

# MODELING PRIVATE INVESTMENT CASH FLOWS WITH MARKET-SENSITIVE PERIODIC GROWTH

October 2020

## AUTHOR

**Vishv Jeet, PhD**

Vice President

vishv.jeet@pgim.com

+1 973 367 6859

The PGIM Institutional Advisory & Solutions group advises institutional clients on a variety of asset allocation and portfolio construction topics, and delivers bespoke research based on an institution's specific objectives.

For inquiries and to learn more about PGIM's investment advisory capabilities, email [IAS@pgim.com](mailto:IAS@pgim.com) or visit [pgim.com/IAS](http://pgim.com/IAS)

**For Professional Investors only. Not for use with the public. All investments involve risk, including the possible loss of capital. There is no guarantee that any particular asset allocation will meet your investment objectives.**



**Modeling the cash flows of private investments is an important challenge for institutional investors. While the Takahashi and Alexander (TA) model for private investment cash flows has stood the test of time, we suggest a small change in the model that makes it more amenable to be deployed in market simulation and scenario analysis.**

**We provide a comparison between the original and modified TA model using cash flow data from Burgiss and show that our change does not detract from the spirit of the TA model but ties it with the public market in an intuitive way. We also provide a regression-based analysis to correlate the growth of public and private markets.**

Modeling the cash flows of private investments is an important challenge for institutional investors. With a cash flow model an analyst can simulate possible market scenarios, cash flow shortfalls, and liquidity crises. Such analyses can be very useful for CIOs who make important decisions related to asset allocation and liquidity planning. A cash flow model is also useful to estimate the amount of dry powder which is a useful ingredient to design commitment strategies to build and maintain a desired private investment net asset value (NAV) in an overall multi-asset class portfolio.

We start with the Takahashi and Alexander (TA) model of private investment cash flows and explore a change to the model in which a series of periodic growth rates are used to model distributions and valuations (as opposed to a single lifetime growth parameter). In a simulation setting these growth rates can be correlated with public market returns which makes the model more realistic as the model's valuations and distributions become responsive to market movements. We also provide a regression-based framework to estimate period-specific growth.<sup>1</sup>

Using historical simulation on actual market data we show that the modified version of the TA model does a better job modeling actual cash flows, while retaining the spirit of the original TA model.

<sup>1</sup> We do not change the contribution model as it is more involved and requires more granular data (see O'Shea and Jeet (2018a, 2018b)).

**The findings shown are derived from statistical models. Reasonable people may disagree about the appropriate model and assumptions. Models should not be relied upon to make predictions of actual future account performance. See additional disclosures.**

## The Takahashi and Alexander Model

Takahashi and Alexander (2001) provide an intuitive framework to model private capital cash flows and valuation. The model makes use of several parameters that must be calibrated using real cash flow and valuation data. With carefully estimated parameters the model can effectively forecast expected cash flows and valuation for a diversified portfolio of commitments or a vintage. The TA model is a continuous model; it does not incorporate the lumpiness of cash flows. More specifically, it does not predict zeros (periods of inactivity) which are fairly common for individual funds. However, this is not an issue at the portfolio or vintage level in which cash flows are aggregated across funds. Below, we briefly describe the TA framework.

### Contribution Model

The contribution model states that the capital call ( $C_t$ ) amount in the next period is proportional to the uncalled capital ( $UC_{t-1}$ ) amount at the end of current period. That is:

$$C_t = UC_{t-1} \times RC(\text{Age}_{t-1}),$$

where RC is the rate of contribution and  $\text{Age}_{t-1}$  is the age of investment at the end of current period. RC can be estimated in a straightforward manner using linear regression between observed time series of capital calls and uncalled capital.<sup>2</sup>

### Distribution Model

The distribution model, similar to the contribution model, states that the distribution amount ( $D_t$ ) in the next period is proportional to the NAV at the end of current period:

$$D_t = NAV_{t-1} \times (1+G) \times RD(\text{Age}_{t-1}, \text{bow}, L),$$

where RD specifies the rate of distribution. RD is further modeled as a function of age along with two constant parameters: bow and lifespan. The lifespan parameter L is the expected lifespan of a private investment, from the first call to the last distribution. The bow parameter lets users express their view on how the rate of distribution changes over the lifetime. A higher bow parameter produces a higher rate of distribution later in the investment's lifetime, implying that the investment has a longer duration as capital stays invested longer. The rate of distribution (RD) is defined as:

$$RD = \left( \frac{\text{Age}_{t-1}}{L} \right)^{\text{bow}}$$

A third parameter G specifies the rate at which NAV grows. Unlike the RC parameter, all the parameters (bow, growth and lifespan) in the distribution model are constants as they do not change with the age of the investment.

### NAV Model

The NAV model assumes that all cash flows occur at the end of a period. Given the contribution and distribution models it is straightforward to model NAV:

$$NAV_t = NAV_{t-1} (1+G) + C_t - D_t$$

The NAV model is a direct consequence of the modified-Dietz return formula:

$$r_t^{\text{modDietz}} = \frac{NAV_t - NAV_{t-1} - CF}{NAV_{t-1} + WCF}$$

Since all cash flows happen at the end of a period, the time-weighted cash-flow term (WCF) is zero. This results in the following simplification:

$$r_t^{\text{modDietz}} = \frac{NAV_t - NAV_{t-1} - CF}{NAV_{t-1}}$$

$$NAV_t = NAV_{t-1} (1 + r_t^{\text{modDietz}}) - CF$$

Now replacing  $r_t^{\text{modDietz}}$  with a constant growth parameter G (a simplification) and CF with  $D_t - C_t$ , we get the TA NAV model.

