Modeling and Analyzing R&D Strategy of Takeda Pharmaceutical Company

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Abstract:

Since the COVID-19 pandemic, rising public interest in health and well-being has increased expectations for the creation of innovative pharmaceuticals. At the same time, the environment surrounding pharmaceutical companies' research and development activities has become increasingly challenging. In this study, we examine Takeda Pharmaceutical Company, a global pharmaceutical firm, and conduct a feedback loop analysis. Through this analysis, we identify the relative dominance of reinforcing and balancing loops across different periods. Based on these findings, this study provides a perspective on how managers can incorporate feedback loop structures into strategic decision-making.

1. Introduction

A pharmaceutical company depends on investment in research and development as a critical foundation for its survival and growth. Therefore, pharmaceutical companies must expand their internal pipelines (product candidates) both qualitatively and quantitatively while considering their financial strategies. Achieving this objective requires a logical understanding of the interrelationship between financial strategy and R&D strategy and the ability to make timely and appropriate decisions. This study develops a model that incorporates the interrelationship between financial strategy and R&D strategy, thereby contributing to more informed managerial decision-making.

The Global Risks Report 2026 published annually by the World Economic Forum (WEF) identifies inequality as a severe global risk and highlights its close association with a decline in health and well-being. In recent years, expectations for innovation in areas such as oncology and neuroscience have increased, particularly following the development and global deployment of mRNA vaccines during the COVID-19 crisis **[1]**. Pharmaceutical companies constitute one of the key actors driving such innovation.

The pharmaceutical industry contributes directly to the Sustainable Development Goal of "Good Health and Well-being." In 2022, the industry generated approximately USD 2.3 trillion globally and employed about 75 million people, thereby making a significant contribution to the global economy **[2]**. At the same time, the environment surrounding pharmaceutical companies has become increasingly complex due to multiple factors, including accelerating technological innovation, tightening regulations, intensifying

competition, and rising R&D costs. To sustain continuous innovation, managers in pharmaceutical companies must analyze situations in which numerous factors interact in complex ways and formulate and implement appropriate strategies.

System Dynamics (SD) enables the analysis of situations in which multiple factors interact in complex ways. Rodrigues et al. [3] identify four key characteristics of SD: (1) the "endogenous point of view", (2) scenario analysis: navigating uncertainty, (3) interdisciplinary collaboration, and (4) supporting policymakers with decision support tools. In particular, SD models composed of feedback loops facilitate scientifically informed decision-making.

SD also demonstrates strong effectiveness in the study of corporate strategy. Gary et al. [4] explain that SD can make unique and important contributions to strategy research in four particular areas: (1) laboratory experiments of individual and team decision making, (2) bootstrapping decision rules using numerical data from the field, (3) variation in resource accumulation and implementation strategies, and (4) dynamics of competitive rivalry. In particular, research on decision rules and on the relationships between resources and strategy plays an important role in enhancing the effectiveness of strategic actions.

SD also contributes to the formulation of corporate strategy. Morecroft et al. [5] report that the process of developing an SD model with the participation of a startup's management team revealed strategic issues that the executives had not previously recognized and contributed to the development of the firm's growth strategy.

SD also enables the evaluation of strategic alternatives. Łatuszyńska and Borawska [6] note that SD models can comprehensively analyze a variety of business strategy options and evaluate their economic and technological impacts on firms. SD translates causal relationships observed in the real world into feedback loop structures and incorporates time delays, thereby enabling the reproduction of realistic system behavior.

Finally, SD models support the overall execution of business strategy. Lyneis [7] states that details, calibrated system dynamics models offer an effective tool for supporting the business strategy. Lyneis proposes a four-stage approach consisting of: (1) business structure analysis, (2) the development of a small insight-based model, (3) the development of detailed, calibrated models, and (4) on-going strategic management system and organizational learning. This approach resembles the clinical development programs of pharmaceutical companies and enhances the reliability and validity of SD models.

As described above, SD enables the study and analysis of situations in which numerous elements interact in complex ways and supports the formulation and execution of strategy. As global society and business environments become increasingly complex and the role of SD expands, more researchers and practitioners are expected to adopt SD in their work. Therefore, it becomes important to establish an environment in which researchers and practitioners with a basic understanding of SD can develop SD models with minimal difficulty.

2. Methods

This study examines Takeda Pharmaceutical Company (hereafter, Takeda) as a representative pharmaceutical firm. This chapter first provides an overview of Takeda and then describes the development of the SD model for the firm.

Takeda, founded more than 240 years ago, operates as a global pharmaceutical company. In 2015, the company appointed its first non-Japanese president (a French national), which accelerated its globalization efforts. Currently, the company employs approximately 50,000 people worldwide and generated sales exceeding 4.5 trillion yen in fiscal year 2024. Its business portfolio encompasses six key areas: gastrointestinal diseases, rare diseases, plasma-derived therapies, oncology, vaccines, and neuroscience. In fiscal year 2018, the company acquired Ireland-based Shire plc for approximately 6.8 trillion yen. This transaction remains the largest acquisition by a Japanese company as of 2026 (Nikkei, 2018/5/18).

Pharmaceutical companies experience sharp declines in sales after key products lose patent protection and face generic competition. Takeda follows this pattern. In fiscal year 2009, the company faced the global patent expiration of several blockbuster products, which led to a significant sales decline. For pharmaceutical companies, sustained investment in research and development remains crucial for achieving long-term growth.

This study selects Takeda for analysis because it exemplifies how the firm can rapidly transform its organization while implementing R&D investments in an environment where the global positioning of pharmaceutical companies has become critically important—and how it connects these investments to tangible results. Such insights offer valuable guidance to managers who navigate corporate strategy with constant awareness of global risks. The author served at the company for over 30 years in roles spanning sales, strategic planning, development strategy, product strategy, investor relations, and sustainability, thereby acquiring a multifaceted perspective for analyzing the firm.

