A SIMULATION MODEL OF PHARMACEUTICAL RESEARCH, DEVELOPMENT AND PRODUCT LIFE CYCLES

by

BRYCE MICHAEL QUAYLE

Bachelor of Political Economy
The Johns Hopkins University
(1987)

Submitted to the Alfred P. Sloan School of Management
in Partial Fulfillment of
the Requirements for the Degree of
Master of Science in Management

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June 1994

Signature of Author _____
MIT Sloan School of Management
May 13, 1994

Certified by _____
Professor Stewart C. Myers
Gordon Y. Billard Professor of Finance
Thesis Supervisor

Accepted by _____
Jeffery A. Barks
Associate Dean, Master's and Bachelor's Programs

A SIMULATION MODEL OF PHARMACEUTICAL RESEARCH, DEVELOPMENT AND PRODUCT LIFE CYCLES

by

BRYCE MICHAEL QUAYLE

Submitted to the Alfred P. Sloan School of Management
on May 13, 1994, in partial fulfillment of
the requirements for the Degree of
Master of Science in Management

ABSTRACT

This thesis consists of a "User's Guide" and a "Reference Manual" for a model designed to simulate the processes of pharmaceutical research, development and sales. The model itself is intended to be a simplified representation of these processes in which users can input specific values for various parameters and/or assumptions used in the different stages throughout the model. The model is not intended to be a completely accurate depiction of the exact process by which a drug is discovered or designed and eventually brought to market, but rather a simplified representation of the process that allows users to study the effects of changes in factors both endogenous and exogenous to the model.

The model was built as part of the first stage of the research project on "Risk and Return in Pharmaceutical R&D" being conducted through the MIT Program on the Pharmaceutical Industry. The overall project seeks to investigate the risk, profitability and cost of capital for investment in pharmaceutical R&D, building on the work done in several studies published previously. More specifically, the project will examine the varying cost of capital at specific stages throughout the R&D process and the product life cycle. In contrast to prior studies, however, this model is not intended to be used in research entirely based on historical data, but rather as a platform for running monte carlo simulations in an attempt to understand and predict the impact of changes in parameters specified in the model or of the adoption of new or different policies that affect the healthcare industry.

The User's Guide describes the model's installation procedures and the basic functionality of the model from the user's perspective. The Reference Manual provides a detailed description of the parameters included in the model and a complete overview of the model's structure. The thesis concludes with a summary of the planned uses for the model and the next steps in the aforementioned research project. Also discussed are potential applications for the model in studying the effects on pharmaceutical R&D of changes in the healthcare industry or of the adoption of various regulatory policies.

Thesis Supervisor: Professor Stewart C. Myers
Title: Gordon Y. Billard Professor of Finance

Acknowledgments

I would like to thank Professor Stewart C. Myers for the opportunity to work on this project and for his guidance throughout.

I would also like to thank Jerry Lumer for his help in designing and testing the model, and for his work in reviewing the existing literature on the topic of pharmaceutical costs and returns.

Table of Contents

Introduction

The following paper consists of a "User's Guide" and a "Reference Manual" for a model designed to simulate the processes of pharmaceutical research, development and sales. The model itself is intended to be a simplified representation of these processes in which users can input specific values for various parameters and/or assumptions used in the different stages throughout the model. The model is not intended to be a completely accurate depiction of the exact process by which a drug is discovered or designed and eventually brought to market, but rather a simplified representation of the process that allows users to study the effects of changes in factors both endogenous and exogenous to the model.

The model was built as part of the first stage of the research project on "Risk and Return in Pharmaceutical R&D" being conducted through the MIT Program on the Pharmaceutical Industry. The overall project seeks to investigate the risk, profitability and cost of capital for investment in pharmaceutical R&D.[1] Several studies on the costs of pharmaceutical R&D have been published to date. This project intends to build on that work by studying some specific issues, particularly with regard to the varying cost of capital at specific stages throughout the R&D process and the product life cycle.

A portion of the structure of the model is largely based on the work done by DiMasi, Hansen, et al (1991), Grabowski and Vernon (1990 and 1993), and by the U.S. Congressional Office of Technology Assessment (1993). Particularly, the actual structure of the R&D process and many of the base case assumptions are drawn from these studies. In contrast to these studies, however, this model is not intended to be used in research entirely based on historical data, but rather as a platform for running monte carlo simulations in an attempt to understand and predict the impact of changes in parameters

[1] "Risk and Return in Pharmaceutical R&D," Research Project Description, Massachusetts Institute of Technology Program on the Pharmaceutical Industry, November 1993.

specified in the model or of the adoption of new or different policies that affect the healthcare industry.

Specifically, the model will be used as a part of the research project to:

- "analyze how risk and investors' required returns change over the product life cycle;
- analyze the errors and biases in alternative accounting measures of pharmaceutical company profitability, and to develop improved measures that could be calculated from publicly available financial data; and
- make predictions of the risks of pharmaceutical and biotech stocks."[2]

The model is composed of six components, as depicted on the conceptual diagram on the following page. On the diagram, the circles represent the components with which users interact and the boxes represent the components that do not require user interaction. The arrows represent the flow of information among the components.

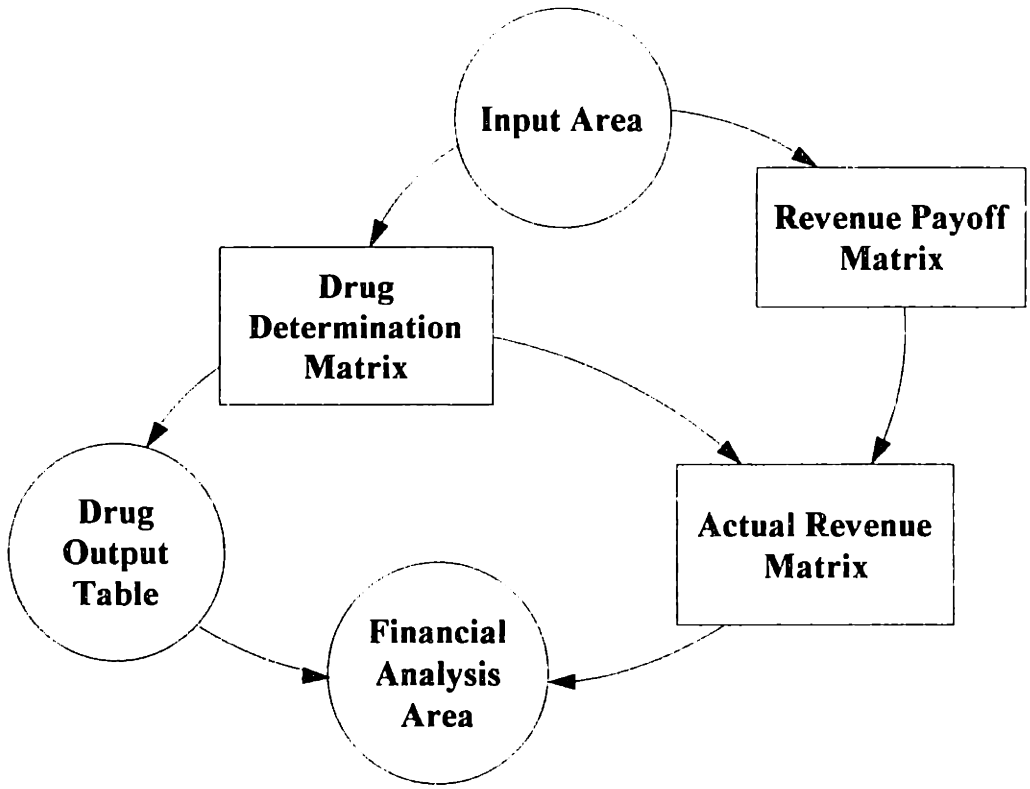
Briefly, the model functions as follows:

- Users enter their own assumptions of the values of various parameters used in the model, e.g., success rates for the various R&D stages, product revenue paths, costs incurred in the different stages, etc. This information is entered into the Input Area and the Drug Output Table.
- These assumptions flow into the Drug Determination Matrix where the paths that drugs follow from their inception throughout their useful lives are determined. The assumptions related to revenue flow into the Revenue Payoff Matrix where the revenue is calculated for all possible permutations of drugs that the model allows.
- Information flows from the Drug Determination Matrix and the Revenue Payoff Matrix to the Actual Revenue Matrix where the revenues generated in each iteration of the model are calculated.

---

[2]"Risk and Return in Pharmaceutical R&D," Research Project Description, Massachusetts Institute of Technology Program on the Pharmaceutical Industry, November 1993.

- Information out of the Drug Determination Matrix also flows to the Drug Output Table in the form of the numbers of drugs in every stage in the process in each of the 40 years of model's time horizon.
- Finally, the Financial Analysis Area uses revenue information from the Actual Revenue Matrix and cost information from the Drug Output Table to compile a cash flow and an income statement. This section also contains user defined parameters that affect how the financial statements are prepared and some basic financial assumptions related to working capital, administrative costs, depreciation, etc.



