
# Quantitative 101:
# Cash Flow Model Forecasting

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# What is Cash Flow Forecasting?

- Cash Flow Forecasting is projecting future behavior of portfolios based upon existing & planned commitments or investments

- Future behavior usually includes Cash and NAV projections for portfolios of primary investments, secondary investments and co-investments

# Cashflow Forecasting (CFF) versus Risk Management (RM)

- On liquid assets, you manage your risk by rebalancing your portfolio

- This does not work for private equity
  - Timing and value is uncertain for illiquid assets, contrary to the public market
  - The Secondary market is a very poor tool when liquidity is required (usually in a crisis when offering is extremely poor and punitive for the seller)

- Risk management in private equity is essentially about <u>carefully building your portfolio</u> in order to achieve a particular risk profile

- A Cash Flow Forecasting Tool is the only way to assess future behavior of a defined portfolio

- Therefore, good cashflow forecasting is an <u>absolute pre-requisite</u> for any Portfolio Construction/Risk Management activity

# A Few Very Wrong Ideas About CFF & RM

- Idea #1: Favorite subject of Academics, which translates into “not for me”
- Idea #2: Required to satisfied the regulators, which translates into “complete waste of my time”
- Idea #3: I am using an internal built model, which translates into “I check the box, so let me now do serious things”

# Partially True …

- Relevant for institutional investors, typically as limited partners:
  - Basel III
  - Solvency II
  - AIFMD
  - Etc.

Solvency II : For private equity investments, the European Insurance and Occupational Pensions Authority (EIOPA) first suggested that the standard model should use a risk weighting of 49%, significantly higher than the industry felt was appropriate. But the final set of the Delegated Acts agreed upon in the beginning of 2015 differentiates private equity from other types of alternative investment fund that will continue to attract a 49% risk weighting. It states that private equity funds that are closed-ended and unleveraged and venture capital funds that are EuVECA designated will both be treated as the so-called 'type 1 equities' and will attract a significantly lower risk weighting of 39% (source Invest Europe).
**However, 30% would probably better reflect the actual risk of this asset class as supported by cashflow forecasting and risk calculation.**

Basel III
http://investeurope.eu/content/microsites/cfo-coo_summit_2011/1400-Denayer.pdf
https://www.pwc.com/us/en/financial-services/regulatory-services/publications/assets/pwc-basel-iii-capital-market-risk-final-rule.pdf
Solvency II
https://www.insuranceassetrisk.com/content/analysis/insurers-private-equity-investment-gets-a-fillip-from-brussels.html
https://www2.deloitte.com/content/dam/Deloitte/lu/Documents/financial-services/performancemagazine/articles/lu-impacts-solvency2-investment-policy-insurers-012016.pdf
AIFMD
https://www.pwc.com/gx/en/asset-management/aifmd/assets/pwc-aifmd-for-private-equity.pdf
https://www.kpmg.com/IE/en/IssuesAndInsights/ArticlesPublications/Documents/navigate-through-aifmd-july-2014.pdf

# But Doing It Properly Can Help Save A Lot …

### Exhibit 1: The Importance of Risk Measurement in Private Equity: The Experience from the Global Financial Crisis 2008 - 2009

The collapse of Lehman Brothers in the autumn of 2008, the largest bankruptcy in history, resulted in the deepest global recession for at least three generations. As market participants became extremely risk averse, financial markets for risky assets shut, while yields on safe assets fell to record lows. Investors' cash flow models were generally not designed to cope with this tail risk, and many long-term asset allocators found themselves short of liquidity as distributions from private equity funds dried up at the same time asmargin calls increased and redemptions were suspended by hedge funds and similar vehicles.

Confronted with significant unfunded outstanding commitments and an acute shortage of liquidity, many private equity investors sought to sell stakes in private equity funds in the secondary market. However, given the huge macroeconomic uncertainty, the profound lack of liquidity and the massive degree of risk aversion, there were few buyers. As net asset values (NAVs) were only gradually adjusted in line with the rapidly deteriorating operating performance of underlying portfolio companies and the decline in public markets, there was a wide gap between sellers' and buyers' price expectations. In the first half of the year, this gap proved unbridgeable for many portfolios, causing a steep fall in the volume of secondary transactions.

