An Economic Case for Transparency in Private Equity: Data Science, Interest Alignment and Organic Finance

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Abstract: The private equity asset class has grown rapidly since 2008, attracting institutional investors in need of higher returns than those expected from public markets. But while most investors would say they have been rewarded with good performance, this success is hard to objectively demonstrate due to intransitive metrics and unmeasured risks. It is our belief that there is a pressing need to substantiate the economic case for private equity. In this article, we describe a new transparency framework, which we situate in our research agenda on 'organic finance'. The framework uses data science technology to operationalize private equity data and institute a scientific approach to performance measurement. We elucidate what scientific measurement should look like in private equity, incorporating examples of technologies in use today. We also reveal how bringing new levels of transparency into the asset class can, on its own, create significant value. Finally, we look at the effect of organic finance on the industry, connecting greater transparency to a structural shift that enables efficiencies, expansion, and innovation. The magnitude and sustainability of this shift reinforces the economic case for private equity, albeit with far more transparency than is practiced today.

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Introduction

Organic Finance refers to an emerging investment philosophy underpinned by greater information transparency between investors and the sources of investment return (base assets). In pursuit of investment transparency, organic finance leverages technologies to reveal and report evidence on investment structures, which allows investors to better understand and assess the value-producing investment opportunities via observable facts. The key ingredient of organic finance is therefore data; specifically, the data needed to calculate valuations, returns, risks, fees, performance attribution, and other performance categories of base assets. This information forms a pathway of facts through the investing value chain, allowing a comparison, at every stage, of investment options to facilitate efficient capital allocation. Through appropriate processing of data – converting it into information, knowledge, and intelligence – organic finance aims to help investors fulfill their essential role in the capitalist system.

In a prior paper on organic finance, we used a case study of public equities to highlight how an index vehicle uses layers of abstraction from underlying economic assets to deliver diversified index-like returns, highlighting how the process of productization distorts the risk-return profile of the investment product from its underlying asset (Monk et al., 2017). That paper showed there was a return premium that could be reaped, via organic finance factors, when investing in products that offer an undistorted representation of risk. In this paper, we turn our attention to private equity. With its classic long-only simplicity and trusted relationships, private equity should theoretically embody the organic finance philosophy. Yet, perhaps more than any other asset class, private equity (PE) has become the antithesis of transparency.

In PE, we identify several structural impediments to transparency. For example, returns and fees are not measured at the base asset or the industry level, thwarting meaningful comparison by investors. Since base asset data is not routinely collected, exercised, or modeled by limited partner investors (LPs), the true investment risk within their PE portfolios is largely unknown. Instead, LP datasets usually contain only the quantities needed to calculate an internal rate of return (IRR), namely cash flows of funds and their vintage year. In our experience, this is inadequate to achieve true 'see-through' to the base assets and overall portfolio transparency (i.e., organic finance). Indeed, it is within this opacity that a misalignment of interests between LPs and GPs has flourished. It may be tempting for the industry to accept opacity as a natural, permanent, and even desirable characteristic of private market investing. But, as we show below, opacity is an unchecked tax on participants, limiting the industry's ability to evolve and curtailing its value-add to the broader economy.

In what follows, we describe an organic finance framework that draws on recent breakthroughs in data science technology to dismantle the underlying structural issues that drive opacity in private equity. We show how the outputs of this framework build real transparency throughout a portfolio, creating means for new metrics, operational efficiencies, and a sustainable investing edge for both LPs and general partners (GPs). We also discuss how a focus on base assets can contribute to private equity's body of knowledge, supporting enquiry into risk management, explanatory power of GP skill, quantifying value of active management, and more. This state-of-

the-art elevates the concept of transparency away from a private company's secrets to information that allows capital allocators to see the patterns of the past and apply them to reduce uncertainty of the future. Importantly, the building blocks of organic finance are base asset data, and we offer a practical means of collecting and modeling organic it so that those who want transparency are not prevented from developing and benefiting from it.

Structural Basis of Opacity in Private Equity

"The real question is, is it beating the public markets, and if it's not then it's not worth it."
Prof. Steve Kaplan[1]

Investing involves making purposeful capital-allocation decisions based on measurement and comparison of returns, risk, costs, and other factors defined by the investor. As suggested by Prof. Steve Kaplan (above), an assessment of *relative* performance – not only among private asset managers but also against publicly traded comparables[2] – fits logically into private equity investment decision-making. However, structural elements in private equity make such comparisons ambiguous and the economic case uncertain. Apart from the absence of a continuously observable price, which we discuss later in this paper, what are these structural issues and how do they drive opacity? We identify three key issues below:

1. *Intransitive Metrics*

In private equity, the ubiquitous performance metric is the internal rate of return (IRR). The problem is that the IRR has intransitive properties that prevent meaningful comparisons, and thus, prevent transparency. In mathematics, transitivity refers to the logic of relations such that if A > B, and B > C, then A [must be] > C. The *absence* of this property is undesirable in a metric because it renders comparisons (and rankings) inconclusive, and aggregation disorderly. To illustrate this in private equity, consider the simple example of two funds (Figure 1), with two investments of equal amounts made and exited at the same times.

The higher total return of Fund A in dollars over the same investment period as Fund B ($110 for Fund A and $90 for Fund B) would logically make Fund A the better performing fund. Yet Fund B is the better performing fund through the lens of the IRR (66% for Fund B versus 40% for Fund A), since the metric is influenced by the higher *early* returns. The metric assumes that the early returns are re-invested at the same rate[3], giving the illusion of better performance to the lower dollar-returning fund. This same property accounts for the remarkable 'since inception' IRR of private equity firms that started in the 70s and early 80s. Large pools of arbitrage in the market at that time drove up early returns that, like the example in Figure 1, continue to boost the 'since

[1] Prof. Steve Kaplan, discussing the 'illiquidity premium' at the 2016 Fiduciary Investors Symposium in Chicago, as reported by Amanda White, Top1000Funds.com

[2] This could be a broad index, a custom benchmark, or the returns of the allocator's public equities.

[3] Research by Gottschalg and Phalippou (2007) found that setting the IRR's reinvestment rate to 12% significantly re-orders funds ranked by IRR, to the extent that some funds billed as 'top performing' were, in fact, mediocre.

inception' metric of these firms today. This is not only misleading as an indicator of their contemporary performance, but it forms a performance moat around the top private equity firms against which emerging managers and strategies struggle to appear competitive.

	Fund A			Fund B		
	Call	Dist.	IRR	Call	Dist.	IRR
1/1/2015	$ -100			$ -100		
1/1/2016		$ 110			$ 190	
Asset 1			10.0%			90.0%
1/1/2017	$ -100			$ -100		
1/1/2018		$ 200			$ 100	
Asset 2			100.0%			0.0%
Totals	$ -200	$ 310		$ -200	$ 290	
Profit		$ 110			$ 90	
Fund IRR			40.3%			66.1%

Figure 1: Intransitive Properties of the IRR

Turning now to the contemporaneous fund; if the IRR illusion is widely understood, the natural consequence would be purposeful engineering of early outflows. Since a GP with an existing top quartile fund[4] can raise a follow-on fund more than five times faster than a bottom quartile counterpart (Barber and Yasuda, 2016), such engineering may occur even at the cost of value maximization for the LP (and the asset). One such scheme, termed "IRR juicing", targets the metric's variables *time to,* and the *size of,* early distributions. For example, the use of fund subscription lines of credit (also known as 'equity bridge financing') to delay capital calls[5], and aggressive forecasting to increase debt-fueled dividends. While unsavory, IRR juicing does not necessarily constitute GP misconduct, and it may in fact be explicitly provided for in limited partner agreements.

Consider then, the hampering effect of the IRR metric on the evolutionary mechanics of investors rewarding managers who make relatively good returns and punishing those who do not. Or consider asset managers trying to market growth-oriented products using a metric that inherently rewards early distributions. Consider also the confusion of trustees and beneficiaries unable to connect a reported return to the portfolio valuation or their account balances. The IRR metric is thus inadequate, and even unhelpful, in promoting understanding of PE performance. And yet, capital allocation remains inveigled by IRR metrics and performance. This has itself become a structural issue because the opacity of the IRR metric creates the illusion of high returns and props up outdated investment models, effectively ossifying the industry.

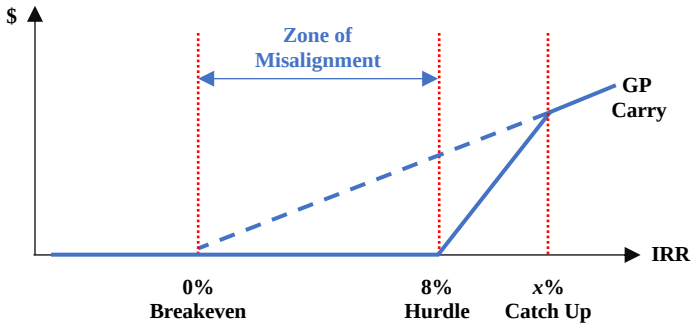
[4] PE firms may voluntarily submit their funds' data (usually NAVs and cash flows) to a third-party service (e.g. Cambridge Associates, Preqin). The resulting analysis groups the performance of funds with the same beginning year or vintage into quartiles on the basis of their IRR and multiples.

[5] In a 2018 "Performance" magazine article, Armstrong-Cerfontaine and Partington describe equity bridge financing as beneficial to investors for allowing capital calls to be more predictably staggered, and GPs to be more 'reactive' to investment opportunities. However, the greatest benefit – indeed the headline benefit in the article – is the boost given to the fund's IRR: up to 5% improvement for delayed investment capital calls, and 2% improvement for delayed fee capital calls. The use of subscription lines of credit to juice IRR is also established empirically in the literature, see Albertus and Denes (2020).

2. *Risk Misalignment*

The hurdle mechanism within the industry's conventional 2-8-20 fee structure – where 2% is the base fee, 8% is the performance hurdle, and 20% is the variable component paid to GPs – is driven by the IRR calculation. As such, it may be employed by the GP to maintain the appearance of alignment, while, in reality, skewing risk and return in their favor. Since the variable component is not benchmarked against anything other than the entry investment, some may not regard it as a true performance fee. Rather, it is exactly what its original name implies: a carried interest in the profit, an incentive, normally a 20% / 80% split between GP and LPs respectively. Performance is tethered to a nominal proxy – typically 8% annualized – called the hurdle or preferred rate of return. Once the IRR of the fund or the asset exceeds the specified hurdle, the GP's right to their carried interest is triggered.[6]

Using the inflation-adjusted average annual return of the S&P 500 as a market proxy – approximately 7.7% – arguably, the intent of the hurdle is to ensure outperformance against the U.S. public markets, thus aligning the participants' return objectives. However, 'juicing' the IRR effectively (and unpredictably) lowers the GP's minimum performance threshold. In high performing funds, the lower threshold might have negligible impact. But in mediocre funds, IRR-juicing drives more fees to the GP and further reduces performance for LPs.[7]



A hurdle rate creates a zone of misalignment where the LP is 'in the money' and the GP is not. In this zone, an LP has certainty of 100% of the profits, while the GP has certainty of 0%.

This incentivizes the GP to use risk to achieve certainty of profits even though this serves to reduce both the certainty and the portion of profits for the LP.

