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[Naude Shamma Geste](#) *

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Article

The Financial Transformation of the Video Game Industry: Systematic De-Risking and Policy-Induced Fragility in the Games-as-a-Service Era

Naude Shamma Geste

Shanghai University; ngeste@shu.edu.cn

Abstract

The video game industry has shifted from transaction-based “unit sales” to a “Games-as-a-Service” (GaaS) model defined by recurring digital revenue. This study investigates how this transition impacts firms’ systematic risk (equity beta) and cost of equity. Using a longitudinal panel of publicly listed gaming companies (2015–2025) and a Fama-French multi-factor framework, we quantify the relationship between GaaS reliance and market risk. Empirical findings reveal a significant de-risking effect: the GaaS Ratio (share of recurring revenue) is negatively associated with market beta (coefficient -1.0045 , $p = 0.025$). This suggests that recurring streams reduce systematic risk by improving cash-flow predictability. However, residual analysis uncovers a “GaaS Paradox”: while these models lower exposure to broad market swings, they introduce heightened fragility to non-market shocks. Specifically, GaaS-heavy firms show extreme sensitivity to regulatory changes (e.g., loot box bans), platform policy shifts (e.g., Apple’s IDFA), and global engagement fluctuations. We conclude that the GaaS transformation has fundamentally altered the sector’s financial architecture. Systematic risk has declined, but policy-induced and platform-related risks have risen, necessitating that investors treat gaming stocks as high-sensitivity proxies for digital engagement and regulatory stability.

Keywords: games-as-a-service; systematic risk; equity beta; policy uncertainty; platform risk; video game

1. Introduction

The video game industry has emerged as a global economic juggernaut, generating nearly \$190 billion in revenue in 2024 – a figure that now surpasses the combined global revenues of the music and film industries (Alcazar & Baird, 2025). This growth has been driven by a profound transformation in business model and cash-flow generation: the transition from a product-based logic of one-time unit sales to a relationship-based “Games-as-a-Service” (GaaS) framework. Enabled by ubiquitous broadband and digital distribution, GaaS emphasizes ongoing post-launch engagement and monetization through microtransactions, season passes, battle passes, and subscriptions, rather than a single point-of-sale transaction. In essence, the focus has shifted from selling games as products to monetizing players as continuous services over the game’s lifecycle (Moro-Visconti, 2021). This transition has fundamentally changed revenue dynamics in gaming, much as the Software-as-a-Service (SaaS) revolution did in enterprise software (Nezami, Tuli, & Dutta, 2022) – converting volatile one-off sales into smoother, recurring revenue streams.

In theory, GaaS models offer more stable “long-tail” cash flows that should reduce earnings volatility and, by extension, lower a firm’s exposure to broad market risk. A larger base of predictable recurring revenue can cushion quarterly performance against the hit-driven boom-bust cycle of traditional game releases (Alvarez & Marsal, 2025). However, the GaaS paradigm also introduces new dimensions of risk that were less pronounced in the old model. These include heightened regulatory and political risks stemming from GaaS monetization practices (for example, regulatory

scrutiny over the “gamblification” of games via loot boxes and other chance-based rewards) and platform ecosystem risks due to heavy dependency on third-party platforms and data policies (for example, changes in Apple or Google app store rules can directly affect user acquisition and revenues). Recent controversies over loot boxes – virtual treasure boxes with randomized rewards purchasable for real money – have prompted regulatory investigations and even outright bans in some jurisdictions, underscoring the political risk facing GaaS strategies (European Parliament, 2023). Similarly, policy changes by platform gatekeepers (such as Apple’s App Tracking Transparency framework limiting IDFA identifiers) can abruptly alter the economics of user acquisition for game publishers, acting as idiosyncratic shocks to companies reliant on data-driven marketing (Cheyre et al., 2024).

The goal of this research is to disentangle the net effect of GaaS adoption on video game companies’ risk profiles. On one hand, greater GaaS revenue share should de-risk firms by smoothing and diversifying cash flows, thereby reducing systematic risk (market beta) and the cost of equity capital. On the other hand, GaaS-heavy firms might become more sensitive to non-market factors – particularly regulatory actions, platform policies, and shifts in user engagement – which do not covary neatly with the market and thus manifest as idiosyncratic or residual risks. We posit that the financial evolution of gaming has created a trade-off where traditional market risk is exchanged for new forms of fragility.

To explore this, we construct a panel dataset of major publicly listed video game publishers from 2015 to 2025 and measure each firm’s GaaS Ratio (the proportion of revenue from recurring digital sources) over time. We then estimate firms’ equity betas and perform panel regressions in extended CAPM and multi-factor settings to test whether increasing GaaS reliance is associated with lower market beta. Additionally, we analyze specific shock events through the lens of regression residuals for two industry leaders – Electronic Arts (EA) and Take-Two Interactive (TTWO) – to illustrate how GaaS-oriented companies respond to regulatory and platform disruptions. Our findings confirm a significant de-risking effect in terms of market beta reduction, but also highlight a paradoxical increase in sensitivity to policy and platform shocks (“policy-induced fragility”).

2. Literature Review

2.1. The Financial Economics of Recurring Revenue

In corporate finance theory, a firm’s systematic risk (beta) is fundamentally linked to the volatility of its cash flows relative to fixed obligations. Firms with highly variable or unpredictable revenues – especially against a backdrop of largely fixed costs or commitments – tend to exhibit higher equity betas, as earnings swings are amplified in their effect on equity value. By contrast, businesses that can smooth their revenue streams (for instance, via long-term contracts or subscription models) should experience lower earnings volatility and, consequently, lower systematic risk of equity (Nezami, Tuli, & Dutta, 2022). Empirical research on the software industry has borne this out: the shift from one-time license sales to Software-as-a-Service (SaaS) subscriptions is credited with stabilizing revenue and improving valuation multiples (Chen et al., 2021; Guajardo, 2022), as investors reward the greater predictability and lower risk of recurring revenue models (Nilsen et al., 2024). In essence, spreading customer payments over time (and continuously renewing them) reduces the lumpiness of cash inflows and the dependence on continual hit products, thereby reducing the covariance of the firm’s profits with market swings. Valuation models for such recurring-revenue firms correspondingly place greater weight on forward-looking metrics like annual recurring revenue and deferred revenue (a liability capturing prepaid subscription fees) than on current period earnings (Moro-Visconti, 2021).

The video game sector’s embrace of Games-as-a-Service can be seen as a parallel to the SaaS revolution in enterprise software. Under the old model, game publishers faced “blockbuster risk” – revenues spiked upon a new game launch and then rapidly tailed off, making financial performance highly dependent on the timing and success of hits. In the new GaaS model, monetization is spread

out over the product's life via a series of smaller transactions and continuous engagement. This theoretically lowers revenue volatility and the hurdle rate for investment, as each game can generate a steady stream of cash rather than a single burst. By converting what was once a volatile, hit-driven sales curve into a more predictable annuity-like stream, GaaS should, *ceteris paribus*, reduce a firm's exposure to broad market fluctuations. In other words, if traditional "unit sales" revenue has a higher beta (β_{units}) than service-based revenue (β_{services}), then increasing the weight of services in the revenue mix will lower the company's overall beta. This intuition underpins the de-risking hypothesis in our study.