While institutions seeking to liquidate (parts of) their private equity holdings included a wide range of investors, US university endowments are reported to have been particularly keen in reducing their exposure, which in individual cases accounted for more than 20% of their total assets under management (AUM).

**EVCA** Risk Measurement Guidelines 2013

# The Main Risks That You Are Exposed To:

- Funding risk: The unpredictable timing of cash flows poses funding risks to investors. Commitments are contractually binding and defaulting on payments results in the loss of private equity partnership interests

- Liquidity risk: The illiquidity of private equity partnership interests exposes investors to asset liquidity risk associated with selling in the secondary market at a discount on the reported NAV

- Market risk: The fluctuation of the market has an impact on the value of the investments held in the portfolio

- Capital risk: The realization value of private equity investments can be affected by numerous factors, including (but not limited to) the quality of the fund manager, equity market exposure, interest rates and foreign exchange

# The Key Objectives of Private Equity Risk Management

- Properly understanding the risks associated with investing in private equity

- Accurately measuring the risk of an investment decision or a specific capital allocation

- Helping the construction and planning portfolios that match specific risk profiles

# The Current Status

- Despite increasing allocation of private equity in LP portfolios
- Despite huge progress in financial risk management
- Private equity CFF and Risk Management is still an immature and an under documented discipline

# Concrete Benefits Of A RM/CFF Solution

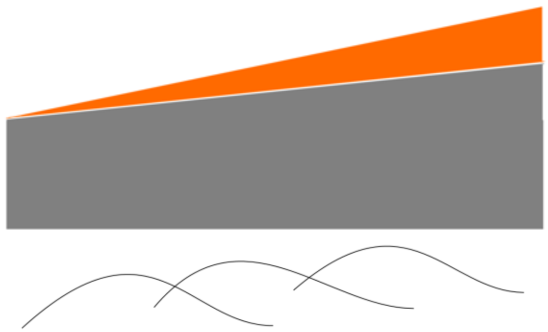
- Example #1: Develop a New Private Equity Program

- Example #2 : Maintain a x% exposure to Private Equity

- Example #3 : Protect your Private Equity program from crisis

# Example #1 : Developing a New Private Equity Program

- Build a program to achieve a X% allocation in PE by a defined timeline
- Solution: test multiple scenarios that include primary & secondary purchases to accelerate ramp up



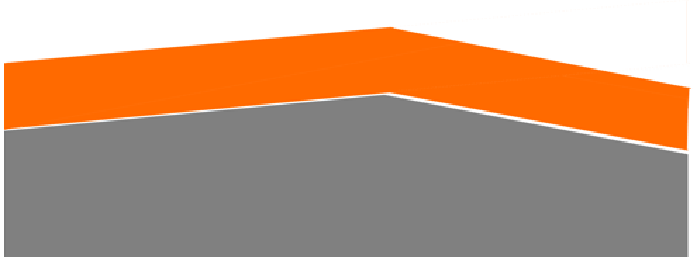
# Example #2 : Maintaining a x% Exposure to Private Equity

- Maintain a X% allocation in PE in term of NAV over time
- Solution: properly plan additional commitments to maintain PE NAV within specific bands

# Example #3 : Protect your Private Equity program from a Crisis

- Change of other assets' value can change your exposure to private equity and can force you to react and write off part of your program

- Solution: stress your portfolio with different scenarios mimicking past financial crisis



# Cash Flow-Based Modeling Approach

- Cash flow-based models for private equity funds can be non-probabilistic (deterministic) or probabilistic (stochastic)

- Cash flow volatility-based models can be built using a "bottom-up" approach where the fund's cash flows are derived from the cash flows of the individual investee companies, or through a "top-down" approach where the fund's cash flows are determined, for example, by comparing it to other funds