User's Guide

Overview

The Pharmaceutical Simulation Model is a financial model of investment in a program of research and development. The model incorporates many assumptions regarding the pharmaceutical research, development and marketing processes and produces possible outcomes based on these assumptions. Users can input their own assumptions and run simulations to try to understand the behavior of the system under the parameters provided. Once the user has input her assumptions, she can then run repeated iterations of the model. Each iteration or trial will produce different results based on random draws that take place every time an iteration is calculated. Sets of these iterations can be run to generate samples of data to analyze in trying to ascertain the model's behavior under various different scenarios.

The model was built in spreadsheet format using Microsoft® Excel 4.0 for IBM-PC compatibles and consists of six main components: the Input Area, the Drug Output Table, the Financial Analysis Area, the Drug Determination Matrix, the Revenue Payoff Matrix, and the Actual Revenue Matrix. Using the model only requires interaction with the first three of these main components, while the other three components can be considered to be working "behind-the-scenes." All six of the components are described in full and complete detail in the Reference Manual and can be examined or changed by users should they see fit.

The model is set up so that users can enter their own assumptions of the many parameters used throughout the model and observe the behavior of the system under different scenarios. Users can enter assumptions in the three sections of the model mentioned above. Throughout these sections of the spreadsheet any cell that is set up as a user input cell is shaded green.

Once the user has changed the default assumptions or parameters, the model's output in the Drug Output Table and the Financial Analysis Area can be examined. A new iteration or "run" of the software is obtained each time the spreadsheet's "calculation" function is used, (via either the "F9" key or the menu item "Options > Calculation > "Calc Now" button). Further, it is intended that the model be used in monte carlo simulations in conjunction with simulation software designed for use with Microsoft Excel. Examples of such software include @Risk by Palisades and Crystal Ball by Descioneering.

Throughout the entire spreadsheet you will notice cells that have small, red squares or dots in their upper, right-hand corners. You can double-click on these cells with a mouse one at a time and a pop-up window will appear with some note of explanation as to the contents of that cell or a related operation.

In order to move from section to section of the spreadsheet, it may be easier to use Excel's "Go to" function rather than scrolling around with the cursor. Hit the "F5" key or click on the "Formula>Goto..." option from the menu and a window will appear with all of the range names that have been defined in the spreadsheet. Using the scrollbar if necessary, find the name of the area you wish to go to and double-click on it. All of the six main components of the spreadsheet are named and will, therefore, be listed in this window. Do not delete any of the range names that have been defined, as many of them are referenced in formulae throughout the spreadsheet.

Getting Started

System Requirements

- IBM compatible PC with a 386sx processor or higher
- Minimum of 4MB of RAM memory, preferably more
- A hard disk with at least 2 MB of free space
- A 3 1/2 inch disk drive for model installation
- Microsoft Excel 4.0 or higher

Note on Usage with Excel for the Macintosh. While the model should be able to function effectively in Excel for the Macintosh, to date there have been errors that appear to be largely cosmetic in nature. When the spreadsheet is opened on a Macintosh, a number of cells appear to contain random, garbage-type symbols, but the contents of their cells appears to be intact. It has not yet appeared that the functioning of the model is impaired in Excel for the Macintosh, however, for optimal performance it is recommended that the model be run on an IBM compatible personal computer. Further, the installation process described below may not work on a non-IBM type computer due to the need to decompress files in copying them from a floppy to hard disk.

Installing the Model

Since the model requires more storage capacity than a high density diskette, it has been necessary to compress the Excel spreadsheet containing the model, as well as the two accompanying documents, the User's Guide and the Reference Manual. The files have been compressed using PKZIP software that is also included on the diskette. In the course of the automatic installations described below, a c:\PHARMA directory will be created that will contain three files, the spreadsheet containing the model and the two document files. If your "a:" drive is not a 3 1/2 inch floppy disk drive or your "c:" drive is not your main hard drive, proceed to the manual installation instructions below.

To install from Windows:

- Insert the diskette in the "a:" drive. Click on the "File" pull down menu of the Program Manager and choose "Run." Type "a:\install" and hit enter.

To install from DOS:

- Get to the DOS prompt. In Windows this can be done either by exiting Windows altogether by choosing the "Exit Windows" option under the "File" pull down menu of the Program Manager, or by double-clicking on the DOS icon in the Main group of the Program Manager.

- Get to the prompt in the root directory, i.e., the "c:\>" prompt, by typing "cd \" and hitting enter. Type "a:\install". This assumes that the diskette is in the "a:" drive and that your root directory on your hard drive is the "c:" drive.

- To get back to Windows, type "exit" if you got to DOS via the DOS icon or type "win" if you got to DOS by closing Windows altogether.

Manual Installation:

- With the diskette in the floppy drive, at the DOS prompt (see above for how to get to the DOS prompt) type the following:

  [floppy drive letter]:\pkunzip pharma.zip [hard drive letter]:\[destination directory]\

Example:

Suppose that your 3 1/2 inch floppy drive is the "b:" drive and that your hard drive is drive "d:", and you want to put all the files in your Excel directory. At the "d:\>" prompt you would type:

b:\pkunzip pharma.zip d:\excel\

Setting Parameters or Assumptions

As mentioned above, any cell in the spreadsheet that is green is a designated input cell, meaning that its contents can be changed by the user. These input cells appear in three components of the model: the Input Area, the Drug Output Table, and the Financial Analysis Area. All of the model components are described in detail in the Reference Manual.

The Input Area (see Appendix A.) contains the assumptions that are the key drivers of the system's behavior. Users can enter information on the following:

- Scientific hurdle rates for each stage in the drug development process
- Economic hurdle rates for each stage in the drug development process
- Probabilities for each of the five drug quality categories
- Baseline revenues over the product life cycle of each of the drug quality categories
- Probabilities for drugs of each quality category that a competitive drug will enter the market in any of the five stages after the drug is approved
- Probabilities for drugs of each quality category that a new indication of the drug will be approved by the FDA in any of the five stages after the drug is approved
- The factor by which revenue is adjusted if a competitor enters
- The factor by which revenue is adjusted if a new indication is approved
- Product manufacturing costs as a percent of total sales
- Administrative costs as a percent of total sales

The Drug Output Table (see Appendix B.) contains the inputs for cost assumptions for each of the stages of drug R&D. For each stage, costs are divided into three categories: capital expenditures, research, and administrative. In all stages except basic research, the costs are on a per drug basis, i.e., total costs for a given stage in a given year are simply the number of drugs in that stage that year times the total costs per drug. The

costs for basic research are incurred each year regardless of the number of compounds under investigation or the number of compounds that are found. The three different categories were chosen to allow flexibility in analyzing results from the model. Capital expenditures are kept separate for accounting purposes, and research expenditures are kept separate to allow for the testing of different accounting treatments and/or policies.

The Financial Analysis Area (see Appendix C.) contains assumptions made in the reporting of the financial results. These inputs include:

- Initial setup costs of the research program
- The minimum level of corporate G&A
- The research program's initial asset base in dollars
- The average life of the assets
- Accumulated depreciation
- Whether or not to capitalize research expenditures
- The depreciable life of research expenditures, if chosen to be depreciable
- The tax rate
- Inventory as a percent of sales
- Accounts receivable as a percent of sales
- Accounts payable as a percent of sales
- Working capital carrying costs

Reference Manual

Overview

The Pharmaceutical Simulation Model functions as follows:

- The user enters information in the shaded, green cells of the spreadsheet and activates the "Calculation" or "calc" function of the spreadsheet. For example, see the shaded areas of Appendix A.

- When the "calc" function is activated, the computer generates new random numbers wherever specified in the spreadsheet.

- Based on the new random numbers, complete event paths are determined for each of the four possible drugs/compounds that can be discovered or synthesized each year. In the Drug Determination Matrix, the path for every drug from its inception in Basic Research through its last marketing/sales stage is determined for all of the drugs that could possibly arise over years 1 through 40. The events on these paths include: success or failure in each of the R&D stages, determination of the drug's quality category, approval for new indications of the drug, and the emergence of competitors to the drug.

- Based on the paths set forth in the Drug Determination Matrix, the Drug Output Table is filled in with the number of drugs in each stage and the corresponding costs that occur in each stage. In most of these stages the costs are determined simply by the number of drugs in a specific stage in a certain year, but the capital expenditures made for the construction of manufacturing facilities are determined by expected, future sales which are in turn determined by the drug's quality category.

- Also based on the paths set forth in the Drug Determination Matrix, the total revenues in each year are determined in the Revenue Lookup Matrix and the Actual Revenue Matrix and are summed up in the Financial Analysis Area.

- In the Financial Analysis Area, the aforementioned costs and revenues are used to prepare a cash flow statement and an income statement. In preparation of these statements various calculations are made that include schedules of depreciation and tax loss carry forwards and the option to capitalize research expenditures.

