Re-estimation of Valuation Methods for Medical-Device Enterprises at Different Financing Stages

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Abstract. As global demographic ageing intensifies and healthcare demand escalates, the medical-device sector has become a focal point for capital allocation. Valuation of these enterprises, however, remains highly intricate owing to protracted research and development(R&D) horizons, rigorous regulatory oversight, and pronounced revenue uncertainty. Conventional relative multiples (e.g., price-to-earnings, price-to-sales) and absolute discounted-cash-flow frameworks exhibit limited efficacy when applied to pre-revenue or revenue-volatile start-ups. This study introduces a precedent-transaction–anchored valuation paradigm that bifurcates firms into two distinct stages: (i) core product already commercialized and (ii) core product pre-commercial. Stage-specific valuation determinants are delineated, permitting calibrated premia and discounts relative to the selected comparable. Empirical calibration using Shenzhen MGI Tech Co., Ltd, Qitan Technology Ltd., Shangyang Medical and others corroborates the model's validity and precision across successive private placement rounds. Relative to traditional methodologies, the proposed framework delivers markedly superior accuracy and operational applicability for early-stage medical-device enterprises, furnishing investors and entrepreneurs with a more robust valuation reference.

Keywords: Medical Devices, Enterprise Valuation, Start-ups.

1 Introduction

The accelerating global demographic transition toward an older population is exerting an upward and proportional pressure on the demand for medical services and associated technologies. Simultaneously, emerging economies, most notably China are experiencing sustained Gross Domestic Product (GDP) expansion alongside progressive enhancements in healthcare infrastructure and reimbursement policy, thereby catalyzing a substantial surge in medical consumption. Within this macro-context, both institutional and private capital have reoriented their attention toward the healthcare sector. In 2024, global private placements in healthcare reached United States Dollar (USD) 115 billion, the second-highest annual figure on record. As a critical sub-segment, the medical-device industry has consequently attracted heightened investment interest. Yet, owing to its distinctive industrial attributes, medical-device enterprises exhibit valuation characteristics that diverge markedly from those of conventional sectors. Ex-

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tended R&D cycles, rapid technological obsolescence, and stringent regulatory scrutiny—coupled with formidable market-access barriers—render valuation exercises considerably more complex than in mature industries.

Traditional valuation techniques can be broadly classified into relative and absolute approaches. Relative methodologies—encompassing the price-to-earnings (P/E), price-to-sales (P/S), and price/earnings-to-growth (PEG) multiples—derive enterprise value from observable market benchmarks. Absolute techniques, exemplified by the discounted-cash-flow (DCF) and dividend-discount (DDM) models, ground valuation on projected future cash flows. Both families of methods, however, presuppose a reasonably predictable revenue trajectory; it is extremely hard to apply for medical-device start-ups, many of which operate in a pre-commercial or pre-revenue state [1].

The extant academic literature offers only limited guidance on refining valuation frameworks specific to medical-device ventures. Lei Zhang employs DCF and P/E as foundational tools, augmenting them with a suite of firm-specific adjustment factors to value Reach Surgical Co., Ltd, Sino Medical Sciences Technology Inc., and Synaptic Medical [2]. Yet the analysis is circumscribed in two principal respects. First, all target firms possess commercially approved products and are situated in the growth phase; firms still navigating R&D or clinical validation where cash flows are non-existent are excluded [2]. Second, because the sample exhibits stage homogeneity, the adjustment factors and their associated weights are held constant, focusing narrowly on endogenous variables while neglecting exogenous determinants such as reimbursement policy or regulatory pathway shifts [2].

Douglas Paulsen's findings on U.S. early-stage device companies underscore the valuation impact of external variables, including FDA review timelines, insurer coverage decisions, and patient willingness-to-pay [3]. Alan Grilling further advocates a stage-gated valuation architecture concept, development, and commercialization, arguing that uncertainty profiles evolve across gates and that uniform adjustment factors are therefore inappropriate [4]. These contributions collectively reveal the inadequacy of Lei Zhang's models in capturing the heterogeneity intrinsic to early-stage medical-device enterprises.

In summary, extant research on start-up medical-device enterprises reveals substantial room for refinement in valuation precision, stage-contingent adjustment mechanisms, and the integration of sector-specific parameters. Early-stage firms confront two dominant sources of uncertainty: "development uncertainty," encompassing product design, performance, and technical feasibility, and "post-launch uncertainty," defined as the exogenous drivers that dictate successful market entry. This study, therefore, partitions firms at the inflection point of product commercialization, conducts valuation analyses anchored by illustrative cases, and applies a differentiated set of internal and external factors that materially influence valuation at each stage. By substituting precedent transaction comparable for traditional relative or absolute methods—both of which presuppose stable financials—the proposed framework materially enhances valuation accuracy, thereby providing actionable guidance to entrepreneurs, investors, and financial institutions operating in the private medical-device market.