# Deterministic Models

- Used where too little benchmark data is available for a stochastic approach
- Should be based on a limited number of parameters which (due to the lack of data) might be highly subjective
- Because of these limitations, deterministic models should not be overcomplicated
- They are mostly used to test portfolio strategies for very large, diversified portfolios of funds, and often associated to stress scenarios
- Despite obvious limitations, they are widely used as they are often built on top of Excel with simple approaches

# Stochastic Models

- Preferred approach for mid- and long-term horizon
- Requires decent benchmark data
- Requires to buy a packaged solution or to have internally some development skillset (MatLab, VBA, etc.)
- Result is less intuitive to use (intervals of confidence versus simple straight figures)
- Should however be the preferred solution whenever possible

# Bottom-up Models

- In practice, the bottom-up approach is often impractical due to
  - The lack of appropriate information at the limited partner level
  - The large volume of data that has to be collected for large portfolios
  - The projection of the unfunded part of the portfolio
  - The complexity of specifying each cash flow position
- A bottom-up approach is not necessarily superior to a top-down approach and in many cases is simply not applicable (e.g. for very young funds with a lot of unfunded capital)
- The choice between bottom-up and top-down therefore highly depends on the size and maturity of the portfolio of funds to be modeled

# Different Methods To Forecast Cash Flows

- Bottom-up
  - Parameters Based

- Top-down
  - Yale Model
  - Template Based Method
  - CF Library Method
  - DPI & PICC Method

# Bottom-up – Parameters Based (1/3)

- Usually starts with a pattern of quarterly or annual contributions (drawdowns curve), associated to each fund investment and properly stretched based on the actual commitment
- Each future contribution is associated to Fees or to a new investment
- Each investment (actual or forecasted) has a dedicated J-curve based on few simple parameters (Holding Period, Exit Multiple & NAV Curve)
- The Portfolio behavior is calculated by aggregating J-curves for the total portfolio

# Bottom-up – Parameters Based (2/3)

### Drawdowns curve

| Quarter index | % called |
|---|---|
| 1 | 6,00% |
| 2 | 4,00% |
| 3 | 4,00% |
| 4 | 4,00% |
| 5 | 6,00% |
| 6 | 6,00% |
| 7 | 6,00% |
| 8 | 6,00% |
| 9 | 6,00% |
| 10 | 5,00% |
| 11 | 4,00% |
| 12 | 4,00% |
| 13 | 4,00% |
| 14 | 4,00% |
| 15 | 4,00% |
| 16 | 4,00% |
| 17 | 4,00% |
| 18 | 4,00% |
| 19 | 4,00% |
| 20 | 4,00% |

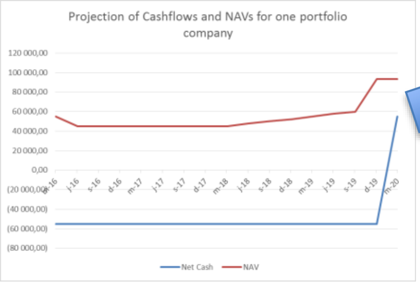
Total drawdowns 93,00%

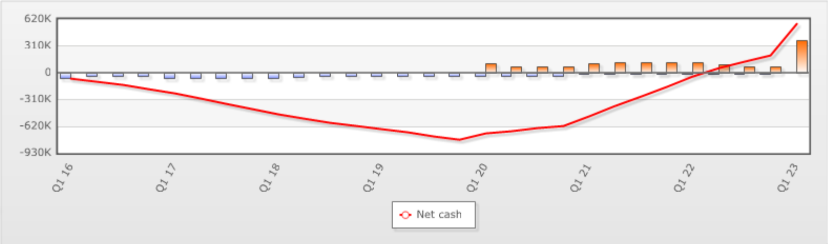
### Management fees

| | |
|---|---|
| Initial fee rate | 2,00% |
| Initial fee basis | Commitment |
| Step down rate | 1,50% |
| Step down starting quarter | 6 |
| Step down basis | Net invested |
| Frequency | Quarterly |
| Method of Payment | In advance |
| Outside Commitment | No |