<sup>2</sup> RC is usually estimated as a piece-wise constant function of age.

## TA Model Parameters

The parameters of the TA model are classified into two categories: model-specific and model-free. The RC and bow are the model-specific parameters, meaning they do not have a meaningful interpretation outside the model and must be estimated using the model equations. The growth and lifespan parameters are model-free (*i.e.*, exogenous to the model) and are meaningful numbers on their own and must be estimated independently of the TA model.

The TA model is an abstract model and its explanatory power lies in its parameter estimates. Commercial data providers provide parameter estimates and update them as new data become available. RC, growth, bow, and even lifespan parameters are continuously changing – as investors try to improve the TA model’s ability to match actual cash flows and NAVs.

## An Example

Figure 1 shows how the TA model generates cash flows and valuations given a set of parameters values. For a \$1 commitment and assuming the rate of contribution (RC) to be 25% in the first year, 33% in the second year and 50% thereafter, the entire commitment is called by year 7 to 8. Assuming a lifespan of 13y, bow of 2 and growth (G) of 12%/y, all distributions are paid by the end of year 13 resulting in an annualized IRR of 12%.

Figure 2 plots the time series of uncalled capital, valuation and distribution. The uncalled capital decays at a rate specified by the rate of contribution. The NAV rises initially and reaches a peak; thereafter distributions increase and NAV declines. By the end of year 13 all cash flow activity ceases as the commitment reaches the end of its lifespan.

Note that the IRR of cash flows generated by the TA model is exactly 12%/y. This is not a coincidence, but rather a defining feature of the model illustrating its internal consistency. The IRR produced by the TA model’s cash flows is independent of the RC, L, and bow parameters and is solely a function of the growth (G) parameter.

We compute several performance measures from the TA model cash flows (Figure 3). The money multiple (TVPI, a ratio of total value to paid in capital) of the investment is 1.73 which is a joint function of the *growth* and *bow* parameters. The endurance of IRR (or duration), which measures how long the full capital commitment stays invested, is about 4.5y over the investment’s 13y lifetime.<sup>3</sup> Given the hypothetical performance of the assumed public market benchmark in the third column one can also compute the Kaplan-Schoar public market equivalent (PME) and direct alpha which is roughly the PME annualized over the investment duration.

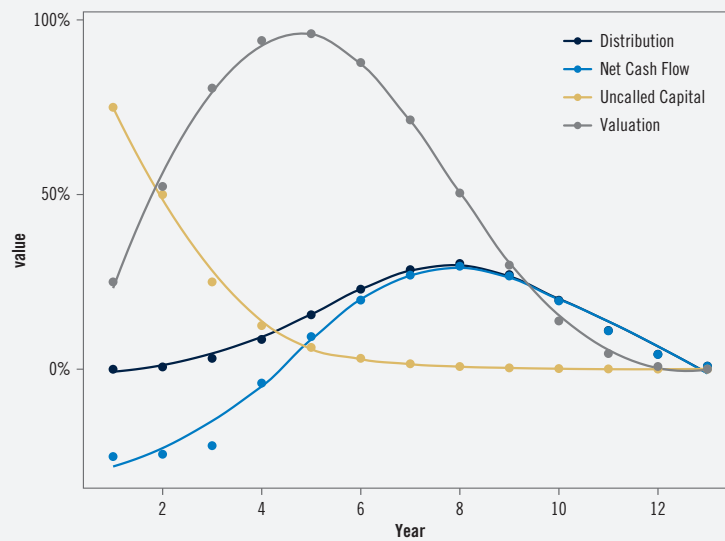
**Figure 1: Illustration of TA Model: Parameters, Cash Flow, and Valuation**

Year	Input		Parameters				Output				
	Commitment	Market	RC	L	G	B	Contribution	Uncalled	Distribution	Valuation	NCF
1	1.0	5.0%	0.25	13	12%	2	0.25	0.75	0.00	0.25	-0.25
2	1.0	4.0%	0.33	13	12%	2	0.25	0.50	0.01	0.52	-0.24
3	1.0	6.0%	0.50	13	12%	2	0.25	0.25	0.03	0.80	-0.22
4	1.0	1.0%	0.50	13	12%	2	0.13	0.13	0.09	0.94	-0.04
5	1.0	-1.0%	0.50	13	12%	2	0.06	0.06	0.16	0.96	0.09
6	1.0	2.0%	0.50	13	12%	2	0.03	0.03	0.23	0.88	0.20
7	1.0	7.0%	0.50	13	12%	2	0.02	0.02	0.29	0.71	0.27
8	1.0	8.0%	0.50	13	12%	2	0.01	0.01	0.30	0.50	0.29
9	1.0	2.0%	0.50	13	12%	2	0.00	0.00	0.27	0.30	0.27
10	1.0	5.0%	0.50	13	12%	2	0.00	0.00	0.20	0.14	0.20
11	1.0	7.0%	0.50	13	12%	2	0.00	0.00	0.11	0.04	0.11
12	1.0	2.0%	0.50	13	12%	2	0.00	0.00	0.04	0.01	0.04
13	1.0	3.0%	0.50	13	12%	2	0.00	0.00	0.01	0.00	0.01

Source: PGIM IAS. Provided for illustrative purposes only.