2 Re-estimation of Sector Valuation

2.1 Traditional Valuation Methodologies and Their Deficiencies

Traditional valuation techniques encounter pronounced limitations when applied to medical-device enterprises, particularly those in early developmental phases. In consumer-discretionary sectors, such as fast-moving consumer goods firms, companies commercialize products without protracted R&D timelines, licensing procedures, or post-market surveillance obligations. The apparel industry exemplifies this contrast: the "fast-fashion" paradigm compresses the interval between concept and retail shelf to as little as six weeks, albeit at the expense of product quality and design integrity [5,6]. Conversely, medical-device firms confront an extended pre-commercial interval devoid of stable cash flows. Empirical evidence assembled by Yuki Ushimaru indicates that development timelines range for medical devices are usually from one to 114 months, with a mean duration of 36 months [7]. Most private placement rounds occur within this interval, necessitating substantial capital infusions to bridge the chasm between prototype and regulatory approval.

Pre-commercial medical-device firms, however, derive only sporadic income from ancillary services, rendering the relevant multiples either non-computable or negative. And even if listed companies within the same therapeutic vertical may be invoked as comparable, the stage differences between these entities and an early-stage target vitiates the reliability of such multiples; the resultant valuation serves merely as an indicative benchmark rather than a dependable estimate.

Absolute valuation fares no better. DCF models presuppose forecastable revenue trajectories and stable growth parameters—conditions that pre-commercial medical-device firms manifestly disqualify. Consequently, both relative and absolute methodologies are ill-suited to the valuation of nascent medical-device enterprises.

2.2 Methodological Innovation and Valuation Factor Selection in the Medical-Device Sector

Given that the comparative valuation and absolute valuation are not able to apply to pre-commercial medical-device firms, this study substitutes the precedent-transaction approach as its analytical foundation. Identification of a suitable private-equity or M&A comparable is predicated upon two orthogonal criteria. First, the stage of the company from the reference transaction must coincide with the target firm, at before or after the inflection point of product commercialization. Second, the comparator must operate within the identical therapeutic niche and possess an analogous product. For instance, if the target company's core asset is a cardiac-epicardial ablation platform scheduled for market entry within 12–24 months, the suitable precedents transactions cases would encompass prior financings of firms whose primary technology (radiofrequency, cryoablation, or pulsed-field ablation) was also likewise 12–24 months from approval. Due to residual heterogeneity existing between target and precedent necessitates the introduction of stage-specific adjustment factors. These factors are selected according to their material influence on the probability of achieving the next milestone implicit in

the firm's current life-cycle objective. Investors typically infer this objective from deal teasers, management roadshows, or the business plan.

Table 1. Valuation factors for enterprises (During the transaction procedure)

Factors	(Level A)	(Level B)	(Level C)
Market Share	The target has more market share	Both have a similar size of market share	The comparable has more market share.
Mass-Production	The target able to achieve mass production	Both can achieve mass production	The comparable able to achieve mass production
Technology Maturity	The target's technology is more mature	Technology maturities are similar for both	The target's technology is less mature
Private-Market Active Level (for both commercialized or not)	The Investors were more active, and market sentiment was more optimistic	The private market active level was similar to that when the comparable firm raised capital.	The investors were less active, and market sentiment was less optimistic.
Global Macro Environment	The target benefited from a global event favorable to the sector.	The global environment was similar to that when the comparable firm raised capital.	The comparable firm raised capital when a global event unfavorable to the sector occurred.
Firm-Specific Policy Support.	The target enjoyed supportive policies that the comparable firm did not.	Both enjoy similar firm-specific policy support.	The comparable firm enjoyed supportive policies that the target firm did not.
Core Medical Device Products Has Not Been Commercialized			
Management Team	Target's team comprises more and better-qualified professionals with interdisciplinary expertise.	Team background is similar to that of the comparable firm.	Target's team comprises fewer and lower-qualified professionals with interdisciplinary expertise.
First-Mover Advantage	Target is expected to launch earlier in its niche than the comparable firm.	Expected launch timing is similar to that of the comparable firm.	Target is expected to launch later in its niche than the comparable firm.
Pain-Point Resolution	Target's product directly addresses a critical technology pain point that the comparable firm's product does not.	Impact on pain points is similar to that of the comparable firm.	Target's product fails to resolve pain points that the comparable firm's product addresses.
Industry Policy	There are new favorable policies for the sector that were introduced	The policies for the industry were similar when raising capital.	There are new unfavorable policies for the sector that were introduced.