The following sections describe the development of the SD model for Takeda. This study constructs the SD model sequentially through the stages of conceptualization followed by formulation. The data used for this analysis rely exclusively on publicly available company disclosures and information from industry publications.

2.1. Conceptualization

Conceptualization constitutes the initial process in SD model development. Randers **[8, p. 118]** defines conceptualization as a stage "establishes the focus of the study—the general perspective and time horizon. The critical decisions are made on what part of reality to study and how to describe it." This study defines conceptualization as "the process by which modelers simplify and clarify the ideas or aspects of the world they seek to represent." Specifically, this process involves articulating problems from complex situations and articulation basic model specifications. This study divides conceptualization into four processes: problem articulation, establishment of the purpose of the SD model, development of the reference mode,

and development of the dynamic hypothesis —and describes them below

2.1.1. Problem articulation

This study defines a problem as "a behavior observed in the system that deviates from expectations and requires resolution" (an event).

Problem articulation constitutes the first and most critical process in conceptualization. Sterman **[9, p. 89]** states that "the most important step in modeling is problem articulation." This study previously presented the Problem Articulation Process (PAP), a method for clarifying problems, at ISDC 2025 **[10]**.

PAP draws inspiration from Chain of Thought (CoT) **[11]**, a technique that promotes consistent intermediate reasoning. PAP targets participants in group model building (GMB), members of specific projects, and large language models (LLMs). LLMs substitute for the selective information-processing capabilities possessed by expert SD modelers.

This study employs an LLM to rapidly articulate the problem for Takeda. To verify the stability of the outputs, this study conducts PAP ten times, reviews all results, integrates five outputs that reference key themes (debt from M&A, pipeline enhancement, and pursuit of financial soundness), and articulates the problem as follows:

- Achieving both the qualitative and quantitative expansion of the pipeline and the maintenance of financial soundness under the burden of debt.

2.1.2. Establishment of the purpose of the SD model

Building on the problem articulated in the previous section, this study establishes the purpose of the SD model (hereafter, the purpose). This study defines the purpose as "what the SD modeler intends to accomplish in addressing the problem (intention)."

The purpose holds critical importance. Forrester **[12, p. 137]**states that "In constructing a useful dynamic model of corporate behavior it is essential to have clearly in mind the purposes of the model."

Richardson and Pugh **[13, p. 18]** also explain that establishing the purpose "act as critically important filters, screening out unnecessary details and centering the modeler's attention on the significant aspects of feedback system." The following section develops the purpose based on the problem for Takeda articulated in Section 2.1.1.

- This study aims to understand how Takeda's management achieved qualitative and quantitative expansion of the R&D pipeline—and thereby increased sales and profits—following the 2009 patent cliff of major global products, through the 2011 acquisition of Nycomed (approximately 1.11 trillion yen) and the 2018 acquisition of Shire, and how the company can further expand its pipeline and elevate sales and profits over the next five years starting from fiscal year 2024.

2.1.3. Development of the reference mode

Building on the purpose established in the previous section, this study develops the reference mode. This study defines the reference mode as "one or more patterns over time (which may include future projections) for variables that capture the essence of the problem and support the purpose of model development."

The reference mode holds critical importance. Randers **[8, p. 122]** notes that "The identification and description of a reference mode greatly facilitate the selection of the basic causal structure of the model." Sterman **[9, p. 90]**states that "the reference mode (so-called because you refer back to them throughout the modeling process) help you and your clients break out of the short-term event-oriented worldview so many people have." From these insights, the reference mode plays a key role in determining the model's causal structure and maintaining a medium- to long-term perspective for SD model developers.

To develop the reference mode, this study first identifies "variables that capture the essence of the problem and support the purpose of model development" (hereafter, variables). After considering the problem articulated and purpose established, this study extracts the following five variable candidates: (1) R&D expenses, (2) debt, (3) operating cash flow, (4) debt /EBITDA ratio, and (5) number of compounds in Phase III clinical trials. Upon further evaluation in light of the model purpose, this study selects "R&D expenses" from the perspective of clearly depicting the behavior of qualitative and quantitative pipeline expansion (Figure 1).

Following Saeed **[14]**, who notes that "the time horizon reference mode depends on the purpose of the model," this study sets the time horizon from 2009—the year of the patent cliff for major product—through the latest financial disclosure (fiscal year 2024) and five years into the future, to 2029. Note that R&D expenses for 2025–2029 derive from the 6.3% CAGR observed in 2009–2024 R&D expenses.

Ford **[15]** explains that "a border enclosing the parts of system structure needed to generate the behavior of interest." This study defines the boundary as "the scope that encompasses sufficient feedback structures to reproduce the reference mode." Mashayekhi **[16]**notes that "It is during this process that the boundary of the model is modified." Consequently, models risk becoming endlessly complex by incorporating ever more elements. To address this, Sterman **[9, p. 97]** proposes creating "excluded." Accordingly, this study recognizes excluded such as non-R&D expenses within Takeda and external factors to Takeda (e.g., market share, competitors' sales) and thereby establishes a provisional boundary.