Detailed Description of the Model

Input Area

The Input Area (see Appendix A.) is the primary area for users to enter their own assumptions of the many parameters in the model. Areas are provided for users to enter the following:

Scientific hurdle rates for each stage in the drug development process. With the exception of the value for Basic Research, these numbers represent the probability that a drug will successfully complete a given stage and progress to the next stage. While the actual process in a pharmaceutical company for coming up with compounds that will enter the preclinical phase involves the screening of many thousands compounds, the model's treatment of Basic Research is a significant simplification of the actual process.

The hurdle rate for Basic Research represents the probability that a compound will be found that has a high chance of progressing through the preclinical tests. In the model in each year, there are four, independent chances or random draws to see if such a compound

is discovered in Basic Research. For example, if the Basic Research hurdle rate is set at 60%, then there are four random draws each with a 60% chance that a compound with a high chance of progressing through the preclinical tests will be found. This would lead to a 13% probability that four compounds are discovered (0.60^4) and a 2 1/2% chance that zero compounds are discovered (0.40^4).

The Basic Research stage has been designed in this fashion as a modeling simplification needed to make it feasible to track each drug through its entire path of events from discovery all the way through the time that it goes off patent.

Economic hurdle rates for each stage in the drug development process. The economic hurdle rates are similar to the scientific hurdle rates in that they are the probabilities that a drug will progress through the various stages successfully. However, the possible source of failure is not scientific risk, but rather unfavorable business or market conditions. That is, each number is the probability that the program would discontinue with the development of a particular drug for market-based reasons. Examples of such a reason could include the market potential for the drug being so small that the company would not achieve a positive return by incurring the development costs for the drug or that other companies are much further along in development of a drug for the same or a similar indication.

Probabilities for each of the five drug quality categories. After a drug has received FDA approval, it is placed in a drug quality category. A random number is drawn in the Drug Determination Matrix and based on the probability ranges for drug quality in the Input Area each drug is assigned a category. There are five possible categories: Dog, Below Average, Average, Above Average, and Blockbuster. The random number generated ranges evenly from greater than or equal to zero to less than one and the drug quality is determined by where the random number falls in the ranges set forth in the Input Area.

Users can vary the frequency of occurrence of each drug quality type by changing the determination ranges.

Baseline revenues over the product life cycle of each of the drug quality categories. Each drug quality category has a baseline revenue path over the course of its product life cycle that can be entered into a table in the Input Area. These numbers represent the annual revenues generated by a drug as it goes through each of the stages following FDA approval assuming that no additional indications are approved and that no competition enters the market.

Probabilities for drugs of each quality category that a competitive drug will enter the market during any of the five stages after the drug is approved. In each year of the five stages after a drug is approved, there exists some probability that another drug approved for the same indication enters the market having a negative impact on revenues. These probabilities vary from stage to stage and among drug quality categories, and are set forth in a table in the Input Area.

Probabilities for drugs of each quality category that a new indication of the drug will be approved by the FDA during any of the five stages after the drug is approved. In each year of the five stages after a drug is approved, there exists some probability that the drug is approved for an additional indication having a positive effect on revenues. These probabilities vary from stage to stage and among drug quality categories, and are set forth in a table in the Input Area.

The factors by which revenues are adjusted if a competitor enters or if a new indication is approved. When a competitor enters the market or when a new indication is approved the drug's baseline revenues determined by its quality category are multiplied by some factor.

The default values for the factors are 0.75 for a competitor and 1.25 for a new indication. Thus, if a drug were to have revenues of $100 million in a specific year, but one competitor entered the market and one new indication were approved, revenues would actually be 100 x .75 x 1.25 or 93.75. These factors are multiplicative so that if two competitors were to enter the market revenues would be multiplied by $(0.75)^2$, or three competitors would mean a factor of $(0.75)^3$, etc.

In each year after FDA approval, there is a possibility that one competitive drug could enter the market and that one new indication is approved. The number of competitors or new indications that can occur in each drug path is limited to three of each.

Product manufacturing costs as a percent of total sales. This number determines the manufacturing costs in the Financial Analysis Area as a simple percent of sales in each year.

Administrative costs as a percent of total sales. This number determines the program's administrative costs in the Financial Analysis Area as a simple percent of sales in each year. In the Financial Analysis Area, there is also an input cell for a minimum level of administrative costs in each year. This minimum is in place to account for the fact that the program incurs administrative costs whether or not revenues are present in any given year.

Drug Output Table

In the Output Table (see Appendix B.) users can observe drugs as they go through the various stages. In each stage both before and after approval the number of drugs in each stage in each year is specified. Also shown are the costs that are incurred in each stage that directly result from the presence of the drugs in that stage in any given year.

R&D Costs. The costs incurred prior to FDA approval are divided into three categories: research expense, capital expenditures, and administrative expenses. This categorization has been made to facilitate the preparation of the cash flow and income statements in the Financial Analysis Area, as well as to make the model useful for the analysis of the impact of different accounting rules and/or financial reporting procedures. The costs of Basic Research are considered to be spent each year regardless of the number of drugs or compounds that are discovered or synthesized in that year. The rationale is that the activities in this stage are conducted regardless of the actual success achieved in discovering or synthesizing compounds. In the next stage, Preclinical Testing, through Phase II, the costs incurred are simply driven by the number of drugs in each stage in each year. The annual costs per drug in each stage can be entered by users in the "Assumptions" column of the Drug Output Table.

For example, on pp. 39 in Appendix B. you can see that in year 6 there are 8 drugs in preclinical testing. In the Assumptions column the annual costs per drug are $4 million, so you can see that the total costs for preclinical testing in year 6 are $32 million and that the costs for year 7 in which there are 7 drugs in preclinical testing are $28 million.

Plant Manufacturing Costs. The capital expenditures in Phase III and Filing for Approval are primarily expenditures made in constructing manufacturing facilities for full scale production. The plant construction costs are considered to be proportional to the drug's product category and are spread evenly over the 4 years prior to FDA approval. The rationale is that companies do have some expectation as to the quality category of a drug. The total cost of manufacturing facilities will be on average 40% of the drug's expected sales in year 10. Half of these expenditures are made prior to launch and the other half is spread out evenly over the 10 years after launch. Since companies have an idea as to which category the drug will most likely in, it is assumed that they spend a total of 40% of the sales expected in the 10th year of the baseline revenue stream. Thus, these

calculations are made ignoring the possibilities of new indications or competition since these are factors that could not be foreseen by companies at this stage in the development process. This methodology was used in Grabowski and Vernon (1990), in contrast to the methodology in the OTA study which assumed flat costs of $25 million 1/3 in year -2, 1/3 in year -1 and 1/3 in year of launch.

Marketing Costs. The costs incurred after FDA approval fall into two categories: marketing and capital expenditures. The capital expenditures are those mentioned in the prior paragraph for manufacturing facilities during the 10 years after a drug is approved. The marketing costs for a specific drug vary directly with its sales. In the first year after FDA approval, the Launch stage, marketing costs are assumed to be equal to the revenues generated in that year. In the second year, marketing costs fall to 50% of revenues, and in each remaining year of the patent life marketing costs are equal to 25% of revenues. After the drug goes off patent, the marketing costs fall to 6.5% of annual revenues. This methodology is based on the methods used by Grabowski and Vernon (1990) and the OTA study (1993).

Financial Analysis Area

This section (see Appendix C.) of the model includes the following: a cash flow statement, an income statement, a depreciation and asset base schedule, a schedule that provides the option to capitalize research, a schedule of tax loss carry forwards, and a calculation of working capital in each year.

Several assumptions are made in this section that users have the option to change. The following are the user input items shaded in green in the spreadsheet:

Initial Setup Costs on the cash flow statement. This represents the cash outlay at the beginning of the research program for any one-time charges such as buildings, hiring expenses, etc.

Corporate G&A on the cash flow statement. This number is used as the minimum level of corporate general and administrative expenses in a given year. This is not the same as the administrative costs included in R&D stages prior to approval, but rather represents an allocation of corporate overhead for items such as corporate executives, the legal department, the finance department, etc. In the Input Area there is a variable for the administrative expenses as a percent of total sales. The Corporate G&A line in the cash flow statement reports the maximum of the corporate G&A number specified here and the dollar value of the percent of sales specified in the Input Area. A minimum is in place to account for those years in which there are zero or very small sales, since general and administrative costs would be incurred nonetheless.

Initial Asset Base on the depreciation schedule. This allows users to provide for the possibility that the program already has some assets in place at the program's inception. The value entered here is added to the capital expenditures made in year 1 to determine the value in year 1 shown on the Gross Fixed Assets line of the depreciation schedule.

Average Asset Life on the depreciation schedule. The number of years over which assets are depreciated. Straight line depreciation has been used in determining the depreciation expense for each year.