Figure 2: GP's Choice: Effect of Hurdle Rate on GP Interests

The hurdle component of the profit-share model also creates a risk asymmetry in favor of the GP. As shown in Figure 2 above, an interval of misaligned interests is created between break-even and the hurdle rate. In this zone, the GP has 0% certainty of profits while the LP has 100% certainty. Risk is therefore the GP's key to clearing the hurdle, even though it serves to reduce certainty of profits for the LP.

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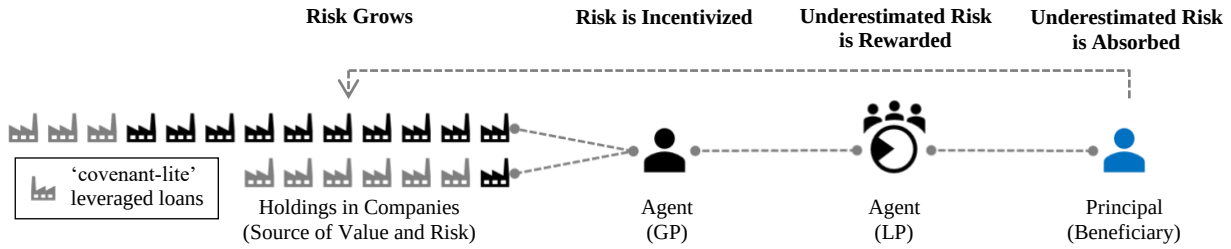
[6] The hurdle rate prevents profit-taking by the GP until the LPs have their invested capital returned (i.e. 1.0x MOIC) plus the hurdle rate. With some variations, return of invested capital may be assessed per asset (American model), or in aggregate i.e. to the fund (European model).

[7] The Institutional Limited Partner Association (ILPA) recommends GPs use the credit draw-down date rather than the LP capital call date to calculate IRR, specifically to guard against a GP receiving carry (and likely ensuing claw back disputes over the calculation of IRR) in cases where the unlevered IRR may not meet the hurdle (ILPA, 2017).

Certainly, the LP can also benefit from the higher return potential created by risk. However, unlike LPs, GP's invest disproportionately less than their carried interest portion. This sets up an asymmetry of risk over which a GP's 'skin in the game' does not usually prevail; the asymmetry provides GPs a material stake in the upside without a commensurate exposure to the downside. The LP and the creditors hold substantially all the risk. So, while the hurdle rate incentivizes risk, the absence of risk thresholds in the fee structure allows the *amount* of risk to be unchecked.

To create a natural deterrent to excessive risk, many LP agreements stipulate a GP invest their own capital alongside LPs. However, a GP generally does not start with zero risk because the management fee they receive creates a negative risk. Should the LP choose to accept capital as invested 'in-kind' for a waiver of their management fee, tax arbitrage[8] reduces the real capital committed by the GP and further lowers their risk. Consider also that in-kind arrangements mean GPs do not have to meet urgent and unpredictable capital calls, reducing their liquidity-related costs. The hurdle mechanism therefore creates an illusion of risk alignment, while granting GPs less downside risk at no cost to their upside potential.

PE's artificially low volatility effectively 'cleanses' risk inside the fund, unwittingly creating an agency issue between the LP and its beneficiaries in the process. Conservative valuations provide a cushion between reported value and exit value that allows returns to appear smooth at the fund level, even in times of high market volatility.[9] When LPs are rewarded based on risk-adjusted returns so calculated, they are incentivized to retain data and metrics that underestimate risk in the portfolio (see Figure 3). Real risk, ultimately absorbed by the beneficiary, is permitted to mount.



When LPs are rewarded for underestimating risk, the system's counterweight to the GP's risk incentive is lost. Consequently, risk grows inside portfolios (global basis) from which the GP benefits disproportionately. When risk is accurately measured and appropriately rewarded, LP and beneficiary are brought into greater alignment and the system benefits, i.e. excessive risk is checked.

Figure 3: Misalignment Between LP and the Beneficiary

[8] At the time of writing, management fees received by the GP are deemed ordinary income, and taxed as such. If management fees are instead deemed invested capital, proceeds may be regarded as capital gains and taxed accordingly [at the more attractive rate].

[9] In 2019, for example, the SEC issued a $5m fine to a GP for undervaluing holdings for the purpose of smoothing returns: https://www.sec.gov/litigation/admin/2019/ia-5245.pdf.

The natural counterweight to GPs being disproportionately rewarded for risk is an LP actively engaged in measuring risk in the PE portfolio; and modern portfolio theory would suggest risk management is necessarily the central thesis of LP value contribution. But without appropriate holdings level data and modern measurement technology, LPs cannot fulfill this expectation. The investment agenda, by default, can only regard any accumulation of risk in the system with a pragmatic nonchalance.[10]

3. *The Net-of-Fees Paradigm*

The industry practice of reporting performance net-of-fees adds to the ambiguity of private equity's economic equation. An absence of data also shrouds potential misconduct and makes it more difficult for LPs to 'follow the money'. It may not be surprising then, that misconduct is widespread.[11]

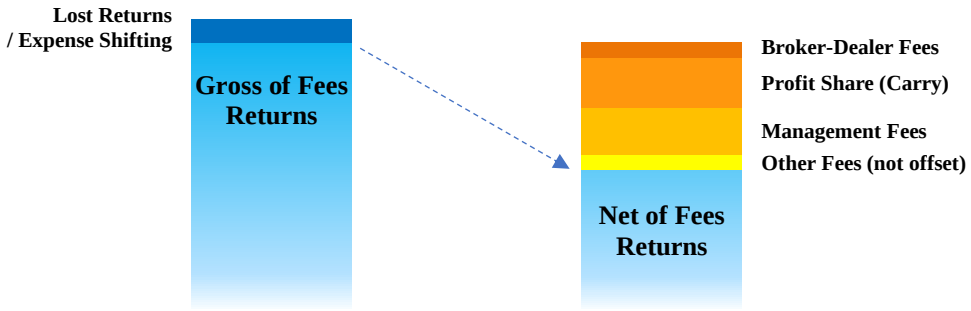


Figure 4: Fiduciaries Need Gross-of-Fees Data to "Follow the Money"

Key to monitoring topline performance is data from the base assets. However, even when investment schedules[12] are included in quarterly reporting, the high dimensionality[13] and non-uniformity of the reported data has thus far limited its ingestion and use by LPs. Adding to the opacity, valuations of base assets may not accurately represent exit value, given GP proclivity to be conservative in their valuations. And the valuation cushion may also create wiggle room for misappropriation of profits. For example, GPs can exploit their authority over [especially] deal-related expenses of portfolio companies without necessarily triggering fiduciary concerns.[14] It is

[10] For example, co-investment vehicles lower effective fees for LPs but they also add concentrated investment risk to the portfolio that may not represent a fair exchange.

[11] In his 2014 "Spreading the Sunshine" speech, Andrew Bowden (then Director of the SEC's Office of Compliance Inspections and Examinations) reported violations of law or material weaknesses in controls related to advisor handling of fees and expenses in over 50% of examinations.

[12] Investment schedules typically contain the identities and periodic valuations of base assets, along with entry and exit dates.

[13] A data dimension specifies context of data quantities. In private equity, "asset valuation" may be in the dimension of the whole asset, the fund's holdings, or a limited partner's interest. When quantities are provided without explicit dimensionality, they are ambiguous, and introduce error into processes. Commonly referenced dimensions in private equity include waterfall (e.g. gross/net-of-fees) and holdings (enterprise/fund/LP-specific).

[14] Fee acceleration, for example, is where an exiting portfolio company is required to buy itself out of service contracts from GP affiliates or operating partners using exit proceeds that would otherwise be deemed profits.

feasible that private equity GPs, like their hedge fund counterparts, manage net returns to a peer or historical benchmark (Getmansky, Lo, and Makarov, 2004), which allows them to presumably maximize fee opportunities in the setting of either a positive or negative investment outcome.

Misconduct aside, if topline returns are not rigorously measured, then a position as to the reasonableness of fees[15] is difficult to arrive at. Despite a growing intuition that certain GP fees are excessive relative to manager contribution,[16] most LPs have only rudimentary understanding of what they are paying GPs.[17] In response to pressure from [often] beneficiaries, the net-of-fees paradigm is instead used to frame the issue of fees as a matter of asset allocation (into low fee strategies)[18]. However, framing fees this way deflects away from examining the relevant issue of the economic value of active management, i.e. the GP's contribution to returns. In the public equities' domain, where gross returns data is more widely available, econometric models have extended the body of knowledge beyond benchmark-based attribution to explicitly link manager actions to their returns (Lo, 2008) and better explain manager skill. In contrast, private equity's attempts to quantify active management remain largely deficient; the value bridge is theoretically flawed (Porter, 2019) and the representativeness of the public market equivalent (PME) is conditioned on a subjectively chosen benchmark. In private equity, managers can avail their carried interest on an absolute basis, not a relative basis, meaning that a rising market can become *more* expensive for LPs. When the whole-enterprise values of held assets are data not collected by LPs, they may avoid questioning the value of active management, and preserve the illusion of an economic case in which they have become reputationally invested. Phalippou (2020) describes at least ten years of the asset management industry taking substantially *all* excess returns, leaving LPs with a net-of-fees return equal to public market returns. This is a serious claim; it equates to billions of dollars being syphoned off, undisclosed by sophisticated investors, in much the same fashion Charlie Munger (2003) describes as "febezzlement".[19]

Phalippou's conclusions, as contentious as they may be to some, illustrate the power of intransitive metrics, unmeasured risk, and the net-of-fees paradigm to create opacity and –

[15] In the U.S., fiduciaries operating under the Uniform Prudent Management of Institutional Funds Act (UPMIFA) and the Employee Retirement Income Security Act (ERISA) are required by statutory law to record and make informed judgements as to the reasonableness of fees.

[16] Aggressive use of debt to lever returns stokes this intuition. Consider that a company's valuation may appreciate over time simply because market prices are rising. The returns from these economic tailwinds are systemic returns, which could also be harvested from liquid stocks. Systemic returns, amplified by leverage, may outpace the GP's hurdle rate and earn them their carried interest. This illustrates, albeit simply, how a manager need not exercise operational skill – growth that outpaces the market – to realize profits, and that the leverage may represent a particularly bad deal for the LP on a risk-adjusted basis.

[17] For instance, in a 2015 Commonfund Institute report, only 18% of polled endowments reported that they considered performance fees to be an investment cost.

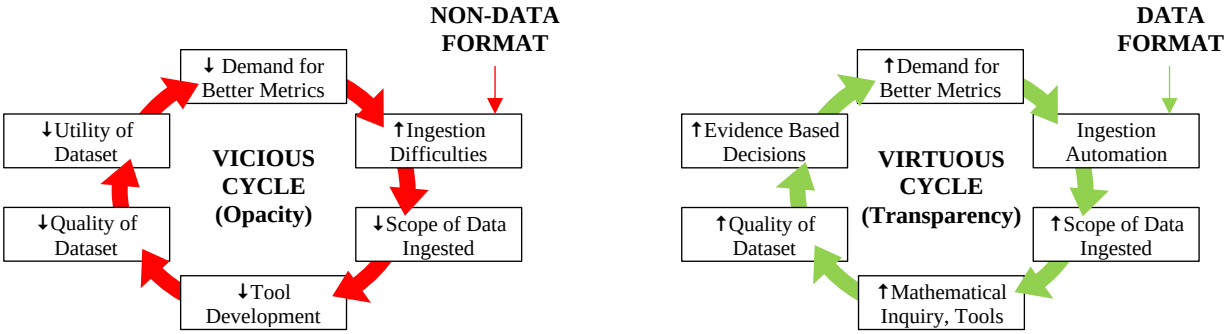
[18] See for example, the Yale Endowment's position on fees in their 2016 annual report, p.16.