### Waterfall

| | |
|---|---|
| Hurdle | 8,00% |
| Catchup | 100,00% |
| Carried interest | 20,00% |
| Carried Calculation | Deal by deal |
| Clawback | No |



# Bottom-up – Parameters Based (3/3)

- Forecasting behavior of a mature fund is a bit tricky with excel but not overly-complicated with a script:
  1. Calculate unfunded commitment
  2. Calculate the number of remaining investments based on a model
  3. Allocate remaining investments to remaining investment period (using a stretched or an extended period based on pace of actual investments versus model)
  4. Add distributions based on Exit Multiples & Holding Periods for past and new investments
  5. Future NAV is usually deducted from dedicated NAV curve of each investment

- Stochastic forecasting is usually achieved with different Exit scenarios for each investment with a probability, i.e. 30% probability of Multiple 2, 3 and Holding Period 4-years, 40% probability, etc.

# Top-down – Yale Model (1/4)

- Published in Jan 2001 by Dean Takahashi & Seth Alexander (Yale University Investments Office)

- The model uses six inputs to project capital contributions, distributions, and net asset value:
  - RC Rate of contribution
  - CC Capital commitment
  - L Life of the fund (years)
  - B Factor describing changes in the rate of distribution over time
  - G Annual growth rate (%)
  - Y Yield (%)

- The model has three outputs:
  - C Capital contributions ($)
  - D Distributions ($)
  - NAV Net asset value ($)

# Top-down – Yale Model (2/4)

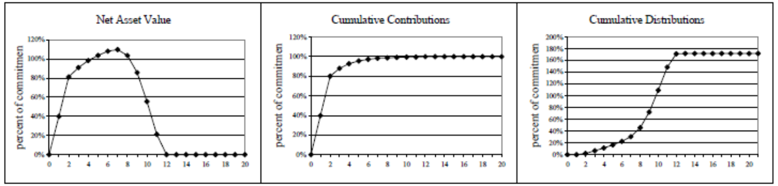
- Capital Contributions
  - $C(t) = RC(t)\ (CC - PIC(t))$

- Distributions
  - $D(t) = RD * [NAV(t-1) * (1 + G)]$
  - $RD = Max\ [Y, (t/L)^B]$

- NAV
  - $NAV(t) = [NAV(t-1) * (1 + G)] + C(t) - D(t)$

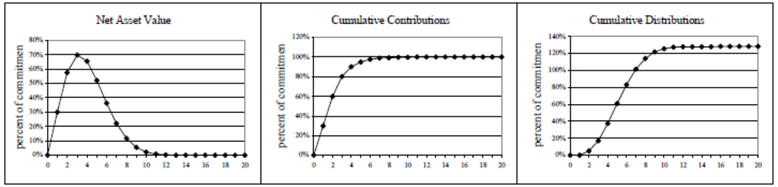
# Top-down – Yale Model (3/4)

**Real Estate** **Exhibit 1**



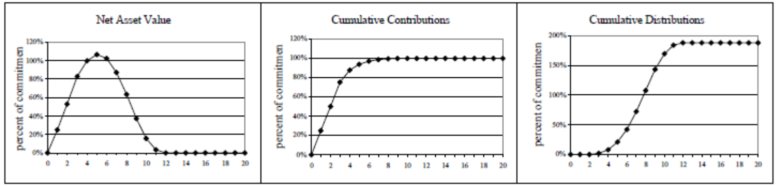

| | |
|---|---|
| Growth | 8.0 % |
| Life | 12 years |
| Initial Contribution Rate | 40.0 % |
| Contribution Rate | 40.0 % |
| Bow | 5.0 |
| Yield | 5.0 % |

