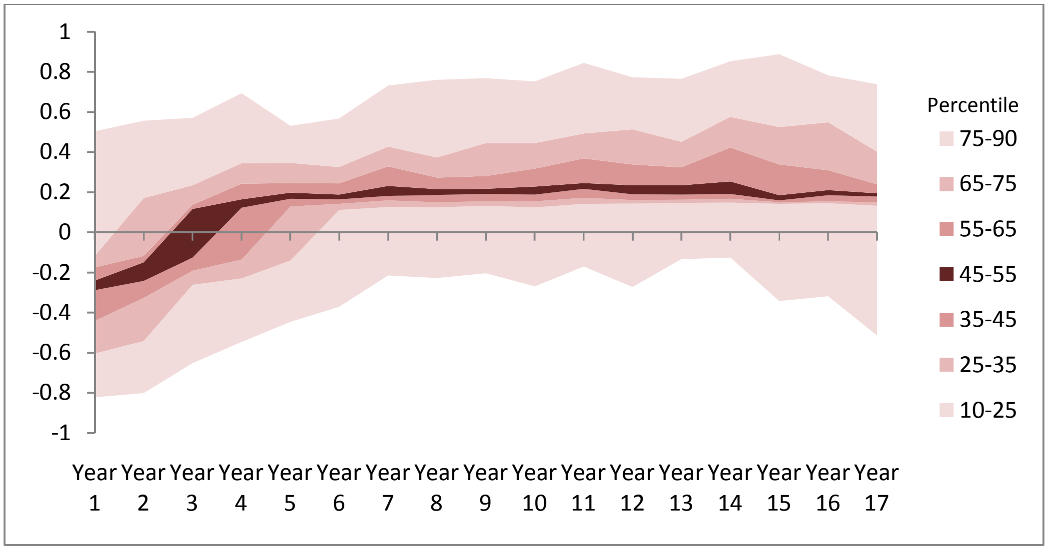
Figure 4, below, shows the grouping of IRRs for our entire population. The results are distributed in a somewhat bimodal pattern. The majority of funds appear to move towards a positive IRR by around year seven after the inception of the fund. This suggests that the distribution of the IRRs changes over time. Figure 5, which plots the evolution of the distribution of IRRs in a 'fan chart' format, confirms this. As fund life increases, it is more likely that the IRR of the fund will become positive and stable – with this taking around four years for the median IRR funds and up to around seven years for those funds in the higher or lower percentiles.

Figure 4: All IRRs by year since inception of fund (a)



(a) Excluding IRRs generated within one month of first drawdown.

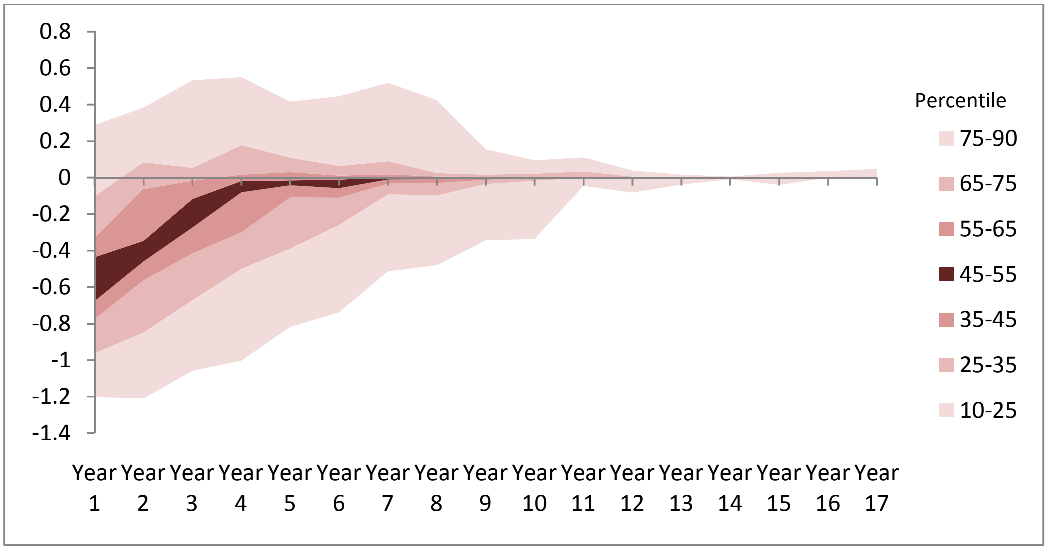
Figure 5: All IRRs by key percentiles (a)



(a) Figure 5 plots the evolution of key percentiles of the distribution of interim IRRs over time. The central decile of the distribution, between the 45th and 55th percentile, is shown in the darkest red bar in the middle of the Figure. Thereafter, the pairs of distributional bands on either side of the central decile are shown in progressively lighter shades, until the final pair of bands covers the 10th–25th and 75th–90th percentiles, respectively. The distribution is based on all funds which have reached a fund valuation of zero at 18 years since inception and therefore does not include a small number of funds with a non-zero valuation after this time. It is truncated at Year 17 due to the small number of funds that survive beyond this point.

To look at whether this implies unconditional bias, we need to examine the difference between interim and final IRRs for our funds for each year. As noted previously, in a world of perfect foresight all interim IRRs would be equal to the end IRR of each fund. Therefore, the difference between interim and final IRRs observed under perfect foresight would be expected to be zero at all points. As we can see from Figure 6 below, this is not the case, and convergence to zero takes some time.

Figure 6: Difference between end IRR and interim IRR by percentile (a)



(a) See footnote to Figure 5.

In addition to visual inspection, it is also appropriate to apply formal tests to the data in Figure 6. Table C presents the results of hypothesis tests – a simple t-test for the mean and the binominal sign test for the median – that the mean and median of the distribution, by year of the fund, are equal to zero. These confirm that, at the start of the sample, both mean and median IRRs are significantly below their final realised values. However, by year 7 there is no significant evidence of bias. This indicates that, if anything, initial valuations are likely to underestimate final returns. But there is no sign that valuations are systematically over-optimistic.