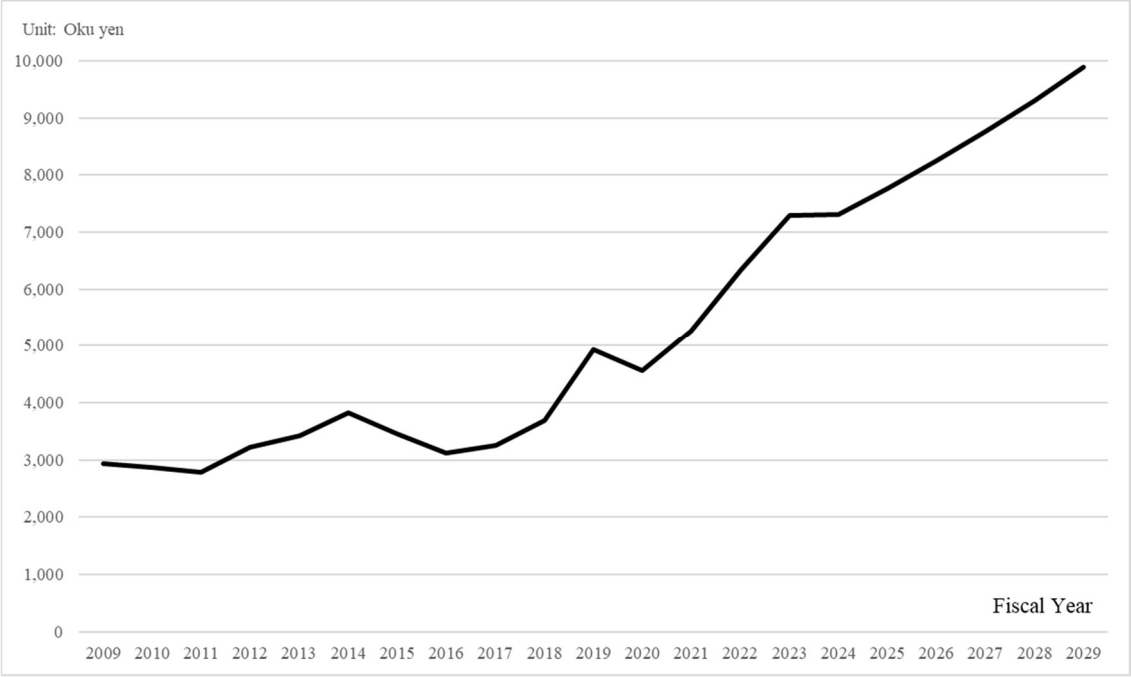

Figure 1: Reference mode of Takeda Pharmaceutical Company

2.1.4. Development of the dynamic hypothesis

Building on the reference mode established in the previous section, this study develops the dynamic hypothesis. Dynamic hypothesis formulation represents the final stage of conceptualization. This study defines the dynamic hypothesis as the visualized feedback loop structures that the modeler hypothesizes as generating the behavior in the reference mode.

The dynamic hypothesis holds critical importance. It enables hypothesis testing and explicitly identifies the endogenous feedback structures that produce the problem behavior. Although SD founder Forrester does not use the term “dynamic hypothesis,” he emphasizes “As the first step, the relevant system must be described and hypothesis(theory) generated for how the system is creating the troubling behavior” **[17]**

The following section outlines the process for developing Takeda's dynamic hypothesis and the subsequent steps after its creation.

(Dynamic Hypothesis Development Stage)

1). This study confirms that Takeda's dynamic hypothesis excludes the excluded variables identified in Section 2.1.3.

2). The dynamic hypothesis consists of one reinforcing feedback loop (R loop) and one balancing feedback loop (B loop). This study sets three variables for the R loop and five for the B loop.

3). This study incorporates “R&D expenses,” “interest-bearing debt,” and “Debt/EBITDA ratio” from the variables identified in Section 2.1.3. Additionally, to represent “qualitative and quantitative pipeline expansion” mentioned in the model purpose, this study includes “total Phase 3 (P3) value.”

4). This study designates “pressure to cut expenses” as the intervention point.

(Post-Dynamic Hypothesis Development)

5). This study verbalizes the hypothesis as follows. The R loop functions as the “driver of R&D activities.” Investing in R&D expenses not only advances in-house product development but also intensifies licensing and M&A activities. Acquiring more P3 assets externally increases total P3 value, which—after a delay—influences outcomes to elevate both sales and R&D expenses. Conversely, the B loop functions as the “controller of R&D activities.” Rising R&D expenses reduce operating profit and EBITDA. In the context of increasing Debt from M&A, Debt/EBITDA ratio rises, heightens pressure to cut R&D expenses, and prompts management actions to reduce R&D spending.

(1). Feasibility of achieving the model purpose: Achievable. This study can examine R&D investment and qualitative/quantitative pipeline expansion before and after major acquisitions from the perspectives of P3, total P3 value, and R&D expenses.

(2). Ability to explain the reference mode: Explainable. Despite the influence of the B loop (controller), the R loop (driver) exerts stronger dominance, resulting in the upward trajectory observed in the reference mode.

(3). Consistency of information links (causal direction and polarity): Consistent. Both R and B loops maintain uniform causal directions and polarities.

(4). Time unit determination: The time unit adopts “year.” The rationale stems from the annual cycle of R&D budgeting and execution.

6). This study identifies the following candidates for stocks and flows.

Stock: “Total P3 value” (from the perspective of accumulation).

Flow: “P3 value” (inflow/outflow to the above stock).

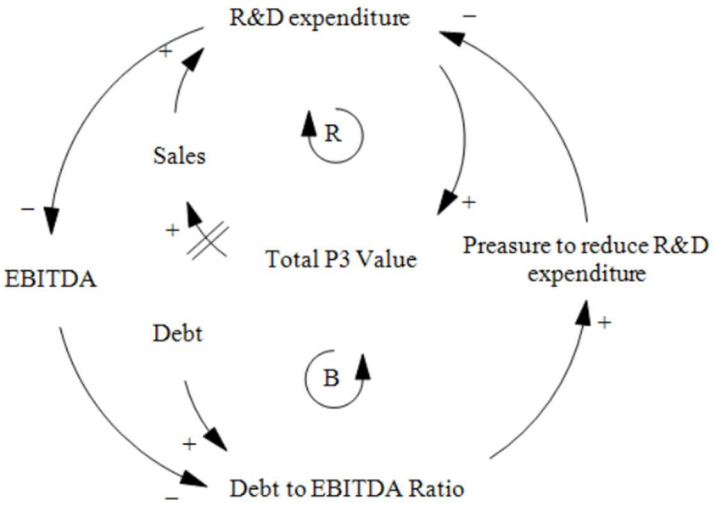

Figure 2: Dynamic hypothesis of Takeda Pharmaceutical Company

2.2. Formulation

This study develops Takeda model based on the dynamic hypothesis. The following section describes the concept of pipeline quality and quantity and explains the structure of the Takeda model (see Supplementals). The model is implemented using Vensim PLE Plus 10.4.