During the pre-commercial phase, the overriding imperative is regulatory clearance and market introduction. Here, the caliber of the management team constitutes a pivotal determinant. A founding team with advanced biomedical credentials, complemented by members holding senior research or managerial positions in Fortune-500 pharmaceutical or device corporations, and fortified by proprietary intellectual property, signals both translational capability and the integrative competence required to orchestrate cross-disciplinary R&D talent (e.g., physician-scientists and biomedical engineers) [1]. When the precedent transaction lacks such attributes, the target commands an upward valuation adjustment. Post-commercialization, however, the strategic agenda shifts to ecosystem construction or public-market readiness; managerial track record has already been validated and thus recedes in marginal relevance. Instead, technological maturity, scalable manufacturing capacity, and policy variables such as reimbursement breadth exert greater influence on forward milestones.

Adjustment factors are summarized below, differentiated by commercial status. The valuation date for both the target and precedent is synchronized. For companies whose core device has been commercialized, each factor is assigned a symmetric ±20 % adjustment: +20 % if the target surpasses the precedent, 0 % if parity obtains, and –20 % if the target is inferior. Interaction effects among factors are captured multiplicatively, e.g., Target company with 2 advantageous factors with 0 offsetting disadvantages compare to comparable company.

$$\text{Pre-money Valuation of Precedent Transaction} \times 1.2^2 \times 0.8^0 \quad (1)$$

Unlike their commercialized companies, the success of pre-commercial medical-device enterprises hinges on a multiplicity of determinants; however, two are pre-eminent: first-mover advantage and product quality. Product quality is inferred from clinical-phase feedback and is obtainable only through interviews with experts; this information cannot be unavailable to collected at this stage for this paper. And the first-mover advantage is intimately linked to centralized procurement policy: if the subject firm is unable to secure it, and the products produced by competitors who received the competitive advantages from being first movers are satisfactory to the industry, downstream adopters will not pronounce brand-switching inertia without any special reasons. Consequently, first-mover advantage and product quality exert a disproportionately large influence on valuation for pre-commercial ventures. As shown in Table 1, all ancillary factors are down weighed to ±10%, while these two core factors retain a ±20% adjustment magnitude. The factor sets for both pre-commercial and commercialized firms, refined from Lei Zhang, are as follows [1].

3 Case Applications

3.1 Data Acquisition

Global market conditions are derived from research reports published by investment banks, securities firms, and specialized healthcare consultancies. The precedent transaction data are sourced from the China Venture database and additional records pro-

vided by the author's internship host. Owing to the confidential nature of certain information, all non-public transaction details have been anonymized. And apologizes for any inconvenience this may cause.

3.2 Results and Comparative Analysis

Commercialized Case I: MGI Tech Co., Ltd Series B：On 28 May 2020, MGI Tech announced the completion of a USD 1 billion Series B round led by IDG Capital, CPE, and China Renaissance New Economy Fund, among others. Public disclosures indicate that the proceeds were intended to bolster R&D, expand the sequencing ecosystem, reduce sequencing costs, and accumulate capital for an eventual public listing [8].

As shown in Table 2, the acquisition of Pacific Biosciences by Illumina is selected as the precedent M&A transaction. Although the deal was terminated by the UK government in 2020, the definitive agreement signed in 2018 disclosed an offer of USD 8 per share, representing a 71 % premium to the volume-weighted average price. On a fully diluted basis, Pacific Biosciences' enterprise value at that juncture was USD 1.2 billion [9].

Table 2. MGI Tech Co., Ltd Series B vs. Pacific Biosciences

Valuation Factors	Comparison Results
Industry Competitive Structure	Level B
Mass-Production Capability	Level A
Technology Maturity	Level A
Private-Market Active Level	Level B
Global Macro Environment	Level A
Firm-Specific Policy Support.	Level B

Commercialized Case I – Summary：MGI Tech's pre-money valuation at its Series B round can be expressed as:

$$1{,}200{,}000{,}000 \times 1.2^3 = 2{,}073{,}600{,}000 \approx \text{USD } 2.0736 \text{ billion} \quad (2)$$

In an actual transaction, MGI Tech raised USD 1.0 billion in Series B financing. The post-money valuation was RMB 22.049 billion. After subtracting the newly injected capital, the implied pre-money valuation approximated RMB 14.9 billion, which, converted at the then-prevailing exchange rate, corresponded to roughly USD 2.085 billion. This outcome aligns closely with the theoretical figure. To corroborate the viability of the valuation method, a second case - Qitan Technology's Series C round will now be examined.