Accumulated Depreciation on the depreciation schedule. An initial value for accumulated depreciation can be specified to account for the portion of the Initial Asset Base that has

been depreciated already. This number should never be greater than the Initial Asset Base and should be set equal to zero if the Initial Asset base is equal to zero.

Option to Capitalize Research. A schedule is provided to allow for the capitalization and depreciation of research expenditures. If users wish to run scenarios in which research expenditures are capitalized rather than treated as normal expense items, a "1" should be placed in the green cell specified. The schedule for research has the same structure as the asset depreciation schedule and requires similar inputs with regard to the Initial Research Base, the Average Research Life over which the research expenditures will be depreciated, and an initial level for Accumulated Depreciation of research. When this option is selected, the Research Expense line in the Income Statement reports the "Research Depreciation Expense" calculated using straight line depreciation rather than the actual research expenditures made in a given year.

Tax Rate on the income statement. The tax rate to which the program is subjected can be specified to allow for differences in among different companies' effective tax rates. For example, a company's effective tax rate could vary depending on its state and local taxes, its use of Puerto Rican or other off shore facilities, etc. On the income statement there is a line for effective tax rate which simply shows the taxes paid by the program in a given year divided by its sales. This effective tax rate can fluctuate with the program's tax loss carry forward situation.

Inventories, Accounts Receivable and Accounts Payable as percents of sales. Working capital is calculated as Inventories plus Accounts Receivable minus Accounts Payable, each of which is determined as some percentage of revenues that is specified where indicated in the Financial Analysis Area.

Drug Determination Matrix

The Drug Determination Matrix can be thought of as the "workhorse" of the model. It is here that the path for every possible drug over the 40 year time horizon is determined. The matrix is made up of a repeated table that covers the entire life of a drug from discovery through off-patent sales. In each of the 40 years covered in the model, the Basic Research program has the possibility of discovering or synthesizing up to four compounds per year. These drugs then proceed through all of the successive stages dropping out when they fail to pass a hurdle rate. The entire process for the drugs discovered in the first year happens in the range with the defined name "Drug Path Module." Across the top of the Drug Determination Matrix are the calendar years that coincide with those at the top of the Drug Output Table. The years going down the left side of the matrix represent the years in which groups of drugs are beginning in Basic Research, e.g., the fifth Drug Path Module down is labeled with a "5" indicating the group of drugs that begin in Basic Research in year 5.

For example in year 1, four possible drugs can be discovered. In year 2 these drugs, if discovered, move from Basic Research to Preclinical Testing. While the year 1 group of drugs is in Preclinical Testing in calendar year 2, the year 2 group of drugs is just starting out in Basic Research. On the Determination Matrix you can see that the Drug Path Module for the year 1 group of drugs is copied one calendar year over and placed below the year 1 group to make up the Drug Path Module for the year 2 group of drugs. This replication is carried out for all 40 years, such that for each year's group of drugs starts out in Basic Research with the Basic Research column of the Drug Path Module lined up some distance below the corresponding calendar year indicated along the top of the Determination Matrix. A detailed explanation of each possible event along the path follows.

Basic Research: one year Four random numbers are generated, one for each possible drug. If the random number is less than the Basic Research scientific hurdle rate specified in the Input Area by the user, then a "1" is placed on the Drug line. If the random number is higher than the hurdle rate, then a "0" is placed on the line to represent the fact that no compound was discovered.

For example, see pp. 55 in Appendix D. In the printout of this particular iteration, in year 1 the four random numbers drawn are 0.76, 0.07, 0.84, and 0.42. Since the hurdle rate for success in this stage as entered in the Input Area is 60% or 0.60, a compound is discovered when the random number drawn is less than 0.60. See that Drugs are found and indicated by the number "1" for the random numbers 0.07 and 0.42, and that "0"s are placed after the random numbers 0.76 and 0.84.

Preclinical Testing: three years Any drug/compound that is discovered in Basic Research automatically moves on to Preclinical Testing where it stays for three years.

Phase I: one year Two random numbers are generated for each drug: one for the scientific hurdle and one for the economic hurdle. If both of these two numbers are below the two, respective hurdle rates specified for Preclinical Testing in the Input Area by the user, then a drug progresses into Phase I from Preclinical Testing.

In this stage and in successive stages the economic hurdle rate is included to provide the ability to test scenarios in which such a probability would vary. Currently, the default value of all of the economic hurdle rates is one, so that no drug can fail to progress to the next stage as a result of economic conditions. Varying economic conditions and subsequent probabilities of failure due to non-scientific reasons will be the subject of further study and can easily be incorporated into the model in the future by entering economic hurdle rates with values less than one into the Input Area.

Phase II: two years Again, two random numbers are generated for each drug: one for the scientific hurdle and one for the economic hurdle. If both of these two numbers are below the two, respective hurdle rates specified for Phase I in the Input Area by the user, then the drug progresses into Phase II from Phase I.

Phase III: three years Again, in the first column two random numbers are generated for each drug: one for the scientific hurdle and one for the economic hurdle. If both of these two numbers are below the two, respective hurdle rates specified for Phase II in the Input Area by the user, then the drug progresses into Phase III from Phase II. In the second column of Phase III, the two random draws take place to see if the drug successfully passes through Phase III to Filing for FDA Approval.

For example, again see pp. 55 in Appendix D. See in year 9 that Drug #2 which has been successful thus far drops out because its Random #1 which represents the scientific hurdle is a 0.89 while the scientific hurdle rate set forth for Phase III in the Input Area is 0.85. The Random #1 for Drug #4 is 0.07, so the drug succeeds in Phase III and proceeds to the Filing for FDA Approval stage.

Filing for FDA Approval: three years In the first column, again two random draws take place for the scientific and the economic hurdles and success is dictated by the these numbers being below the thresholds set forth in the Input Area. If both hurdles are passed successfully, a "1" will be on the Drug line which represents that the drug will be approved by the FDA at the end of the three year period.

In the third column of Filing for Approval, a random draw takes place to determine the drug's quality category. In this column, the "1" that has heretofore represented the existence of a drug in any stage is replaced with the drug's quality code. The codes for the drug quality categories of Dog, Below Average, Average, Above Average and Blockbuster are 1, 2, 3, 4, and 5, respectively.

Launch: one year Two random draws take place in the launch year: one to determine the FDA approval of a new indication of the drug and one to determine the entrance of a combative drug into the market. The probability that either of these events will occur varies by drug quality category and by stage of the product life cycle. The probabilities are input by users in two matrices in the Input Area. If the random numbers are below the respective thresholds set forth in the appropriate matrices, then the events occur. If a new indication for a drug is approved, then a "0.1" is added to the drug's quality code. If a competitive drug enters the market, then a "0.01" is added to the drug's quality code. For example, if a drug has been determined to be of average quality, then its code is a "3". If a new indication is approved for the drug or if a competitor enters the market, the drug's new code would be "3.10" or "3.01," respectively. If both events were to occur, then the drug's code would be "3.11."

Post Launch I, II, III, and IV: three years each In every year the two draws described under Launch take place and the possibility exists that the drug will either get approved for an additional indication, that it will face a new competitor, or both. There is one chance per year for each of these events to take place, and the number of times they can occur is limited to three. That is, one drug can be approved a maximum of three times for new indications and it can face a maximum of three competitors. As each event occurs the appropriate "0.1" or "0.01" is added to the drug code. Since each event can only occur three times the maximum levels for each drug code are 1.33, 2.33, etc., depending on the drug quality category. These codes allow the drug's characteristics to be carried with it throughout its path in the Drug Path Module. For example, a code of 5.13 always represents a drug that is a blockbuster with one new indication and three competitors.

Revenue Payoff Matrix

The Revenue Payoff Matrix is where the revenue for a given drug code in a given stage is determined. Along the top row of the matrix is each year in the product life cycle following FDA approval. Along the left side of the matrix is a listing of all possible combinations of drug quality categories, new indications and competitors. Each cell in the matrix shows the annual revenue for a drug based on its stage in the product life cycle, the drug quality category, the number of new indications and the number of competitive drugs.

The top row for each drug quality category references the revenue path matrix specified by the user in the Input Area. These are the baseline revenues for drugs when they have no new indications or competitors. Each row below is some multiple of the top, baseline row in its quality category, depending on the combination of new indications and competitors. The factors by which baseline revenues are multiplied are also entered by the user in the Input Area. The values in the cells of the Payoff Matrix are equal to the baseline revenue for a specific quality and product life cycle stage, multiplied by the new indications factor raised to an exponent equal to the number of new indications times the competition factor raised to an exponent equal to the number of competitors. In formula form, the value in each cell equals

$$\text{Cell Value} = (\text{baseline revenue}) * (\text{new indications adjustment factor})^{\text{number of new indications}} * (\text{competition adjustment factor})^{\text{number of competitors}}$$

For example, see pp. 59 in Appendix E. See that a Below Average Drug with no new indications and no competitors has a Path Code of 2.00. The values across the 2.00 line are equal to the revenue path for a Below Average Drug set forth in the Input Area. Also

notice that the Adjustment Factors at the top of the matrix are equal to those defined in the Input Area. To see how one cell is calculated, look at the revenue in Post Launch I, year iii for a Below Average Drug with 1 new indication and 0 competitors. The drug's path code is 2.10 and the baseline revenue for a Below Average Drug in that stage is 25.00. Since there is 1 new indication, the revenue for a 2.10 drug is equal to the baseline revenue times the adjustment factor of 1.25, or 31.25.