[19] Febezzlement, a term coined by Charlie Munger, describes asset management fees as waste. In his own words: "As long as the market keeps going up, the guy who's wasting all this money doesn't feel it, because he's looking at these steadily rising values. And to the guy who is getting the money for investment advice, the money looks like well-earned income, when he's really selling detriment for money, surely the functional equivalent of undisclosed embezzlement" (2003, p.17).

simultaneously – a convincing economic case. Indeed, these factors have become structural impediments to transparency, which until resolved, prevent conclusive evidence as to whether private equity investment is 'worth it'.

The Organic Finance Framework: A Framework for Transparency

An economic model in which rents match returns, and risk is unchecked, is illogical and unsustainable. However, if we accept Phalippou's (2020) conclusions, that is precisely where we find ourselves. For many practitioners, it is difficult to accept this reality, especially if, in their own portfolios, they can point to growth not possible if invested capital is merely recycled. The goal of transparency, then, is to remove performance ambiguity and reform the model with explicit accountability to alignment and economic sustainability. To achieve this, we propose a new framework that makes use of technology to modernize (1) investment data and (2) performance measurement. These two key elements stimulate a virtuous data cycle, as shown in Figure 5, that creates the preconditions for thoughtful reform of private equity's economic model.



The *format* of data received by LPs and their service providers exacerbates the need to rationalize scope of data collection. For example, important investment artifacts like investment schedules and cash flow statements, are routinely issued by GPs in portable document format (*.pdf) containing prose, truncated numbers, and detail-poor graphical representations. Extraction of data from these sources is therefore bound to be, at least in part, a manual process requiring not only re-creation of the data but also its interpretation. The need for interpretation makes ingestion expensive, slow, and error prone. Given data dimensionality, the probability of *mis*interpretation during the ingestion process is high. Costs tighten the *scope* of ingestion, creating datasets unavoidably oriented towards the industry's principal metrics, which makes it difficult to evolve the economic model to greater alignment and sustainability.

Figure 5: Effect of Natural Data Cycles on Transparency

1. *Organic Finance Framework: Modernizing Investment Data*

In private equity, the source of investment value and risk is the operating company held by the fund. Within an organic framework, therefore, reported data begins with accounting quantities from these companies and includes their cash flows from and to the fund. The fund's accounting quantities are then added to the dataset, including capital flows and commitment schedules, valuations of base assets, fees, carried interest, and holdings data. Authorized service providers may add quantities to the dataset, e.g., an independent valuation. Data *flow* describes the movement of this data through a 'security network' – the machines and software of authorized

parties – ultimately compiling a full, multi-dimensional dataset that provides traceability between the LP and the base asset producing value and risk (see Figure 6).

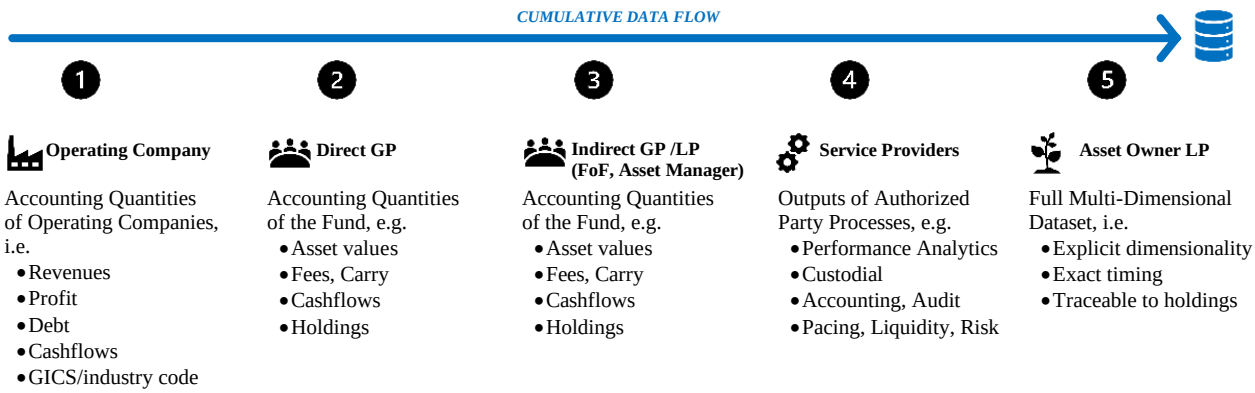


Figure 6: Private Equity Data Flow Through A Security Network

Critical to the integrity of the network is the concept that data may be added to the flow but not removed from it. This represents a substantial change from today's reporting norm, where much of the data from holdings are truncated and transformed by GPs into detail-poor visualizations and/or replaced with forward-looking descriptions locked in slide presentations and pdf documents. In contrast, Figure 6 describes a cumulative data flow creating a pathway of facts between the LP and the underlying assets. It should be noted that the data required to achieve this is not burdensome to the GP or the network because it does not represent a requirement for new, *additional* data. While the data flow outlined in Figure 6 could theoretically be achieved using spreadsheets, in practice spreadsheets tend to introduce other obstacles. For instance, widely-endorsed reporting templates – such as those published by ILPA – specify a reporting uniformity in the quantities and dimensions a GP can use to describe an investment. This may force a rigidity at odds with investment reality and unintentionally minimize the investment context needed for transparency and interpretation.[20]

A more forward-compatible and audit-friendly solution is a digital information flow where reporting data is machine readable, dimension-specific, and tethered to accounting standards (Hoffman, 2020). Fortunately, this is not as far-fetched as may be anticipated; extensible business reporting language (XBRL) offers a universal financial reporting framework[21] that meets these

[20] This effect may be observed in commercial datasets, where a need for data uniformity (so that processes can be run) shrinks data collection, sometimes to just fund-level cash flows. As lamented by academics, the breadth of research and reliability of findings in private equity are materially limited by the narrow scope of datasets (Braun, Jenkinson and Stoff, 2017). In the ILPA capital call/distribution template, tying cashflows to holdings appears to be optional and calls for multiple data points, e.g., holding name and transaction description, to be lumped into one field – an unfortunate cost to downstream data ingestion.

[21] Financial reporting in XBRL is both human readable and machine readable.

requirements and is already in widespread use.[22] Privately held companies that go public on U.S. exchanges (and others) are required to submit regulatory filings using XBRL, and as such, many private equity firms and their accountants already have experience with it. XBRL is an open source (freely available) library that may be extended, via the development of additional private-equity-specific taxonomies, to accommodate and fully explain the dimensions and nuances of private asset investing without duplication of already-established business reporting standards. And finally, since the change is essentially one of reporting format (rather than substance), GP cooperation need not be contingent upon a legal consensus of the fund's LPs. Thus, a reporting protocol rather than a template may finally lift the industry out of spreadsheets and the filing cabinet, and into the modern era.

The most immediate benefit of a digital data flow is cost reduction.[23] It costs the network time and money to construct human-readable investment artifacts from data, and then costs it again to isolate and re-ingest the same data. Since re-ingestion is replicated to some extent by the service providers of each LP in every fund, potential savings are significant. The second benefit of the digital flow described herein comes from its natural fit with service-enhancing technologies such as distributed ledgers (blockchain), smart contracts, and innovative web services. In a digital flow, these would run on a continuous and far more economical basis than today's manual processes, improving governance and transparency. In summary, modernization of investment data is as concerned with *flow* as it is with *scope*; to a large extent the two work in lockstep. Modernized flow will allow a broader scope of data to find their way efficiently into databases, accessible to LPs, researchers and policymakers, where they can affect a virtuous data cycle and a path to transparency. For a full list of base asset data recognized by the organic finance framework, please see Appendix A.

2. Organic Finance Framework for PE: Modernizing Performance Measurement

Within the organic finance framework, modernizing performance measurement makes use of technology to deliver on four themes to unify measurement of private assets with the rest of the portfolio:

(i) Real time capabilities
(ii) Scalable valuation
(iii) Repeatability
(iv) Measurement of relative performance

2(i) Real Time Capabilities

Reporting in private equity is usually lagged, often by months, which inhibits quantitative applications for the simple reason that it is difficult to make old insights actionable. Reporting is also infrequent and contains asynchronous quantities, which in combination tend to reduce

[22] Reporting in XBRL is *required* by the SEC in the U.S., HMRC in the U.K., and ACRA in Singapore. Other regulatory bodies that have adopted XBRL standard include the FDIC (U.S.),

[23] It should be noted that the cost of ingesting data from spreadsheets rather than pdf files also reduces ingestion costs, and may be an interim solution that has the benefit of being immediately implementable.

operational processes to their crudest version.[24] Although a heuristic approach may have been acceptable in the past, it is inadequate for the larger private equity allocations and more direct investment strategies that are increasingly found in LP portfolios. In the organic framework, therefore, the first theme of modernizing performance measurement is improving its proximity to 'real time'. Real time in this case means end-of-same-day.

2(ii) Scalable Valuation

As discussed previously, modernized data flow instantly distributes accounting quantities across an authorized network, but valuation poses a significant challenge to a real time agenda because, as the output of a manual estimation process, it introduces delay. Valuation is an input to all performance measurement, and the inevitable trade-off between speed and quality of its estimation quickly diminishes the economic potential of modernization. It is therefore recognized by the organic framework that valuation be the output of a *scalable* process in which quality is measured and actively managed.

The literature shows that data science technologies have already been successfully applied to valuation. For example, using the UC Investments[25] as their case study, Guimaraes, Monk and Porter (2018) demonstrate enhanced accuracy of portfolio valuation, using an automated process that runs same day, i.e., real time as defined in the organic framework. The automated procedure described by the authors greatly minimizes reporting lag from an LP's portfolio operations, allowing refinement of liquidity algorithms, scope for economic benefit, and management innovation. For instance, as noted by the authors and others[26], the same process may be applied to daily valuation of private assets in defined contribution retirement savings plans.[27]

Data science technologies may also be used to estimate exit or company fair value,[28] introducing valuation scalability to the authorized network via direct GPs (see Figure 6). In the UC Investments case study (2018), the authors also refer to data science technology estimating exit value from a

[24] For example, LPs may apply a beta quantity to their private equity portfolio derived from years-old published research rather than from their own contemporaneous portfolio data, despite the likelihood that volatility varies widely over time and between portfolios of different assets (or even the same assets in different ratios).

[25] UC Investments is the investment organization of the Regents of the University of California, Office of the President, Office of the Chief Investment Officer. At the time of writing the case study, UC Investments managed $10b in alternative illiquid assets on behalf of the University's endowment and defined benefits pension.