2.2. Policy Uncertainty, Regulation and Asset Pricing

While recurring revenues can smooth internal cash flows, external policy uncertainty can still inject risk into firms' valuations. Pastor and Veronesi (2013) demonstrate that political and regulatory uncertainty commands a significant risk premium in equity markets – stocks exposed to higher policy risk tend to have higher expected returns to compensate investors for that uncertainty. In other words, when government actions or rules can substantially alter a firm's economic environment, rational investors will discount its price, and this "policy risk factor" can show up as an additional component of returns. Baker, Bloom, and Davis (2016) further show that news-based measures of economic policy uncertainty are negatively associated with investment and can move asset prices globally, underlining that regulatory news is a non-diversifiable risk to some extent (Baker, Bloom, and Davis, 2016).

For video game companies, policy risk is highly localized around consumer protection regulations and monetization practices. The rapid rise of loot boxes and similar microtransactions in the late 2010s led to public and governmental concern that these mechanics exploit psychological principles akin to gambling (particularly among minors). As a result, gaming firms have faced an onslaught of regulatory scrutiny and legislative proposals aimed at curbing "predatory" monetization. This uncertainty spans multiple jurisdictions: for example, whether loot boxes might be legally classified as gambling (which could impose strict regulations or bans), whether spending limits or probability disclosures will be mandated, and how data privacy rules (like the GDPR or Apple's privacy changes) might restrict targeted advertising for games. Each new bill or government inquiry introduces uncertainty about the future revenue model for GaaS-oriented firms. Consistent with the ideas of Pastor and Veronesi, investors require a risk premium for this regulatory uncertainty, effectively putting a valuation ceiling on companies that rely heavily on contentious monetization methods.

Empirically, we have seen that the failure of industry self-regulation in addressing these concerns often precipitates harsher regulatory intervention. In the context of loot boxes, voluntary rating disclosures and parental controls did little to stem public backlash. A recent longitudinal study in the UK found widespread non-compliance with the gaming industry's own self-regulatory codes for loot boxes on mobile app stores, implying that the industry's promises of restraint were not being effectively enforced. This breakdown in self-governance has spurred governments to step in more forcefully. For instance, Belgium and the Netherlands moved to classify certain loot boxes as gambling by 2018 when industry efforts fell short, and other countries have since considered similar moves (see Section 4). Investors have started to price in these looming interventions as a real risk: whenever regulatory momentum builds, it effectively caps the upside of GaaS-heavy firms by threatening a portion of their future cash flows. We might term this the "regulatory overhang" or a policy risk beta – a sensitivity to the likelihood and severity of regulatory changes. Notably, Baker et al. (2016) documented that surges in policy uncertainty indices coincide with stock market declines, and in gaming we observe analogous episodes where regulatory news drives outsized stock moves (for example, see the 2023 China case in Section 4). In Europe, legal scholars have even debated using general consumer protection laws (such as the EU's Unfair Commercial Practices Directive) to crack down on loot box mechanics, underscoring that the regulatory environment for GaaS is in flux and subject to legal reinterpretation. In sum, greater GaaS exposure may lower traditional market beta

but could raise exposure to a policy risk factor – an additional component of risk related to the shifting regulatory landscape.

2.3. Behavioral Economics, Social Risk, and Gamer Welfare

A complementary perspective comes from behavioral economics and the emerging literature on the social/ethical risks of game monetization. GaaS strategies often leverage psychological mechanisms similar to those used in gambling to drive player spending and engagement. Loot boxes are the quintessential example: they employ variable-ratio reinforcement schedules (random reward drops) that are known to stimulate compulsive behavior. Drummond and Sauer (2018) found that video game loot boxes are psychologically akin to gambling, sharing important features such as random chance, enticing visuals, and near-miss stimuli that condition players to chase rewards. From an ethical and regulatory standpoint, this blurring of gaming and gambling raises red flags – especially when minors are involved. Research has identified robust correlations (Appendix A.1) between loot box spending and problem gambling symptoms. In multiple large-scale surveys, individuals who spend heavily on loot boxes tend to score significantly higher on problem gambling indices, even after controlling for demographics and gaming frequency. Zendle and Cairns (2019) replicated these findings, reinforcing that the relationship is not a statistical fluke – higher loot box expenditures are consistently linked with greater risk of gambling problems in a dose-response manner. (Zendle & Cairns, 2019) These results do not prove causation, but they strongly suggest that loot boxes either attract those with predispositions to gambling or actively contribute to the development of problematic gambling behaviors (or both).

From an ESG (Environmental, Social, and Governance) investment perspective, such findings imply that companies employing aggressive monetization schemes may be creating long-run social liabilities. While these practices can be extremely profitable in the short term, they carry the risk of backlash – whether through negative publicity, consumer alienation, or eventual legal penalties – that can translate into financial costs. In recent years, we have indeed seen instances where public sentiment turned against certain monetization tactics (e.g. the “Battlefront II” loot box controversy in 2017), forcing companies to abruptly pivot and even impacting sales. Regulatory crackdowns represent a crystallization of this social risk: when authorities ban or limit a lucrative practice (like loot boxes), firms not only lose that revenue stream but also may suffer reputational damage. King and Delfabbro (2018) have called for practical social responsibility measures from game companies to preempt these issues, essentially arguing that the industry should self-impose safeguards (like spending limits, transparency in reward probabilities, and robust parental controls) to mitigate harm. The implication is that companies which ignore such measures court a growing reputational and regulatory risk that can manifest in sudden financial losses when the “social license to operate” is revoked. Indeed, as we will discuss, GaaS-heavy firms have seen their stock prices react violently during regulatory episodes – suggesting that the market is keenly aware of the fragility introduced by monetization practices that push ethical boundaries. In summary, while GaaS has been a financial boon, it has also entangled firms in social and behavioral controversies that pose idiosyncratic risks distinct from traditional market factors.