Actual Revenue Matrix

In the Actual Revenue Matrix (see Appendix F.), the drug codes from the Drug Determination Matrix are matched with the corresponding codes in the Revenue Payoff Matrix to determine the actual revenues generated by all existing drugs in each year. Each cell contains a formula that references the appropriate cell in Determination Matrix and then "looks up" that drug's revenue in a specific year in the Revenue Payoff Matrix based on the drug's code and in which stage of the product life cycle the drug is in. The total revenues are summed up by year at the bottom of the matrix.

Summary

Integrity of the Model. The structure of the model has been checked extensively through debugging processes, however, simulations may reveal the need to make further modifications.

Next Steps/Areas for Further Study. The next step in the use of the model on the Risk and Return in Pharmaceutical R&D research project is to test the set of default assumptions/parameters that has been compiled through a review of existing literature and through discussions with people from both academia and industry. These assumptions will be tested by determining the NPV of one drug based on the structure of the R&D process and the product life cycle as they are set forth in the model. Refinements will then be made to the base set of assumptions and/or the structure of the model to ensure that both the model itself and the base assumptions pass checks of reasonability. The model can then be used to calculate the cost of capital and associated risk at each stage of the R&D process and the product life cycle. Further, the model can then also be used to run monte carlo simulations to test the effects of alternative accounting treatments on the measurement of the profitability of investment in pharmaceutical R&D.

While these are the primary, intended uses for the model as a part of the aforementioned research project, other uses of the model could certainly be considered as topics for further study. Perhaps one of the most apparent, additional applications of the model would be to study the effect of pharmaceutical price regulations. Another related area of study would be to examine the impact of the prevalence of managed care in the country's healthcare system. For example, continued proliferation of managed care could cause the impact on prices of competitive, "me-too" drugs to be much more severe than it is today. The model could be used to examine profitability under various different scenarios in which managed care plays roles of varying significance.

Managed care could also have dramatic effects on the baseline revenue paths defined for each product category. As more pharmaceutical purchasing decisions are made based on the inclusion of drugs on the formularies of managed care organizations, the payoffs to getting on the right formulary could be much higher while the probability of actually being chosen for the formulary could be lower. Again, the effects of such developments could be studied with the model through running simulations of different possible scenarios.

Bibliography

Cockburn, Iain and Rebecca Henderson (1993), "Racing to Invest?: The Dynamics of Competition in Ethical Drug Discovery", mimeo, MIT Sloan School of Management, September 1993.

DiMasi, Joseph A., Ronald W. Hansen, Henry G. Grabowski, and Louis Lasagna (1991), "Cost of Innovation in the Pharmaceutical Industry", Journal of Heath Economics, Vol. 10, pp. 107-142.

DiMasi, Joseph A., Mark A. Seibring, and Louis Lasagna, (1994) "New Drug Development in the United States, 1963 to 1992", Center for the Study of Drug Development, Tufts University, 1994.

Grabowski, Henry G. and John M. Vernon (1991), "A New Look at the Returns and Risks to Pharmaceutical R&D", Management Science, Vol. 36, pp 804-821.

Grabowski, Henry G. and John M. Vernon (1993), "Returns to R&D on New Drug Indications in the 1980's", Working Paper, Duke University, September 1993.

U.S. Congress, Office of Technology Assessment (1993), "Pharmaceutical R&D: Cost, Risks and Rewards", OTA-H-522, Washington, DC: U.S. Government Printing Office, February 1993.

Appendix A. Input Area

Stage-by-Stage Success Probabilities

	Basic Research	Pre Clinical Testing	Phase I	Phase II	Phase III	Filing
Scientific Hurdle	60%	90%	80%	50%	85%	75%
Economic Hurdle	n/a	100%	100%	100%	100%	100%

Product Revenue Paths

	Probability Ranges		*Revenue per Year per Stage*				
	Lower Bound	Upper Bound	Launch	Post Launch I	Post Launch I	Post Launch I	Post Launch IV
Dog	0.00	0.20	3	10	15	25	15
Below average	0.21	0.45	12	25	30	65	40
Average	0.46	0.80	30	85	140	190	155
Above average	0.81	0.95	60	170	350	550	340
Blockbuster	0.96	1.00	85	375	1200	1400	775

Probabilities of Competitive Entry

==> Need to limit the # of total possible competitors to 2 or 3

		Revenue per Year per Stage				
			Post	Post	Post	Post
	Code	Launch	Launch I	Launch I	Launch I	Launch IV
Dog	1	5%	15%	1%	1%	1%
Below average	2	5%	15%	10%	1%	1%
Average	3	5%	20%	35%	50%	25%
Above average	4	10%	20%	40%	60%	40%
Blockbuster	5	10%	25%	40%	60%	40%

Effects

Assume that each competitor reduces revenue path by 25% and that the effects are muliplicative not additve with each additional competitor. That is, 1 = 25% reduction, 2 = 43.75% reduction, 3 = 57.8% reduction; or revenue = .75^n(original), n=# of comp's

The adjustment factor, now set at 25%, can be specified below.

Probabilities of New Indication Approvals

==> Need to put some limit on the # of total possible new ind's

		Revenue per Year per Stage				
	Code	Launch	Post Launch I	Post Launch I	Post Launch I	Post Launch IV
Dog	1	1%	15%	15%	1%	1%
Below average	2	1%	15%	25%	1%	1%
Average	3	1%	20%	40%	35%	10%
Above average	4	1%	20%	40%	35%	10%
Blockbuster	5	1%	15%	50%	40%	10%

Effects

Each additional indication increases the revenue path by 25%

The adjustment factor, now set at 25%, can be specified below.

Revenue Adjustment Factors:

Competition:	0.75
New Indication:	1.25

Explanation:

These factors are the revenue multipliers that determine the effects of new indications and the entry of competitors on a drugs revenue

Product Manufacturing Costs as a Percent of Sales: 10%

Administrative Costs as a Percent of Sales: 11.10%

Appendix B. Drug Output Table

Pharmaceutical Life Cycle Model

Version 3.0

			1	2	3	4	5
Basic Research	# of drugs in this stage	**Assumptions**	2	3	3	3	2
	Costs:						
	Research	6.5	6.5	6.5	6.5	6.5	6.5
	Capital Expenditu	3.0	3.0	3.0	3.0	3.0	3.0
	Administrative	2.5	2.5	2.5	2.5	2.5	2.5
	Total	12.0	12.0	12.0	12.0	12.0	12.0
Preclinical Testing	# of drugs in this stage		0	2	5	8	9
	Costs per Drug:						
	Research	2.0	0.0	4.0	10.0	16.0	18.0
	Capital Expenditu	1.0	0.0	2.0	5.0	8.0	9.0
	Administrative	1.0	0.0	2.0	5.0	8.0	9.0
	Total Costs	4.0	0.0	8.0	20.0	32.0	36.0
Phase I	# of drugs in this stage		0	0	0	0	2
	Costs per Drug:						
	Research	2.0	0.0	0.0	0.0	0.0	4.0
	Capital Expenditu	0.5	0.0	0.0	0.0	0.0	1.0
	Administrative	0.5	0.0	0.0	0.0	0.0	1.0
	Total Costs	3.0	0.0	0.0	0.0	0.0	6.0
Phase II	# of drugs in this stage		0	0	0	0	0
	Costs per Drug:						
	Research	4.0	0.0	0.0	0.0	0.0	0.0
	Capital Expenditu	1.6	0.0	0.0	0.0	0.0	0.0
	Administrative	1.0	0.0	0.0	0.0	0.0	0.0
	Total Costs	6.6	0.0	0.0	0.0	0.0	0.0
Phase III	# of drugs in this stage		0	0	0	0	0
	Costs per Drug:						
	Research	8.0	0.0	0.0	0.0	0.0	0.0
	Capital Expenditures - 1st Year		0.0	0.0	0.0	0.0	0.0
	Total Capital Expenditures		0.0	0.0	0.0	0.0	0.0
	Administrative	2.0	0.0	0.0	0.0	0.0	0.0
	Total Costs	10.0	0.0	0.0	0.0	0.0	0.0

Pharmaceutical Life Cycle Model

Version 3.0

			1	2	3	4	5
Filing for Approval	# of new drugs in this stage		0	0	0	0	0
	Costs per Drug:						
	Research	0.0	0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	0.0
	Administrative	1.0	0.0	0.0	0.0	0.0	0.0
	Total Costs	0.0	0.0	0.0	0.0	0.0	0.0
Launch	# of new drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	0.0
Post Launch I	# of drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	0.0
Post Launch II	# of drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	0.0
Post Launch III	# of new drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	0.0
Post Launch IV	# of drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0