2.2.1. Concept of Pipeline Quality and Quantity

A pipeline refers to drug candidates under development that are in the clinical trial stage. Pharmaceutical clinical development consists of Phase I trials (assessment of safety, pharmacokinetics, and pharmacodynamics), Phase II trials (assessment of efficacy, safety, and dosage), and Phase III trials (confirmation of efficacy and safety in a large patient population).

This study focuses on development projects in Phase III (Phase 3; hereafter P3) when examining pipeline quality and quantity. A development project reaching P3 indicates that sufficient information on clinical efficacy and safety has accumulated and that the firm makes a strategic decision to undertake the large-scale investment required for P3.

Based on this reasoning, this study defines pipeline quality as the "number of P3 projects" (i.e., how many P3 projects Takeda holds). In contrast, this study defines pipeline quantity as the "total P3 value," which represents the sum of the projected peak sales of each P3 project. This study collects the value of each P3 project from company disclosures, industry articles, and expert commentary. This study uses Japanese yen (JPY) as the unit of value.

2.2.2. Structure of the Takeda Model

The Takeda model consists of reinforcing (R) loops and balancing (B) loops. In the R loop, this study defines two stocks - "total P3 value" and "value under regulatory review" - based on the accumulation characteristics of the process. Investment in R&D activates R&D activities, increases the number of P3 projects, and accumulates the total value of these projects as the stock "total P3 value." P3 requires an average of 37 months to complete. After this period, Takeda submits the drug to regulatory authorities, and the application undergoes a nine-month review process. Once approval is granted, Takeda launches the product as a new drug.

This study defines "sales" as the sum of "sales from new products" and "sales from existing products." Sales incorporate the impact of the Shire acquisition starting in FY2019 (although the acquisition occurs in FY2018, this study assumes that the full impact begins in FY2019). This study calculates R&D expenditure by multiplying sales by the R&D expenditure ratio. R&D expenditure also incorporates the impact of the Shire acquisition starting in FY2019.

In the B loop, this study defines "recognized debt–to–EBITDA ratio" as a stock because it represents a level variable. An increase in R&D expenditure reduces operating profit and consequently reduces EBITDA.

As EBITDA declines, the debt–to–EBITDA ratio increases. This increase strengthens the pressure to reduce R&D expenditure and therefore pushes the R&D expenditure ratio downward.

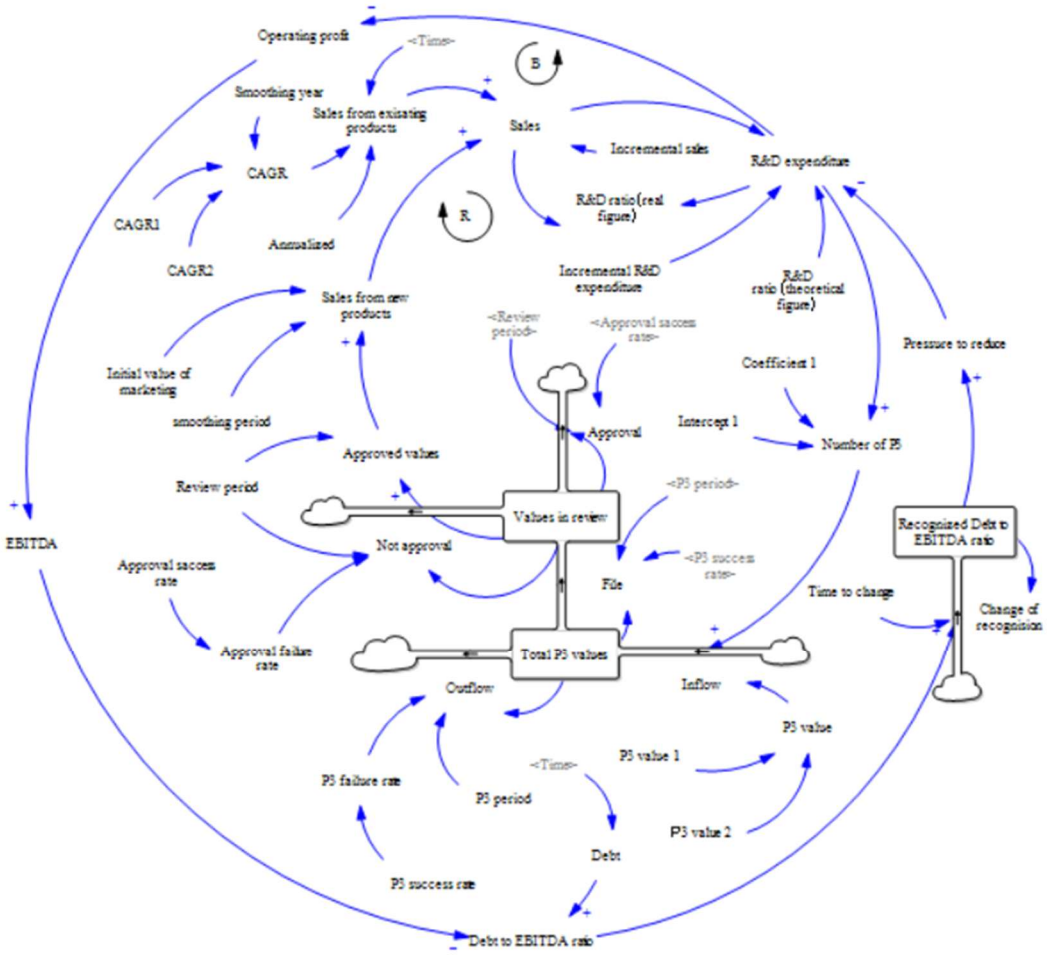

Figure 3: Takeda model

3. Results

This study conducts a simulation of R&D expenditure in the Takeda model (FY2009–FY2029) and presents a comparison with the reference mode (Figure 4).