**Oil & Gas**




| | |
|---|---|
| Growth | 8.0 % |
| Life* | 15 years |
| Initial Contribution Rate | 30.0 % |
| Contribution Rate | 50.0 % |
| Bow | 1.0 |
| Yield | 15.0 % |

**Leveraged Buyouts**




| | |
|---|---|
| Growth | 13.0 % |
| Life | 12 years |
| Initial Contribution Rate | 25.0 % |
| Contribution Rate | 50.0 % |
| Bow | 2.5 |
| Yield | 0.0 % |

Yale SCHOOL of MANAGEMENT

# Top-down – Yale Model (4/4)

- Forecasting the behavior of mature fund is usually pretty simple in Excel as new quarterly figures are derived from simple statistics (PIC(t), NAV(t-1), …)

- Complexity comes from properly calibrating growth rate, usually done using the solver of Excel (calculated to match a dedicated TVPI or IRR)

- Stochastic forecasting is achieved by defining a range of potential TVPIs or IRRs for each fund and at each iteration, assess growth rate to deliver selected TVPI or IRR

# Top-down – Template Based (1/3)

- Usually starts with a pattern of quarterly or annual contributions AND distributions, associated to each fund type and properly stretched based on actual commitment

- Each distribution is stretched based on expected TVPI for the fund

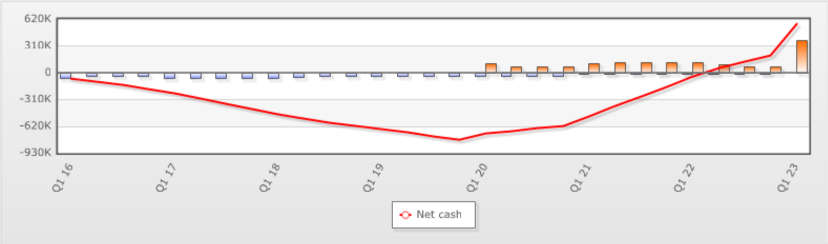
- Portfolio behavior is calculated by aggregating J-curves for total portfolio

# Top-down – Template Based (2/3)

Cashflows Curve

All figures MUST be entered for a commitment of 100

| Date Contribution | Contribution | Distribution | | NAV |
|---|---|---|---|---|
| | | Income | Equity | |
| 30/06/2013 | 6,00 | 0,00 | 0,00 | |
| 30/09/2013 | 6,00 | 0,00 | 0,00 | |
| 31/12/2013 | 6,00 | 0,00 | 0,00 | |
| 31/03/2014 | 6,00 | 0,00 | 0,00 | |
| 30/06/2014 | 6,00 | 0,00 | 0,00 | |
| 30/09/2014 | 5,80 | 0,00 | 0,00 | |
| 31/12/2014 | 5,80 | 0,00 | 0,00 | |
| 31/03/2015 | 5,80 | 0,00 | 0,00 | |
| 30/06/2015 | 5,50 | 0,00 | 0,00 | |
| 30/09/2015 | 5,50 | 0,00 | 0,00 | |
| 31/12/2015 | 5,50 | 0,00 | 1,16 | |
| 31/03/2016 | 5,50 | 0,00 | 1,16 | |
| 30/06/2016 | 5,00 | 0,00 | 1,00 | |
| 30/09/2016 | 5,00 | 0,00 | 1,00 | |
| 31/12/2016 | 3,50 | 0,00 | 1,00 | |
| 31/03/2017 | 3,50 | 0,00 | 1,00 | |
| 30/06/2017 | 2,70 | 0,00 | 2,00 | |
| 30/09/2017 | 2,70 | 0,00 | 2,00 | |
| 31/12/2017 | 2,70 | 0,00 | 2,00 | |
| 31/03/2018 | 2,70 | 0,00 | 2,00 | |
| 30/06/2018 | 1,00 | 0,00 | 3,00 | |
| 30/09/2018 | 1,00 | 0,00 | 3,00 | |
| 31/12/2018 | 0,80 | 0,00 | 3,00 | |



