PEI

Scientific Infra
& Private Assets

SIPA KNOWLEDGE CERTIFICATION · REQUIRED READING

Level 2 — Intermediate: Methodology

Classification Standards, Factor-Based Shadow Pricing, Fair-Value Measurement, and Index Construction

LEVEL	FOCUS	PREREQUISITE	PRIMARY AUDIENCE
Intermediate	**Methodology**	**A current Entry pass**	**Product, research, risk**

How to use this reading

This document is the required curriculum for the Intermediate level and presupposes the Entry reading. It sets out the methodology underlying SIPA's data: the structure and governance of the TICCS and PECCS classification standards; the cross-sectional factor model by which unlisted companies are "shadow priced" from observed transactions, including the dynamic estimation of time-varying factor prices; the alignment of the approach with the IFRS 13 fair-value standard; and the construction and maintenance of the market indices. The treatment is technical but self-contained. Worked examples show the model reproducing observed transaction prices; sources are cited as (Author, Year) and listed in full, with identifiers, in the References.

MODULE 2.1

The TICCS classification standard

TICCS is a class-based taxonomy of infrastructure companies composed of four independent pillars. Each pillar is exhaustive and internally mutually exclusive, so that a company is assigned to exactly one class per pillar unless it genuinely spans several, in which case class weights are used.

Pillar	Structure	Classes / examples
Business Risk	3 classes, 5 sub-classes	Contracted, Merchant, Regulated
Industrial Activity	8 super-classes, ~35 classes, ~100 sub-classes	Power, Transport, Renewables, Network Utilities, Social, Data, Environmental, Energy resources

Pillar	Structure	Classes / examples
Geo-economic exposure	4 classes	Breadth of geographic and economic exposure
Corporate Structure	2 classes, 2 sub-classes	Corporate vs Project Finance

Two design features deserve emphasis. First, the taxonomy is “one-to-many”: a real company belongs to every pillar simultaneously and may occupy several classes within a pillar — a mixed vehicle owning both a water-treatment plant and a generation asset is weighted across the relevant Industrial Activity classes rather than forced into one. This preserves the purity of each pillar while accommodating real corporate structures. Second, the classification is dynamic: an asset’s TICCS profile evolves as it moves from a construction phase to an operational phase, changing its risk characteristics over its life.

TICCS is not itself a pricing model; it is a structured, objective description of real-world characteristics. Its classes nonetheless correspond to systematic differences in value, which is what makes them useful for indexing. SIPA’s infrastructure data show, for instance, that median valuation multiples differ across Business Risk classes and between corporate and project-finance structures, so that the classes partition the universe into economically distinct segments. That classification carries pricing content is consistent with the broader evidence that the choice of classification scheme materially affects measured return co-movement and valuation (Bhojraj, Lee & Oler, 2003; Chan, Lakonishok & Swaminathan, 2007).

Governance. TICCS and PECCS are revised through periodic open market consultation, advised by a Review Committee and finalised by the relevant Executive Committee. Since 2022 the Industrial Activity pillar is mapped to standard industry schemes and to the EU Taxonomy, allowing TICCS to be used alongside other standards. The standards are published as open, versioned documents under a Creative Commons licence.

MODULE 2.2

The PECCS classification standard and machine-learning classification

PECCS classifies private companies by fundamental economic characteristics rather than by industry alone. Its pillars are independent; within each pillar the classes are exhaustive and mutually exclusive. The multi-pillar design is deliberate: it captures dimensions of risk that a single industry hierarchy cannot express, avoids the excessive nesting that plagues purely industrial schemes, and permits the valuation effect of each characteristic to be estimated separately.

Pillar	Structure	Note
Activity	12 classes, 67 sub-classes	Mappable to standard industry schemes; the only pillar so mapped
Lifecycle phase	3 classes, 7 sub-classes	Stage of maturity / growth
Revenue model	4 classes, 14 sub-classes	e.g. subscription, advertising, reselling, production
Customer model	2 classes, 8 sub-classes	Business-focused vs Consumer-focused (government sales = Business-focused)
Value chain	3 classes, 6 sub-classes	e.g. products, services, hybrid

Classification method. Activity classification draws heavily on textual data — company business descriptions — with standard-industry codes as a strong predictor. The non-activity pillars are assigned by a supervised machine-learning classifier rather than by hand-coded rules, which confers several practical advantages: the classifier returns a class probability rather than only a label; it cannot generate mutually contradictory assignments; it is invariant to the order in which criteria would otherwise be applied; and its predictions remain robust as the training data grow and the model is retrained. PECCS does not attempt to re-invent industry classification — the Activity pillar builds on, and maps to, established definitions, consistent with evidence that well-constructed industry groupings improve comparability (Chan, Lakonishok & Swaminathan, 2007) — but its non-activity pillars add risk dimensions that conventional codes omit, and SIPA reports materially different multiples and returns across, for example, revenue-model and customer-model classes.