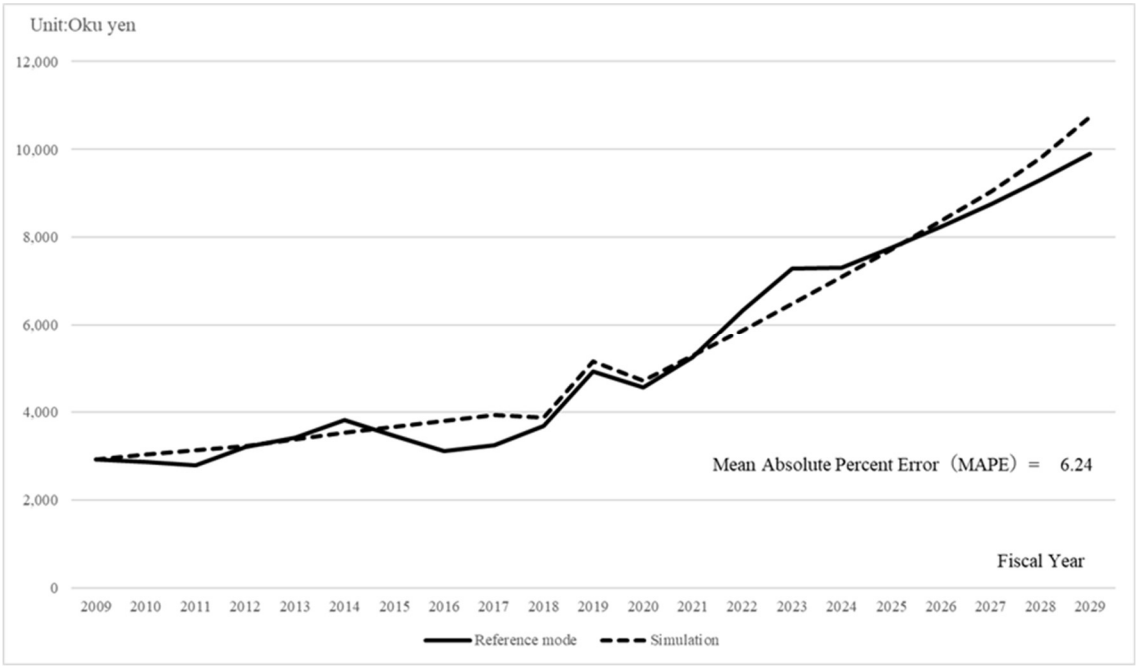

Figure 4: Comparison between behavior of simulation results and reference mode

This study next conducts a Behavior Reproduction Test **[18]** to examine the extent to which the behavior generated by the model is consistent with the observed behavior in the real world. Sterman **[9, p. 875]** introduces six tests for behavior reproduction. Among these, this study applies the Mean Absolute Percent Error (MAPE). The result shows that MAPE equals 6.24% (Figure 4). The simulation results are consistent with the pattern of the reference mode and support the dynamic hypothesis.

This study further analyzes whether the causal structure of the Takeda model operates as intended. In this analysis, this study changes the R&D expenditure used in the reference mode to extremely small and extremely large values and then examines the number of P3 projects (pipeline quality) and the total P3 value (pipeline quantity) in 2029.

The expectation is that when R&D expenditure becomes extremely small, both values fall to less than half of the normal case, whereas when R&D expenditure becomes extremely large, both values increase to unrealistically high levels. This study calculates the number of P3 projects using the equation coefficient* R&D expenditure plus constant. When R&D expenditure equals zero, the number of P3 projects becomes 11 (only the constant term remains) compared with the normal case, and the total P3 value decreases to approximately half. In contrast, when R&D expenditure increases to 100 times the normal level, both the number of P3 projects and the total P3 value rise to unrealistically large levels (Table 1).

These results confirm that the causal structure of the Takeda model is consistent with the intended design.

Table 1: Causal relation confirmation in 2029

	Number of P3	Total P3 values（Oku yen）
Normal case: R&D expenditure x 1	24	78,507
Abnormal case:R&D expenditure x 0	11	40,134
Abnormal case: R&D expenditure x 100	＞1, 000	>100,000

4. Discussion

This study analyzes which influence predominates—the drivers of R&D activities (R loops) or the controllers (B loops)—by examining the entire model across the period before and after the Shire acquisition (including future years). Loop analysis methods include Loop Dominance **[19]**, Pathway Participation Method **[20]**, Loop Impact **[21]**, and Loops That Matter **[22]**. Given the purpose of this study, Loops That Matter represents the optimal approach.

At the same time, this study prioritizes a method that researchers and practitioners with a certain knowledge and experience in SD can easily understand and implement. Therefore, this study applies a relatively simple custom method inspired by Loop Dominance. Specifically, this study compares the trajectory of R&D expenditure under R loops alone, B loops alone, and the standard case where both R and B loops operate simultaneously. This study then judges loop dominance and compares the results with those from Loops That Matter conducted afterward.

This study sets the full analysis period from FY2009 to FY2029 and divides it into three periods: Period 1 (pre-Shire acquisition: FY2009–FY2017), Period 2 (post-Shire acquisition to present: FY2018–FY2024), and Period 3 (five years ahead: FY2025–FY2029).