Table C: Tests for bias in interim IRRs (a)

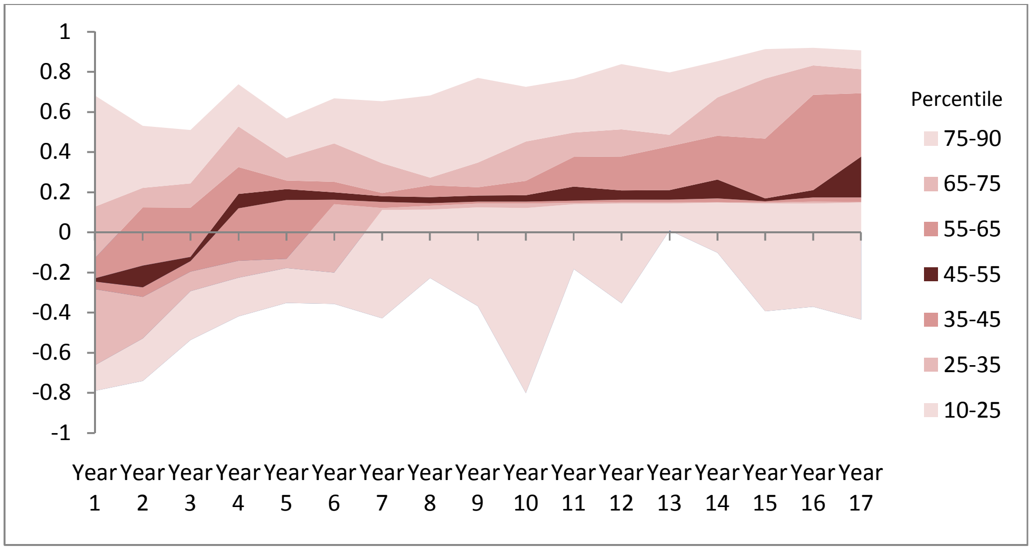
	Mean		Median	
	Test statistic	P-value	Test statistic	P-value
Year 1	-8.14	0.000	5.85	0.000
Year 2	-6.78	0.000	4.36	0.000
Year 3	-5.10	0.000	4.12	0.000
Year 4	-2.99	0.003	2.10	0.036
Year 5	-2.81	0.006	1.57	0.116
Year 6	-2.69	0.008	2.25	0.024
Year 7	-0.44	0.664	0.17	0.861
Year 8	-0.89	0.373	1.33	0.185
Year 9	-0.61	0.541	1.44	0.149
Year 10	-1.78	0.078	0.56	0.573
Year 11	1.89	0.062	1.92	0.055
Year 12	0.16	0.876	0.89	0.374
Year 13	-1.51	0.136	0.77	0.442
Year 14	0.05	0.962	0.81	0.417
Year 15	0.40	0.691	0.42	0.677
Year 16	1.23	0.231	1.75	0.080
Year 17	1.40	0.183	0.35	0.724

(a) Shading indicates statistical significance of non-zero mean (median) at the 5% level.

4.2 Separating venture and buyout funds

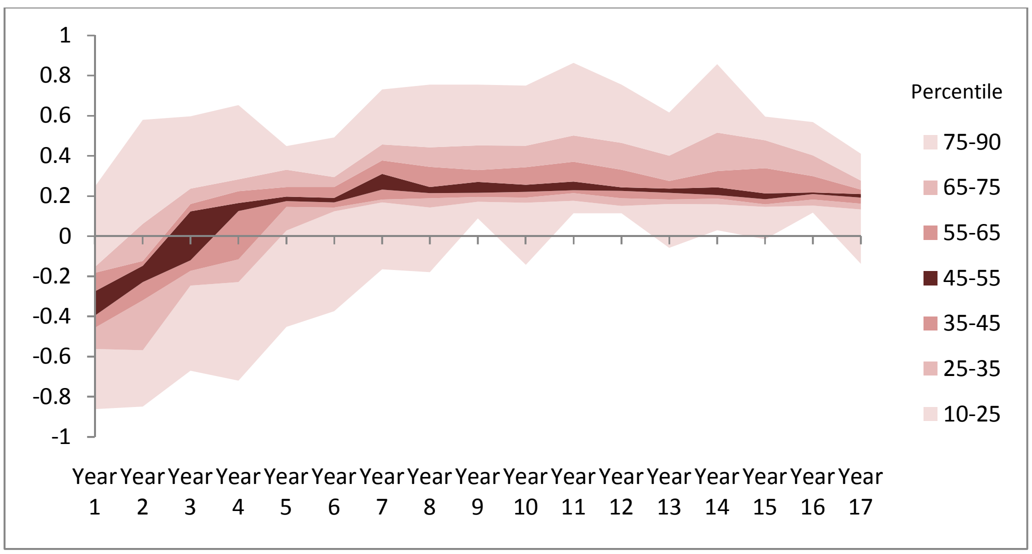
While the previous section considered all types of private equity funds in our sample, it is also interesting to examine the behaviour of VC and buyout funds separately. Figures 7 and 8 plot IRR percentiles (by year of fund), split between VC-focused funds and buyout-focused funds. Here we see a similar pattern of distribution as seen across the whole population, with increasing IRRs in the initial years, before becoming stable for the majority of percentiles. However, this pattern is more pronounced for buyout funds than for VC funds, suggesting that there is greater volatility in our population of VC funds – particularly the further the fund from the mean IRR.

Figure 7: Distribution of VC IRRs by year of fund (a)



(a) See footnote to Figure 5.

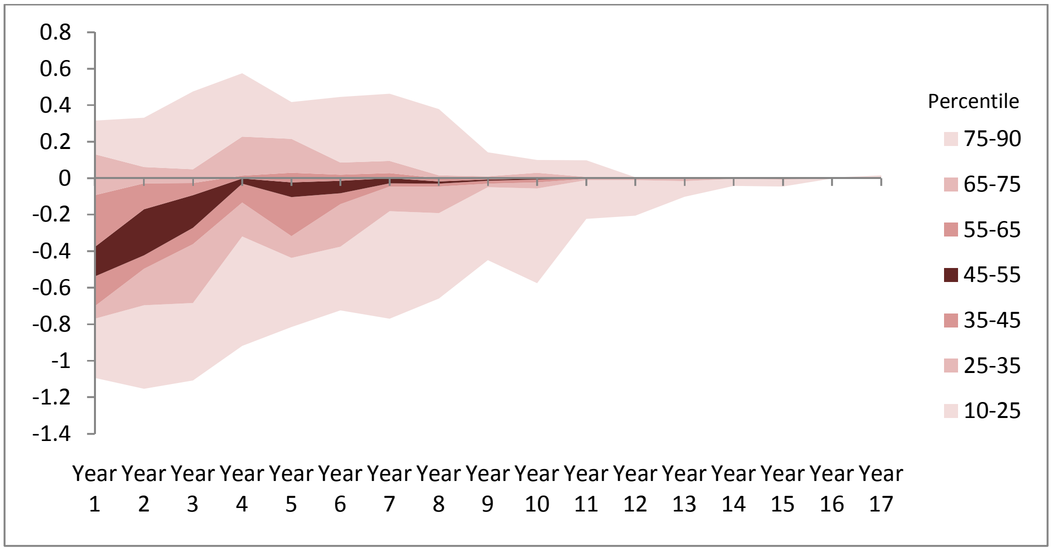
Figure 8: Distribution of buyout IRRs by year of fund (a)



(a) See footnote to Figure 5.