<sup>3</sup> The endurance of IRR is computed as the log (IRR) / TVPI.

**Figure 2: Visualization of TA Model Cash Flow and Valuation**



Source: PGIM IAS. Provided for illustrative purposes only.

**Figure 3: Performance Analysis of TA Model Cash Flows**

Performance Measure	Value
TVPI	1.73
IRR	12.00%
Endurance	4.56
PME w.r.t Market	1.05
Direct Alpha	1.11%

Source: PGIM IAS. Provided for illustrative purposes only.

### Periodic Growth TA Model

We explore a modified version of the TA model with potentially different values for the growth parameter in every period. The contribution model and the formula of RD remain unchanged.

#### Modified Distribution Model

$$D_t = NAV_{t-1} \times (1 + G_{t-1}) \times RD(\text{Age}_{t-1}, \text{bow}, L),$$

#### Modified NAV Model

$$NAV_t = NAV_{t-1} (1 + G_{t-1}) + C_t - D_t$$

The advantage of the modified model is that although the contribution model is unchanged, having the distribution and valuation models subject to growth specific to each period may bring the TA model closer to reality.

## Estimating Periodic Growth with Lagged Regression

Periodic returns of private investments (*i.e.*, modified-Dietz returns or quarterly IRRs) are known to be smoothed (Getmansky, *et al.* 2004). To estimate these parameters using periodic returns we use a lagged regression model, along the lines of the CAPM.<sup>4</sup> Reliable estimates of these parameters can be useful for risk estimation, return attribution and asset allocation. We seek to model the periodic growth parameters, as a function of public market returns, to be able to simulate quarterly IRRs based on simulated market returns. Consider the following model:

$$r_t^{\text{pvt}} - r_t^{\text{rf}} = \alpha + \beta (r_t^{\text{mkt}} - r_t^{\text{rf}}) + \epsilon_t,$$

in which the periodic returns of a private asset are regressed against periodic public market returns. The model decomposes the private asset's returns into three components: an alpha (a constant return), a beta (a return correlated with the market excess return), and an unexplained, or idiosyncratic, return that has a mean of zero and is uncorrelated with the market excess return.

Given that private returns are likely smoothed over time, to explain private returns in terms of the public market return we will use as explanatory variables the contemporaneous market return as well as several lagged market returns.<sup>5</sup> A model that includes  $K$  lags of market returns, in addition to the contemporaneous return, is as follows:

$$r_t^{\text{pvt}} = \alpha + \sum_{k=0}^K \beta_k r_{t-k}^{\text{mkt}} + \epsilon_t$$