[26] Notably, the World Economic Forum (2020) and U.S. industry association Defined Contribution Alternatives Association (DCALTA) (2021).

[27] In June 2020, the U.S. Dept of Labor published an information letter providing legal clarity for the inclusion of private assets within 401(k) and 403(b) retirement plans ("DC plans"), which usually offer daily dealing (deposits and withdrawals) to plan holders. As a result, private assets in DC plans need to be valued daily.

[28] In the U.S., Accounting Standards Codification 820 defines "fair value" for GAAP reporting purposes as "the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date." This revised definition emphasized *exit value* as the measure of an investment's fair value.

company's accounting quantities, its industry, and a rigorous daily market calibration. In this paper we test the same technology's accuracy to exit value using an expanded dataset. We then compare its predictive accuracy to that of the 'market multiples' valuation method commonly used by direct GPs (Gompers, Kaplan, and Mukharlyamov, 2015). A full discussion of the data and analysis is provided in Appendix B. But, in short, we find that the valuation technology demonstrates higher statistical reliability than the manual method in providing a contemporaneous fair value as tested against actual exit prices.[29] The technology's combination of accuracy to exit value and processing speed thereby fulfills the organic framework's requirement for real time scalable exit valuations.

With data flow, scalable exit valuation technology may be implemented by any of the authorized participants in the network. This flexibility allows direct GPs, indirect GPs, asset owner LPs and others to scale up service levels and capabilities when and as they wish to capitalize on their own operational and commercial opportunities. For some practitioners, economic benefit may come in the form of lower costs. For others, economic benefit may come from a widened array of valuation quantities[30] to better inform asset allocation, risk management, and actuarial computations.

2(iii) Repeatability

Valuation as a 'black box' is not an insignificant obstacle to market adoption of valuation technology, the concern being replicability of the valuation. This concern stems from conventional valuation methodologies being inherently subjective, where variable quantities may be adjusted to influence outputs. The concern is understandable; the SEC has brought about enforcement actions for misrepresentation of performance based on inaccurate valuations, whether they be overly optimistic, overly conservative, or strategically used to smooth.[31] Subjectively chosen quantities make testing of conventional valuations an arduous and discretionary exercise, since chosen quantities may be found at varying points in the valuation methodology. (Although valuation consistency is required by regulatory bodies, the many permitted caveats and exceptions mean that consistency proves difficult to prosecute in practice.) When testing also involves discretion it cannot scale easily, ergo the coarse sampling and crude thresholds that typify such exercises. In other words, for real time valuation to be adequate, efficacy testing must also be scalable. Therefore, the third theme of the organic framework is *repeatability*, a property that enshrines scalable testing and necessitates a different, scientific approach to valuation.

[29] Our findings are consistent with research by Jenkinson, Sousa and Stucke (2013) that found valuations reported by the direct GP tend to be conservative relative to exit values, on the order of 35%.

[30] For example, for reporting and audit an LP may target GP-reported NAVs, however the same LP operations may use a data science derived fair value for input to liquidity algorithms. These values, tethered to the same accounting quantities, may exist without conflict in the portfolio management toolkit.

[31] See for example, settled action where conservative valuation of assets was pursued by the SEC presumably as a deterrent to smoothing of returns. Available online at https://www.sec.gov/litigation/admin/2019/ia-5245.pdf.

Valuation may be thought of as an algorithm, a series of steps or sequenced computations to solve a problem. The scientific approach demands the absence of subjectivity as far into the sequence as possible. Where factors unobservable to the algorithm need to be considered, a fiduciary's subjectivity may be applied *after* objective components are calculated, making the quantity and its influence on outputs readily noticeable to concerned parties. All steps that are free of individual judgment may then be repeated – and the same output achieved – by any third party using the same algorithm. Back testing and retrospective comparative analysis, rather than opinion, provide the evidence as to the integrity of the algorithm. The same tests may then be repeated on the fiduciary's own dataset, i.e., made more specific, to substantiate confidence in the algorithm outputs. Valuation science is in its nascence in private equity and may grow to include multiple technologies, each with a proprietary approach. Regardless of which technology a practitioner or security network may implement, the property of repeatability is fundamental to its scalability and suitability to the task of real time performance measurement.

2(iv) Relative Performance

Relative performance is the fourth theme of modernizing performance measurement within the organic finance framework. A reliable measure of relative performance is needed to rank performance, quantify *out*performance, and isolate value drivers. Comparability is what makes transparency actionable to investors as they seek greater value, and it is essential to improving investment strategy, compensation structures, and policy agendas. In all cases, the definition and integrity of the idiosyncratic/systemic boundary – separating company-specific returns from market returns – is paramount to the fairness and utility of a relative performance measure.

In a benchmark-based decomposition of returns (see Figure 7), the active/passive (AP) boundary is usually defined by a broad benchmark like the Russell 3000. Size and sector also variably affect returns, defined in a decomposition by an idiosyncratic/systemic (IS) boundary. In private equity, a meaningful IS boundary is technically difficult to achieve due to the vicissitude of positions occurring over the lifetime of a fund, and the methodologies required to overcome this are not native to the PME approach. While the PME method has generality and power, its embedded subjectivity, and issues with specificity and/or stability over time, make it unsuitable as a boundary within a decomposition framework and as a measure of excess returns.

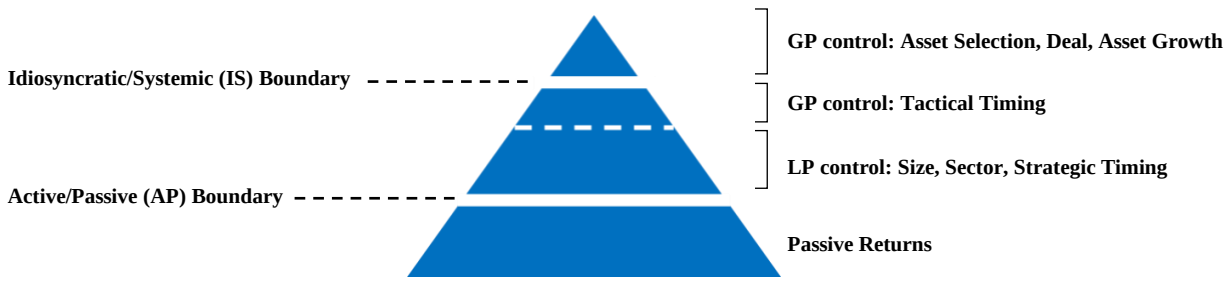


Figure 7: Repeatable Decomposition of Private Equity Asset Returns

As a simple example, consider a broad benchmark gaining 20% while the technology sector goes down 15%. Portfolios weighted in technology assets would be comparatively poor performers but, with a technology recovery, would appear [erroneously] to be outperforming. Construction of an IS boundary for the purpose of measuring and comparing excess returns in private equity requires indexing technology capable of achieving a more technical similarity to the target asset, e.g. non-market-cap-weighted indexing (Lo, 2015). The literature shows that such indexing technologies have already been successfully applied to performance attribution in the private equity context (Porter and Porter, 2018). As the authors point out, where managers have control of the company, rigorously measured idiosyncratic returns can be attributed to manager skill. And, where the IS boundary is of systematic and repeatable construction, systemic returns may be 'zeroed' – against which the excess returns, or manager skill, can be compared directly, *irrespective of a fund's vintage* and *irrespective of the size and sector* of the underlying companies. In other words, a technically exacting IS boundary makes direct comparison of private equity returns and attribution possible, through time, between managers, and to the market.

Implementation Focus	Technology Capability	Technology Goal	Management Goal
i) Modernized Data	**Flow** **Scope**	**Virtuous Data Cycle**	**Transparency**
ii) Modernized Measurement	**Real Time** **Scalable Valuation** **Repeatability** **Relative Performance**	**Resolve Structural Issues**	**Explicit Accountability to Alignment and Economic Sustainability**

Figure 8: Organic Finance Framework for Technology-driven Transparency and Intelligence

Undoubtedly, data science technologies play a vital role in the implementation of our organic finance framework. They unlock new capabilities in data and measurement for the resolution of entrenched structural issues: intransitive metrics, high costs, misaligned compensation, and a vicious data cycle (see Figure 8). These are the same impediments to transparency that surreptitiously feed the "billionaire factory" as described by Phalippou (2020). This description is disputed of course, but in the absence of real transparency, the charge cannot be fully refuted.

Into the Great Wide Open: Transformative Potential of Organic Finance

Organic finance may reveal some uncomfortable truths and challenge some accepted practices, but it is also likely to reveal star performers, trigger innovation, widen the addressable market, and provide for thoughtful reform of the economic model. The following section describes some of these opportunities.

1. *Organic Finance Applications for the LP*

A repeatable decomposition of returns, starting from measurably accurate *exit* valuations[32] that are fully scalable will generate compelling opportunities for LP investors to improve manager evaluation, portfolio construction, and other existing LP processes. However, an objective[33] definition of the IS and AP boundaries (see Figure 7) also allows the LP's contribution to returns to be repeatably isolated for the first time (which we acknowledge may or may not be a welcome advancement for some LPs that have enjoyed the comfort of 'not knowing'). But with data science technologies, the LP portion of returns can be measured at the asset level and rolled up to the portfolio, replacing the use of single and inappropriately broad benchmarks to approximate portfolio 'alpha' and 'beta'. Within the bounds of accurately measured 'active' systemic returns are the proofs that LPs need to (a) substantiate their value-add, and (b) improve the strategies, policies, operational methods, and relationships that comprise their active management. And, from a desire to outperform this metric, comes the business case for innovation and seeding within their active management toolkit.

1(i) Manager Evaluation

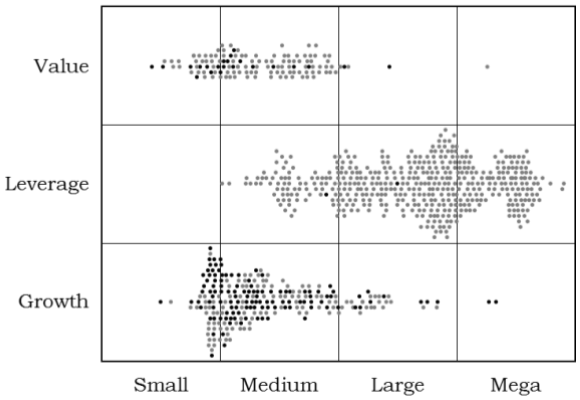
Rarely within an LP's activities are the deal sourcing, financial engineering, or growth stewardship that characterize idiosyncratic returns. Instead, the LP's role is to exercise control over sources of systemic returns through its partnership choices. They can do this because a fundraising GP's industry expertise and investment targets are known to the LP prior to investing. Logically, then, portfolio beta that outperforms market beta (defined by the AP boundary) is a result of those choices and may therefore be framed as 'LP skill'. When manager selection is layered on top of these systemic 'bets', it becomes tightly integrated as the tactical component of strategic portfolio construction, along the lines of modern portfolio theory (MPT).[34] Characterizing GPs by their investment *style* is therefore of considerable importance to LPs, as is rigorously ranking them by their track record of excess returns. In other words, *limited* partners are engaged in the work of sourcing and selecting *general* partners that maximize both systemic and idiosyncratic returns, an approach to which modernized measurement is essential.