MODULE 2.3

Factor-based shadow pricing

The valuation engine is a cross-sectional factor model. The premise, familiar from asset-pricing theory, is that the systematic component of value is spanned by a small set of common risk factors, while idiosyncratic, firm-specific variation is diversifiable and should not be priced in a well-diversified setting (Fama & French, 1993, 2015). Applying this premise to unlisted companies is natural: observable transactions are scarce, so a factor structure that borrows strength across the whole cross-section is precisely what is needed to value assets that have not themselves traded.

Two modelling choices are important. The model is calibrated to actual transaction prices, not to appraised valuations, because appraisals are smoothed and biased (Getmansky, Lo & Makarov, 2004). And the quantity modelled is a valuation ratio — for example price-to-sales (P/S) — rather than a return series, because a company that transacts at most once cannot furnish a conventional return. Formally, for asset i observed at time t:

> *Y(i,t) = beta′ X(i,t) + epsilon(t) — where Y is the valuation ratio, X is the vector of factor exposures (the “loadings” or betas) read from the company’s financials, beta is the vector of factor prices to be estimated, and epsilon is a well-behaved disturbance. Once beta is known from recent transactions, any company with observable exposures X can be priced — its shadow price.*

The three-step logic

- From observed transaction prices, recover the risk premia implied by recent deals.
- Estimate the price of each factor, given the factor exposures of the transacting companies.
- Apply the estimated factor prices to a target company’s exposures to obtain its risk premium and shadow price, whether or not it has traded.

Factor selection. Candidate factors are admitted on three criteria, in order of priority: a clear economic rationale for a systematic link to transaction prices; statistical evidence of covariance between the factor loadings and observed prices; and availability of the underlying predictor data for the entire universe, so that every asset can in fact be priced. The resulting core factors combine firm-level financials with a macro-financial factor and classification dummies.

Factor	Proxy	Economic rationale (supporting literature)
Size	Total assets	Larger assets are more illiquid and complex to transact (Fama & French, 1993)

Factor	Proxy	Economic rationale (supporting literature)
Leverage	Senior debt / total assets	Affects the risk borne by equity cash flows; estimated sign is time-varying (see below)
Profitability	Return on assets (pre-tax)	More profitable firms have less uncertain payouts (Novy-Marx, 2013)
Investment (Capex)	Capex / total assets	Higher capital intensity raises overrun and execution risk (Fama & French, 2015)
Term structure	Yield-curve slope (long minus short)	Proxies macro-financial conditions; a flat/inverted curve has predicted downturns (Estrella & Mishkin, 1998)
Segment dummies	TICCS / PECCS classes	Segments differ systematically in risk and price (Bhojraj et al., 2003)

The term-structure factor merits a note. Its primary justification here is as a proxy for macro-financial conditions and forward-looking risk, for which the slope of the yield curve is a well-documented indicator (Estrella & Mishkin, 1996, 1998); the evidence that yield-curve factors also carry cross-asset predictive content is corroborative (Chen & Tsang, 2013). The volatility-of-returns literature likewise cautions that exposure to priced risk, not raw variance alone, is what should command a premium (Ang, Hodrick, Xing & Zhang, 2006), which is why the model prices exposures to common factors rather than fitting individual price histories.

Estimation. SIPA does not rely on a single static regression. Model construction proceeds through a disciplined pipeline: economically required regressors (size, leverage, market valuation and the like) are imposed a priori; forward-stepwise selection admits further useful regressors; polynomial terms test for non-linearity; a Lasso (Least Absolute Shrinkage and Selection Operator) penalty shrinks and selects among second-order predictors; Principal Component Analysis distils correlated second-order predictors into a few economically interpretable components; and, finally, Dynamic Linear Models (a state-space, Kalman-filter formulation) estimate time-varying coefficients. In one reported infrastructure specification the preferred model attained an adjusted R-squared of about 0.26 with a variance-inflation factor of about 1.36, indicating no material multicollinearity despite the inclusion of principal components.

Factor loading versus factor price, and time variation. A factor loading (beta) is a company's exposure to a factor, observed from its financials. A factor price is the premium or discount the market currently attaches to that factor, estimated from recent transactions. Two companies with identical loadings will be valued differently as factor prices move over the cycle; this is why the coefficients are estimated dynamically rather than as fixed averages. The state-space estimator updates the factor prices on each transaction date, tolerates the irregular, clustered arrival of private deals, and attenuates the influence of individual outliers; SIPA reports 95% confidence intervals around each factor price to convey its variation through time.