This study conducts simulations for three patterns: Case 1 activates only the R loop (deactivating the B loop), Case 2 activates only the B loop (deactivating the R loop), and the base case activates both R and B loops (Table 2). The base case yields the same values as the simulation results in Figure 4.

Table 2: Simulation Scenario

Case	Content	Method to Deactivate Loops
Case 1	Only R loop active (deactivate B loop)	Break the link from auxiliary variable "Pressure to Reduce" to auxiliary variable "R&D Expenses".
Case 2	Only B loop active (deactivate R loop)	Break the link from "Sales from New Products" to "Sales".
Base Case (BC)	Both R and B loops active (same as simulation results in Figure 4)	

This study examines the trajectory of R&D expenditure in Case 1, Case 2, and the base case (BC) (Figure 5). In Period 1, Case 2 demonstrates the strongest B-loop influence. In contrast, Period 2 reverses this pattern. The Shire acquisition strengthens the R-loop influence in Case 1. If Takeda continues its current R&D strategy, this study predicts that R-loop influence predominates in Period 3 as well.

In the Takeda model, this study constructs the R loop as the driver of R&D activities and the B loop as the controller. Therefore, the R loop consistently functions as a growth-accelerating loop, while the B loop functions as a growth-limiting loop.

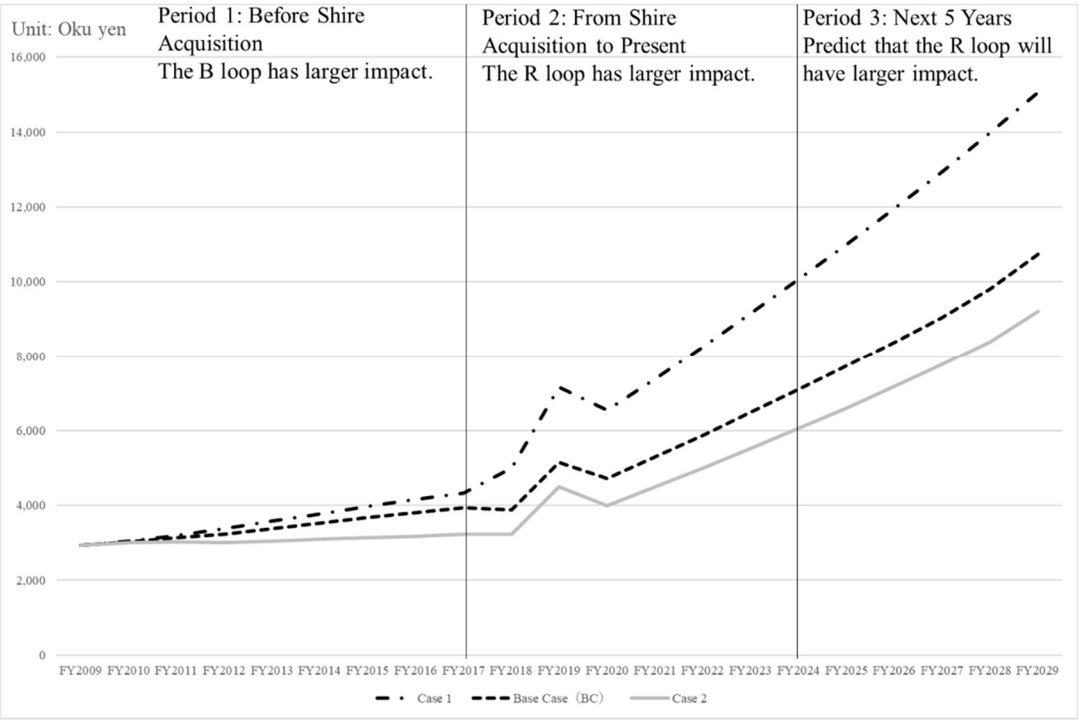

Figure 5: Comparison of R&D Expenses (Case 1, Case 2, Base Case)

This study next calculates the influence of each loop quantitatively. This study extracts the R&D expenditure values from Case 1, Case 2, and the base case for each year and computes the R-loop influence (1) and B-loop influence (2) using the following equations (Appendix A), which it then graphs (Figure 6).

This study computes the R-loop and B-loop influences using the relatively simple approach of the absolute difference in R&D expenditure values.

Equation (1) for R-loop influence uses, in the numerator, the absolute difference between R&D expenditure in Case 1 and the base case (BC), and, in the denominator, the sum of the absolute difference between Case 1 and BC and the absolute difference between Case 2 and BC. This approach calculates the relative influence of the R loop as a proportion of the total influence, which sums the influences of the R

loop (Case 1) and B loop (Case 2).

Equation (2) for B-loop influence uses, in the numerator, the absolute difference between R&D expenditure in Case 2 and BC, and, in the denominator, the sum of the absolute difference between Case 1 and BC and the absolute difference between Case 2 and BC. This approach calculates the relative influence of the B loop as a proportion of the total influence, which sums the influences of the R loop (Case 1) and B loop (Case 2).

$$\textbf{R loop influence} = \frac{|\text{Case 1's R\&D expenses} - \text{BC's R\&D expenses}|}{|\text{Case 1's R\&D expenses} - \text{BC's R\&D expenses}| + |\text{Case 2's R\&D expenses} - \text{BC's R\&D expenses}|} \quad (1)$$

$$\textbf{B loop influence} = \frac{|\text{Case 2's R\&D expenses} - \text{BC's R\&D expenses}|}{|\text{Case 1's R\&D expenses} - \text{BC's R\&D expenses}| + |\text{Case 2's R\&D expenses} - \text{BC's R\&D expenses}|} \quad (2)$$

The above simplified method for calculating loop influence is possible only due to the specific structure of this study's model and cannot be applied generally.