[32] 'Exit valuation' indicates a true mark-to-market or theoretical exit valuation, as opposed to the usually smoothed and negatively biased GP-reported base asset valuations. Negative reporting bias will tend to mis-attribute the source of any alpha as being from deal savvy and reduce reported volatility.

[33] 'Objective' is used as a mathematical term throughout this document. In mathematics, objective refers to a process free of subjective inputs, even if the subjectivity is *impartial*. Objective processes have no subjective inputs and are repeatable.

[34] Some LPs, such as secondaries funds of funds, may organize opportunity selection along the lines of a knowledge arbitrage rather than MPT.

The most effective way of sourcing GPs would be for each LP to use modern measurement to analyze *all* the fundraising GP data to which it has access[35] and map them according to universally applicable style parameters. This would remove sample selection bias[36] and unconscious bias[37] from [at least] the initial selection process, as well as illustrating the LP's full opportunity universe organized by style parameters (see Figure 9). The process could then focus on outperformers (i.e., managers with highest returns in excess of the IS boundary) in each category of the opportunity universe. As previously discussed, modernized data allows base assets to be tagged by systemic descriptors (asset size is shown in Figure 9 but could also be country/region, sector, or even an ESG score) and investment strategy (shown) which, when rolled up to the manager level, provide an objective style categorization of the fundraising GP. The point is that, however the opportunity universe is arranged by the LP, it is data-driven and informative to the LP investment agenda.



The fundraising universe can be analyzed and mapped by each LP to graphically depict their unique opportunity universe. The chart (at left) is organized by a company size continuum along the horizontal plane, and investment strategy categories stacked vertically (non-continuum). Each gray dot represents a GP, categorized by the average size of target asset and investment strategy in their [multi-fund] fundraising data. This example shows a trailing 36-month universe. Most GPs in this example are in the style box 'Large Leverage'. The black dots indicate GPs with highest idiosyncratic returns from technology companies. Other overlays (e.g., region/country) may be used to further telescope or query the opportunity universe per the LP's criteria.

Figure 9: Example 'GP Style' Mapping of an LP's Opportunity Universe

Implicit in a fundraising universe compiled by the LP, rather than a third party, is its accurate depiction of opportunities actually accessible to the LP. In this regard, the fundraising universe is the LP's unique opportunity universe from which the LP can credibly: i) consider asset allocation and other strategic decisions in the context of a dispassionate assessment of their reality; ii) test

[35] Upon approval from the fundraising GP, the LP has access to fundraising materials which typically include Class III data, such as cash flows, operating fundamentals, and transaction values at entry and exit. GP approval may be withheld if the fund is already oversubscribed, meaning each LP has a unique opportunity universe that may contain different or fewer top-performing GPs.

[36] In this context, sample selection bias means shortlisting investment candidates by non-scientific means. Real world examples include: (a) the smaller LP whose investment committee is presented with three investment opportunities by their advisor, who also happens to be the asset manager of one of the options on offer; and (b) larger LP with an under-resourced 'open door' policy that reduces the screening process to brand recognition and fund numeral. Sample selection bias has the potential to adversely affect portfolio performance.

[37] In a 2018 study, Lyons-Padilla et al found evidence of racial and gender disparities in how investors evaluate funds and allocate money. Of note, the researchers found that asset allocators "have trouble gauging the competence of racially diverse teams", a reflection of the fact that manager competence is not a reliably measured quantity. In its absence, reliance on instinct – and unconscious bias – persists in the evaluation process.

forward-looking investment opportunities, performance assumptions, and market scenarios; and iii) quantify opportunity cost by analyzing the opportunities *not* invested in.

Braun, Jenkinson, and Stoff (2017) extol the virtues of collecting and retaining all possible fundraising data regardless of whether an investment is made, and many indirect managers (e.g., funds of funds) may already apply their scale advantages to do just that. However, automated data science tools make large-scale quantitative analysis practical for *all* LPs, even smaller and ramping organizations. And, the efficiency of technology also impacts the *scope* of analysis, making a decomposition of returns practical on every base asset of every fundraising GP. With base asset analytics, excess returns can be associated with factors beyond style, such as industry and deal team, which in turn may unlock greater predictive power in manager evaluation (Korteweg and Sørensen, 2015).

The power of base asset analysis applies to emerging managers[38] too. In a 2017 Preqin survey, 41% of surveyed LPs said they would not seed or invest in a first-time fund because of the importance of an established track record, while at the same time acknowledging the attractive opportunity first-time funds still represent (Preqin, 2018). And yet, most first-time funds are set up by individual investors who indeed have investing track records, albeit tied to individual deals and not funds at prior firms. The fact that LPs have difficulty comparing individual deals to the fund-level performance of established GPs – to the extent that they forego the opportunity – provides further practical evidence of the inadequacy of conventional metrics to build conviction and inform due diligence.[39]

By measuring performance of the base assets, organic finance allows single deals to be appropriately categorized and compared directly to many single deals of similar style across the more established managers in the LP's opportunity universe. Unambiguous and aggregable through-fund information equips LPs with a negotiating authority, who may use it to establish a target allocation to emerging managers, negotiate revenue share of the fund, an ownership stake in the GP entity, rights of governance, and rights to favorable economics in future funds (Dartley and Katlowitz, 2018) – all of which can add significant real returns and competitive edge to the LP for years.

1(ii) Active Management of the Opportunity Universe

From a time-series of objectively measured base asset valuations, a technically exacting definition of the IS and AP boundaries makes performance comparable over time without vintage year caveat, and without necessitating an investment exit (for the data to be unbiased). LPs can use these qualities to quantify the changing caliber of their opportunity universe. In some

[38] Defined herein as managers raising their first fund.

[39] During pandemic lockdowns, which prevented in-person meetings, emerging managers accounted for just 11.7% of private equity capital raised globally – its lowest since the 2008 global financial crisis (Pitchbook, 2020). LPs instead backed established GPs whose brand and scale gave LPs sufficient comfort to bend due diligence rules that require in-person meetings.

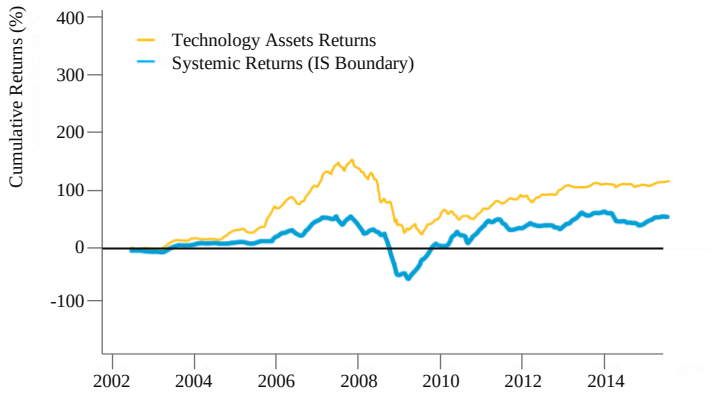
respects, the opportunity universe is analogous to the direct GP's deal flow, and the LP's ability to improve the quality of it may also be considered active management. After all, many LPs pay high sums to its own leadership and external advisors to access better returning opportunities. The measured opportunity universe refines the general goal of 'improvement' to be both targeted (e.g., addressing a certain style deficit) and incremental (e.g., improving the count, average and median values) in addition to targeting specific GPs. With its own metrics of improvement established, each LP can hold its team accountable to achieving them.

Comparability across time allows 20-year-old data to be as informative to decision-making today as one-year-old data. Fundraising data is 'ideal' for modeling due to the enhanced comparability of gross-of-fees data (Braun, Jenkinson, and Stoff, 2017), and since one GP's track record may contain in the vicinity of 100 base assets over a 20-year period, a sizeable dataset (proprietary to the LP) can accumulate relatively quickly.

Deeper datasets – widened in scope and made interrogable by modernized measurement – open up private equity to factor analysis for the first time. Modernized measurement is the missing link that allows external factors to be mapped reliably onto private assets, and from which investing intelligence can theoretically be extracted. It is entirely feasible, then, that beyond manager evaluation, a dataset of transitive and consistently derived quantities in time-series can support proprietary econometric modeling informative to returns, volatility, capital adequacy, investment pacing, and liquidity algorithms. In other words, insight garnered from factor analysis of assets *outside* the portfolio can feasibly be used to improve the management of assets *inside* the portfolio.

1(iii) Novel Portfolio Intelligence

Notwithstanding the foregoing, if Class III data is collected on portfolio holdings, then the same through-fund analyses and econometric modeling of the opportunity universe can be applied to the portfolio. To illustrate, Figure 10 measures returns of technology company holdings within the funds of an LP portfolio, along with the systemic returns of those assets as measured by the IS boundary. As shown below, public equities type metrics, including volatility and risk, are calculated free of reporting bias (see p.13) and smoothing since the valuations are repeatably and objectively measured.



	TECH ASSETS	SYSTEMIC RETURNS
Volatility	43.98%	35.49%
IRR	14.28%	6.83%
Sharpe	0.4030	0.1924
VaR (95%)	0.0041	0.0033
CVaR/ES (95%)	0.0064	0.0052
Max Drawdown	38.80%	46.40%

Modernized performance data and modernized performance measurement parameterizes private assets at the holdings level; the portfolio's constituent firms. When weightings and mathematical form of holdings-level proxy benchmarks are preserved under aggregation, performance attribution of selected parameters (e.g. industry, investment mandates, ESG, etc.) can also be measured on a through fund basis. Thus, returns attributable to LP investment strategy – their management levers – can be isolated.

Figure 10: Objective, Asset-Specific IS Boundary Provides LPs Novel Portfolio Intelligence

These analytics advantage LPs in several ways, starting with improving inputs to liquidity algorithms. When valuations exhibit negative bias (i.e., GP-reported NAVs), modeled exit distributions tend to be understated, which in turn may affect a cash drag on portfolio returns. Particularly for portfolios containing large exposures such as co-investments, analytics derived from objective and more accurately targeted exit valuations introduce opportunities to tighten liquidity management and engage in more active oversight of risk.

Second, flexible parameterization allows construction of 'thematic' through-fund aggregations capable of informing specific LP investment strategies or programs, such as investing mandates[40] or companies that satisfy LP-specified ESG[41] criteria. The behavior of through-fund aggregations is [to date] impossible for LPs to measure within their own portfolio. Instead, for many LPs, investment rationales and even benchmarking tend to rely on extrapolation of 'industry' level research. As shown in Figure 10, however, the organic finance framework makes it possible to measure risk and returns of underlying companies, and map alternative data – which is often industry, location, or even security specific – to the holdings (rather than less precisely to funds), making benchmarking more effective. Risk, returns, and decomposition of returns – objectively and systematically measured at the holdings level – bring a quantitative legitimacy to investment programs that are increasingly important aspects of LP active management.

[40] Hyper-local investing, for example, which may include (in the case of a university endowment) investment quotas for student founded or university-sponsored ventures.

[41] ESG stands for 'environmental, social, and governance' and is used by the investment community as a means of identifying assets and strategies that meet certain sustainability criteria, that at the time of writing, have no universal standard, i.e. ESG criteria may be set separately by the LP and the GP for the same asset.