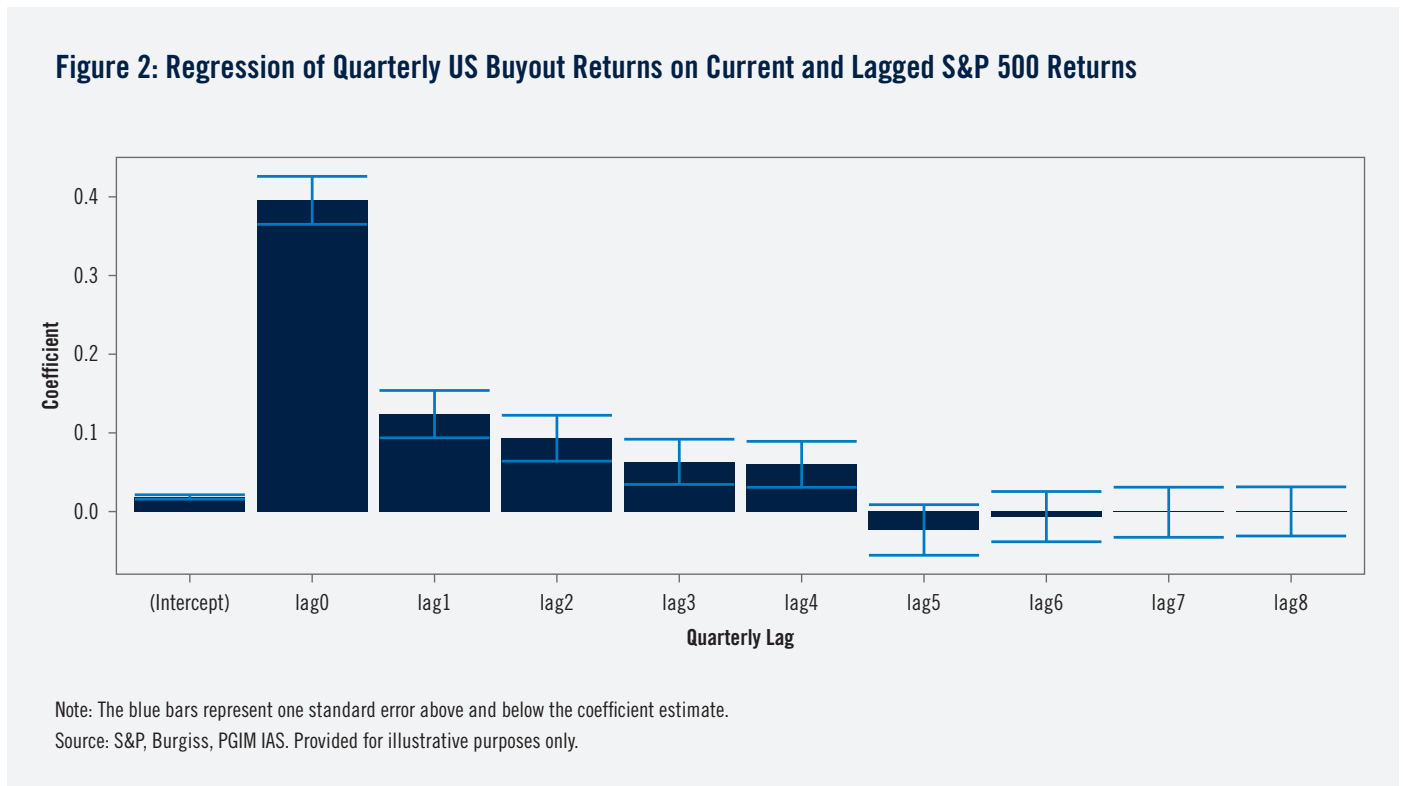


Figure 4 shows the coefficient estimates for US buyout quarterly returns, pooled across all vintages, from Q1 1980 to Q1 2020.<sup>6</sup> Up to 4 lags of S&P 500 quarterly returns seems relevant. The overall beta (*i.e.*, the sum of the coefficients on the contemporaneous and first four lagged public market returns) is about 0.75. The adjusted-R<sup>2</sup> is 0.58 and the standard deviation of residuals is about 1%. The regression was fitted using exponentially-smoothed weights on time-series observations (older observations are given smaller weights). We used a half-life of 20q, which means that a 5y-old observation is given only half the weight compared to the most recent observation.

<sup>4</sup> See O'Shea and Jeet (2017) for a detailed literature review.

<sup>5</sup> For simplicity, the term corresponding to risk-free rate is dropped here.

<sup>6</sup> See coefficient estimates and fit statistics in the Appendix.

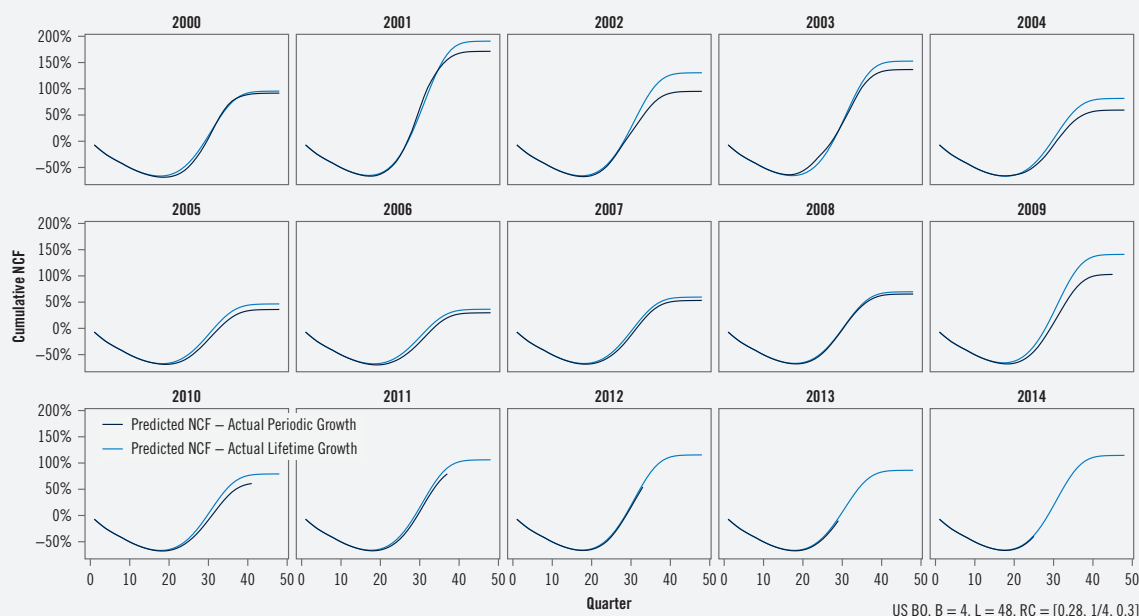
## Comparison of Lifetime and Periodic Growth TA Models

We now compare the two versions of the TA model: one that uses a single lifetime growth parameter and one that uses a set of periodic growth parameters. For this comparison we fix all other TA parameters which we calibrate using pooled US buyout data across vintages 1980 through 2020. We use a bow factor of 4, lifespan of 12y, and rate of contribution 28% in the first year, 25% in the second year and 30% onwards.

To begin, we first use actual growth data for the two sets of growth parameters. For the lifetime growth parameter, we use the actual 12y IRR, when available, and since-inception IRR otherwise, as reported by Burgiss. For the set of periodic growth parameters, we use actual quarterly IRRs, also from Burgiss. This exercise provides an “estimation-free” comparison between the two models. In reality, the value of a cash flow model lies in its predictive power for which we would also have to predict (or, estimate) the growth parameter.