The estimated coefficients are economically legible. In SIPA's private-equity model, holding other factors constant, a one-unit increase in the profitability factor raised P/S by approximately 1.0%; a change in the term-structure factor moved P/S only slightly (of order 0.1% for a ten-point change); deals seeking greater control, and add-on acquisitions, reduced P/S by roughly 12% and 10% respectively; and younger firms were priced consistently higher. Notably, over the sample's benign credit cycle higher deal leverage was associated with higher valuations — acquirers paying up for companies able to service more debt — which illustrates that an estimated factor sign can depart from a naive prior and can itself change over time. Dynamic estimation is what allows such evolving relationships to be captured.

> *Scope caveat, to be carried into all technical communication: the model prices the systematic component of value and deliberately omits the idiosyncratic component. Its shadow prices are therefore accurate on average within a segment rather than exact for any single company. A key robustness check is that the model's pricing residuals behave like white noise — mean zero and approximately symmetric — so that individual errors diversify away at the segment and index level.*

Worked example — the model reproduces two dissimilar transactions

M40 motorway, United Kingdom (2010). A fund acquired a 50% interest in this shadow-toll concession. From the asset's factor exposures and the prevailing market prices of risk, the model estimated an equity value of about USD 116.3m against a reported USD 115.5m (+0.71%), with estimated price-to-sales of 2.66 versus 2.64 reported. The company reported little capital expenditure at the time — a low investment-factor loading — which lowered its risk premium relative to the sector average.

Cloosh Valley wind farm, Ireland (2018). Here the model estimated about USD 155.3m against a reported USD 160.2m (-3.01%). The project remained partly in development, so its investment (capex) loading stood far above the sector average — of order 39% versus 8% — which, because capital intensity raises execution risk, elevated its risk premium and discount rate. The model captured this and priced the asset to within about three percent of the observed deal (SIPA methodology notes).

The two cases differ in sector, geography and stage, yet the same consistent methodology reproduces both prices, using inputs — factor loadings and market prices of risk — that are transparent and documented.

MODULE 2.4

Alignment with IFRS 13

IFRS 13 defines fair value as an exit price: the price that would be received to sell an asset in an orderly transaction between market participants at the measurement date (IFRS Foundation, 2011). Two of the standard's concepts shape the design of the valuation approach.

- **Principal market.** Fair value should reflect the price in the market with the greatest volume and activity that is accessible to the holder. infraMetrics addresses this by covering approximately the twenty-five most active national markets — the "Broad Market" — while privateMetrics draws on transactions from more than one hundred countries, with flagship indices spanning around thirty of the most significant markets.
- **Unit of account.** IFRS 13 requires the measurement to be consistent with the level at which the asset is recognised. The model values the company first, because the company's economics drive the value of the individual securities in its capital structure; security-level values follow from the enterprise value.

Because the model's inputs are drawn from the same illiquid markets in which the assets themselves trade, rather than from listed proxies, there is no need to assume an ad hoc "illiquidity premium." Systematic risk is captured in the market-calibrated factor prices; asset-specific adjustments are documented separately. SIPA's dedicated valuation framework develops this IFRS-13-aligned, mark-to-market approach in full (Blanc-Brude & Gupta, 2021).

MODULE 2.5

Index construction and maintenance

An index is published for a TICCS or PECCS segment only where the data can support one: SIPA computes a segment index where more than roughly twenty-five constituents are available for more than five consecutive years. This data-sufficiency rule is why the published set comprises a few dozen headline indices rather than thousands of thinly populated ones.

Weighting. privateMetrics indices are weighted neither equally nor by company market capitalisation, but by the sector-and-country weight of each segment in the global economy. Country weights begin from gross domestic product and are then adjusted — for government revenues, for the restrictiveness of foreign direct investment, and for the revenue of publicly listed companies — before conversion to the relevant exchange rate against the US dollar. Where a country lacks sector data, the missing weight is imputed at the global median and the full set of weights is rescaled to sum to one. The resulting sector-country weights are then converted to integers, which determine how many constituents are drawn from each sector-country cell.

Selection. Within each country-sector cell, the companies ranked highest by shadow valuation are selected. For the private3000 specifically, the constituents are the higher-ranked companies by shadow valuation within each cell that are not already members of the private2000, so that the two indices are complementary rather than overlapping.

Maintenance and turnover control.

- Corporate actions are processed monthly; ranking and weight revisions are applied annually.
- Turnover is contained by banding — buffer zones around the inclusion and exclusion thresholds, so that borderline names are not churned in and out — and by hard-stop rules that cap total turnover at any review.
- Marked-to-market valuation requires, each quarter and in every market, an updated term structure of interest rates built from government-bond yields across maturities; foreign-exchange conversion uses period-end spot rates.

Governance and robustness. The flagship indices are ESMA-registered, IOSCO-aligned benchmarks with fixed constituent lists managed by an Index Committee. A defining signature of a genuine, unsmoothed index is the absence of serial correlation in its returns together with an economically believable Sharpe ratio — both of which SIPA reports for its calculated indices, in contrast to contributed appraisal indices (Getmansky, Lo & Makarov, 2004).

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