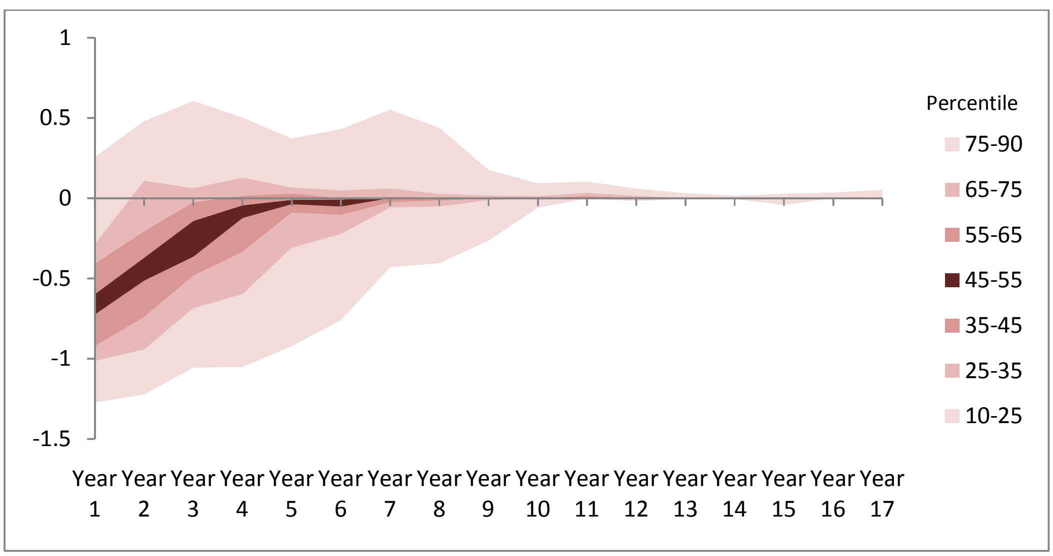
This result is largely borne out by investigating the difference between interim and final IRRs for our venture and buyout populations (Figures 9 and 10). Again we see a similar pattern to that of the whole population, with the majority of convergence in the distribution completed between years 4 and 7. However, for VC funds, the further the fund is from the median, the longer the time taken for the interim IRR to converge on the final IRR. This suggests that there is greater volatility within our VC population compared to our buyout population, and that the valuations placed on these portfolios may not, on average, be quite as accurate as those valuations carried out by a buyout fund. That is likely to reflect the nature of VC investments, compared with buyouts, where the risk-reward vector for any single investment is typically much higher.

Figure 9: Distribution of differences between VC interim and final IRRs (a)



(a) See footnote to Figure 5.

Figure 10: Distribution of differences between buyout interim and final IRRs (a)



(a) See footnote to Figure 5.

Once again we ran the statistical tests for means and medians of the data shown in Figures 9 and 10. Results are presented in Table D. The picture is surprisingly similar – in the early years of a fund's life, interim IRRs tend to be significantly below final realisations. However, this difference becomes insignificant by the time funds reach year 7, suggesting that managers' valuations improve over time. Furthermore, the convergence in the overall distribution is encouraging, although this in part reflects the dwindling sample size, as relatively few funds survive for a very long time. There are instances where VC funds have underestimated funds' final returns at around the tenth year, while buyout funds overestimated, but for both types of funds these instances were short-lived. There is no systematic evidence of bias in interim IRRs (and hence valuations) once funds are sufficiently mature.

Table D: Tests for bias in VC and buyout funds (a)

	Venture Capital				**Buyout**			
	Mean		Median		Mean		Median	
	T-stat	P-value	T-stat	P-value	T-stat	P-value	T-stat	P-value
Year 1	-2.08	0.046	2.16	0.031	0.999	0.323	4.286	0.000
Year 2	-4.36	0.000	2.91	0.004	-4.943	0.000	3.510	0.000
Year 3	-3.70	0.001	2.86	0.004	-3.355	0.001	2.667	0.008
Year 4	-1.09	0.280	0.68	0.496	-2.792	0.007	1.656	0.098
Year 5	-2.03	0.047	1.20	0.229	-2.137	0.036	0.994	0.320
Year 6	-2.27	0.027	1.82	0.068	-2.005	0.048	1.656	0.098
Year 7	-1.77	0.082	1.02	0.306	0.089	0.930	0.113	0.910
Year 8	-1.37	0.177	1.40	0.162	-0.138	0.891	0.000	1.000
Year 9	-1.82	0.074	2.05	0.041	0.248	0.805	0.000	1.000
Year 10	-2.13	0.037	1.30	0.193	0.045	0.965	2.125	0.034
Year 11	0.32	0.753	0.27	0.784	2.504	0.015	2.806	0.005
Year 12	-1.17	0.248	0.15	0.880	1.243	0.219	1.429	0.153
Year 13	-0.55	0.586	0.00	1.000	-0.994	0.325	1.200	0.230
Year 14	-1.45	0.156	-0.19	0.850	0.518	0.608	1.251	0.211
Year 15	0.94	0.355	0.00	1.000	-1.478	0.154	0.485	0.628
Year 16	0.90	0.378	1.25	0.211	-0.903	0.380	0.555	0.579
Year 17	1.06	0.306	0.00	1.000	-0.765	0.459	0.316	0.752

(a) Shading indicates statistical significance of non-zero mean (median) at the 5% level.

4.3 Why might early IRRs be underestimates?

Our results above suggest that, while there is no evidence of systematic overvaluation, initial valuations of PE investments are often understated, compared with the final realised returns. This is in many respects both understandable and expected, given the complex interactions that occur during the initial years of a fund's life in four key areas: drawdowns; method of valuation; restructuring of portfolio companies and the J-curve effect; and changing investment and divestment plans. Looking at each of these in turn, we can begin to build a clearer picture of the reasons for these initial underestimates.