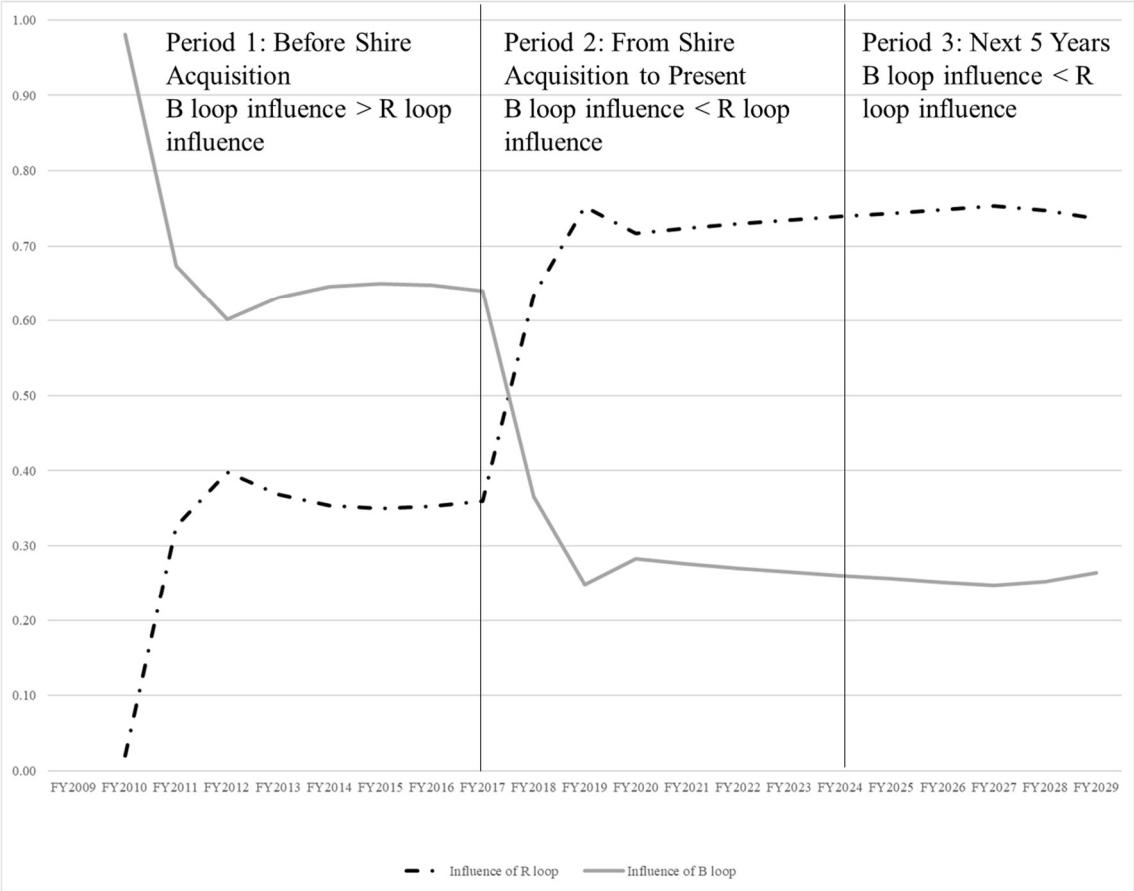

Figure 6: Changes in the Influence of Reinforcing (R) Loops and Balancing (B) Loops

The graph reveals that Period 1 shows B-loop dominance, whereas Periods 2 and 3 show R-loop

dominance. This study also conducts simulations using Loops That Matter (LTM) on the same model and confirms the same tendency.

The following section analyzes the loop influence by period, pipeline quality (number of P3 projects), and pipeline quantity (total P3 value). For loop analysis, this study evaluates data starting from FY2010. This study starts from FY2010 because all cases—Case R, Case B, and the base case—use identical initial R&D expenditure values in FY2009. In contrast, this study analyzes the number of P3 projects and total P3 value starting from FY2009.

Period 1 Analysis (FY2010–FY2017; Pre-Shire Acquisition)

In FY2010–FY2017, the controller B loop exerts greater influence than the driver R loop. B-loop influence starts at 0.98 (FY2010), temporarily falls to 0.67 (FY2011) and 0.60 (FY2012), but then gradually rises to 0.64 (FY2017) alongside increasing debt (average: 0.68). This study infers that the high value of 0.98 in FY2010 stems from the FY2008 M&A activity immediately before Period 1, which leaves a strong residual effect of the B loop as Takeda focuses on controlling R&D activities amid heightened awareness of debt.

In contrast, R-loop influence rises from 0.02 (FY2010) to 0.40 (FY2012) but then declines gradually to 0.36 (FY2017) (average: 0.32).

This trajectory of loop influences suggests that R&D activities remain restrained during this period. In reality, Period 1 sees a series of negative events: successive patent expirations of major products, large-scale litigation, and the termination of a promising major P3 project. Takeda conducts four aggressive M&As during this time, causing interest-bearing debt to surge from 3.3 billion JPY (FY2009) to 985.7 billion JPY (FY2017).

Pipeline quality shows a slight increase in the number of P3 projects, from 14 (FY2009) to 15 (FY2017). Pipeline quantity expands 3.6-fold, from 1.03 trillion JPY (FY2009) to 3.7 trillion JPY (FY2017). The disproportionately large growth in P3 value relative to the number of projects reflects the acquisition of P3s with high projected peak sales. In FY2015 of Period 1, a new CEO (French national) assumes office and initiates a strategic shift in R&D activities.