Commercialized Case II – Qitan Technology Series C：On 26 December 2022, Qitan Technology announced the completion of a Series C financing totaling RMB 700 million. Meituan acted as the lead investor, HUAGAI Capital and Boyuan Capital as follow-on investors. According to publicly available market information, the proceeds will be deployed to (i) refine the product matrix, (ii) accelerate the launch of medium-

and high-throughput sequencing platforms, (iii) expand into more diversified application scenarios, and (iv) intensify market penetration to broaden the commercialization landscape as shown in Table 3.

As Qitan Technology also operates within the gene-sequencing sector, the private transaction of MGI Tech's Series B financing is adopted herein as the comparable private transaction benchmark [10].

Table 3. MGI Tech Co., Ltd Series B vs. Qitan Technology

Valuation Factors	Comparison Results
Industry Competitive Structure	Level C
Mass-Production Capability	Level C
Technology Maturity	Level C
Private-Market Active Level	Level C
Global Macro Environment	Level C
Firm-Specific Policy Support.	Level C

Commercialized Case II – Summary：The pre-money valuation of Qitan Technology's Series C round is calculated as:

$$2{,}073{,}600{,}000 \times 0.86 = 543{,}581{,}798 \approx \text{USD 544 million} \quad (3)$$

Empirically, Qitan Technology raised RMB 700 million in its Series C financing. The post-money valuation was RMB 4.308 billion. After subtracting the newly injected capital, the implied pre-money valuation approximated RMB 3.608 billion, which—converted at the then-prevailing exchange rate corresponded to roughly USD 517 million. This outcome is closely aligned with the theoretical estimate.

Pre-Commercialized Case – Shangyang Medical: Strategic Investment Round (Precedent Transactions Method) : On 31 August 2023, Shanghai MicroPort EP MedTech Co., Ltd invested RMB 52.9412 million in Shangyang Medical. Upon completion of the transaction, Shanghai MicroPort EP MedTech Co., Ltd will hold a 15.00 % equity stake in Shangyang Medical, thereby enhancing its R&D footprint in the PFA domain, expanding its electrophysiological diagnosis and therapy portfolio, and reinforcing its competitive position.

Given that early-stage medical-device enterprises typically have no commercialized products, they exhibit higher uncertainty and greater external sensitivity than firms with already-commercialized offerings. Consequently, for unlisted cases, it construct a valuation range by aggregating data from several precedent transactions. Given Shangyang Medical's therapeutic focus and the expectation that its core product will reach the market within the next one to two years, this analysis adopts three listed peers—Jinjiang, Company W, and Company J as the precedent transaction set. Relevant valuation and transaction information for these comparables is presented in Table 4: Comparable Listed Enterprises.

Table 4. Precedent transaction information

RMB (Mm)	Business & Products	Financing Round	Pre- Money Valuation

Jinjiang Electronic	3D mapping system, pulsed-field ablation (PFA) system	Equity transfer	450
Company W	3D mapping system, cryoablation	Series B	400
Company J	3D mapping system, RF & PFA ablation systems	Pre-Series A	350

Based on the aggregated data from the three precedent transactions above, this paper establishes a baseline valuation range of RMB 350 to 450 million. As shown in Table 5, only the cases of Enterprise J and Jinjiang Medical need to be referenced for benchmarking purposes.

Table 5. Shangyang Medical vs. Jinjiang Electronics

Valuation Factors	Comparison Results
Management Team	Level A
First-Mover Advantage	Level B
Pain-Point Resolution	Level B
Private-Market Active Level	Level A
Industry Policy	Level C

Table 6. Shangyang Medical vs. Compnay J

Valuation Factors	Comparison Results
Management Team	Level A
First-Mover Advantage	Level B
Pain-Point Resolution	Level B
Private-Market Active Level	Level B
Industry Policy	Level A

Pre-Commercialized Case I – Summary：The pre-money valuation of Shangyang Medical is calculated as: Upper-bound scenario (anchored on Jinjiang Electronics):

$$450{,}000{,}000 \times 0.8 \times 1.1 \times 1.1 = 435{,}600{,}000 \approx \text{RMB 436 million} \quad (4)$$