First, drawdowns. The database used for this analysis is on a net-of-fees basis. Therefore, in the initial years of these funds, a significant proportion of the first drawdowns from investors represent amounts drawn down to pay management fees. These are in proportion to the total commitments of investors to the fund, as opposed to the amount invested in those early years. These management fees will go into paying for the running costs of the fund, and will not be invested. As such, they do not lead to a commensurate investment which will form part of the value of the fund's portfolio. In later years, as the fund is fully invested, these management fees form a much lower proportion of total drawdowns. Other things being equal, this timing effect would lower initial estimates of interim IRRs, as management fees – which do not contribute to a fund's IRR – form a greater proportion of the funds' drawdowns.

Second, the valuation methodology used in the initial years of a fund's life will have an effect upon initial and final IRRs. One method of valuation, which is recommended by the IPEV guidelines, is to value investments at cost for a period after acquisition (see the summary of valuation methodologies in Annex A). These 'at cost' valuations do not pick up increases in the value of the company in the initial years or expected future valuations, and therefore the reported IRR is understated in initial years.

Third, initial underestimates of IRRs should be seen in the context of the classic J-curve effect. Some interim valuations may reflect current market value, rather than future expected returns. If so, then given that the market value of a portfolio company often falls in the initial years of a buyout as restructuring occurs, it is likely that to some degree this underestimated IRR represents the current market value of the company, which may typically increase more in later years.

Finally, the valuations of funds could be expected to naturally evolve over time, as investments and divestments are made. Whilst a fund will often have a set investment plan, it is reasonable to assume that GPs do not have perfect foresight around exactly where and how they will invest the funds available to them. Therefore, the initial underestimates of IRRs could to some degree reflect the uncertainty around the many differently timed transactions that the average fund undertakes, and the lack of perfect foresight around these transactions.

It is likely that all of these factors will influence initial IRRs to some degree, and will be to a greater or lesser extent responsible for the initial underestimates of IRRs that are evident in the data. Further work on the interplay between these factors is a possible avenue for future research.

It is worth noting that all of these interactions reflect the fundamental nature and measurement of VC and buyout funds. But it is also possible that exogenous factors such as economic shocks may play a role in the evolution of interim IRRs. This possibility is discussed and explored in Section 5.

4.4 Differences between first time and follow-on funds

Apart from splitting our sample by investment focus (ie VC versus buyout), it is also useful to divide fund performance in other ways. One obvious avenue of exploration was to examine whether first-time funds perform differently to follow-on funds. Given the widely acknowledged persistence of returns across funds (Kaplan and Schoar, 2003), it may be that only strong-performing GPs survive to set up follow-on funds, which could have an impact on the evolution of performance.

Our dataset allows us to identify whether a particular fund is a first-time or follow-on fund, thereby letting us test this hypothesis. However, it is important to note that our data identifies the fund vintage by the PE house, rather than by the individual GP. As such, our data do not capture incidences where individual GPs leave one PE house to join another. In those instances, investors may refer to the individual's own track record as a fund manager, which could influence fundraising and investment performance. Unfortunately, we have no way of controlling for individual GP transitions between funds and firms.

We split our sample into first-time and follow-on funds; by number, the former accounted for just under 40% of total funds. As before we examined the distributional evolution of interim IRRs, compared with the final realised IRRs, and re-ran the statistical tests for bias. Results are shown in Table E below: once again, while there is evidence of upward convergence towards the final realised IRR when both first-time and follow-on funds start, there is no evidence of systematic bias after that transition.[6]

Table E: Tests for bias in first and follow-on funds (a)

	First funds				**Follow-on funds**			
	Mean		Median		Mean		Median	
	T-stat	P-value	T-stat	P-value	T-stat	P-value	T-stat	P-value
Year 1	1.00	0.326	3.21	0.001	-1.773	0.083	3.818	0.000
Year 2	-2.88	0.006	2.09	0.037	-6.474	0.000	4.171	0.000
Year 3	-2.26	0.029	2.04	0.041	-4.813	0.000	3.512	0.000
Year 4	-1.20	0.238	0.72	0.471	-2.874	0.005	1.976	0.048
Year 5	-1.26	0.214	0.29	0.771	-2.690	0.009	1.637	0.102
Year 6	-1.48	0.145	1.43	0.153	-2.290	0.025	1.637	0.102
Year 7	-0.26	0.796	-0.14	0.888	-0.355	0.723	0.222	0.824
Year 8	-0.11	0.916	1.43	0.153	-1.156	0.251	0.450	0.653
Year 9	0.16	0.873	1.19	0.233	-1.015	0.313	0.793	0.428
Year 10	-0.90	0.372	0.00	1.000	-1.572	0.120	0.598	0.550
Year 11	1.56	0.127	0.79	0.429	1.145	0.256	1.707	0.088
Year 12	0.03	0.978	0.51	0.607	0.357	0.723	1.750	0.080
Year 13	-0.09	0.925	0.00	1.000	-1.590	0.119	1.200	0.230
Year 14	0.64	0.525	0.67	0.502	-1.015	0.318	2.121	0.034

(a) Shading indicates statistical significance of non-zero mean (median) at the 5% level.

4.5 Separating funds by performance

The persistence of performance also suggests another line of enquiry – in particular, to examine the evolution of interim IRRs, conditional on the relative performance of those same funds so far. Because the BVCA collects performance data from all its members that raise money from third-party investors, we are able to accurately identify the best and worst performing funds. The BVCA already publishes top- and bottom-quartile returns by vintage year in its annual *Performance Measurement Survey* (see BVCA, 2010). It is possible that the evolution of interim IRRs for top-quartile funds is different to bottom-quartile funds. For instance, if bottom-quartile funds appear to perform poorly because interim valuations are too low, and subsequently rise, then this pattern may not be evident in the aggregate data.

One key issue in testing this hypothesis was picking which year of a fund's life was most appropriate to make the top/bottom quartile distinction, given the obvious variation in

[6] Table C only reports results up to Year 14 as sample sizes beyond that point were too small.

interim IRRs (Figure 4). In light of the observed upward convergence in early IRRs documented so far, we decided to rank our funds at Year 5, around the time that the downward initial bias had started to fade. In doing so, we had 33 funds in each of the top- and bottom-quartile categories, and tested again for bias in each of these subsamples.

The results are shown in Table F. Interim valuations at Year 5 appear to have been over-optimistic for top-quartile funds, while they are too low for bottom-quartile funds. But those biases quickly evaporate – and, as before, there is no statistical evidence of systematic bias once the initial convergence had taken hold. These results were broadly unchanged when we divided funds into top and bottom quartiles at Year 3, rather than Year 5 (Table G).