Pharmaceutical Life Cycle Model

Version 3.0

			6	7	8	9	10
Basic Research	# of drugs in this stage	**Assumptions**	2	3	4	1	2
	Costs:						
	Research	6.5	6.5	6.5	6.5	6.5	6.5
	Capital Expenditu	3.0	3.0	3.0	3.0	3.0	3.0
	Administrative	2.5	2.5	2.5	2.5	2.5	2.5
	Total	12.0	12.0	12.0	12.0	12.0	12.0
Preclinical Testing	# of drugs in this stage		8	7	7	9	8
	Costs per Drug:						
	Research	2.0	16.0	14.0	14.0	18.0	16.0
	Capital Expenditu	1.0	8.0	7.0	7.0	9.0	8.0
	Administrative	1.0	8.0	7.0	7.0	9.0	8.0
	Total Costs	4.0	32.0	28.0	28.0	36.0	32.0
Phase I	# of drugs in this stage		3	3	3	1	2
	Costs per Drug:						
	Research	2.0	6.0	6.0	6.0	2.0	4.0
	Capital Expenditu	0.5	1.5	1.5	1.5	0.5	1.0
	Administrative	0.5	1.5	1.5	1.5	0.5	1.0
	Total Costs	3.0	9.0	9.0	9.0	3.0	6.0
Phase II	# of drugs in this stage		2	2	3	2	1
	Costs per Drug:						
	Research	4.0	8.0	8.0	12.0	8.0	4.0
	Capital Expenditu	1.6	3.2	3.2	4.8	3.2	1.6
	Administrative	1.0	2.0	2.0	3.0	2.0	1.0
	Total Costs	6.6	13.2	13.2	19.8	13.2	6.6
Phase III	# of drugs in this stage		0	2	3	4	5
	Costs per Drug:						
	Research	8.0	0.0	16.0	24.0	32.0	40.0
	Capital Expenditures - 1st Year		0.0	9.5	27.5	12.8	1.3
	Total Capital Expenditures		0.0	9.5	37.0	49.8	41.5
	Administrative	2.0	0.0	4.0	6.0	8.0	10.0
	Total Costs	10.0	0.0	29.5	67.0	89.8	91.5

Pharmaceutical Life Cycle Model

Version 3.0

			6	7	8	9	10
Filing for Approval	# of new drugs in this stage		0	0	0	0	1
	Costs per Drug:						
	Research	0.0	0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	1.3
	Administrative	1.0	0.0	0.0	0.0	0.0	1.0
	Total Costs	0.0	0.0	0.0	0.0	0.0	2.3
Launch	# of new drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	0.0
Post Launch I	# of drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	0.0
Post Launch II	# of drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	0.0
Post Launch III	# of new drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	0.0
Post Launch IV	# of drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0

Pharmaceutical Life Cycle Model

Version 3.0

		Assumptions	11	12	13	14	15
Basic Research	# of drugs in this stage		3	2	1	4	2
	Costs:						
	Research	6.5	6.5	6.5	6.5	6.5	6.5
	Capital Expenditu	3.0	3.0	3.0	3.0	3.0	3.0
	Administrative	2.5	2.5	2.5	2.5	2.5	2.5
	Total	12.0	12.0	12.0	12.0	12.0	12.0
Preclinical Testing	# of drugs in this stage		7	6	7	6	7
	Costs per Drug:						
	Research	2.0	14.0	12.0	14.0	12.0	14.0
	Capital Expenditu	1.0	7.0	6.0	7.0	6.0	7.0
	Administrative	1.0	7.0	6.0	7.0	6.0	7.0
	Total Costs	4.0	28.0	24.0	28.0	24.0	28.0
Phase I	# of drugs in this stage		3	4	1	2	2
	Costs per Drug:						
	Research	2.0	6.0	8.0	2.0	4.0	4.0
	Capital Expenditu	0.5	1.5	2.0	0.5	1.0	1.0
	Administrative	0.5	1.5	2.0	0.5	1.0	1.0
	Total Costs	3.0	9.0	12.0	3.0	6.0	6.0
Phase II	# of drugs in this stage		2	2	4	1	2
	Costs per Drug:						
	Research	4.0	8.0	8.0	16.0	4.0	8.0
	Capital Expenditu	1.6	3.2	3.2	6.4	1.6	3.2
	Administrative	1.0	2.0	2.0	4.0	1.0	2.0
	Total Costs	6.6	13.2	13.2	26.4	6.6	13.2
Phase III	# of drugs in this stage		3	2	2	4	4
	Costs per Drug:						
	Research	8.0	24.0	16.0	16.0	32.0	32.0
	Capital Expenditures - 1st Year		0.0	9.5	1.3	12.8	0.0
	Total Capital Expenditures		14.0	10.8	10.8	23.5	14.0
	Administrative	2.0	6.0	4.0	4.0	8.0	8.0
	Total Costs	10.0	44.0	30.8	30.8	63.5	54.0

Pharmaceutical Life Cycle Model

Version 3.0

			11	12	13	14	15
Filing for Approval	# of new drugs in this stage		1	0	1	0	0
	Costs per Drug:						
	Research	0.0	0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		9.5	0.0	9.5	0.0	0.0
	Administrative	1.0	1.0	0.0	1.0	0.0	0.0
	Total Costs	0.0	10.5	0.0	10.5	0.0	0.0
Launch	# of new drugs in this stage		0	0	0	1	1
	Marketing Costs		3.0	30.0	0.0	30.0	0.0
	Capital Expenditures		0.5	3.8	0.0	3.8	0.0
Post Launch I	# of drugs in this stage		0	1	2	2	2
	Marketing Costs		0.0	5.0	44.4	23.1	74.4
	Capital Expenditures		0.0	0.5	4.3	4.3	7.6
Post Launch II	# of drugs in this stage		0	0	0	0	1
	Marketing Costs		0.0	0.0	0.0	0.0	3.5
	Capital Expenditures		0.0	0.0	0.0	0.0	0.5
Post Launch III	# of new drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	0.0	0.0
Post Launch IV	# of drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0

Pharmaceutical Life Cycle Model

Version 3.0

		Assumptions	16	17	18	19	20
Basic Research	# of drugs in this stage		2	2	2	3	1
	Costs:						
	Research	6.5	6.5	6.5	6.5	6.5	6.5
	Capital Expenditu	3.0	3.0	3.0	3.0	3.0	3.0
	Administrative	2.5	2.5	2.5	2.5	2.5	2.5
	Total	12.0	12.0	12.0	12.0	12.0	12.0
Preclinical Testing	# of drugs in this stage		7	8	6	6	7
	Costs per Drug:						
	Research	2.0	14.0	16.0	12.0	12.0	14.0
	Capital Expenditu	1.0	7.0	8.0	6.0	6.0	7.0
	Administrative	1.0	7.0	8.0	6.0	6.0	7.0
	Total Costs	4.0	28.0	32.0	24.0	24.0	28.0
Phase I	# of drugs in this stage		2	1	4	1	2
	Costs per Drug:						
	Research	2.0	4.0	2.0	8.0	2.0	4.0
	Capital Expenditu	0.5	1.0	0.5	2.0	0.5	1.0
	Administrative	0.5	1.0	0.5	2.0	0.5	1.0
	Total Costs	3.0	6.0	3.0	12.0	3.0	6.0
Phase II	# of drugs in this stage		1	2	1	3	0
	Costs per Drug:						
	Research	4.0	4.0	8.0	4.0	12.0	0.0
	Capital Expenditu	1.6	1.6	3.2	1.6	4.8	0.0
	Administrative	1.0	1.0	2.0	1.0	3.0	0.0
	Total Costs	6.6	6.6	13.2	6.6	19.8	0.0
Phase III	# of drugs in this stage		4	2	2	1	3
	Costs per Drug:						
	Research	8.0	32.0	16.0	16.0	8.0	24.0
	Capital Expenditures - 1st Year		1.3	0.0	3.3	0.0	12.8
	Total Capital Expenditures		14.0	1.3	4.5	3.3	16.0
	Administrative	2.0	8.0	4.0	4.0	2.0	6.0
	Total Costs	10.0	54.0	21.3	24.5	13.3	46.0