Third, public equity style metrics on through-fund aggregations open the data up to meaningful factor analysis, important for learning which/how investment criteria connect with investment outcomes. This is the foundation of an investing intelligence usually only accreted by deal teams over time. However, the LP has two things in its favor; its dataset derived from multiple partnerships, and now, data science tools capable of implementing the organic finance framework. These elements allow LPs to build proprietary investing intelligence quickly and reliably via scientific interrogations of the LP dataset. In other words, in the organic finance framework, novel transparency is a gateway to novel investing intelligence.

1(iv) Risk Management

When only fund level data is available, both systemic and idiosyncratic risk existing inside the fund is inscrutable to analysis, and risk is reduced to an indiscriminate market force. When holdings level data is available, and the organic finance framework is *not* implemented, valuation lag, bias and smoothing again work to obscure systemic and idiosyncratic risk. For these reasons, the risk frameworks of private equity portfolios tend to operate [pragmatically] at the fund level, incorporating broad exogenous assumptions about the behavior of the portfolio's underlying companies, including their correlation to public markets.[42] For the most part, these frameworks ignore idiosyncratic risk,[43] including leverage. If idiosyncratic risk were to be managed, a lack of its reliable measurement would likely result in a proliferation of partnerships, also known as 'spray-and-pray'. LPs are therefore largely left with managing risk in a normal distribution view of the world. The problem is that this viewpoint is unrealistic, and even potentially dangerous, for the purpose of risk management.

As shown in Figure 10, the organic finance framework can measure systemic risk[44] with more specificity across the portfolio. Objective asset level metrics also let the LP better address different forms of risk (e.g., liquidity) within the portfolio without layering on complexity and over-reach. Asset level measurement is also needed to realize advantage from the LP's through-fund or "hilltop" view of multiple concurrent investments across multiple managers and asset sub-classes – unique insights to which the value at risk (VaR) metric is not normally privy. For example, in the leveraged loan market, LPs have gained exposure to both supply and demand sides via private debt and private equity, respectively. In so doing, LPs have unwittingly fanned a supply-demand dynamic that has seen loan volumes spike and loan quality deteriorate (Kakouris, 2021). In 2020, more than half of buyout deals were leveraged at greater than seven times EBITDA compared with less than 40% at the height of borrowing pre-GFC (Bain & Co, 2021). There are several obvious parallels with the lead up to the 2008 financial crisis, not least of which is the

[42] The 'diversification effect' of private equity is likely overestimated, both in academic works and in practice. The smoothing that GPs apply is demonstrably not formulaic between periods. Therefore, de-smoothing techniques are unable to restore the real time series. In reality, de-smoothing adds another layer of noise, most probably accelerating the computed diversification effect.

[43] See for example, Buchner's risk framework for private equity (2017) and the BVCA's research paper on risk management for private equity portfolios (Diller and Jäckel, 2015).

[44] Systemic risk as measured by VaR / 'value-at-risk' – since 1999 an almost universal measure of the probability that a given loss might occur within a portfolio of assets.

enrichment of intermediaries, but what is concerning is the proliferation of private debt positions held by the same demand base as private equity positions, i.e., a loading up of downside risk.[45]

In concise testimony to the U.S. House of Representatives in 2009, Dr. Richard Bookstaber, noted author of financial risk management, explained the liquidity crisis cycle and its modes of contagion as observed in the 2008 financial crisis. There is room, he argued, for a regulatory body to exercise a hilltop view for the purpose of anticipating crises by measuring asset level data (like leverage and loan volumes) across multiple large firms. Albeit in a much smaller universe, the same theoretical oversight could be developed by LPs using asset data, holdings data, and securities data from every GP in their own portfolio. From these data, important liquidity cascades – the contagion pathways within the portfolio – or other crisis scenarios can be modeled and tested for capital impact. This is increasingly important for LPs given the widespread combination of subscription lines of credit, covenant-lite leveraged loans, and unprecedented levels of 'dry powder'[46] – all of which may trigger sharp upticks in capital calls at the same time that equity prices drop. By measuring their own universe, LPs could provide a form of collective governance over the market. In theory, this would provide a natural check against risk accumulation within the system without relying on regulation.

Given their position in the chain, with their abstracted 'hilltop vantage', LPs could also discharge an important *system* oversight function. Appropriate data, tools and incentives are critical for LPs to fulfill this expectation. In a previous paper discussing organic finance, it was shown that mathematical complexity of derivative liquid asset securities can create layers of abstraction that allow risk to grow unappreciated and unchecked. Although the mechanics are different in private equity – value and risk metrics are either obscured or missing altogether – the outcome is the same: risk proliferates. As in public equities, there may well be a financial reward to be reaped by LPs who utilize their organic, through-fund view to better manage risk.

2. *Organic Finance and Opportunities for the GP*

The holdings level focus of the organic finance framework offers actionable insights to GPs too, starting with instrumenting their active management of company growth as it relates to capital structure. In a presentation to his alma mater in 2008, Henry Kravis of KKR, opined on the de-risking effect of company growth in the buyout model. It was with this understanding, he said, that his firm transitioned from "buy it, fix it, sell it" to "buy it, *grow* it, sell it". However, one of the most enduring criticisms of the buyout model is that its use of debt curtails real growth and relies on a rising market for solvency.[47] The literature well explains the trade-off between costs

[45] Falling equity prices and widening credit spreads go hand-in-hand in financial crises, increasing the likelihood that the same factors that negatively impact private debt will also negatively impact private equity, i.e. increasing correlation between assets and asset classes.

[46] Dry powder is a euphemism for committed capital, meaning the summed capital pledged by LPs to funds but not yet drawn down. In 2021 it is estimated PE dry powder has reached $1.9T (source: Preqin).

[47] Some practitioners have characterized the buyout model as 'levered beta' that LPs could harvest from the public markets with lower risk and at a lower fee load.

and benefits of debt, but in practice it remains difficult to determine empirically if buyout transactions are done with an optimal capital structure (PERC, 2021).

It may be theoretically possible to optimize leverage mathematically, but there are so many variables in non-trivial, non-linear relationships that, in practice, heuristics will probably be needed. One candidate heuristic would be: set leverage levels to maintain approximately the same growth as a suitable proxy, thereby enabling leverage to multiply returns without sacrificing growth. One of the core issues here is how company growth is measured. Conventional valuation methods tend to obscure real growth because they incorporate a mix of idiosyncratic and market factors, some of which are subjectively determined and often inconsistently applied.[48] Under these conditions, an asset's value may rise when its fundamentals are unchanged (rising market), and conversely, an asset's value may not rise when its fundamentals are improved (flat or falling market). Management thresholds for debt are thereby made less reliable when considered as a percentage of company value.

This imprecision can lead to excessive leverage in one direction and underutilization of leverage in the other, neither of which may be appealing to investors. However, when debt is considered in the context of a repeatable *fundamental* valuation, where noise from operator subjectivity and the market are systematically removed, the relationship between growth and leverage may be made unambiguous. By way of example, the valuation methodology described in Appendix B contains a fundamental contribution, analogous to a repeatable intrinsic value, that can be used to measure the economic size or fundamental economic value of a company without interference from market noise or subjective operator inputs. The efficiency of the technology can be conceptualized by its explanatory power of (or accuracy to) price; in theory, an output with high explanatory power would support greater fine tuning than an algorithm with lower explanatory power.[49]

Rather than focusing on debt ratios, a robust quantification of fundamental growth enables a different approach. The same technology used to value the private asset can also measure the fundamental value and growth of a proxy benchmark. When the private asset's growth decelerates relative to that of its benchmark, then debt levels may be reduced to bring growth back in line with that of its 'beta'. Similarly, there may be room to apply debt when the private asset's fundamental growth outpaces that of its benchmark. Using the fundamental growth of a suitably specific proxy benchmark creates a new growth-driven threshold to augment the conventional default-driven approach, and simultaneously removes the concern that debt reduction is arbitrary or counter to performance enhancement. After all, as alluded to by Kravis in 2008, it is growth *in excess* of systemic growth that should attract the attention – and high fees – of limited partners.

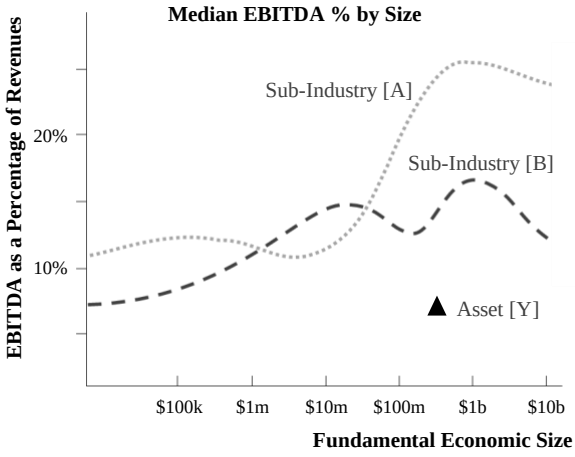
[48] See page 14 for discussion.

[49] Explanatory power of the commonly used multiples method to price is approximately 0.44 (averaged across all sectors) as measured by the R-square statistic, while the fundamental contribution of the valuation algorithm tested in Appendix B has an R-square of 0.813.

Valuation is essential to the dynamism of the capital markets: when parties are confident that the value of equity they stand to receive at least matches the value of their money, liquidity tends to ensue. It follows that valuation technology with organic finance properties (such as described in Appendix B) can fulfil the role of an unbiased price proxy or intrinsic value, offering GPs more pathways to liquidity. For example, a consistent and accurate (to exit value) price proxy may serve to streamline performance fees under ERISA.[50] GPs become fiduciaries under ERISA and 'prohibited transaction' rules take effect, often resulting in typical quarterly incentive fee structures being modified to annual. However, when valuation technology can independently, objectively, and consistently determine whether performance goals have been met on a more frequent basis, performance fees are payable on a similarly more frequent basis and in compliance with ERISA guidance. This paves the way for GPs to innovate fee structures while offering greater transparency and faster reporting to their LPs. In another example, GP-led secondaries transactions can benefit from a reliable alternative to last-reported NAV, a widely acknowledged less-than-adequate liquidity compass in the secondary transactions. Technology has a role to play in terms of valuation speed and reliability of decision-support, which in the rapidly evolving secondaries setting, empowers GPs to take a more proactive stance in selecting and timing entries and exits.

In amongst all the performance claims built around IRR, LPs have demonstrated an appetite for differentiation based on innovation and specialization (Bain & Co., 2021). Extended holding periods, fee caps of various flavors, and accommodating liquidity are examples of innovations. Specialization relates to a niche expertise – industry, geographical or ESG-related – capable of attracting higher quality deal flow and more positive outcomes. Both forms of differentiation are appealing presumably because – in theory – they drive higher returns and offer insurance against weak economic conditions. Using modernized measurement to link theoretical to actual outcomes might be a powerful and sustainable source of market validation for GPs. But, as laid out in the opportunities for LPs, transitive measures at the base asset level enable more than just a 'better mousetrap'. The property of transitivity means GPs can build unique aggregated views of assets, against which they can compare current holdings and/or acquisition targets (Figure 11).