Table F: Tests for bias in top- and bottom-quartile funds at Year 5 (a)

	Bottom quartile (Year 5)				**Top quartile (Year 5)**			
	Mean		Median		Mean		Median	
	T-stat	P-value	T-stat	P-value	T-stat	P-value	T-stat	P-value
Year 5	-4.97	0.000	4.07	0.000	3.849	0.001	3.133	0.002
Year 6	-2.12	0.042	2.65	0.008	0.561	0.579	0.348	0.728
Year 7	-0.15	0.882	0.00	1.000	0.712	0.482	0.884	0.377
Year 8	-1.03	0.309	1.80	0.073	0.694	0.493	0.177	0.860
Year 9	-1.10	0.282	0.91	0.361	-0.945	0.352	1.114	0.265
Year 10	-1.42	0.167	0.59	0.556	-1.077	0.291	0.385	0.700
Year 11	1.15	0.262	1.31	0.190	0.135	0.893	0.000	1.000
Year 12	-1.70	0.105	0.71	0.480	1.580	0.128	0.707	0.480

(a) Shading indicates statistical significance of non-zero mean (median) at the 5% level.

Table G: Tests for bias in top- and bottom-quartile funds at Year 3 (a)

	Bottom quartile (Year 3)				**Top quartile (Year 3)**			
	Mean		Median		Mean		Median	
	T-stat	P-value	T-stat	P-value	T-stat	P-value	T-stat	P-value
Year 3	-10.79	0.000	4.77	0.000	3.254	0.003	2.652	0.008
Year 4	-2.63	0.013	1.44	0.151	-0.562	0.578	0.530	0.596
Year 5	-3.16	0.004	1.86	0.063	-0.517	0.609	0.177	0.860
Year 6	-2.15	0.040	1.64	0.100	-0.813	0.423	0.177	0.860
Year 7	-1.36	0.183	1.28	0.201	0.884	0.384	0.530	0.596
Year 8	-0.97	0.341	2.08	0.038	-0.064	0.949	0.530	0.596
Year 9	-0.20	0.842	1.70	0.089	0.165	0.870	0.718	0.473
Year 10	-0.01	0.994	0.59	0.556	-0.318	0.753	0.000	1.000
Year 11	-0.12	0.908	0.64	0.522	1.787	0.085	0.417	0.677
Year 12	-1.25	0.224	-0.25	0.803	1.676	0.108	1.376	0.169

(a) Shading indicates statistical significance of non-zero mean (median) at the 5% level.

When conducting this analysis, it is important to note that the funds in our sample are drawn from different vintages. That means that, while we are able to compare years of different funds' lives , those years are occurring at different times: for instance, Year 1 of a 1990 vintage fund will be 1990, while that would be Year 11 of a 1980 vintage fund. As such, we should ideally control for the underlying economic situation. Given that fund performance depends on enterprise value, which in turn can reflect both wider economic conditions and company-specific developments, it is important to consider the impact that the state of the economy can have on returns. In particular, if particular economic circumstances – which are beyond the control of GPs – drive strong or weak performance, that makes comparing different funds' returns more complex. In addition, unexpected macroeconomic developments can also drive returns away from what GPs had previously expected, and hence could drive final IRRs away from interim measures. The next section examines this in more detail.

5. Testing for conditional bias in interim IRRs

The previous section found that there was no statistically significant evidence of positive bias in interim IRRs, although initial valuations do appear to have underestimated final returns in the past. This strongly indicates that PE valuations are not overly optimistic. But, in conducting this analysis, we did not take account of any of the economic shocks that may have driven valuations (and hence returns) away from what GPs previously expected. This section addresses this issue.

5.1 Identifying economic shocks and generating conditional IRRs

Before we can take account of how economic shocks may have affected the time profile of interim IRRs, we first have to identify and quantify what those economic shocks were. This quantification necessarily requires some form of economic model.

Different economists favour different forms of economic models, and there are many potential types to choose from. Because our focus was primarily empirical, we decided against using a Dynamic Stochastic General Equilibrium (DSGE) approach, as the rich theoretical structure that these models enjoy typically comes at the cost of them being very small, having to extensively manipulate data, or being very complex. A benchmark vector autoregression (VAR), meanwhile, offers a relatively simple approach, but again typically covers only a limited number of variables.

Given that we wanted to capture a wide variety of data, we opted for the factor-augmented VAR approach first proposed by Bernanke *et al* (2005), and recently applied to UK data by Mumtaz *et al* (2011). We do not provide a detailed description of the modelling process here, as these two references provide an excellent guide. To summarise, a FAVAR combines the simplicity of a standard VAR approach with the ability to incorporate hundreds of data series. Once the data are compiled, the modelling approach uses principal components from the dataset, and models a limited number – typically less than ten – of those components in VAR form. The first ten principal components tend to capture the majority of the variance in the underlying dataset, while the eigenvectors from the principle component transformations allow impulse responses to be mapped back onto individual data series.

Given the international nature of many BVCA members and their investments, we decided to proceed with two FAVARs – one based on annual UK data, sourced primarily from the Office for National Statistics (ONS), and one based on annual international economic data, sourced primarily from the International Monetary Fund (IMF). The residuals from these two models then formed our estimates of the economic shocks that hit the UK and global economies.[7] A full list of the economic data used to generate the models, and the residuals from these models, are available in Annex B.

Finally, we generated conditional IRR series from our unconditional IRRs using simple regressions of the unconditional data on our generated shock series for the first four principal components. By construction, the residuals from these regressions were orthogonal to the economic shocks that we had identified.

5.2 Results for conditional interim IRRs, using UK shocks

Having constructed these conditional measures of interim IRRs compared with final (realised) IRRs, we then proceeded to test for evidence of bias in the distribution as before. The results from this exercise, using estimates of economic 'shocks' from the UK FAVAR, are shown in Table H. These results are broadly comparable to those based on unconditional IRRs in Table C, with no sign of systematic overvaluation. However, early valuations are still downwardly biased, indicating that macroeconomic developments are not the cause of the same bias seen in the unconditional data. In turn, that is consistent with early valuations being low for the investment- and fund-specific reasons set out in Section 4.3.

These results are also consistent with PE's ability to ride out the macroeconomic cycle – with no sign that, having controlled for the cycle, there is any systemic overvaluation of assets. This result also chimes with other work by Wright *et al* (2011), which found that PE-backed companies performed better during the recent recession than comparable public and private companies.

[7] This mirrors the approach described in Blanchard and Fisher (1989) .