Pharmaceutical Life Cycle Model

Version 3.0

			16	17	18	19	20
Filing for Approval	# of new drugs in this stage		0	0	2	0	1
	Costs per Drug:						
	Research	0.0	0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	10.8	0.0	70.0
	Administrative	1.0	0.0	0.0	2.0	0.0	1.0
	Total Costs	0.0	0.0	0.0	12.8	0.0	71.0
Launch	# of new drugs in this stage		0	1	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	0.0	0.0	4.3	0.0
Post Launch I	# of drugs in this stage		1	1	0	0	2
	Marketing Costs		26.6	7.5	0.0	0.0	0.0
	Capital Expenditures		3.8	3.8	0.0	0.0	4.3
Post Launch II	# of drugs in this stage		2	2	2	1	1
	Marketing Costs		47.3	47.3	98.4	26.6	26.6
	Capital Expenditures		4.3	4.3	7.6	3.8	3.8
Post Launch III	# of new drugs in this stage		0	0	1	2	2
	Marketing Costs		0.0	0.0	5.9	75.4	75.4
	Capital Expenditures		0.0	0.0	0.5	4.3	4.3
Post Launch IV	# of drugs in this stage		0	0	0	0	0
	Marketing Costs		0.0	0.0	0.0	0.0	0.0

Appendix C. Financial Analysis Area

Financial Analysis:

			Year 0	1	2	3	4	5	6	7	8	9	10
Cash Flows	Total Revenues		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cash Outflows												
	Initial Setup Costs	50.0		50.0									
	Research		0.0	6.5	10.5	16.5	22.5	26.5	32.5	42.5	52.5	70.5	62.5
	Marketing		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Change in WC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Capital Expenditures		0.0	3.0	5.0	8.0	11.0	12.0	14.1	16.0	26.6	23.5	34.1
	Manufacturing Costs		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Administrative		0.0	2.5	4.5	7.5	10.5	11.5	13.0	15.0	17.5	21.0	20.5
	Corporate G&A	25.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
	Total Costs		0.0	37.0	45.0	57.0	69.0	75.0	84.6	98.5	121.6	140.0	142.1
	Net Cash Flow		0.0	-37.0	-45.0	-57.0	-69.0	-75.0	-84.6	-98.5	-121.6	-140.0	-142.1
Asset Base													
	Initial Asset Base	100.0											
	Average Asset Life	15 years											
	Gross Fixed Assets		100.0	103.0	108.0	116.0	127.0	139.0	153.1	169.1	195.6	219.1	253.1
	Accum Depreciation		50.0	53.5	57.2	61.1	65.5	70.4	75.9	82.1	89.7	98.3	108.6
	Depreciation Expense		0.0	3.5	3.6	3.9	4.4	4.9	5.5	6.2	7.6	8.6	10.3
	Net Fixed Assets		50.0	49.5	50.8	54.9	61.5	68.6	77.2	86.9	105.9	120.8	144.5
Treatment of Research	**Capitalize Research ? Enter '1' for Yes or '0' for No:**					0							
	Initial Research Base	0.0											
	Average Research Life	15 years											
	Gross Capitalized Research		0.0	6.5	17.0	33.5	56.0	82.5	115.0	157.5	210.0	280.5	343.0
	Accum Depreciation		0.0	0.4	1.5	3.7	7.2	12.2	19.0	28.3	40.4	56.4	75.5
	Depreciation Expense		0.0	0.4	1.1	2.1	3.5	5.0	6.9	9.2	12.1	16.0	19.1
	Net Capitalized Research		0.0	6.1	15.5	29.8	48.8	70.3	96.0	129.2	169.6	224.1	267.5

Financial Analysis:

			11	12	13	14	15	16	17	18	19	20
Cash Flows	Total Revenues		0.0	496.0	310.0	3.0	40.0	92.5	122.5	205.3	295.3	295.3
	Cash Outflows											
	Initial Setup Costs	50.0										
	Research		56.5	44.5	40.5	38.5	52.5	50.5	66.5	34.5	36.5	34.5
	Marketing		3.0	35.0	44.4	53.1	77.9	73.8	54.8	104.3	102.0	102.0
	Change in WC		0.0	85.3	-32.0	-52.8	6.4	9.0	5.2	14.2	15.5	0.0
	Capital Expenditures		30.5	26.9	27.9	24.9	35.1	33.6	103.7	100.0	95.1	164.0
	Manufacturing Costs		0.0	49.6	31.0	0.3	4.0	9.3	12.3	20.5	29.5	29.5
	Administrative		19.5	16.0	16.0	14.5	18.5	17.0	20.5	14.0	13.0	13.5
	Corporate G&A	25.0	25.0	55.1	34.4	25.0	25.0	25.0	25.0	25.0	32.8	32.8
	Total Costs		134.5	312.4	162.2	103.5	219.3	218.2	287.8	312.5	324.4	376.3
	Net Cash Flow		-134.5	183.6	147.8	-100.5	-179.3	-125.7	-165.3	-107.2	-29.1	-81.0
Asset Base												
	Initial Asset Base	100.0										
	Average Asset Life	15										
	Gross Fixed Assets		283.6	310.5	338.4	363.3	398.4	431.9	535.6	635.5	730.6	894.6
	Accum Depreciation		120.3	133.0	146.7	161.1	176.9	193.9	216.7	244.6	277.0	318.2
	Depreciation Expense		11.7	12.7	13.7	14.4	15.8	17.0	22.8	27.9	32.4	41.2
	Net Fixed Assets		163.3	177.5	191.7	202.2	221.4	238.0	318.9	390.9	453.6	576.4
Treatment of Research	**Capitalize Research ? Enter '1' for Yes**											
	Initial Research Base	0.0										
	Average Research Life	15										
	Gross Capitalized Research		399.5	444.0	484.5	523.0	575.5	626.0	692.5	727.0	763.5	798.0
	Accum Depreciation		97.1	120.2	144.5	169.7	196.8	225.4	256.5	287.9	319.6	351.5
	Depreciation Expense		21.6	23.1	24.3	25.2	27.1	28.6	31.1	31.4	31.7	31.9
	Net Capitalized Research		302.4	323.8	340.0	353.3	378.7	400.6	436.0	439.1	443.9	446.5

			21	22	23	24	25	26	27	28	29	30
Financial Analysis:												
Cash Flows	Total Revenues		417.2	553.5	560.8	625.5	769.3	833.1	795.3	1587.5	1891.7	1925.8
	Cash Outflows											
	Initial Setup Costs	50.0										
	Research		44.5	44.5	44.5	48.5	46.5	50.5	42.5	42.5	34.5	34.5
	Marketing		193.8	215.5	147.1	183.6	295.1	346.9	252.1	405.5	492.8	662.1
	Change in WC		21.0	23.4	1.3	11.1	24.7	11.0	-6.5	136.3	52.3	5.9
	Capital Expenditures		122.6	128.2	128.2	93.5	92.5	88.8	88.8	80.0	74.7	74.8
	Manufacturing Costs		41.7	55.4	56.1	62.5	76.9	83.3	79.5	158.7	189.2	192.6
	Administrative		15.0	15.5	16.5	16.5	16.5	17.5	16.5	15.0	12.0	11.5
	Corporate G&A	25.0	46.3	61.4	62.3	69.4	85.4	92.5	88.3	176.2	210.0	213.8
	Totai Costs		484.9	544.0	455.9	485.2	637.7	690.5	561.2	1014.3	1065.4	1195.1
	Net Cash Flow		-67.7	9.5	105.0	140.2	131.6	142.6	234.1	573.2	826.3	730.7
Asset Base												
	Initial Asset Base	100.0										
	Average Asset Life	15										
	Gross Fixed Assets		1017.2	1145.4	1273.6	1367.1	1459.6	1548.4	1637.2	1717.2	1791.9	1866.7
	Accum Depreciation		364.8	416.8	473.9	533.5	595.2	658.8	724.0	790.2	857.0	924.3
	Depreciation Expense		46.6	52.0	57.1	59.5	61.7	63.5	65.2	66.2	66.8	67.3
	Net Fixed Assets		652.4	728.6	799.7	833.6	864.4	889.6	913.2	927.0	934.9	942.4
Treatment of Research	**Capitalize Research ? Enter '1' for Yes**											
	Initial Research Base	0.0										
	Average Research Life	15										
	Gross Capitalized Research		842.5	887.0	931.5	980.0	1026.5	1077.0	1119.5	1162.0	1196.5	1231.0
	Accum Depreciation		384.2	417.8	452.0	487.2	523.2	560.1	597.4	635.0	672.5	709.7
	Depreciation Expense		32.7	33.5	34.2	35.2	36.0	36.9	37.3	37.6	37.4	37.2
	Net Capitalized Research		458.3	469.2	479.5	492.8	503.3	516.9	522.1	527.0	524.0	521.3