[50] ERISA, which stands for Employee Retirement Income Security Act of 1974, sets forth minimum standards for pension plans in the U.S. to protect the interests of plan participants. ERISA is enforced by the U.S. Department of Labor (DoL).



A mathematically derived intrinsic value, such as a fundamental economic size, may provide a more reliable measure of growth because noise from subjectivity and the market is systematically removed from the model.

The comparability of the size quantity allows company growth to be mapped in a unique non-time series way, against which ratios of interest may be mapped. The chart at left shows how relationships between data from a company's financial statements (in this case EBITDA as a % of revenues) vary in non-uniform ways between industries and relative to the company's size.

Individual assets (e.g. Asset Y) may be similarly measured and compared to median values – of multiple ratios – to understand the relative "health" of portfolio companies at actual and projected sizes.

Figure 11: Mapping Asset Growth in Non-Time Series for Novel Base Asset Comparisons

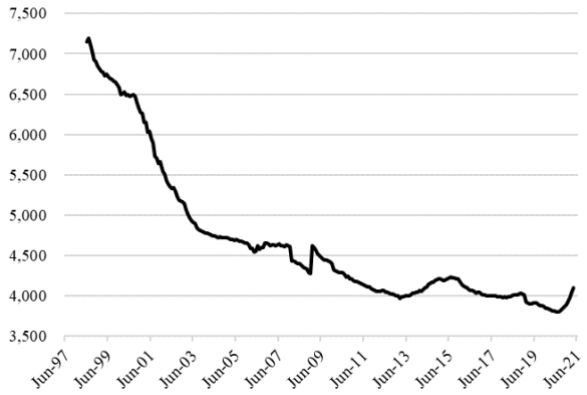
There is widespread agreement among the literature that the asset management industry needs to "adopt technology" to build value and scalability into their offering. Here we advocate that technology of the organic finance framework (modernized measurement) can also build investing edge. Insights and decision support from factor analysis, active data-driven risk management, evidence-based differentiation, new asset level intelligence (such as the nature of growth) – form a way to hone ideas and de-risk opportunities (i.e. innovation) that is both compelling and sustainable.

3. Organic Finance and Opportunities for the Industry

Since the late 1990s the public markets have become more concentrated, with 48 percent fewer listed companies overall (Figure 12) and pronounced thinning among public 'micro-cap' companies, i.e. companies with market capitalizations of less than $250 million (Blecher, 2020). Large inflows of capital to the private markets over the same period[51] have lowered the cost of capital and provided capacity for larger financing rounds (de Fontenay, 2017), making it possible and even advantageous for private companies to delay going public until after they have achieved scale (or put it off altogether). Since growth is more pronounced in smaller market cap companies (Decker et al., 2017), there is evidence to suggest private markets expansion has contributed to a stagnation in the public markets (de Fontenay, 2017).

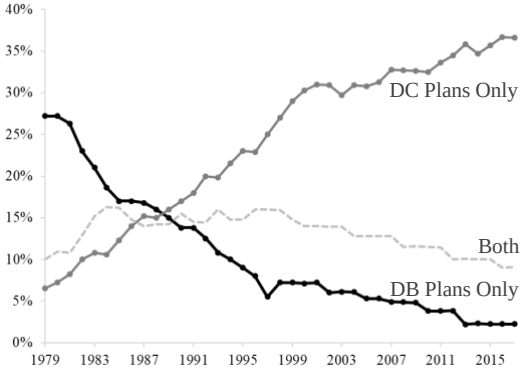
[51] According to Preqin sourced data, private markets AUM surpassed $7.3T in 2020 (an all-time high), representing an increase of approximately 65% over AUM in 2010.

Number of Listed Companies – U.S. Domestic



Source: World Federation of Exchanges

Percentage of Private-Sector Wage and Salary Workers Participating in an Employment-Based Retirement Plan



Source: U.S. Dept of Labor

A shrinking universe of high growth public stocks (shown in the chart at left) coupled with a shrinking segment of American savers in DB plans and therefore with access to high growth opportunities in private markets (shown in the chart at right), are two dynamics affecting the retirement outcomes of a large segment of American retirement savers. Legal uncertainty from structural issues that has previously deterred DC plan sponsors from private equity, is minimized by the organic finance framework.

Figure 12: Twin Factors Affecting Access to High Growth Assets (U.S.)

This stagnation may be adversely impacting retirement outcomes for a large and growing segment of American retirement savers who, because they are unable to participate in defined benefit (DB) plans, have no way to access private equity. DB plans have historically invested in private equity[52], but fewer employers now offer them[53] because they are considered expensive and uncompetitive (Munnell and Soto, 2007). The more widespread DC plans offer participants up to daily liquidity, which creates an operational challenge for inclusion of private equity because it is generally illiquid and unpriced. Further, heavier-than-public-equity fee structures and intransitive metrics expose plan sponsors to legal uncertainty in the face of ERISA fiduciary standards.[54] As a result, most U.S. DC plans have no exposure to the asset class. At the same time, SEC regulations permit such access to high net-worth individuals as accredited investors.[55] Therefore, these two factors – concentration of public markets and shift to DC plans – work to unfairly exclude the 'average' saver from a prized source of high growth.

[52] As an indicator, U.S. public DB pension plans have increased their private equity allocation from ~3.6% in 2001 to ~9.3% in 2020. Sourced from Public Plans Database (2020) *available at* https://publicplansdata.org/quick-facts/national

[53] DB plans are tied to employers who bear the liability of paying out employee benefits regardless of market conditions. In contrast, DC plan assets are owned by employees with no future liability conferred to the employer.

[54] For example, in *Anderson v. Intel Corp. Investment Committee*, the plaintiff alleged breach of ERISA fiduciary standards for including alternative assets (such as private equity) in Intel's employee retirement plan citing excessive fees and underperformance.

[55] Defined under Regulation D of the Investment Company Act of 1933 [17 CFR § 230.501], an individual may qualify as an accredited investor if they have a net worth that exceeds $1 million, or an income in excess of $200,000 in each of the two most recent years.

Given their high rates of participation, DC retirement plans are a logical and increasingly likely channel[56] through which unequal access could be given meaningful correction. However, the legal concerns of many plan sponsors may not be assuaged by assurances, even if they are made by regulatory bodies or court officials. What plan sponsors need is evidence-based technology solutions to industry structural issues because the structural issues create the operational challenges that then create legal exposures. Daily valuation offers a good example of this. When the daily valuation is informed by factors non-specific to the underlying assets, erroneous volatility can cause daily pricing to be inaccurate, unfair, and potentially dilutive to participants, i.e. a legal exposure (DCALTA, 2021). Since a reliably accurate valuation is an essential input to liquidity algorithms, *in*accurate valuations can also underpin a higher-than-necessary cash drag on a portfolio, i.e. a second legal exposure under ERISA.

Fees offer a second illustrative example. It may be feasible for plan sponsors to demonstrate fiduciary prudence over private equity fees by establishing the value of their GPs' active management. Part one would establish value relative to the accessible universe of GPs, and part two would establish value relative to that generated by their own public equities portfolio. This would demonstrate a repeatable and robust process designed to optimize outcomes for participants. However, without modernized measurement, quantifying the value of GP active management is an unavoidably subjective endeavor with little clarity – mathematically or legally – in the end. Together, the four themes of modernized measurement enumerate the properties technology solutions need to stand up to rigorous enquiry, and which simultaneously can help plan sponsors specify product design and minimize legal exposure.

The main opportunity presented by organic finance to the industry is therefore de-risking its expansion. The organic finance framework can already help define a suitable price proxy candidate capable of bridging the daily environment of the DC plan to the illiquid environment of its underlying holdings. For instance, industry group DCALTA (2021) published a practical daily valuation framework that draws from organic finance themes. Transparency as defined by organic finance reveals a path forward for plan sponsors and participants, and with hundreds of billions in 'new' capital in play,[57] GPs may also find their contribution to transparency 'worth it'.

It is somewhat paradoxical that it may be in pursuit of trust (and capital) of "unsophisticated" investors that transparency finally gains purchase in the private markets. But, the benefits of extended datasets, populated with the "Class III" data shown in Appendix A and transitive performance analytics, benefit the industry beyond ERISA funds and functions too. For instance, Class III data are ideal for much-needed empirical research to develop effective policy, risk-

[56] Important recent legal outcomes are: (i) On 3 June 2020, the DoL issued an Information Letter confirming that private equity may be offered as part of a diversified investment option within different types of DC plans; and (ii) On Jan. 21, a California federal judge granted defendants' motion to dismiss in the *Anderson v. Intel Corp. Investment Policy Committee* case. The decision addresses the question of whether including private equity in a DC plan constitutes a breach of ERISA's fiduciary standards.

[57] At end Q4/2020, employer-sponsored U.S. defined contribution (DC) plans contained $9.6T in assets, including $6.7T in 401(k) plans and $1.2T in 403(b) plans.

informed fee structures, more efficient paths to liquidity, and empirical understanding of alternative value drivers like environmental impact.

As illustrated, the products of the organic finance framework are objectively measured asset-level value and risk – the essential elements of transparency and a natural foil to exploitative enterprise. As illustrated, these crucial measures potentiate much more than 'better' oversight of GPs. They expand the instruments of active management available to LPs and GPs, and de-risk innovation and expansion. In conditions that make private equity returns vulnerable (such as large capital inflows, high valuations and unprecedented levels of dry powder), this instrumentation buoys investing and operational 'edge'. Larger bets, strategic concentrations, risk alignment, operating agility – these are the outcomes of a more rigorous factoring of external conditions onto internal reality – and the manifestations of that edge. LPs and GPs that continue with an investment strategy organized around yesterday's metrics and yesterday's models will be at a significant disadvantage.

Conclusions

Lack of transparency, traceable to structural issues, has meant that private equity is an industry built on trust. Yet, despite this, the industry is increasingly noted for its misconduct, misrepresentation, and outsized economic rents – perpetrated by 'rapacious' managers upon their 'trusted relationships'. As a result, many in the industry are questioning the legacy framework that puts LPs at a structural disadvantage and costs them billions. At the heart of the problem is opacity detailed in this paper. These are the issues that propagate high costs, entice exploitative behavior, and accelerate risk. These are also the issues that stand in the way of responsible cultivation of value and risk implicit in the organic finance paradigm.

In the past, inadequate measurement of the private equity portfolio was accepted by LPs. After all, allocations were so low and the returns so seemingly predictable that it became feasible even for larger allocators to treat private equity risk as 'round-off error' to the portfolio. Industry participants – GPs in particular – were not motivated to ensure performance data and metrics keep pace with industry expansion. However, as the strategic importance of private equity to the portfolio and the economies of developed nations grows, it is increasingly less feasible to accept any of this.

Refreshingly, the agents of change need not be teams of lawyers or government officials. The agents of change could instead be the outputs of the virtuous data cycle and LP conviction, because they disrupt the causative structural issues. In so doing, organic finance concepts like objective measurement of the value and risk generating asset are made a practical reality.

The performance truths surfaced by objective measurement do more than grease the wheels of the old framework; they fundamentally change it to a better one. Structurally driven performance transparency allows, for example, a higher comfort level with (real) long-term investing and more confidence in thematic investing (e.g. in line with an LP's environmental or

social goals). This has the potential to extend the ecosystem beyond the beneficiary to society as a whole, achieving alignment all the way through.