We compare these two TA model versions using 15 consecutive vintages from 2000 to 2014. Figure 5 shows the cumulative net cash flow, by vintage, generated by each model. A quick look at Figure 5 may tempt one to conclude that the two models are nearly the same, as the periodic and lifetime growth models’ cumulative cash flows track each other well. Toward the end of 12y lifespan the periodic and lifetime models start to drift apart as the quarterly IRRs become noisier as valuations gets smaller. However, since these noisy periodic growth estimates are applied to smaller valuations, the gap between the two models is effectively small.

**Figure 5: Comparison of TA Model Versions – Actual Lifetime vs. Actual Periodic Growth Data**  
**Estimated Cumulative Net Cash Flow, by Vintage**



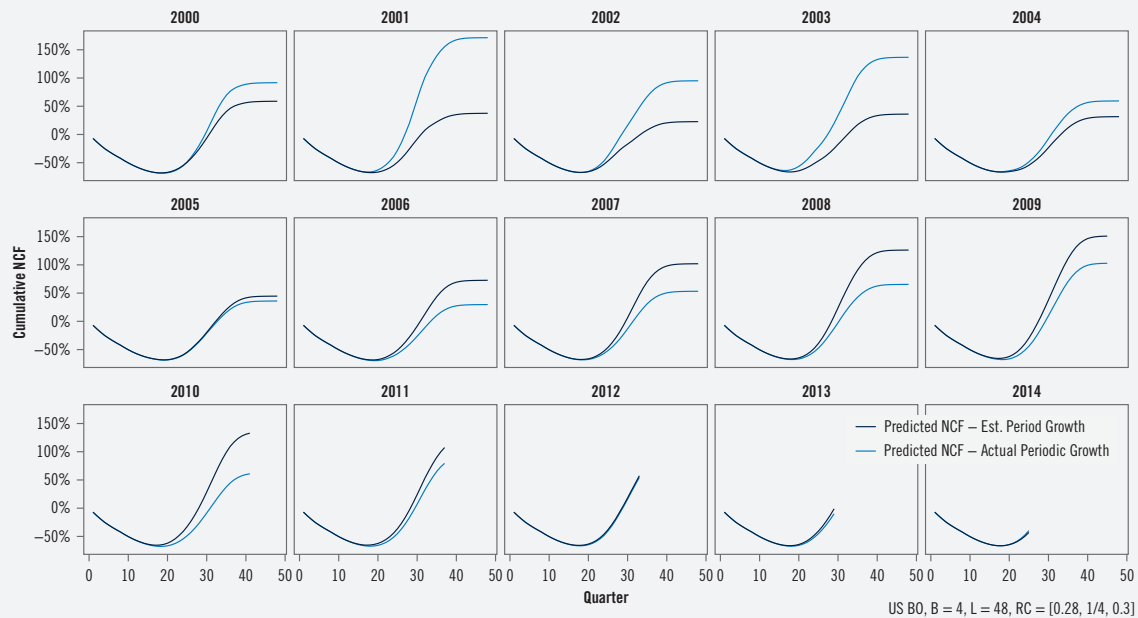
Source: S&P, Burgiss, PGIM IAS. Provided for illustrative purposes only.

Having established that the periodic growth TA model version can potentially perform as well as the lifetime growth version, the issue becomes how well can we estimate periodic growth. Figure 6 compares two periodic growth TA models: One using *actual* periodic growth data (Figure 5) and one using *estimated* periodic growth data from the lagged regression as described above. We ran the lagged regression every quarter using data only available up to, but not including, the current quarter. Using the regression coefficient estimates and actual market returns, we estimate the quarterly IRRs and use them as the periodic growth parameters.<sup>7</sup> The estimated quarterly IRRs are independent of underlying NAV size and cash flows.

As expected, Figure 6 shows that the actual and estimated quarterly IRRs produce different cumulative cash flows for a given vintage. However, for most vintages, they follow each other reasonably well. But the real test is how well the predicted net cash flows compare with actual net cash flows.