3. Literature Review

3.1. Extended CAPM with a Policy Risk Factor

To formally assess the interplay between recurring revenue adoption and risk, we extend the standard Capital Asset Pricing Model to account for an additional systematic factor capturing regulatory or policy risk. The classical one-factor CAPM posits that a stock’s expected excess return $E(R_i)$ is governed by its sensitivity $\beta_{i,M}$ to the market portfolio’s excess return $E(R_m)$:

$$E(R_i) = R_f + \beta_{i,M}(E(R_m) - R_f),$$

where R_f is the risk-free rate. We augment this with the Fama-French factors for size (SMB) and value (HML), as is common for equity risk modeling of individual firms, and introduce a new factor P to represent policy risk. The extended model can be written as:

$$E(R_i) = R_f + \beta_{i,M}(E(R_m) - R_f) + \beta_{i,SMB}E(SMB) + \beta_{i,HML}E(HML) + \beta_{i,P}E(P).$$

Here, $\beta_{i,P}$ represents firm i 's sensitivity to news or shocks related to regulatory changes and policy interventions. Conceptually, the policy risk factor P could be proxied by an index of regulatory news intensity or a dummy variable for major policy events. A firm with a high $\beta_{i,P}$ would be one whose stock price reacts strongly to legislative announcements or regulatory decisions. In our context, we expect that companies with heavy GaaS exposure (and especially those deriving significant revenue from contentious monetization like loot boxes) might load heavily on this P factor. For example, news of a potential loot box ban or a new app store rule change could send those stocks sharply lower, reflecting a high β_p . By including this factor in the asset-pricing model, we acknowledge that some portion of gaming firms' risk is not explained by broad market movements, size, or value, but by this orthogonal dimension of regulatory shock risk.

While directly estimating β_p requires a time series for P (which is non-trivial to construct, given the sporadic nature of regulatory events), we use this theoretical extension to guide our empirical approach. In particular, when we analyze residuals from a market model, spikes in those residuals during known policy events can be interpreted as manifestations of this policy risk factor. Our hypothesis is that as the industry has moved toward GaaS, the market beta (β_M) of game companies has declined (due to revenue smoothing), but the policy beta (β_p) has increased (due to regulatory sensitivity). The net effect on total risk is ambiguous ex-ante, which is why empirical analysis is needed.

3.2. Beta Decomposition and the De-Risking Hypothesis

Another way to conceptualize the effect of changing business models on risk is through a simple beta decomposition. Suppose a game publisher's operations can be thought of as a portfolio of two components: (1) a traditional unit-sales business (sell-and-move-on model) and (2) a GaaS live-services business. Let ω_1 be the fraction of the firm's value coming from the traditional segment and ω_2 be the fraction from the GaaS segment (with $\omega_1 + \omega_2 = 1$). The firm's total equity beta β_{total} could be expressed as a weighted average of the betas of these two segments:

$$\beta_{total} = \omega_1 \beta_{units} + \omega_2 \beta_{services},$$

where β_{units} is the systematic risk of the legacy business model and $\beta_{services}$ is that of the GaaS model. Our de-risking hypothesis can be stated as $\beta_{services} < \beta_{units}$. This is based on the arguments in Section 2.1: the services model smooths revenue and should be less sensitive to cyclical consumer spending patterns or economic shocks (people tend to keep playing and spending small amounts on ongoing games, whereas big upfront purchases are easier to defer in a downturn). If this condition holds, then as ω_2 (the GaaS share) increases, β_{total} should decline correspondingly.

Importantly, this formulation assumes that the two betas are static and exogenous. In reality, as discussed in Section 2.2 and 2.3, expanding ω_2 might also influence the nature of risks the firm faces (introducing policy and social risks). In other words, $\beta_{services}$ might itself evolve over time if the increasing scale of GaaS provokes regulatory responses or other external factors. Nonetheless, in the time frame of our study (2015–2025), the primary effect we expect to observe is the mechanical risk reduction from revenue smoothing. We will test this by examining the correlation between firms' GaaS Ratio and their equity beta. A significantly negative correlation (controlling for other factors like leverage) would support the proposition that shifting to GaaS de-risks the firm in terms of market exposure.

In summary, our theoretical framework yields two key predictions to be tested:

- Prediction 1 (Systematic Risk): Firms with higher GaaS revenue share will exhibit lower market betas, all else equal, reflecting smoother and more predictable cash flows.

- Prediction 2 (Idiosyncratic/Policy Risk): Firms with higher GaaS share will exhibit greater sensitivity to regulatory and platform-specific shocks, which may appear as larger unexplained residual movements during those events (i.e., a higher effective β_p).

The empirical strategy described next is designed to evaluate these predictions using both cross-sectional regression and event analysis of residuals.

3.3. Institutional Timeline and Regulatory History (2010–2025)

To contextualize the evolving risk landscape, it is useful to review major policy and platform developments affecting the video game industry over the past decade. Table 1 provides a timeline of significant regulatory and institutional events from 2010 to 2025 and their impact on the GaaS monetization logic.

Table 1. Key Regulatory and Industry Events Affecting GaaS, 2012–2025.

Year	Jurisdiction	Development	Impact
2012	Japan	“Complete Gacha” Ban	First major crackdown on randomized loot mechanics; forced design overhauls.
2017	Global	Battle Royale Craze (PUBG/Fortnite)	Demonstrated the massive scalability of GaaS; led to a market “re-rating” as investors realized the revenue potential of live services.
2018	Belgium	Loot boxes=Gambling	First Western ban; titles forced to remove monetization in that region.
2021	Global	Apple App Tracking Transparency (ATT)	Abruptly raised marketing costs and lowered revenues for publishers reliant on data-driven user acquisition.
2021	China	3-Hour Weekly Limit (Minors)	Drastically cut youth engagement; slowed overall market growth.
2023	China	Monetization Restrictions	Caused a \$100B market sell-off; highlighted massive “policy risk” for GaaS.
2024	South Korea	Mandatory Odds Disclosure	First law to criminalize hiding drop rates; triggered audits and heavy fines.
2025	EU	Digital Fairness Act	Broad crackdown on “dark patterns” (manipulative design) and aggressive microtransactions.

Notes: Compiled from news reports, regulatory announcements, and industry analyses. Major regulatory documents include the Belgium Gaming Commission report (2018), China NPPA circulars (2021), the draft rules released by China’s NPPA in Dec 2023, the South Korea Game Industry Promotion Act amendment (2024), and EU Commission digital policy proposals (2025). These events collectively illustrate the tightening policy environment around GaaS monetization. Notably, early interventions (Japan’s gacha ban, Belgium’s loot box ban) were isolated national cases, but by the mid-

2020s we see broader regulatory movements in large markets (China, EU, Korea), significantly raising the stakes for globally operating firms.

Several patterns emerge from this timeline. First, regulatory actions often follow public outcry or clear evidence of harm (perceived or actual). For example, Japan's ban on complete gacha in 2012 came after widespread consumer complaints, and Belgium's ban followed an academic report and public debate on the gambling-like nature of loot boxes. These regulations tended to have immediate negative impacts on companies' GaaS revenues in those markets (e.g., Activision-Blizzard had to disable loot boxes in *Overwatch* for Belgian players, potentially reducing engagement). Second, China's policies demonstrate the outsized influence a single government can have due to market scale. The stringent play-time rules of 2021 and the sweeping monetization draft of 2023 essentially introduced a new kind of risk – that an entire segment of players or revenue mechanics can be switched off by fiat. The \$80+ billion market cap wipe-out in 2023 shows investors now react dramatically to such policy news, treating game stocks almost like regulated utilities when these events occur. Third, the introduction of explicit disclosure laws in South Korea and proposed EU-wide principles indicates that transparency and consumer fairness are becoming regulatory expectations. GaaS companies that built monetization on opaque odds or manipulative design are being forced into more transparent, possibly less profitable, practices.