Table H: Tests for non-zero means and medians, conditional on UK shocks (a)

	Mean		Median	
	Test statistic	P-value	Test statistic	P-value
Year 1	-4.82	0.000	5.14	0.000
Year 2	-6.49	0.000	4.33	0.000
Year 3	-4.26	0.000	3.67	0.000
Year 4	-3.05	0.003	1.39	0.165
Year 5	-2.63	0.010	1.23	0.218
Year 6	-2.83	0.005	2.95	0.003
Year 7	-1.69	0.092	2.38	0.017
Year 8	-0.65	0.516	1.07	0.285
Year 9	-1.50	0.135	0.74	0.456
Year 10	-0.75	0.453	0.67	0.504
Year 11	1.79	0.076	0.00	1.000
Year 12	-2.84	0.005	2.05	0.040
Year 13	0.98	0.327	-0.09	0.930
Year 14	0.38	0.708	0.18	0.857
Year 15	-2.07	0.041	1.22	0.223
Year 16	0.96	0.340	0.49	0.624
Year 17	-0.27	0.786	0.40	0.691

(a) Shading indicates statistical significance of non-zero mean (median) at the 5% level.

5.3 Results for conditional interim IRRs, using international shocks

As a second consistency check, we also adjusted our IRRs using the implied shocks from a global economic model, based on IMF data. Once again we tested for bias in these conditional measures of interim IRR differences; results are reported in Table I. As with the UK-adjusted results, there is still significant evidence of undervaluation when funds first start investing, but these low initial IRRs converge on the eventual realised IRRs in a similar fashion. Once again, there is no evidence of systematic overvaluation of interim investments.

Table I: Tests for non-zero means and medians, conditional on global shocks (a)

	Mean		Median	
	Test statistic	P-value	Test statistic	P-value
Year 1	-5.30	0.000	4.82	0.000
Year 2	-6.20	0.000	4.49	0.000
Year 3	-4.66	0.000	3.18	0.002
Year 4	-3.48	0.001	1.71	0.086
Year 5	-2.72	0.007	2.05	0.040
Year 6	-1.96	0.052	2.29	0.022
Year 7	-1.30	0.197	1.07	0.285
Year 8	-2.08	0.040	1.07	0.285
Year 9	-1.33	0.185	1.90	0.057
Year 10	0.76	0.450	1.84	0.066
Year 11	0.58	0.565	0.17	0.866
Year 12	-1.18	0.242	0.68	0.494
Year 13	-0.15	0.883	0.61	0.539
Year 14	-1.26	0.212	1.26	0.207
Year 15	0.74	0.462	1.59	0.111
Year 16	-1.32	0.189	0.10	0.922
Year 17	0.15	0.883	0.20	0.842

(a) Shading indicates statistical significance of non-zero mean (median) at the 5% level.

6. Conclusions

Given the critical role that interim valuations play in gauging private equity fund performance, it is important to examine the reliability of these interim valuations over time. In particular, it is possible that private equity fund managers could be over-optimistic about interim valuations, and hence returns, thereby giving a misleading picture of final performance.

This paper has addressed this issue, focusing on the evolution of interim IRRs over the life of now-closed funds, using data from the BVCA's annual *Performance Measurement Survey*. Exploiting the insights from perfect foresight, following previous literature in unrelated areas, we examine the evolution of interim IRRs as they converge on their final, realised values. We find no evidence of systematic over-optimistic valuation in the data. In fact, the biases that are evident in interim IRRs are negative, and typically at the start of a fund's life, indicating that initial estimates of interim returns are likely to be too low, if anything. These results are robust to conditioning our data on estimates of the economic shocks that were hitting the UK and global economies over the lives of BVCA members' funds.

The fact that we find no systematic evidence of overvaluation is probably related to the fact that, in the UK, interim valuations of private equity and venture capital investments are typically audited by third-parties such as accountancy firms. The low initial valuations of investments could reflect a number of factors, such as the tendency for management fees to represent a larger proportion of drawdowns at the start of a fund's life, or fund managers only gradually moving away from 'at cost' valuation measures over time. Overall, however, on the basis of past evidence there are no grounds for thinking that interim measures of UK private equity performance will systematically overstate final returns.

References

Bernanke, B, Boivin, J and Eliasz, P (2005), 'Measuring monetary policy: a factor-augmented vector autoregression (FAVAR) approach', *Quarterly Journal of Economics*, Vol. 120 (1), pages 387-422.

Blanchard, O and Fischer, S (1989), *Lectures in Macroeconomics*, MIT Press.

BVCA (2010a), 'Benchmarking private equity against public markets', *BVCA Research Note* No. 5.

BVCA (2010b), 'How do exchange rates affect PE returns?', *BVCA Research Note* No. 7.

BVCA (2010c), *BVCA Private Equity and Venture Capital Performance Measurement Survey 2009*, BVCA. Available at http://www.bvca.co.uk/research

Castle, J and Ellis, C (2002), 'Building a real-time database for GDP(E)', Bank of England Quarterly Bulletin, Spring, pages 42-49.

Cumming, D and Walz, U (2009), 'Private equity returns and disclosure around the world', *mimeo*.

IPEV (2009), *International Private Equity and Venture Capital Valuations Guidelines,* September. Available at:
http://admin.bvca.co.uk/library/documents/International_PE_VC_Valuation_Guidelines_Sep_2009.pdf

Kaplan, S and Schoar, A (2003), 'Private equity performance: returns, persistence and capital flows', *MIT Sloan Working Paper* No. 4446-03.

Mumtaz, H, Zabczyk, P and Ellis, C (2011), 'What lies beneath: a time-varying FAVAR model for the UK transmission mechanism', *ECB Working Paper* No. 1320, April.

Panigirtzoglou, N and Scammel, R (2002), 'Analysts' earnings forecasts and equity valuations', *Bank of England Quarterly Bulletin*, Spring, pages 59-66.

Paquet, A (1992), 'Inflation expectations and rationality', *Economics Letters*, Vol. 40, pages 303-08.

Wright, M, Wilson, N and Scholes, L, (2011) 'Private equity portfolio company performance through the recession', available at http://www.bvca.co.uk/research

Annex A: Summary of IPEV Guidelines

IPEV guidelines set out best practice in ascribing value to investments that should be valued at 'Fair Value'.

Fair value is the price at which an orderly transaction would take place between market participants at the reporting date. For quoted instruments, this should be at market prices. However, for unquoted instruments such as private equity, the process is more difficult. The Valuer of the asset needs to work out its value based on the assumption of the business being realised at the reporting date, using a valuation methodology to estimate the hypothetical exchange price.