# Top-down – Template Based (3/3)

- Forecasting the behavior of a mature fund is a bit tricky with Excel but not over-complicated with a script:
    1. Calculate unfunded commitment
    2. Calculate the number of remaining investments based on model
    3. Allocate those remaining investments in remaining investment period (stretched or extended period based on historical pace of investments versus model)
    4. Calculate remaining amount to distribute
    5. Calculate number of remaining distributions based on a model
    6. Allocate those remaining distributions in remaining period (stretched or extended period based on historical pace of distributions versus model)
    7. Future NAV is usually projected based on a growth rate parameter similar to the one used on a Yale Model

- Stochastic forecasting is achieved by defining a range of potential TVPIs for each fund and at each iteration, stretch distributions to deliver selected TVPI or IRR

# CF Library Method

- Require a library of cash flows
- Mostly used with the stochastic method where for each iteration we select (for each fund) cash flows from a similar fund in the library, stretch them to reconcile on expected performance using a method similar to the template-based model
- Template-based models are the derived deterministic version of this approach where the template is used as a proxy of an actual fund

# DPI & PICC Method

- Proxy of the CF Library Method when the only source of information is quarterly benchmark information provided by data providers (PEVARA, Cambridge, etc.)

- All data providers provide history of PICC & DPI per vintage, strategy, size, etc. for the four quartiles

- Based on that we can deduce a template of cashflows per quartile, vintage, strategy & size

| Vintage Year | Stage | Size (Mil) | IRR | DPI | RVPI | TVPI | PICC | DCC |
|---|---|---|---|---|---|---|---|---|
| 1999 | DEV | 0 - 25 $mill | 357,19 | 2,53 | 0,39 | 2,92 | - | - |

# DPI & PICC Method

- For each quarter
  - Based on opening PICC0, we select benchmark data which for this quarter has an opening PICC greater or equal to PICC0, we take it and calculate associated contributions for the quarter, i.e., (PICC – PICC0) * Commitment
  - Based on opening DIP0, we select benchmark data which for this quarter has an opening DPI greater or equal to DPI0, we take it and calculate associated distributions for the quarter, ie DPI * PICC * Commitment – DPI0 * PICC0
  - We use a Yale Model-like approach to assess NAV

- As by definition we usually do not have PICCs and DPIs for a future quarters for a specific fund, we need to collect this information from older vintages. Usually Strategy (buyout, VC, debt, etc.), size and Geographies are used to select applicable benchmarks

- Stochastic forecasting is achieved by randomly picking future PICCs and DPIs within benchmark data and by stretching distributions to deliver selected TVPI or IRR for each fund

# Comparison of Models

- Bottom-up:
  - Pros: lower granularity (deal level) which allows better exposure analysis and correlations to indices; can be influenced by information on deals
  - Cons: requires detailed deal information properly scaled for an investor; will not track the unfunded part of portfolio; lack of proper benchmark databases

- Top-down:
  - Pros: requires minimum, fund-level information; can leverage available benchmark databases (DPI & PICC method); easy to calibrate with few parameters (Yale Model)
  - Cons: hard to implement correlations; too simple solution for direct or co-investments