In summary, the 2010–2025 period has transformed the regulatory risk landscape for gaming: what was once a lightly regulated industry is now facing a patchwork of laws and rules that directly affect game design and monetization. From the perspective of risk pricing, these developments suggest that a significant portion of a GaaS-oriented firm's risk is tied to policy outcomes in key jurisdictions. The next sections will examine how these external shocks and the internal shift to GaaS reflect in financial risk metrics

4. Materials and Methods

4.1. Data, Sample, and Variables

Our empirical analysis employs a panel dataset of publicly listed video game companies over the period 2015–2025. The sample includes 22 major gaming firms (primarily in North America, Europe, and Asia) for which sufficient financial and stock price data are available. These span pure-play video game publishers and developers, excluding console manufacturers or diversified tech conglomerates to maintain a focus on gaming-centric business models. For each firm-year, we compile financial data from annual reports and databases such as Bloomberg and Thomson Reuters. The key independent variable of interest is the GaaS Ratio – defined as the proportion of total revenues in a given year that came from recurring digital sources (e.g. microtransactions, downloadable content, subscription fees, and other “live services” revenue). In practice, firms do not always explicitly break out this number; we approximate it by combining reported “digital net bookings” or “recurrent consumer spending” (as termed by companies like EA and Take-Two) and subscription revenues, divided by total net revenues. Where disclosures are incomplete, analyst reports and industry estimates are used to gauge the split between recurrent vs. one-time revenues.

For each firm and year, we also compute or obtain the equity beta. We measure beta on an annual basis by regressing the stock's weekly returns against a broad market index (MSCI World or S&P 500, depending on primary listing) over a rolling one-year window. This yields an annual beta that reflects the stock's systematic risk for that year. To ensure the statistical validity of the return data used in these regressions, we performed Augmented Dickey-Fuller (ADF) tests on the daily return series. The results (summarized in Table 2) confirm that the returns for all sampled firms and the market index are stationary at the 1% significance level, thereby satisfying the necessary conditions for OLS estimation.

Table 2. Augmented Dickey-Fuller test results.

Series	ADF Statistic	p-value	1% Critical Value	Result
EA Daily Returns	-16.414	0.000***	-3.433	Stationary
TTWO Daily Returns	-18.007	0.000***	-3.433	Stationary
Market Risk Factor (Mkt-RF)	-17.088	0.000***	-3.433	Stationary

Note. The Augmented Dickey-Fuller test evaluates the null hypothesis of a unit root (non-stationary data). *** indicates rejection of the null hypothesis at the 1% significance level, confirming that the daily return series are stationary and suitable for regression analysis.

The use of a rolling window acknowledges that betas can evolve over time – pertinent as companies transition their business models. We also collect control variables that might influence risk, notably the firm’s financial leverage (Debt/Equity ratio) since higher leverage can mechanically amplify equity beta. Another control is firm size (we use market capitalization in USD billions) as larger firms may be more diversified and have different risk characteristics. Table 3 in the results section provides summary statistics for these variables.

To test the de-risking effect of GaaS, we specify a cross-sectional regression model with the firm’s beta as the dependent variable. The primary regression (run for the latest year in the sample, 2025, and also in panel form over years) is:

$$\beta_i = \alpha + \gamma(\text{GaaS Ratio}_i) + \delta(\text{Debt/Equity}_i) + \varepsilon_i$$

The coefficient γ on GaaS Ratio captures the association between reliance on recurring revenue and market risk. A negative γ would support our hypothesis that more GaaS means lower beta. We include the Debt/Equity (DE) ratio to control for leverage effects (higher leverage often implies higher beta due to debt’s fixed claims). Given the relatively small sample size (22 firms), this regression is mainly cross-sectional; however, we also ran panel regressions with firm fixed-effects to verify that within-firm increases in GaaS share correlate with declining beta over time.

In addition to the beta analysis, we conduct a simple examination of valuation implications. If GaaS truly lowers risk, one might expect higher valuations (e.g., price-to-earnings multiples) for firms with more GaaS, ceteris paribus. On the other hand, if investors are pricing in policy risk, that could mute valuation gains. To explore this, we run a secondary regression with the firm’s P/E ratio (price-to-earnings) as the dependent variable, against beta and GaaS ratio. This helps us see whether the market rewards lower beta (via higher P/E) and whether GaaS has a direct effect on valuation multiples when controlling for beta. Due to data availability (some firms had negative earnings in certain years, making P/E not meaningful), this analysis covers 17 observations.

Table 3. Descriptive Statistics for Sample Firms (2015–2025).

Variable	Mean	Median	Std. Dev.	Min	Max
Annual Beta(β)	0.866	0.844	0.312	0.379	1.521
GaaS Ratio (Rec. Rev %)	0.601	0.640	0.156	0.279	0.790
Debt/Equity Ratio	0.322	0.240	0.407	0.000	1.920
Market Cap (USD billions)	24.468	23.600	13.662	2.500	53.600

¹ n = 22 firms. “Annual Beta” is the equity beta computed from weekly returns against the market index for a given year. GaaS Ratio is the proportion of revenue from digital recurring sources (microtransactions, subscriptions, DLC, etc.). Debt/Equity is total debt divided by book equity. Market Cap is firm value in billions USD.

4.2. Identification of Industry & Platform Shocks (Event Residual Analysis)

While regression analysis captures broad trends, it may not fully reflect the tail risks and sudden shocks that GaaS-oriented firms face. To complement the regression results, we perform an event-driven residual analysis focusing on three notable shock events in our 2015–2025 window. We use daily stock return data for two GaaS leaders – Electronic Arts (EA) and Take-Two Interactive (TTWO) – and a market model to compute expected returns. Residuals (actual minus expected return) around the dates of interest indicate the market’s reaction unexplained by general market movements. We selected events that represent the types of non-market shocks GaaS firms are vulnerable to: a platform policy change, an industry-wide engagement shift, and a business model innovation surge. Below we detail each event and why it is illustrative:

- Engagement Mean-Reversion Shock – Post-Pandemic Drop (February 2022): The COVID-19 pandemic in 2020–2021 led to a surge in gaming engagement (a “stay-at-home” boom). By early 2022, as societies reopened, gaming usage and growth rates began normalizing (or even declining from peak levels). On February 1, 2022, both EA and TTWO issued conservative outlooks citing the expected post-pandemic engagement drop-off. Their stocks fell significantly that day (residuals: EA –2.43, TTWO –2.29). Notably, the very next day (Feb 2, 2022), EA’s stock rebounded +5.18% residual after clarifying that underlying demand remained healthy. This whipsaw volatility – a large decline and sharp recovery – suggests that GaaS-heavy stocks are behaving like proxies for digital engagement levels. Small swings or uncertainties in user engagement (active players, playtime, etc.) can translate into outsized stock moves, even if the broader market is stable. In other words, these stocks have become very sensitive to usage metrics, which are somewhat analogous to subscriber numbers for streaming services.
- Business Model Innovation Spike – Battle Royale Craze (March 2017): In early 2017, a new game genre “Battle Royale” (exemplified by PlayerUnknown’s Battlegrounds (PUBG) and later Fortnite) exploded in popularity, demonstrating the massive scalability of GaaS models (tens of millions of players generating recurring revenue). During the week of PUBG’s breakout (mid-late March 2017), gaming stocks like EA saw modest but consistently positive residuals (e.g., EA’s daily residual was +0.79 on March 24, 2017). While not as dramatic as the other events, this period featured a slow market re-rating of the sector as investors digested the implications of a wildly successful GaaS product. The positive residuals imply that the market updated its growth expectations for companies with strong live-service capabilities, reflecting an appreciation of the GaaS model’s scalability. Essentially, it was a repricing of the sector’s beta and growth prospects – although the effect was diffuse and gradual rather than a single-day jump.

By examining stock reactions in these scenarios, we gain qualitative evidence of how GaaS has changed the risk drivers for gaming firms. Traditional gaming companies would have been more influenced by holiday sales cycles or console adoption rates (broad market factors). GaaS firms, by contrast, are jolted by things like privacy policy updates, engagement trends, and viral game phenomena. In the empirical results section, we will connect these observations back to the regression findings, showing that lower market beta does not mean “safer” in an absolute sense – rather, the locus of risk has shifted.

5. Results

5.1. Descriptive Statistics

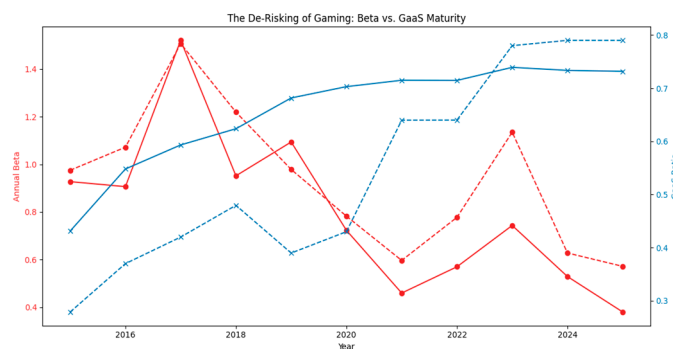


Figure 1. Evolution of Revenue Mix and Market Beta (2015–2025). This figure illustrates the inverse relationship between the percentage of revenue derived from Live Services (GaaS Ratio) and the firm’s systematic risk (Annual Beta).

Table 3 presents summary statistics for the main variables in our sample (mean values are averaged across firms, 2015–2025). These statistics illustrate the financial structure of the industry and provide initial hints of how GaaS adoption correlates with risk and valuation.

Several points are worth noting. The average equity beta is 0.866, below 1.0, indicating that on average these gaming stocks have been slightly less volatile than the overall market. The range of beta is quite wide (from 0.379 to 1.521), reflecting that some firms are very low-risk (perhaps those with diversified portfolios or a large base of recurring revenue), while others have betas well above 1 (likely smaller or more hit-driven companies). The mean GaaS Ratio is 0.601 (60.1%), confirming that over this period a majority of revenue for the average firm comes from recurring sources. Some firms in some years still had less than 30% GaaS (e.g., companies earlier in the transition or those with one-off hardware sales), whereas the most advanced GaaS adopters reached nearly 80% of revenue from recurring digital streams. The standard deviation of the GaaS ratio (0.156) shows considerable cross-firm variation in business model maturity.

Interestingly, the Debt/Equity ratios vary a lot (some firms have virtually no debt, while others have D/E around 1.9). Leverage in this sector is often a strategic choice – some large publishers carry no debt, funding development internally, whereas others have taken debt to finance acquisitions (e.g., mobile studios). Leverage can affect risk (highly levered firms typically have higher equity beta), so it is important we control for it in the regression.

Finally, the firms are moderately large (mean market cap ~\$24B), but with some much smaller (\$2.5B) and some larger (\$50B+). Firm size could intuitively correlate with lower beta (large firms more stable), though in this industry size also often means more GaaS (the biggest companies like Activision Blizzard, EA are also the ones with established live services).

These descriptive stats hint at a negative relationship between GaaS and beta: the highest-beta firms in our sample tended to be those with lower GaaS ratios (and vice versa). We next turn to formal regression analysis to confirm whether this relationship holds when controlling for other factors.

5.2. Main Results : The De-Risking Effect

Table 4 reports the results of the OLS regression testing the association between business model (GaaS) and systematic risk (beta). The dependent variable is the firm’s equity beta (for the year 2025), and the key independent variable is the GaaS Ratio. We include the Debt/Equity ratio as a control. The model fit is modest (Adjusted R^2 around 0.20) but statistically significant overall (F test $p \approx 0.047$).

Table 4. OLS Regression of Equity Beta on GaaS Ratio and Leverage (n = 22 firms, year = 2025).

Independent Variable	Coefficient	Std. Error	t-stat	p-value
Constant	1.4832	0.243	6.099	0.000
GaaS Ratio	-1.0045	0.412	-2.438	0.025
Debt/Equity Ratio	-0.0433	0.158	-0.274	0.787

¹ Note: Adjusted R² = 0.200. F-statistic = 3.620 (p = 0.0466). Dependent variable is annual equity beta.

Coefficients in bold are significant at the 5% level.

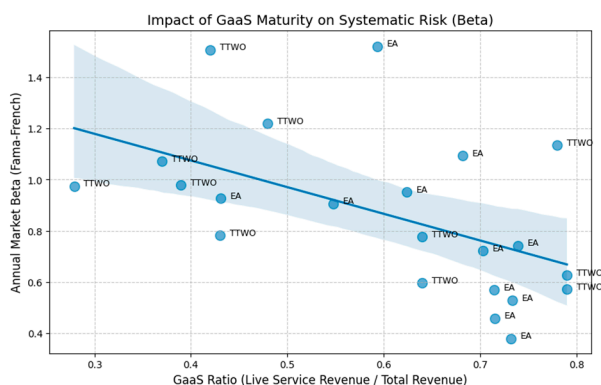


Figure 2. Regression of Systematic Risk on Business Model Maturity. The scatter plot displays the negative correlation between GaaS dependency and Market Beta, with the fitted regression line indicating that higher recurring revenue is associated with lower systematic risk.