In doing so, the Valuer needs to exercise their judgement and take into account the potential impact of a range of factors, including current market conditions; geography; credit risk; impacts of foreign currency fluctuations; rights attributable; equity prices; and volatility. They also need to account for the reduction in the amount that will be attributable to the fund owing to, for instance, the residual payments owing on any financial instruments used.

There are a number of different methodologies that can be used by the Valuer, and they have to exercise their judgement on which is the best to use. In making this decision, there are a number of factors that the Valuer should bear in mind:

- How applicable each of the methodologies are given the nature of the industry and current market conditions;
- The quality and reliability of the data to be used in each methodology;
- The comparability of enterprise or transaction data;
- The stage of development of the enterprise;
- The ability of the enterprise to maintain profits and cashflow; and
- Any additional considerations unique to the enterprise.

The methods of valuation described in the IPEV guidelines are:

i) Price of recent investment

Price of recent investment may provide a reliable indicator of value where the investment was made recently. Using this methodology, the Valuer takes the purchase price of the asset (taking into account the background to the transaction). It is for the Valuer to decide over what time scale the use of the price of recent investment valuation is valid, as it inevitably becomes eroded over time.

ii) Multiples

Where a business has a continuing earnings stream that is considered to be maintainable, the methodology of multiples may be an appropriate means of valuation. It involves applying an earnings multiple to the earnings of the business in order to derive the value. The level of multiple to be used is for the Valuer to decide, based on what is appropriate and reasonable, as well as the level of EBITDA that can be established as stable and maintainable.

iii) Net assets

The value of the business's net assets may be the appropriate method of valuation where the underlying business derives its value largely from the assets that it holds and not through repeated earnings. In order to do this, the Valuer is required to use appropriate measures to value the assets and liabilities of the underlying business.

iv) Discounted cash flows or earnings (of underlying business)

The method of discounted cash flows is a flexible method that can be applied to any stream of cash flows or earnings. It involves the Valuer using their judgement to estimate the present value of future expected cash earnings and using this figure to derive the current value of the business. There is a high degree of subjectivity involved in this valuation method.

v) Discounted cash flows (from the investment)

This method is similar to the method of valuing based on discounted cash flows of the underlying business, but relies on the investment itself. This will be of particular relevance where, for instance, the realisation of the underlying business is imminent and the transaction price has been substantially agreed.

vi) Industry valuation benchmarks

Some industries have specific valuation benchmarks – for instance price per subscriber. Where the underlying business is in such an industry, this valuation benchmark may be appropriate.

Given the wide range of valuation options that are available, there will be a degree of subjectivity – not least in the decision around which valuation method to use. However, in the initial years, it is reasonable to assume that a significant number of funds will use the valuation at cost method, given that it leaves the least room for subjectivity in the valuation methodology.

The effect of holding at cost may be that the valuations that are given to a fund's investments in the initial years underestimate the true market value, and as such we would see IRRs in the initial years below that of the final IRR.

Annex B: List of data series used in FAVARs

This Annex lists the data series that form the basis for the economic models described in Section 5. Data were primarily sourced from the UK Office for National Statistics and from the International Monetary Fund's World Economic Outlook database. Series were log differenced, if required, to ensure stationarity; other variables were expressed as percentages of GDP. Ten principle components were used in the FAVARs, to ensure a large proportion of the series' variance was captured. Further details are available on request.

UK model variables

National accounts aggregates (£mn at current prices), gross domestic product and gross value added

Value and chained volume indices (2006=100): gross domestic product at market prices; gross value added at basic prices; gross national disposable income at market prices; implied deflators from value and volume series

Gross domestic product and gross national income, £mn current prices: gross national income at market prices; net income from abroad; gross domestic product at market prices; gross value added at basic prices

Chained volume measures, reference year 2006: gross domestic product at market prices; gross value added at basic prices; gross value added at factor cost

Gross domestic product by category of expenditure, £ mn (current price and chained volume): household consumption; non-profit institutions serving households' consumption; general government consumption; gross fixed capital formation; exports of goods and services; gross final expenditure; imports of goods and services

Gross domestic product by category of income (£mn current prices): compensation of employees; total gross operating surplus (gos) of corporations, plus gos split by private non-financial corporations / financial corporations / public corporations; other income; taxes on production less subsidies

Households’ disposable income and consumption, £mn current prices : households' income before tax; wages and salaries; gross households' disposable income; adjustment for the change in net equity of households in pension funds; total available households' resources; households' final consumption expenditure; households' saving ratio (per cent)
Households’ income and consumption, chained volume measures: real households' disposable income; households' final consumption expenditure

Household final consumption expenditure, £mn current prices and chained volumes
UK national, total and net tourism
UK domestic categories covering: food and drink; alcohol and tobacco; clothing and footwear; housing; household goods and services; health; transport; communication; recreation and culture; education; restaurants and hotels; miscellaneous

Gross fixed capital formation (GFCF) by sector, £mn current prices and chained volumes: business investment; general government; public corporations; public dwellings; private dwellings
GFCF analysis by asset, £mn current prices and chained volumes: transport equipment; other machinery and equipment; dwellings; other buildings and structures; intangible fixed assets

Gross value added, chained volume indices at basic prices, by category of output, split by broad industry type and detailed service sector and manufacturing splits.

Main market sector groups of industrial production, indices: consumer durables; consumer non-durables; capital goods; intermediate goods and energy

Summary capital accounts and net lending/net borrowing, £mn current prices: gross saving; receivables; payables; gross capital formation
Split for General government / Financial corporations / Non-financial corporations / Households and NPISH

Private non-financial corporations (PNFCs): allocation of primary income account & subdivisions
PNFCs’ secondary distribution of income account, split of resources and uses

PNFCs' capital account – changes in liabilities and net worth
PNFCs' capital account – changes in assets

Balance of payments (current account, £mn): exports (goods/services/total); imports (goods/services/total); balance of trade; income balance; current transfers balance; current balance; current balance as percentage of GDP

Trade in goods (on a balance of payments basis), volumes and prices: total (exports/imports); total excluding oil (exports/imports); total excluding oil and erratic (exports/imports)

Producer and consumer prices

- Producer price index: Materials and fuel purchased by manufacturing industry
- Producer price index: Output: all manufactured products: home sales
- Plant and machinery bought as fixed assets by motor vehicle industry
- Manufactured output: motor vehicle industry
- Consumer prices index (CPI) (2005=100) - All items
- Consumer prices index (CPI) (2005=100) - CPI excluding indirect taxes (CPIY)
- Consumer prices index (CPI) (2005=100) - CPI at constant tax rates (CPI-CT)
- Retail prices index (13 January 1987=100) - All items
- Retail prices index (13 January 1987=100) - All items excluding mortgage interest payments (RPIX)
- Retail prices index (13 January 1987=100) - All items excluding mortgage interest payments and indirect taxes (RPIY)
- Pensioner price index (13 January 1987=100): one-person household
- Pensioner price index (13 January 1987=100): two-person household
- Tax and price index (January 1987=100) - All items