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Appendix A: Example Data

The following table describes the progression of a basic dataset (Class I) to a comprehensive dataset (Class III). Data sources for each of the data classes are also provided.

Most LPs have access to incomplete Class I datasets and smatterings of data from other classes. The vicious data cycle means Class III "general to fund" data are often collected by LPs (in due diligence) but not ingested or exercised. However, the virtuous data cycle makes the fundraising universe potentially the most informative and advantageous dataset in private equity by providing heretofore 'missing' intelligence on relative performance, manager skill, and sources of outperformance. Throughput efficiencies of automated data tools mean deeper quantitative analyses can scale to a far broader slice of the universe, now and historically, enhancing the utility of the dataset well beyond manager evaluation.

	Class I	Class II	Class III [A]
Specific to LP	**Cash Flow Quantities** Currency Fee/Non-fee classification	**Cash Flow Quantities** *In addition to Class I* Asset-specific Date-specific Descriptive apportionment [B]	**Cash Flow Quantities** *Same as Class II*
	Holdings Quantities Fund NAV	**Holdings Quantities** *In addition to Class I* % equity in fund	**Holdings Quantities** *Same as Class II*
General to Fund	**Cash Flow Quantities** Currency	**Cash Flow Quantities** Fee/Non-fee classification Asset-specific Date-specific Descriptive apportionment [B]	**Cash Flow Quantities** *Same as Class II*
	Holdings Quantities Schedule of Investments Industry, Geography Date of Entry Fund NAV	**Holdings Quantities** *In addition to Class I* Sub-industry [C] Date of Exit Ownership %	**Holdings Quantities** *Same as Class II*
	Asset Performance Quantities	**Asset Performance Quantities** Asset NAV Revs (entry, quarterly TTM, exit) EBIT/DA (entry, quarterly TTM, exit) Total Debt (entry, quarterly TTM, exit)	**Asset Performance Quantities** *In addition to Class II* Entry EV / Exit EV
Source	P-CAP Statements Quarterly Reports Quarterly Cash Flow Report	*In addition to Class I* ILPA templates [D]	*In addition to Class II* Entry reporting [E]

Notes:

[A] Class III quantities are routinely prepared by GPs and do not add burden to reporting requirements. For example, asset performance quantities are standard in fundraising materials.

[B] Examples of cash flow descriptions include 'capital call', 'capital gains', 'return of capital', 'ordinary income', etc.

[C] Standardized industry classification, either by GICS or NAICS code, is made more precise by including sub-industry digits, e.g. (using GICS) "101020" energy/oil and gas asset can be made more precise by specifying sub-industry (upstream or downstream) using the appropriate digits, in this example 10102020 and 10102030 respectively.

[D] ILPA has published reporting templates for fees and cash flows. At the end of 2017, more than 200 general partner entities are completing the template when asked.

[E] Entry reporting describes the price of the asset at entry, total debt, deal team, etc. and can be sourced from different documents. While these data are found in quarterly reports, they are normally provided in narrative form. Documentation for subsequent fundraising usually provides these same data in more useful spreadsheet format.

Appendix B: Viability Analysis of an Objective Measurement Framework

Study Description

The [proprietary] dataset consisted of 235 exited assets from 26 buyout funds[58] over the period 1998-2015. Most assets were in North America, however assets in Europe, Latin America and emerging markets were part of the portfolio. Four of the companies were either abandoned or had zero revenues at exit. These had little impact on the aggregate accuracy of the overall portfolio valuation but had to be excluded for other statistical measures. Each asset's data set consisted of gross cash flows, entry and exit financials[59], entry price[60], industry, and location.

Multiples Valuation Methodology[61]

Earnings (EBITDA) multiples were derived from each asset's total enterprise value (TEV) at entry. Consistent with survey findings of Gompers, Kaplan and Mukharlyamov (2015), the same multiples at entry were applied to estimate the asset's fair value at exit.

Objective Valuation Methodology

For each asset, three contributions to company value were modeled:

1. Fundamental Contribution, i.e. the fundamental economic value of the company. This quantity is calculated[62] from a company's industry and financial fundamentals, and is synonymous with a non-market-cap-weighted *size*.

2. Idiosyncratic Contribution, i.e. value not captured by fundamental data. For example, the potential value of a company's intellectual property. Idiosyncratic contribution is calculated by comparing the fundamental contribution (calculated at Step 1) to the actual Market Value of Invested Capital (MVIC) as per $^{MVIC}/_{Fundamental\ Value}$ - 1. The idiosyncratic contribution is therefore modeled from entry information, and reflects a market *premium* (positive or negative) to the asset's size.

[58] A majority of assets purchased by the studied funds fit the buyout model, however, some of the funds contained growth and venture firms.

[59] Financials consist of (at a minimum) Revenues, Earnings (EBIT or EBITDA), and Total Debt.

[60] Here, price is defined as the Market Value of Invested Capital (MVIC), or Total Enterprise Value (TEV) when MVIC is not available.

[61] A less accurate version of this method assumes the average EBITDA multiple of a small, curated set of comparables. This method is highly subjective, and less accurate because it captures only market movements and misses both the significant idiosyncratic component of fair value and size effects on EBITDA multipliers. This method is not included in any results provided herein.

[62] The calculation is performed by an automated, commercially available tool. Use of the tool requires no data science or computing skills.

3. Systemic Contribution, i.e. the value of an asset's market premium on any given day. An objectively constructed modern proxy benchmark (Porter and Porter, 2019) was created for each private asset, containing between 50 and 150 public peers as determined by fundamental economic value (asset size) and industry. The distribution of the benchmark's constituent premia at the entry date was used to determine a percentile ranking of the target asset's premium. The asset's premium percentile was then applied to the proxy benchmark's premium distribution at exit[63], and mapped back to its fundamental size contemporaneously. Then fair value was estimated as $(1 + Market\ Premium) \times Fundamental\ Size$ as at the exit date.

For a fund, GP, or portfolio, asset level results were aggregated to produce measures to test accuracy. The following quantities were measured:

1. $\frac{\Sigma Fair\ Value}{\Sigma MVIC}$ to measure the accuracy of the aggregated fair value estimate against actual values. Perfect accuracy would yield the result of 1.

2. Median $\frac{Fair\ Value}{MVIC}$ to provide another measure of central tendency.

3. R^2(Fair Value, VIC) to measure the proportion of variance of MVIC that is explained by the fair value.

4. Std Dev $\frac{Fair\ Value}{MVIC}$ (standard deviation) to measure the variation of this ratio.

In addition, the statistical technique of bootstrapping was applied to produce the standard error of estimate and to estimate confidence intervals.

[63] The asset's market premium percentile ranking is normally carried forward from Step 2, but with these exceptions: i) venture assets in buyout funds; ii) exceptionally high premiums (high growth potential); and iii) exceptionally low premiums (turn-arounds). To estimate fair value of assets in the three exceptional categories, other models that may for instance revert to the median of assets with extreme premium percentiles. Hence, for the assets whose entry premiums trigger these models, the premium percentile at the exit date differed from the premium percentile at entry. These models were triggered and applied algorithmically, with no subjectivity or tuning.

Comparison of Objective and Multiples Estimation Method

Table 1: Comparative Analysis

Valuation Method	Mean [1]	Std Error [2]	Confidence Interval	Median	Std Dev. (FV/MVIC)	R^2 Pearson	R^2 Spearman	R^2 Log
Objective outliers excluded [3]	0.997404 [6]	0.05	(0.93,1.12)	0.957871	0.52314	0.8677018 [7]	0.932147	0.943737
Multiples outliers excluded [4]	1.044513	0.0825	(0.88,1.25)	0.856205	2.322208	0.737933	0.875733	0.853428
Objective no outlier exclusion	1.006473	0.078	(0.88,1.19)	0.957871	2.288925	0.7363054	0.868691	0.862595
Multiples no outlier exclusion [5]	1.864321	NA	NA	0.812342	NA	NA [8]	NA	NA

Notes:

[1] Mean is calculated as $\frac{\Sigma Fair\ Value}{\Sigma MVIC}$

[2] Standard Error and Confidence Interval are calculated by bootstrapping R=1000

[3] Using the Objective method, fair value can be calculated on all assets.

[4] The Multiples method yielded no meaningful results in some cases (i.e. negative or zero EBITDA). Also, very low or very high entry EBITDA multiples yield nonsensical estimates.

[5] The Objective method with no outlier exclusion is also better than Multiples with outliers excluded in some statistics, and comparable in others.

[6] The aggregate sum is extremely accurate (result is close to 1.0). The standard error is significant, leading to a fairly wide confidence interval. These indicate that a different sample set might yield a different ratio within these bands (discussed below). The conclusion would nonetheless be acceptable in practice.

[7] The R^2 statistic measures the proportion of variance of MVIC that is explained by the fair value. R^2 values of the Objective method show that a very large percentage of the information affecting MVIC is captured by the Objective estimation process.

[8] A small number of assets had extremely high EBITDA multiples (in excess of 10,000), resulting in meaningless outputs for error measures.

The Objective method of estimating fair value of the portfolio demonstrates high accuracy with mean of 0.997404 (see "Objective/outliers excluded" in Table 1, above). The Objective method behaves reasonably even when outliers are included, reflecting the robustness of the method.

While the Objective method's standard error of 0.05 and wide confidence interval (0.93, 1.12) is significant[64], the Multiples method has larger error bands. In fact, the Objective method is significantly better than the Multiples method in every statistic. Comparison of standard deviation is noteworthy because the Multiples method has more than four times that of the Objective method.

Conclusions of the Viability Analysis

The Objective method demonstrates higher statistical reliability than the Multiples method in providing a contemporaneous fair value, as tested against actual exit prices. Since the method less predictive of exit values is in common use among GPs, it is reasonable to conclude that under similar conditions, the Objective method is suitable for practical use in fair value estimation. If

[64] This result indicates that a different sample set might yield a different ratio within these bands but is nonetheless acceptable in practice.

the intent of fair valuation as set forth by FASB is to provide a contemporaneous exit value, then the Objective method can claim legitimacy.

Furthermore, the systematic nature of the Objective method provides for repeatability of analysis. This is a desirable estimation method, because it makes results empirically verifiable, and enables methodological consistency throughout the investment holding period[65].

Given that the Objective method is executed by a fully automated *technology*, it becomes economically and technically feasible to measure fair value on a frequent – even daily – basis. This mechanism, able to run on a near-continuous basis, offers a practical solution to private equity's fundamental problem of absence of observable price.

The foregoing assumes that appropriate data (as described in Appendix A) and data science capabilities similar to those described herein are available to the practitioner. As with adoption of any new technique or technology, there are potential unknown risks. These risks must be considered on balance with the risk of not measuring, the high costs of manual methods and consultants, and the reputational risk of failing to adopt better safeguards when they became available.

[65] In a 2014 speech by Andrew Bowden, in his capacity as Director, Office of Compliance and Inspections at the SEC, said that the aim is to scrutinize whether the actual valuation process aligns with the process that an adviser has promised to investors, rather than to challenge a portfolio company's valuation of "X" as "X-3%".