The GaaS Ratio carries a coefficient of approximately -1.0045 , which is negative and statistically significant ($p = 0.025$). This magnitude suggests that a 1.0 (i.e., 100 percentage point) increase in the GaaS share of revenue would, on average, reduce a company's beta by about 1.00. In more practical terms, a 10 percentage point increase in GaaS revenue share is associated with a 0.10 decrease in beta. This is a material effect. For example, if a firm moves from 50% GaaS to 60% GaaS, we'd predict its beta to drop from, say, 1.0 to around 0.90, all else equal. This result is consistent with our de-risking hypothesis: greater reliance on recurring, service-based revenue does indeed coincide with lower exposure to market risk. The finding aligns with analogous evidence from other industries (e.g., the cloud computing transition in software) that shifting revenue models can alter risk profiles. It appears that investors perceive GaaS-heavy companies as safer in terms of systematic fluctuations – likely because their earnings are more predictable and less tied to the timing of new product releases or economic cycles.

By contrast, the Debt/Equity ratio is not significant (coefficient -0.0433 , $p = 0.787$). The sign is slightly negative, which is actually contrary to the typical expectation that higher leverage would increase beta. However, the effect is near zero and insignificant, suggesting that in this cross-section, leverage differences did not play a major role in explaining beta variation. One possible reason is that the range of leverage in our sample, while broad, might not align neatly with risk – for instance, some small Asian publishers with high beta had low debt, and some larger companies with moderate beta had moderate debt from acquisitions. In any case, controlling for D/E does not diminish the GaaS effect, indicating the GaaS Ratio's relationship with beta is robust and not an artifact of leverage or size.

In summary, the regression confirms a statistically significant de-risking effect: firms that have embraced the GaaS model more fully tend to have substantially lower systematic risk (equity beta). This provides evidence for the first part of the “financial transformation” – a move towards recurring revenue can indeed alter a firm's risk profile in the eyes of the market, presumably through the channel of more stable cash flows.

5.3. Valuation Implications: Beta, GaaS, and P/E Multiples

We next explore whether and how this risk reduction translates into valuation differences. Table 5 presents a regression of firms' Price/Earnings (P/E) ratio on two main factors: their equity beta and their GaaS Ratio. The sample here is a subset ($n = 17$) where we have positive earnings and a meaningful P/E for the year 2025 (some firms with losses or extraordinary items were excluded).

Table 5. Regression of P/E Ratio on Beta and GaaS Ratio ($n = 17$, year = 2025).

Independent Variable	Coefficient	Std. Error	t-stat	p-value
Annual Beta	15.1406	15.611	0.970	0.349
GaaS Ratio	-7.8189	41.282	-0.189	0.852
Constant	28.2185	34.807	0.811	0.431

¹ Note: $R^2 = 0.117$ (unadjusted). Dependent variable is the company's P/E ratio (stock price divided by earnings per share) for 2025.

In this regression, neither independent variable is statistically significant at conventional levels. The coefficient on Beta is positive (+15.14) but with $p = 0.349$, indicating no clear relationship in this limited sample. Interestingly, the positive sign might seem counter-intuitive – one might expect lower beta (safer) stocks to command higher P/Es, not lower. However, recall that in growth industries, higher beta companies sometimes are those with higher growth expectations (investors bid up their prices despite risk). The positive coefficient could be picking up that dynamic: the few firms with high betas in our set might also be those with exciting growth prospects, hence somewhat higher P/Es, offsetting the usual risk-aversion effect. The GaaS Ratio has a negative coefficient (-7.82) but is essentially zero in significance ($p = 0.85$). This suggests that, once we control for risk (beta), having more GaaS isn't directly translating to a higher or lower P/E in a consistent way across this sample.

The lack of significance here should be interpreted with caution given the small sample and potential multicollinearity (beta and GaaS are correlated from the earlier result). The regression does not provide strong evidence that investors are explicitly assigning higher valuation multiples to GaaS-heavy firms after accounting for beta. It may be that much of the valuation effect of GaaS is indirect (through lowering beta and thus cost of equity). Another interpretation is that by 2025, the market generally expected all firms to be moving toward GaaS, so it may not have distinguished strongly on valuation based on GaaS share – instead, differences in P/E might be driven more by growth prospects, IP portfolios, or other idiosyncratic factors.

In qualitative terms, many GaaS-heavy companies traded at high earnings multiples during this period (for example, companies like Roblox or Unity, which are entirely service-based, had very high multiples despite sometimes negative earnings). But within our set of established publishers, the P/E differences were not stark enough to draw firm conclusions. It's possible that while GaaS reduced risk, investors also recognized the emerging fragility (policy/platform risks) and thus did not uniformly assign a premium to GaaS-heavy revenue in pricing. In other words, the stability benefits were balanced by the new uncertainties, leaving valuations roughly in line with traditional metrics like growth rates.

Overall, the valuation analysis suggests that lower risk (beta) does not automatically mean a higher valuation multiple in practice – likely because the market is also weighing other aspects (including perhaps those residual risks we have discussed). This foreshadows our discussion: the GaaS model gives with one hand (stability) but takes with the other (new sensitivities), and investors seem to be aware of both.

7. Discussion

The findings above provide empirical backing for what we term the "GaaS Paradox." On one side of the coin, the pivot to Games-as-a-Service has clearly insulated video game firms from broad

market swings. We observe industry betas that are, on average, below 1, and a significant negative relationship between recurring revenue share and market beta. In practical terms, a company like Electronic Arts today (with a high GaaS ratio from titles like FIFA Ultimate Team) has a markedly lower beta than it might have a decade ago when it relied on annual unit sales. This indicates that investors see these companies as more defensively positioned – their cash flows are steadier and less correlated with macroeconomic cycles or one-off product cycles. The reduction in systematic risk can have concrete benefits: a lower cost of equity capital, potentially higher debt capacity, and more stable valuations. It also aligns with trends in other sectors (enterprise software, media streaming) where the shift to subscription/recurring models has been celebrated for making revenue more predictable and businesses more resilient to economic downturns.

However, the other side of the coin is that GaaS models have effectively traded traditional market risk for heightened idiosyncratic and policy risk. The residual analyses and the historical events discussed illustrate that GaaS-heavy stocks have become extremely sensitive to what we might call engagement risk and regulatory risk. A clear example was the post-pandemic engagement reversion in early 2022: as soon as there were signs that people were spending less time and money on games compared to the lockdown period, the stock prices of GaaS-focused companies swooned, only to rebound when the panic appeared overdone. This kind of volatility around user engagement metrics** is reminiscent of how, say, social media or streaming video companies trade – their stock prices are proxy bets on user growth and retention. For game companies that have effectively become service providers, daily and monthly active users (DAU/MAU) and player spending per user are now leading indicators that can move the stock, above and beyond general economic news.