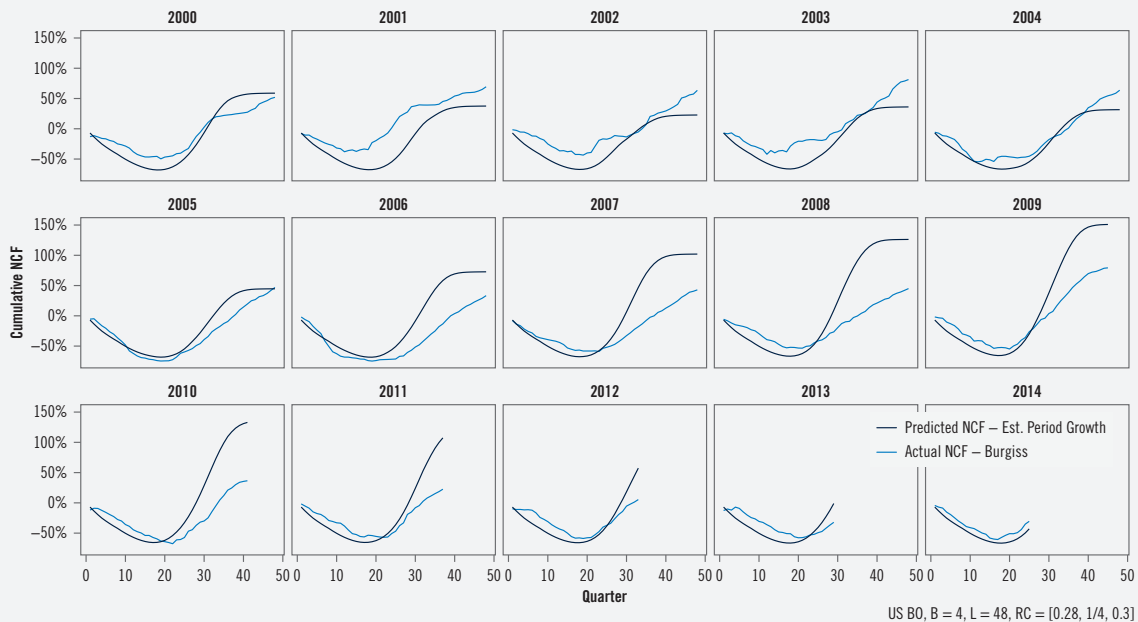
<sup>7</sup> In reality we will also have to predict market return for the most recent quarter, which is a separate challenge. We are using actual S&P 500 index returns because we are interested in the ability of the TA model using the best possible estimates of the periodic growth parameters.

**Figure 6: Comparison of TA Model Versions – Actual vs. Estimated Periodic Growth Parameters  
Estimated Cumulative Net Cash Flows, by Vintage**



Source: S&P, Burgiss, PGIM IAS. Provided for illustrative purposes only.

**Figure 7: Performance of TA Model Version Using Estimated Periodic Growth  
Cumulative Net Cash Flows: Model vs. Actual, by Vintage**



Source: S&P, Burgiss, PGIM IAS. Provided for illustrative purposes only.

Figure 7 compares the model cumulative net cash flows using regression-based periodic growth estimates with actual vintage-level cumulative net cash flows, from Burgiss (scaled to match a dollar of commitment for each vintage). It is evident from Figure 7 that the TA framework with out-of-sample estimated periodic-specific growth rates does a reasonably good job matching actual net cash flows. The large difference from vintage 2006 onward (in the latter half of lifespan) could be due to multiple factors including

modeling limitations, a change (due to the financial crisis of 2008) in the bow factor, lifespan, or even RC parameters. How good is the TA model to match actual net cash flows? This is an interesting but a separate topic beyond the scope of this paper. The purpose of this paper is by and large served by Figures 5 and 6 in which we show that, given the TA model, changing the lifetime growth to period-specific growth does not alter the model significantly but makes it easy to be deployed in simulation settings to generate market-sensitive cash flows.

## Conclusion

The Takahashi and Alexander's framework to model private capital portfolio's cash flows has stood the test of time. However, estimating lifetime growth parameter remains a challenge, especially in a simulation setting in which market returns are sampled many times. How a private investment might behave in different market scenarios is an important portfolio management question.

We present a modified version of the TA model in which the model's lifetime growth parameter is replaced with period-specific growth parameters – *i.e.*, a growth parameter for each period. Periodic growth values are modeled using lagged regression. The modified TA model provides a systematic way to link private capital growth and distribution patterns to the public markets. We present computational evidence using buyout and public market data to show the effectiveness of our approach to make the TA model more useful.

## Acknowledgements

*We wish to thank Dr. Taimur Hyat for his valuable comments and suggestions.*

## References

- Getmansky, Mila, A. W. Lo, I. Makarov (2004). "An econometric model of serial correlation and illiquidity in hedge fund returns." *Journal of Financial Economics*. 74(3). 529-609.
- Jeet, V and L. O'Shea (2018a). "Modeling Cash Flows for Private Capital Funds." Working Paper. Burgiss Applied Research.
- O'Shea, L. and V. Jeet (2018b). "Budgeting for Capital Calls: A VaR-Inspired Approach." Working Paper. Burgiss Applied Research.
- O'Shea, L. and V. Jeet (2017) Estimating Public Market Exposure of Private Capital Funds Using Bayesian Inference. Working Paper. Burgiss Applied Research.
- Takahashi, D. and S. Alexander (2002). "Illiquid Alternative Asset Fund Modeling." *The Journal of Portfolio Management*. 28 (2). 90-100. DOI: <https://doi.org/10.3905/jpm.2002.319836>



## Appendix

**Figure A1: Regression Table of Figure 4: Coefficient Estimates**

Coefficients	Estimate	Std. Error	t-statistic	p-value	Significance
Intercept	0.018567	0.002787	6.661	5.17E-10	***
Lag 0	0.395559	0.03047	12.982	2.00E-16	***
Lag 1	0.123824	0.030092	4.115	6.45E-05	***
Lag 2	0.09322	0.029165	3.196	0.00171	**
Lag 3	0.063234	0.028738	2.2	0.02935	*
Lag 4	0.060042	0.029194	2.057	0.0415	*
Lag 5	-0.02337	0.032121	-0.727	0.46814	
Lag 6	-0.00642	0.031941	-0.201	0.84102	
Lag 7	-0.00089	0.031851	-0.028	0.97786	
Lag 8	0.0001702	0.0312004	0.005	0.99566	

Source: S&P, Burgiss, PGIM IAS. Provided for illustrative purposes only.