- Typical risk for both approaches:
  - Build a model per fund or per deal

# From Deterministic to Stochastic – Monte Carlo

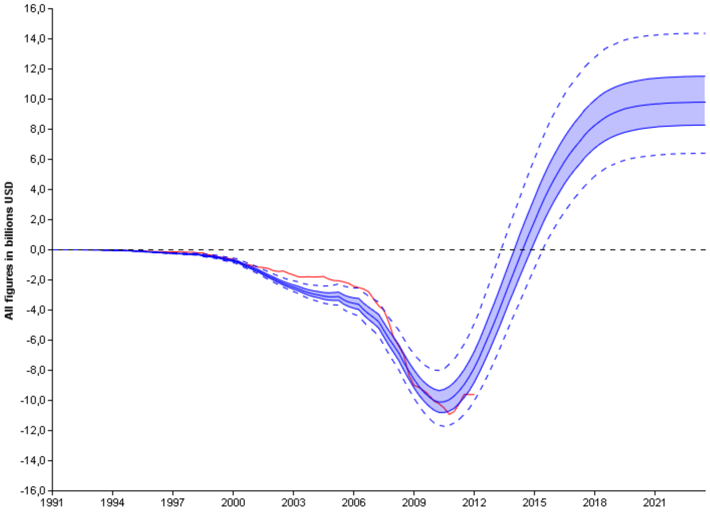
1. For each fund we select a range of expected final performance (IRR or TVPI) with a probability attached to it

2. We apply a Monte Carlo scenario where at each iteration, and for each fund, we randomly pick a final performance and apply one of the forecasting method that has to generate selected performance

3. Leverage internal research department to add projected assumptions on FX rates

# Typical Expected Outcome Of A Risk Model

- Cumulative cash flow forecast



# Stress Testing To Overcome Lack Of Data And Data Quality Problems

- There are limits to the predictive value of historic data

- While it is not possible to anticipate outcomes, it is nevertheless possible and meaningful to evaluate and quantify the impact of shocks that would materially change projections

- A number of shocks should be applied for stress testing, for example:
  - Lower IRRs or multiples than have historically been achieved by funds
  - Longer lifetimes of funds
  - Accelerated draw-downs
  - Delayed repayments
  - Higher volatility of cash flows
  - Higher degree of dependency between funds

# Stress Testing In Action

- Divide distributions by 4 to 5 versus “normal” conditions
- Divide contributions by half versus “normal” conditions
- Expand funds life time by 2 years
- Maintain stress for 2 to 3 consecutive years

**Exhibit 1: U.S. and European buyout realization ratio (blue) vs. GDP growth (grey)**

***Economically challenging periods (early nineties, TMT bubble, sub-prime crisis) are highlighted with a light blue background colour.***

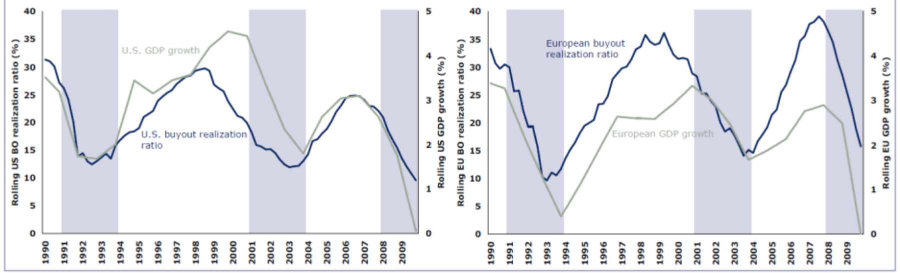
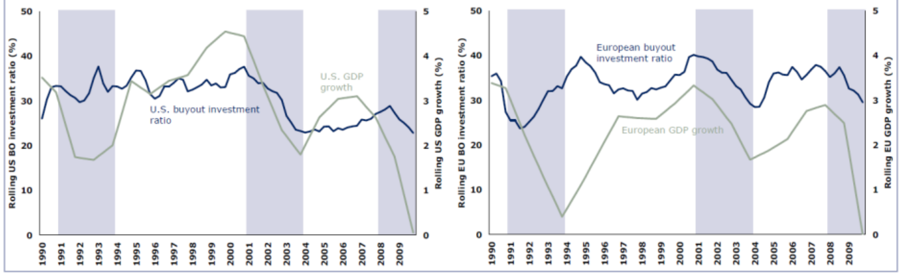



**Exhibit 2: U.S. and European buyout investment ratio (blue) vs. GDP growth (grey)**

***Economically challenging periods (early nineties, TMT bubble, sub-prime crisis) are highlighted with a light blue background colour.***




Souce: https://www.partnersgroup.com/fileadmin/user_upload/Documents/Research_PDF/201010_EQUI_Feeling_the_pulse_of_private_equity.pdf