Similarly, the platform ecosystem risk manifested by Apple's IDFA policy change in 2021 underscores a vulnerability that didn't exist in the old model. A decade ago, if Apple changed an App Store policy, it might affect a small slice of a publisher's mobile game revenue; today, mobile and cross-platform distribution are central, and user acquisition costs can make or break earnings. The nearly 2-sigma drop in TTWO on that news was essentially the market saying: "this new rule permanently raises your marketing costs and lowers your future revenues." Such a shock is largely uncorrelated with the market (Apple's decision was not driven by broad economic forces) – it's a pure idiosyncratic shock hitting these stocks.

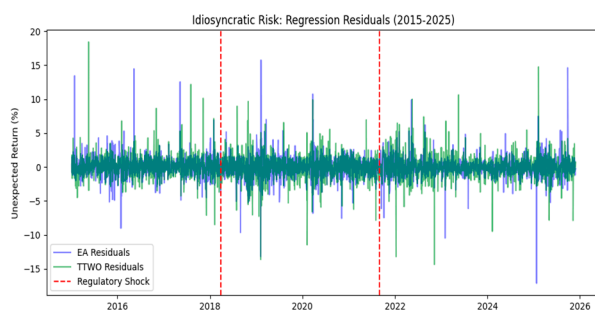


Figure 3. Analysis of Idiosyncratic Risk and Regulatory Shocks. The plot displays the residuals from the market model, highlighting periods of abnormal volatility coinciding with major regulatory events such as the 2018 Loot Box bans and 2021 China gaming restrictions.

The regulatory risk is perhaps the most distinctive aspect of the GaaS era's fragility. When a government like Belgium or China takes action, it can abruptly neuter a revenue stream that GaaS companies have baked into their projections. The China 2021–2023 episodes are instructive. The 2021 under-18 gaming ban and time limits directly threatened the pipeline of new gamers and future spenders, something that would scarcely affect most industries. The draft regulations of 2023 went even further, attempting to constrain core monetization loops. The result – an almost instantaneous tens-of-billions loss in market cap – shows that investors now react to regulatory news in the gaming space with over-sized fear. In financial terms, gaming stocks started to exhibit behavior akin to a

regulated industry (like utilities or tobacco) when bad news hits: a sudden devaluation on the threat of regulation. Yet unlike utilities or tobacco, in good times they also traded on growth narratives. This combination can make for volatile swings.

We can interpret the above through the lens of our extended CAPM: the policy risk factor (β_p) has become highly relevant. GaaS-oriented firms likely have a non-trivial β_p , whereas in the past their β_p might have been effectively zero (when regulation was minimal and inconsequential). The market may be somewhat efficient in this regard – pricing in an expectation that, say, aggressive loot box monetization cannot infinitely scale because at some point regulators will cap it. Therefore, the stock might not rise too high even in boom times, knowing that a “valuation ceiling” exists in the form of potential regulation. This dynamic of an upside cap and a downside shock potential is what we refer to as policy-induced fragility.

From a broader perspective, our results and observations suggest a trade-off in modern video game finance:

- **Stability vs. Fragility:** Internally, cash flows are more stable quarter-to-quarter (reducing earnings surprises and volatility). Externally, the environment is more fragile, as firms are one legislative decision or platform policy change away from a hit to their business model.
- **Lower Market Beta, Higher Residual Variance:** We have quantitatively lower market betas (good for diversification), but higher residual variance not explained by market moves. That residual is where the idiosyncratic action lives – and for GaaS companies, that action is considerable.
- **Investor Base Shift:** These changes possibly also shift who invests in gaming stocks. Lower beta might attract more conservative investors or those seeking “tech-like” steady growth, but the lurking regulatory risk might keep away some risk-averse investors. Meanwhile, some hedge funds might treat these stocks as event-driven trades around regulation or product cycles, which can increase volatility around those events.

It is also instructive to compare the games industry’s trajectory with adjacent entertainment industries. For example, the film industry has not (yet) found a GaaS equivalent – each movie is still largely a one-shot revenue event (though sequels and franchises create a series). As a result, film studios remain hit-driven and, one could argue, have a higher exposure to general economic swings (people cut back on theater spending in recessions). But film and music also don’t face the same kind of regulatory intervention in their monetization – governments don’t dictate how movies can charge or limit how many hours someone can watch. Game companies, by making their product a quasi-service that engages people (especially youth) continuously, have invited a level of social governance that traditional entertainment escaped. This is analogous to how social media companies (free, service-based, engagement-driven) ended up in the crosshairs of regulators over data privacy and societal impact, whereas say book publishers did not.

For investors and analysts, the key implication is that evaluating game companies now requires a dual lens: one must assess both financial fundamentals (e.g., revenue composition, user metrics, IP portfolio) and regulatory exposure (e.g., how much of revenue comes from practices that are under scrutiny, what jurisdictions the firm is exposed to, how diversified their monetization is). Traditional measures like beta, which capture market risk, need to be supplemented with scenario analyses for regulatory events. One practical tool could be a “Regulatory Exposure Index” for each firm – for instance, something that scores how heavily a company relies on loot boxes, minors’ engagement, or single platform dependencies. This could guide adjustments to valuation models (like higher discount rates or lower terminal growth for firms with high scores).

For corporate strategists in the gaming industry, our findings underscore that the benefits of GaaS come with responsibilities and new strategic risks. It is no longer sufficient to manage game development and player acquisition; one must manage regulatory relationships and public perception. Firms that successfully navigate this paradox might be those that self-regulate and innovate in monetization in a consumer-friendly way. If a company can find models that provide recurring income without triggering the ire of players or politicians (for example, purely cosmetic microtransactions, or subscriptions that offer fair value), it can enjoy the lower beta benefits without

as much fragility. In contrast, those that push monetization to exploitative extremes may enjoy short-term gains but at the cost of long-term risk to their cash flows (as evidenced by the events in our timeline).

In conclusion, the video game industry's financial transformation mirrors changes seen in other sectors moving to subscription-like models, but it also highlights a unique aspect: when your revenue model starts to resemble a utility (continuous service), expect to be regulated like one. The paradox is that in making their revenues more continuous and dependable, game companies have made their fortunes more entwined with the whims of policymakers and platform owners. This complex risk-return profile is the new reality for Games-as-a-Service.

8. Conclusion and Implications

This study set out to examine how the shift to Games-as-a-Service has reshaped the risk and return profile of video game companies. The evidence confirms that the industry's financial architecture has indeed changed in fundamental ways. On the one hand, the move from one-off game sales to recurring revenue has lowered systematic risk – we found that companies with higher GaaS revenue reliance have significantly lower market betas, indicating that their stock prices are less sensitive to broad market fluctuations than in the past. This de-risking is a positive development: it suggests that game companies can achieve more stable and predictable earnings, which in theory should lower their cost of equity and potentially allow for higher sustainable leverage or investment, much like SaaS companies in enterprise software have benefited from recurring revenue models.