**Figure A2: Regression Table of Figure 4: Quality of Fit**

Statistic	Value
Residual standard error	0.01081
Multiple R <sup>2</sup>	0.5779
Adjusted R <sup>2</sup>	0.5519
F-statistic, DF = (9, 146)	22.21
p-value	2.2e-16

Source: S&P, Burgiss, PGIM IAS. Provided for illustrative purposes only.

## MORE PUBLICATIONS FROM PGIM IAS

### Publications

- Next-Generation Commodity Benchmarks: RASA Benchmarks Designed to Align with CIO Investment Objectives *(November 2020)*
- Riders in the Storm: How Volatility Events Affect Private Asset Class Performance *(June 2020)*
- The Probability of Recession: A Critique of a New Forecasting Technique *(June 2020)*
- What's in Your Real Asset Portfolio? *(May 2020)*
- Measuring the Value of LP Fund-Selection Skill *(April 2020)*
- Building a Better Portfolio: Balancing Performance and Liquidity *(joint with the GIC – April 2020)*
- What is the Optimal Number of Equity Managers? – A CIO Toolkit for Manager Allocation *(February 2020)*
- Institutional Gold! *(November 2019)*
- A Fair Comparison Framework: Risk and Return in Private & Public Investments *(November 2019)*
- Asset Allocation for “End-State” Portfolios *(September 2019)*
- The Diversity of Real Assets: Portfolio Construction for Institutional Investors *(June 2019)*
- The Tradeoff Between Liquidity and Performance: Private Assets in Institutional Portfolios *(January 2019)*
- Emerging Market Equity Benchmarks for Japanese Investors: Countries, Sectors or Styles? *(October 2018)*
- Forecasting Long-Term Equity Returns: A Comparison of Popular Methodologies *(September 2018)*
- What Can the Markets Tell Us about Future Economic Growth? *(September 2018)*
- How to Measure the Value of Adding a Cross-Sector Manager *(September 2018)*
- Anchor to Windward: Aligning Absolute Return Objectives *(May 2018)*
- When the Dust Flies: How Volatility Events Affect Asset Class Performance *(April 2018)*
- Asset Allocation with Illiquid Private Assets *(February 2018)*
- The Impact of Market Conditions on Active Equity Management *(March 2017)*

### Bespoke Client Projects

- Will my equity managers perform as expected in the next downturn?
- How should we allocate capital across our equity managers?

### Case Studies

- Cenland Corporation—The CIO and the Closing of the DB Plan *(December 2019)*

🔗 [Visit us at pgim.com/IAS](https://www.pgim.com/IAS)

## Important Information

**Past performance is no guarantee or reliable indicator of future results. All investments involve risk, including the possible loss of capital.** These materials are for informational or educational purposes only. In providing these materials, PGIM is not acting as your fiduciary.

**Alternative investments** are speculative, typically highly illiquid and include a high degree of risk. Investors could lose all or a substantial amount of their investment. Alternative investments are suitable only for long-term investors willing to forego liquidity and put capital at risk for an indefinite period of time. **Equities** may decline in value due to both real and perceived general market, economic and industry conditions. Investing in the **bond** market is subject to risks, including market, interest rate, issuer, credit, inflation risk and liquidity risk. **Commodities** contain heightened risk, including market, political, regulatory and natural conditions and may not be suitable for all investors. The use of models to evaluate securities or securities markets based on certain assumptions concerning the interplay of market factors, may not adequately take into account certain factors and may result in a decline in the value of an investment, which could be substantial.

**The analysis in the paper is based on hypothetical modeling.** There is no guarantee, and no representation is being made, that an investor will or is likely to achieve profits, losses or results similar to those shown. Hypothetical or simulated performance results are provided for illustrative purposes only and have several inherent limitations. Unlike an actual performance record, simulated results do not represent actual performance and are generally prepared through the retroactive application of a model designed with the benefit of hindsight. There are frequently sharp differences between simulated results and actual results. In addition, since trades have not actually been executed, simulated results cannot account for the impact of certain market risks such as lack of liquidity. There are several other factors related to the markets in general or the implementation of any specific investment strategy, which cannot be fully accounted for in the preparation of simulated results and all of which can adversely affect actual results.

All **charts** contained herein were created as of the date of this presentation, unless otherwise noted. Performance results for certain charts and graphs may be limited by date ranges, as stated on the charts and graphs. Different time periods may produce different results. **Charts and figures** are provided for illustrative purposes and are not an indication of past or future performance of any PGIM product.