Lower-bound scenario (anchored on Company J):

$$350{,}000{,}000 \times 1.2 \times 1.1 = 462{,}000{,}000 \approx \text{RMB 462 million} \quad (5)$$

The resulting inversion of the valuation bounds (i.e., the lower anchor produces the higher figure) is not uncommon in medical-device appraisals. As previously argued, the commercial success of novel devices hinges on two dominant variables: speed-to-market and product quality. Although Jinjiang and Company W entered the PFA segment earlier than Company J, any marked shortfall—relative to international benchmarks such as Boston Scientific or Johnson & Johnson—in either device performance or user experience would attenuate their first-mover advantage. Consequently, late-stage competitors may suffer a diminished “late-mover penalty.” Quality and usability,

however, can only be reliably gauged through expert interviews; investors can therefore incorporate experts feedback to refine these parameters as shown in Table 6.

In sum, the pre-money valuation for Shangyang Medical in this strategic round is bracketed between RMB 436 million and RMB 462 million. Empirically, the transaction closed at a pre-money valuation of approximately RMB 450 billion, which lies well within the derived interval as shown in Table 7.

Pre-Commercialized Case – Shangyang Medical: Strategic Investment Round (Comparable Company Analysis)

Because pre-commercial enterprises typically require several comparable transactions to establish a defensible valuation range, and because publicly available data at this stage are scarce, it currently lack a second unlisted transaction with sufficient disclosure to corroborate the accuracy of the novel methodology proposed earlier. Consequently, this section reverts to the traditional listed-company comparable approach to value Shangyang Medical's strategic financing round and to assess which method yields more reliable results. Two domestic listed peers that are exclusively focused on electrophysiology, Company W and APT Medical Inc., serve as the valuation comparable.

Table 7. Comparable listed companies – Financial metrics and revenue forecasts for the target

Unit: RMB Mn	Company W		APT Medical Inc.	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Target 2024E Revenue	45.0	55.0	45.0	55.0
Enterprise Value	7,600	7,600	35,310	35,310
2-Year Forward EV/S	11.0x	14.3x	10.2x	13.2x
Liquidity Discount	20%	20%	20%	20%
Implied Pre-Money Valuation	396.0	629.2	367.2	580.8

Following the launch of its core product, Company W generated annual revenue of approximately RMB 50 million in the subsequent fiscal year. By applying a ±10 % adjustment, this study derives a revenue forecast interval and posits that Shangyang Medical's post-launch revenue will plausibly fall between RMB 45 million and RMB 55 million. The roughly range of enterprise value for Company W and APT Medical Inc are between 7.6 billion and 35.3 billion at the end of 2024. Using Wind's projected operating revenues for 2025 and 2026, a two-year forward EV/S multiple is obtained. After imposing a 20 % liquidity discount to account for the restricted marketability of unlisted equity, the valuation range for Shangyang Medical is concluded to be RMB 367 million–629 million.

Relative to the innovative valuation framework proposed herein, the interval produced by traditional methods is markedly wider, suggesting that the comparable listed company approach may offer limited practical guidance when valuing early-stage medical-device firms.

3.3 Pathway and Application

The foregoing methodology applies to medical-device companies whose core products have either been commercialized or remain pre-commercial yet already possess an operating entity. By analyzing stage characteristics and milestone achievements, a set of factors with material probabilistic influence on milestone attainment is identified. Comparing similarities and differences among comparable firms within precedent transactions, premia or discounts are then applied to the pre-money valuations of those transactions, yielding a more refined estimate.

4 Conclusion

The case analysis demonstrates that substituting precedent transactions for traditional relative-valuation and private-equity techniques while adjusting for influential factors yields comparatively precise valuations for medical-device enterprises whose core products are already commercialized. Several commercialized product cases corroborate the method's feasibility. Further, when applied to a pre-commercialized product case, the proposed framework again produces a narrower and more accurate range than conventional relative valuation.

Limitations remain. Factor selection is constrained by the authors' subjective knowledge, and factors materially affecting milestone or financing outcomes may be unquantifiable; industry experts with deeper expertise might select different variables. Moreover, the approach cannot accommodate firms still in the conceptual-product stage, whose future is inherently difficult to forecast. Finally, the study focuses on the primary private-equity market, where data are predominantly non-public. Consequently, the conclusions lack the support of large-scale datasets, and the granularity required to match both financing stage and therapeutic niche renders publicly available data scarce. Policy initiatives that enhance data accessibility would likely improve valuation precision.

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