Construction output, £mn current and constant prices, split by type and sector
Indicators of fixed investment in dwellings, chained volumes

Value and volume of retail sales per week (indices), split by store type
Consumer credit and other household sector borrowing

Sterling exchange rate against major currencies: Japanese yen; US dollar; Swiss franc; euro; Danish kroner; Norwegian kroner; Swedish kroner; Hong Kong dollar
UK international reserves at end of period (US$ million)
Sterling effective exchange rate index (January 2005=100)

Monetary aggregates, flows, amounts outstandingand percentage changes: narrow money & velocity; broad money (M4) & velocity

Public sector expenditure: current expenditure on goods and services; subsidies; net social benefits; net current grants abroad; other current grants; interest paid; total
Public sector receipts: operating surplus; taxes on production; taxes on income and wealth; taxes on capital; other current taxes; compulsory social contributions; interest/ dividends received; rent and other current transfers; total

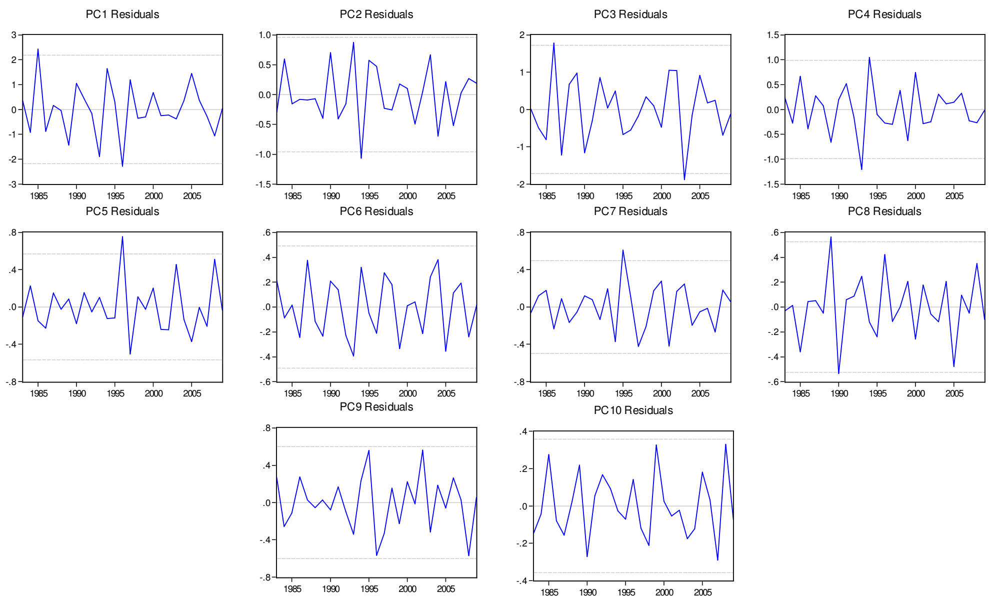
Interest rates and yields, percentage rates
Close previous week: Treasury bill yield; inter-bank 3 months bid rate; inter-bank 3 months offer rate; sterling certificates of deposit (CoD) 3 months bid rate; sterling CoD 3 months offer rate; selected retail banks: base rate
Last working day: 3 month US Treasury bills rate; 3 month euro-dollar rate; British government securities (20 years)

Housing: DCLG all lenders mix-adjusted house price indices: total/new/second-hand dwellings

Labour market statistics: detailed breakdowns of employment/inactivity/unemployment, both on 16+ and 16-59/64 basis (levels and percentage rates).
UK claimant count unemployment level (total/men/women)
UK claimant count percentage rate (total/men/women)

Workforce jobs, split by employment type and detailed industry breakdown

Figure A1: UK FAVAR residuals



<u>International model variables</u>

Data were compiled for the following countries, wherever possible:

Australia, Austria, Belgium, Canada, China, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Taiwan, United Kingdom, United States.

Data series:

- Gross domestic product, constant prices. Expressed in national currency, bns.
- Gross domestic product, current prices. Expressed in national currency, bns.
- Gross domestic product, current prices. Expressed in U.S. Dollars, bns.
- Gross domestic product, deflator. Expressed in index form.
- Gross domestic product per capita, constant prices. Expressed in national currency.
- Gross domestic product per capita, current prices. Expressed in national currency.
- Gross domestic product per capita, current prices. Expressed in U.S. Dollars.
- Output gap in percent of potential GDP. Expressed as percent of potential GDP.
- Gross domestic product based on purchasing-power-parity (PPP) valuation of country GDP. Expressed in current international dollar, bns.

- Gross domestic product based on purchasing-power-parity (PPP) per capita GDP. Expressed in current international dollar.
- Gross domestic product based on purchasing-power-parity (PPP) share of world total. Expressed as percentage.
- Implied PPP conversion rate. Expressed as national currency per current international dollar.
- Investment. Expressed as a percent of GDP.
- Gross national savings. Expressed as a percent of GDP.
- Inflation, average consumer prices. Expressed in index form.
- Inflation, end of period consumer prices. Expressed in index form.
- Six-month London interbank offered rate (LIBOR). Expressed as percentage.
- Unemployment rate. Expressed as percent of total labor force.
- Employment. Expressed as persons, millions.
- Population. Expressed as persons, millions.
- General gvmt. revenue. Expressed in national currency, bns.
- General gvmt. revenue. Expressed as a percent of GDP.
- General gvmt. total expenditure. Expressed in national currency, bns.
- General gvmt. total expenditure. Expressed as a percent of GDP.
- General gvmt. net lending/borrowing. Expressed in national currency, bns.
- General gvmt. net lending/borrowing. Expressed as a percent of GDP.
- General gvmt. structural balance. Expressed as a percent of potential GDP.
- General gvmt. primary net lending/borrowing. Expressed as a percent of GDP.
- General gvmt. net debt. Expressed as a percent of GDP.
- General gvmt. gross debt. Expressed as a percent of GDP.
- Gross domestic product corresponding to fiscal year, current prices. Expressed in national currency, bns.
- Current account balance. Expressed as a percent of GDP.

Figure A2: International FAVAR residuals