These materials represent the views, opinions and recommendations of the author(s) regarding the economic conditions, asset classes, securities, issuers or financial instruments referenced herein, and are subject to change without notice. Certain information contained herein has been obtained from sources that PGIM believes to be reliable; however, PGIM cannot guarantee the accuracy of such information, assure its completeness, or warrant such information will not be changed. The information contained herein is current as of the date of issuance (or such earlier date as referenced herein) and is subject to change without notice. PGIM has no obligation to update any or all of such information; nor do we make any express or implied warranties or representations as to the completeness or accuracy or accept responsibility for errors. Any forecasts, estimates and certain information contained herein are based upon proprietary research and should not be considered as investment advice or a recommendation of any particular security, strategy or investment product. These materials are not intended as an offer or solicitation with respect to the purchase or sale of any security or other financial instrument or any investment management services and should not be used as the basis for any investment decision. No liability whatsoever is accepted for any loss (whether direct, indirect, or consequential) that may arise from any use of the information contained in or derived from this report. PGIM and its affiliates may make investment decisions that are inconsistent with the recommendations or views expressed herein, including for proprietary accounts of PGIM or its affiliates. The opinions and recommendations herein do not take into account individual client circumstances, objectives, or needs and are not intended as recommendations of particular securities, financial instruments or strategies to particular clients or prospects. No determination has been made regarding the suitability of any securities, financial instruments or strategies for particular clients or prospects. For any securities or financial instruments mentioned herein, the recipient(s) of this report must make its own independent decisions.

The information contained herein is provided by **PGIM, Inc.**, the principal asset management business of Prudential Financial, Inc. (PFI), and an investment adviser registered with the US Securities and Exchange Commission. The S&P 500® is widely regarded as the best single gauge of large-cap U.S. equities. There is over USD 11.2 trillion indexed or benchmarked to the index, with indexed assets comprising approximately USD 4.6 trillion of this total. The index includes 500 leading companies and covers approximately 80% of available market capitalization. The 3 Month LIBOR (London Interbank Offered Rate) is the stated rate of interest at which banks in the London wholesale money markets may borrow funds from one another for three months. An investment cannot be made directly in an unmanaged index. PFI of the United States is not affiliated in any manner with Prudential plc, incorporated in the United Kingdom or with Prudential Assurance Company, a subsidiary of M&G plc, incorporated in the United Kingdom. In the United Kingdom and various European Economic Area (“EEA”) jurisdictions, information is issued by **PGIM Limited** with registered office: Grand Buildings, 1-3 Strand, Trafalgar Square, London, WC2N 5HR. PGIM Limited is authorised and regulated by the Financial Conduct Authority of the United Kingdom (Firm Reference Number 193418) and duly passported in various jurisdictions in the EEA. These materials are issued by PGIM Limited to persons who are professional clients or eligible counterparties for the purposes of the Financial Conduct Authority’s Conduct of Business Sourcebook. In certain countries in Asia, information is presented by **PGIM (Singapore) Pte. Ltd.**, a Singapore investment manager registered with and licensed by the Monetary Authority of Singapore. In Japan, information is presented by **PGIM Japan Co. Ltd.**, registered investment adviser with the Japanese Financial Services Agency. In South Korea, information is presented by **PGIM, Inc.**, which is licensed to provide discretionary investment management services directly to South Korean investors. In Hong Kong, information is presented by representatives of **PGIM (Hong Kong) Limited**, a regulated entity with the Securities and Futures Commission in Hong Kong to professional investors as defined in Part 1 of Schedule 1 of the Securities and Futures Ordinance. In Australia, this information is presented by **PGIM (Australia) Pty Ltd.** (“PGIM Australia”) for the general information of its “wholesale” customers (as defined in the Corporations Act 2001). PGIM Australia is a representative of PGIM Limited, which is exempt from the requirement to hold an Australian Financial Services License under the Australian Corporations Act 2001 in respect of financial services. PGIM Limited is exempt by virtue of its regulation by the Financial Conduct Authority (Reg: 193418) under the laws of the United Kingdom and the application of ASIC Class Order 03/1099. The laws of the United Kingdom differ from Australian laws. Pursuant to the international adviser registration exemption in National Instrument 31-103, PGIM, Inc. is informing you of that: (1) **PGIM, Inc.** is not registered in Canada and relies upon an exemption from the adviser registration requirement under National Instrument 31-103; (2) PGIM, Inc.’s jurisdiction of residence is New Jersey, U.S.A.; (3) there may be difficulty enforcing legal rights against PGIM, Inc. because it is resident outside of Canada and all or substantially all of its assets may be situated outside of Canada; and (4) the name and address of the agent for service of process of PGIM, Inc. in the applicable Provinces of Canada are as follows: in **Québec**: Borden Ladner Gervais LLP, 1000 de La Gauchetière Street West, Suite 900 Montréal, QC H3B 5H4; in **British Columbia**: Borden Ladner Gervais LLP, 1200 Waterfront Centre, 200 Burrard Street, Vancouver, BC V7X 1T2; in **Ontario**: Borden Ladner Gervais LLP, 22 Adelaide Street West, Suite 3400, Toronto, ON M5H 4E3; in **Nova Scotia**: Cox & Palmer, Q.C., 1100 Purdy’s Wharf Tower One, 1959 Upper Water Street, P.O. Box 2380 - Stn Central RPO, Halifax, NS B3J 3E5; in **Alberta**: Borden Ladner Gervais LLP, 530 Third Avenue S.W., Calgary, AB T2P R3.

IAS 1106-300



For inquiries and to learn more  
about PGIM's investment advisory  
capabilities, email [IAS@pgim.com](mailto:IAS@pgim.com).

Learn more at [pgim.com/IAS](http://pgim.com/IAS)