Period 2 Analysis (FY2018–FY2024; Post-Shire Acquisition to Present)

The driver R loop overwhelmingly dominates the controller B loop in R&D activities. R-loop influence rises from 0.63 (FY2018) to 0.74 (FY2024) (average: 0.72). In contrast, B-loop influence declines from 0.37 (FY2018) to 0.26 (FY2024) (average: 0.28).

This shift stems from the FY2018 Shire acquisition. Takeda focuses R&D activities on the pipeline acquired through the Shire acquisition, which rapidly activates the R loop. At the same time, debt surges to 5.8 trillion JPY, driving the B loop. This study infers that the B loop's activation precisely constrains R&D expenditure to the base-case level.

In reality, the post-Shire acquisition period brings access to rare disease and plasma fractionation domains, which refresh the pipeline and invigorate R&D activities. During Period 2, the number of P3 projects increases 27% from 15 (FY2018) to 19 (FY2024). Total P3 value grows 67% from 3.8 trillion JPY (FY2018) to 6.3 trillion JPY (FY2024).

Period 3 Analysis (FY2025–FY2029; Next Five Years)

This period represents the prediction horizon. Absent major strategic changes from the current approach, this study predicts that R-loop dominance continues but plateaus. R-loop influence rises slightly from 0.74 (FY2025) to 0.75 and then settles at 0.74 (FY2029) (average: 0.75). In parallel, B-loop influence declines slightly from 0.26 (FY2025) to 0.25 and then settles at 0.26 (FY2029) (average: 0.25). By FY2029, R-loop influence shows a slight year-over-year decline, while B-loop influence shows a slight increase.

The Period 3 reference mode consists of predicted values. This study therefore treats the resulting R-loop and B-loop influence analysis with caution, as it lacks real-world validation. At present, Takeda discloses the establishment of a new department (Strategy & Portfolio Development) effective April 2026, which will influence R&D activities (Takeda press release, January 29, 2026). Takeda also plans a CEO transition to a new U.S. national in June 2026. The new CEO's views on R&D strategy remain unclear at this time. However, given multiple major products facing patent expiration by 2029, Takeda may pursue countermeasures such as M&A.

For Period 3, the number of P3 projects is projected to increase 18% from 20 (FY2025) to 24 (FY2029). Total P3 value is projected to increase 18% from 6.6 trillion JPY (FY2025) to 7.9 trillion JPY (FY2029).

The preceding analysis presents the results from the Takeda model. The analysis confirms the following patterns:

- FY2009–FY2017: B-loop influence predominates. The number of P3 projects (pipeline quality) increases slightly from 14 to 15, while total P3 value (pipeline quantity) expands 3.6-fold from 1.03 trillion JPY (FY2009) to 3.7 trillion JPY (FY2017).
- FY2018–FY2024: R-loop influence predominates. The number of P3 projects rises 27% from 15 to 19, and total P3 value grows 67% from 3.8 trillion JPY to 6.3 trillion JPY.
- FY2025–FY2029: R-loop influence continues to predominate (predicted). The number of P3 projects rises 18% from 20 to 24, and total P3 value increases 18% from 6.6 trillion JPY to 7.9 trillion JPY (predicted).

These tendencies align with the results from Loops That Matter, which confirms the validity of this study's method. The analysis provides executives with a perspective to discern which feedback loops Takeda has emphasized by period and which loops it should prioritize going forward.

5. Conclusion

This study develops an SD model of the relationship between R&D expenditure and debt in pharmaceutical firms. The analysis adopts a relatively simple loop analysis method and examines which feedback loops become dominant over time. The results show a pattern similar to that identified by Loop That Matter.

The contribution of this study lies in two aspects. First, this study develops a model that incorporates the interaction between R&D strategy and financial strategy. Second, by applying a relatively simple SD analysis method, this study provides a perspective that encourages managers to focus on feedback loops when making strategic decisions.

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Appendix A

Unit : Oku yen	Case 1	Case 2	Base Case（BC）	Difference Case1 and BC	Difference case 2 and BC	Sum	Influence of R loop	Average	Influence of B loop	Average
FY2009	2,932	2,932	2,932	0	0	0				
FY2010	3,033	3,002	3,033	1	31	32	0.02		0.98	
FY2011	3,192	3,021	3,136	56	115	171	0.33		0.67	
FY2012	3,377	3,013	3,232	145	219	365	0.40		0.60	
FY2013	3,574	3,050	3,381	193	331	524	0.37		0.63	
FY2014	3,772	3,092	3,532	241	440	680	0.35		0.65	
FY2015	3,967	3,135	3,676	291	541	832	0.35		0.65	
FY2016	4,155	3,179	3,811	344	632	976	0.35		0.65	
FY2017	4,335	3,224	3,936	400	712	1,112	0.36	0.32	0.64	0.68
FY2018	5,009	3,226	3,878	1,131	652	1,783	0.63		0.37	
FY2019	7,159	4,489	5,151	2,009	662	2,671	0.75		0.25	
FY2020	6,554	3,995	4,719	1,834	725	2,559	0.72		0.28	
FY2021	7,393	4,494	5,293	2,100	799	2,899	0.72		0.28	
FY2022	8,262	5,004	5,884	2,378	880	3,258	0.73		0.27	
FY2023	9,151	5,525	6,487	2,664	962	3,626	0.73		0.27	
FY2024	10,060	6,059	7,102	2,959	1,043	4,002	0.74	0.72	0.26	0.28
FY2025	10,992	6,608	7,731	3,261	1,123	4,384	0.744		0.26	
FY2026	11,951	7,176	8,378	3,573	1,202	4,775	0.748		0.25	
FY2027	12,944	7,768	9,047	3,896	1,279	5,175	0.753		0.25	
FY2028	13,976	8,388	9,800	4,175	1,413	5,588	0.747		0.25	
FY2029	15,055	9,205	10,748	4,307	1,543	5,849	0.736	0.75	0.26	0.25