# Beyond Simple Cash Flow Forecasting (1/3)

- Separate short term cash flows (one year horizon) from long term cash flows
  - Usually you have some level of information on short term expected cashflows

- Correlations are usually complicated to use on a top-down approach (not enough granular information) but can be used on bottom up approaches by attaching a company to a specific industry and stretching performances of companies to match a certain level of correlation to the index

# Beyond Simple Cash Flow Forecasting (2/3)

- Secondary Investments are usually easily treated by all the models provided you have at least original commitment, first contribution date, current PICC, DPI & NAV. Without this information (normally available at secondary purchases), cash flow forecasting for secondary investments will not work. Vintage of fund can be used as a reasonable proxy of first contribution date

- Co-Investments are usually managed as a fund with specific parameters based on the selected model. A bottom-up approach is usually recommended as you are supposed to have much more information on those investments

# Beyond Simple Cash Flow Forecasting (3/3)

- The main complexity of most models is linked to the adjustments generated at or just after cutoff date (date where you start forecasting cash flows)

- To avoid brutal change of NAVs or huge cashflows in the 3 to 4 quarters holistic rules are usually such as:
  - No more than X% contribution in a given quarter and Y% in a given year (for example 15% and 40%)
  - No significant contribution beyond an extended investment period
  - Not trying to achieve a large TVPI if there is clearly not enough remaining time to absorb remaining distributions

# Value-At-Risk

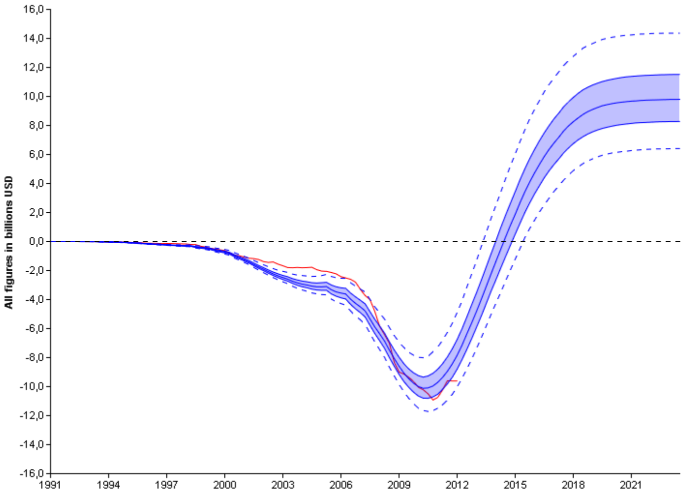
- Definition: VaR represents the maximum capital an investor can lose by a defined time horizon (usually one or two years) and probability (usually 95%, 99% or 99.5%)

- Two approaches can be used for calculating VaR
  - Top-down (based on fund cashflows & NAVs)
    - Based on forecasted NAV movements – usually unreliable
    - Based on NPV of forecasted cashflows with one of two approaches (*EVCA Risk Measurement Guidelines 2013*):
      - VaR for a given time period will be calculated based on the differences between the PV of two periods.
      - Fund growth calculation: Calculate first the fair value of a fund at time t=0 based on m simulations of cash flow series over the entire lifetime (n periods) of this fund. For each scenario, the straight-line growth over its full lifetime and the resulting gain or loss per time period is calculated. The VaR for a given time period is derived from the projecting gains and losses under all scenarios starting from the fund's fair value at t=0

  - Bottom-up (based on deals)
    - NAV movements based on a properly calibrated database of deal-level pattern of private equity investments (*Oliver Gottschalg & Dr Kreuter*)

# Back-Testing Models

- One reasonable way to test that your models work decently is to back-test them by selecting a cutoff date in the past and see how good/bad the model works against actual cash flows




In our example, the red line represents the actual net cashflows while in blue we have the projected behavior starting at the portfolio inception

# Questions?

# Thank You!

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