On the other hand, the GaaS era has introduced a new set of fragilities. We identified a kind of GaaS Paradox: even as market-based risk declines, exposure to policy and platform risks increases. Our analysis of specific shock events – like regulatory crackdowns and platform policy changes – demonstrated that GaaS-heavy stocks can experience abrupt, substantial swings unrelated to overall market movements. In essence, these companies have become vessels for policy sentiment and consumer engagement levels. A modern video game publisher's stock might remain steady during a broad market sell-off, yet plunge on the day a country announces a loot box ban or a tech giant tweaks an algorithm. This is a different risk paradigm than a decade ago.

The implications for investors are significant. Traditional financial metrics and models (CAPM betas, variance-covariance risk assessments) may not fully capture the risk of a GaaS-centric gaming portfolio. Investors should incorporate forward-looking assessments of regulatory exposure: for example, one could adjust discount rates upward or scenario-test revenue projections for potential regulatory outcomes. We suggest the development of a "Regulatory Exposure Index" that rates companies on factors such as percentage of revenue from loot boxes, share of audience that is under regulatory scrutiny (minors, etc.), and dependence on specific platforms (like what portion of revenue flows through iOS/Android subject to their rules). This index could inform required risk premiums or valuation haircuts. Indeed, the market's reactions in 2023 to China's draft rules – effectively erasing \$80-100 billion in value – indicate that such risks are far from hypothetical.

For corporate managers and strategists in the gaming industry, our findings highlight the importance of proactive risk management beyond the traditional scope. It will not suffice to simply enjoy the steady revenues of GaaS; companies must also manage the downside of policy fragility. This can be approached in several ways:

- **Diversification of Monetization:** Relying on a single controversial monetization method (e.g., loot boxes) for too large a share of revenue is dangerous. Firms should diversify their revenue streams – for instance, balancing microtransaction income with subscription revenue (as some publishers have introduced Game Pass-like subscription services), or ensuring a healthy mix of cosmetic vs. pay-to-win items. A more diversified monetization portfolio can reduce the impact if one element is regulated or boycotted.
- **Geographical Diversification:** The timeline showed that policies can vary drastically by country. Companies heavily exposed to one region's rules (e.g., China) took a beating when those rules changed. Ensuring a balanced global revenue spread can mitigate the impact of any one

regulator's actions. Of course, this is easier said than done, as the largest markets (China, US, EU) are hard to replace – but regional tailoring of game versions (as many companies do) can at least contain the spillover.

- **Engagement Management:** Since GaaS firms are now valued partly on engagement metrics, managing those metrics becomes vital. This means not only growing user bases, but maintaining goodwill and avoiding sudden engagement drops. Community management and avoiding public relations disasters (like the aforementioned *Battlefront II* loot box fiasco) are actually risk management exercises for stock stability.
- **Self-Regulation and ESG Alignment:** Perhaps most importantly, game companies need to recognize that long-term survival of the GaaS model may depend on preemptive self-regulation and alignment with consumer protection principles. Implementing measures such as transparent loot box odds (even before being forced), spending caps for younger players, or robust parental controls could reduce the likelihood of draconian government measures. There is evidence that regulators are willing to hold off if the industry shows meaningful self-policing. By embracing a more ethical design approach, companies can not only mitigate policy risk but also appeal to the growing cohort of ESG-conscious investors. In effect, a strategy of “doing well by doing good” may apply – the more a firm can demonstrate it is not exploiting its customers, the less risk of a regulatory shoe dropping (and perhaps the more support from loyal customers and investors it will have).

In closing, the Games-as-a-Service era has undeniably transformed the financial profile of gaming companies. The industry has achieved the dream of recurrent revenue and reduced its traditional cyclical nature, but not without cost. The new model comes with a valuation ceiling imposed by regulatory risk and a tighter leash held by platform partners. Game companies and their investors must now navigate this complex landscape where the biggest risks no longer come from the next console cycle or the success of one holiday's flagship title, but from boardrooms in Washington, Brussels, Beijing, and Cupertino. For academia and future research, this presents fascinating questions: How can we better quantify and hedge policy risk in entertainment industries? Will other sectors (perhaps metaverse platforms or VR services) face similar trade-offs as they seek recurring engagement? And can industries like gaming find equilibrium points of monetization that satisfy growth objectives without inviting prohibitive regulation?

Our study provides a foundation by quantifying the initial risk effects of the GaaS transformation and highlighting the paradox that has emerged. The clear message is that financial innovation and product innovation must be accompanied by governance innovation. As gaming companies continue to evolve, their ability to thrive will hinge on not just designing compelling experiences, but doing so in a way that sustains a long-term, mutually beneficial relationship with players, regulators, and platforms. In the Games-as-a-Service world, managing that ecosystem of stakeholders is as critical to success as managing the bottom line – and indeed, the two have become inextricably linked

Abbreviations

The following abbreviations are used in this manuscript:

ADF	Augmented Dickey-Fuller
CAPM	Capital Asset Pricing Model
CC BY	Creative Commons Attribution
DAU	Daily Active Users
DE	Debt/Equity (ratio)
DLC	Downloadable Content
EA	Electronic Arts
ESG	Environmental, Social, and Governance
EU	European Union
GaaS	Games-as-a-Service

GDPR	General Data Protection Regulation
HML	High Minus Low (the Fama-French factor for value)
IDFA	Identifier for Advertisers (associated with Apple's privacy policy)
IP	Intellectual Property
MAU	Monthly Active Users
NPPA	National Press and Publication Administration (China's regulatory body)
OLS	Ordinary Least Squares (regression estimation method)
P/E	Price-to-earnings
SaaS	Software-as-a-Service
SMB	Small Minus Big (the Fama-French factor for size)
TTWO	Take-Two Interactive

Appendix A

Appendix A.1

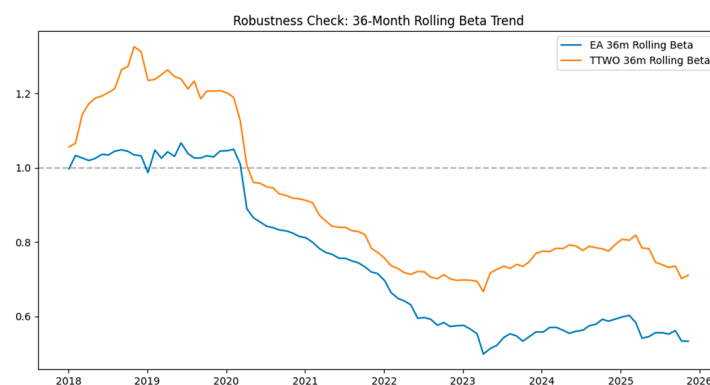


Figure A1. 36-Month Rolling Beta Estimations. To account for short-term market volatility, betas were recalculated using a 36-month rolling window, confirming the long-term trend of declining systematic risk.

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