			31	32	33	34	35	36	37	38	39	40
Financial Analysis:												
Cash Flows	Total Revenues		2295.7	3547.2	3071.9	2803.1	2617.1	2660.4	1195.6	1023.5	1199.2	432.7
	Cash Outflows											
	Initial Setup Costs	50.0										
	Research		38.5	42.5	52.5	44.5	36.5	34.5	46.5	56.5	56.5	68.5
	Marketing		316.5	560.8	543.5	178.5	180.5	113.7	89.3	75.4	21.1	52.2
	Change in WC		63.6	215.3	-81.8	-46.2	-32.0	7.5	-252.0	-29.6	30.2	-131.8
	Capital Expenditures		45.7	56.7	67.7	39.2	39.2	28.6	28.7	58.7	58.3	90.7
	Manufacturing Costs		229.6	354.7	307.2	280.3	261.7	266.0	119.6	102.3	119.9	43.3
	Administrative		13.0	14.5	18.0	15.5	14.5	14.0	17.0	19.0	18.0	21.0
	Corporate G&A	25.0	254.8	393.7	341.0	311.1	290.5	295.3	132.7	113.6	133.1	48.0
	Total Costs		961.7	1638.3	1248.1	822.9	790.9	759.6	181.8	395.9	437.1	191.9
	Net Cash Flow		1333.9	1908.9	1823.8	1980.2	1826.2	1900.8	1013.8	627.6	762.1	240.9
Asset Base												
	Initial Asset Base	100.0										
	Average Asset Life	15										
	Gross Fixed Assets		1912.4	1969.1	2036.8	2076.0	2115.2	2143.8	2172.5	2231.2	2289.5	2380.2
	Accum Depreciation		990.2	1055.4	1120.9	1184.5	1246.6	1306.4	1364.1	1421.9	1479.8	1539.8
	Depreciation Expense		65.9	65.3	65.4	63.7	62.0	59.8	57.7	57.8	57.8	60.0
	Net Fixed Assets		922.2	913.7	915.9	891.5	868.6	837.4	808.4	809.3	809.7	840.3
Treatment of Research	**Capitalize Research ? Enter '1' for Yes**											
	Initial Research Base	0.0										
	Average Research Life	15										
	Gross Capitalized Research		1269.5	1312.0	1364.5	1409.0	1445.5	1480.0	1526.5	1583.0	1639.5	1708.0
	Accum Depreciation		747.0	784.7	823.3	862.4	901.2	939.8	978.9	1019.2	1060.6	1103.7
	Depreciation Expense		37.3	37.7	38.7	39.0	38.9	38.6	39.1	40.3	41.4	43.2
	Net Capitalized Research		522.5	527.3	541.2	546.6	544.3	540.2	547.6	563.8	578.9	604.3

			Year 0	1	2	3	4	5	6	7	8	9	10
Income Statement	Total Revenues		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Expenses:												
	Marketing		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Administrative		0.0	2.5	4.5	7.5	10.5	11.5	13.0	15.0	17.5	21.0	20.5
	Manufacturing Costs		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Corporate G&A		0.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
	Depreciation Expense		0.0	3.5	3.6	3.9	4.4	4.9	5.5	6.2	7.6	8.6	10.3
	Research Expense		0.0	6.5	10.5	16.5	22.5	26.5	32.5	42.5	52.5	70.5	62.5
	EBIT		0.0	-37.5	-43.6	-52.9	-62.4	-67.9	-76.0	-88.7	-102.6	-125.1	-118.3
	Interest Expense		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Prior Losses Deductible		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Taxable Income		0.0	-37.5	-43.6	-52.9	-62.4	-67.9	-76.0	-88.7	-102.6	-125.1	-118.3
	Tax Rate	34%											
	Taxes		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Effective Tax Rate		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Net Income		0.0	-37.5	-43.6	-52.9	-62.4	-67.9	-76.0	-88.7	-102.6	-125.1	-118.3
	Calculation of Tax Loss Carryforward:												
	Net Loss		0.0	-37.5	-43.6	-52.9	-62.4	-67.9	-76.0	-88.7	-102.6	-125.1	-118.3
	Total Balance of Losses		0.0	0.0	-37.5	-81.2	-134.1	-196.5	-264.4	-302.9	-347.9	-397.6	-460.3
	Working Capital:												
	WC Balance		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Items as a % of sales:												
	Inventory	12.7%											
	Accounts Receivable	18.9%											
	Accounts Payable	14.4%											

			11	12	13	14	15	16	17	18	19	20
Income Statement	Total Revenues		0.0	496.0	310.0	3.0	40.0	92.5	122.5	205.3	295.3	295.3
	Expenses:											
	Marketing		3.0	35.0	44.4	53.1	77.9	73.8	54.8	104.3	102.0	102.0
	Administrative		19.5	16.0	16.0	14.5	18.5	17.0	20.5	14.0	13.0	13.5
	Manufacturing Costs		0.0	49.6	31.0	0.3	4.0	9.3	12.3	20.5	29.5	29.5
	Corporate G&A		25.0	55.1	34.4	25.0	25.0	25.0	25.0	25.0	32.8	32.8
	Depreciation Expense		11.7	12.7	13.7	14.4	15.8	17.0	22.8	27.9	32.4	41.2
	Research Expense		56.5	44.5	40.5	38.5	52.5	50.5	66.5	34.5	36.5	34.5
	EBIT		-115.7	283.2	130.0	-142.9	-153.7	-100.1	-79.3	-20.9	49.1	41.8
	Interest Expense		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Prior Losses Deductible		0.0	283.2	130.0	0.0	0.0	0.0	0.0	0.0	49.1	41.8
	Taxable Income		-115.7	0.0	0.0	-142.9	-153.7	-100.1	-79.3	-20.9	0.0	0.0
	Tax Rate	34%										
	Taxes		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Effective Tax Rate		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Net Income		-115.7	283.2	130.0	-142.9	-153.7	-100.1	-79.3	-20.9	49.1	41.8
	Calculation of Tax Loss Carryforward											
	Net Loss		-115.7	0.0	0.0	-142.9	-153.7	-100.1	-79.3	-20.9	0.0	0.0
	Total Balance of Losses		-510.7	-550.4	-178.5	0.0	0.0	0.0	0.0	-345.9	-496.9	-304.9
	Working Capital:											
	WC Balance		0.0	85.3	53.3	0.5	6.9	15.9	21.1	35.3	50.8	50.8

			21	22	23	24	25	26	27	28	29	30
Income Statement	Total Revenues		417.2	553.5	560.8	625.5	769.3	833.1	795.3	1587.5	1891.7	1925.8
	Expenses:											
	Marketing		193.8	215.5	147.1	183.6	295.1	346.9	252.1	405.5	492.8	662.1
	Administrative		15.0	15.5	16.5	16.5	16.5	17.5	16.5	15.0	12.0	11.5
	Manufacturing Costs		41.7	55.4	56.1	62.5	76.9	83.3	79.5	158.7	189.2	192.6
	Corporate G&A		46.3	61.4	62.3	69.4	85.4	92.5	88.3	176.2	210.0	213.8
	Depreciation Expense		46.6	52.0	57.1	59.5	61.7	63.5	65.2	66.2	66.8	67.3
	Research Expense		44.5	44.5	44.5	48.5	46.5	50.5	42.5	42.5	34.5	34.5
	EBIT		29.3	109.1	177.3	185.3	187.1	178.8	251.1	723.3	886.5	744.0
	Interest Expense		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Prior Losses Deductible		29.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Taxable Income		0.0	109.1	177.3	185.3	187.1	178.8	251.1	723.3	886.5	744.0
	Tax Rate	34%										
	Taxes		0.0	37.1	60.3	63.0	63.6	60.8	85.4	245.9	301.4	253.0
	Effective Tax Rate		0%	34%	34%	34%	34%	34%	34%	34%	34%	34%
	Net Income		29.3	72.0	117.0	122.3	123.5	118.0	165.7	477.4	585.1	491.1
	Calculation of Tax Loss Carryforward											
	Net Loss		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Balance of Losses		-109.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Working Capital:											
	WC Balance		71.8	95.2	96.5	107.6	132.3	143.3	136.8	273.0	325.4	331.2

			31	32	33	34	35	36	37	38	39	40
Income Statement	Total Revenues		2295.7	3547.2	3071.9	2803.1	2617.1	2660.4	1195.6	1023.5	1199.2	432.7
	Expenses:											
	Marketing		316.5	560.8	543.5	178.5	180.5	113.7	89.3	75.4	21.1	52.2
	Administrative		13.0	14.5	18.0	15.5	14.5	14.0	17.0	19.0	18.0	21.0
	Manufacturing Costs		229.6	354.7	307.2	280.3	261.7	266.0	119.6	102.3	119.9	43.3
	Corporate G&A		254.8	393.7	341.0	311.1	290.5	295.3	132.7	113.6	133.1	48.0
	Depreciation Expense		65.9	65.3	65.4	63.7	62.0	59.8	57.7	57.8	57.8	60.0
	Research Expense		38.5	42.5	52.5	44.5	36.5	34.5	46.5	56.5	56.5	68.5
	EBIT		1377.4	2115.6	1744.3	1909.5	1771.4	1877.1	732.8	598.9	792.7	139.7
	Interest Expense		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Prior Losses Deductible		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Taxable Income		1377.4	2115.6	1744.3	1909.5	1771.4	1877.1	732.8	598.9	792.7	139.7
	Tax Rate	34%										
	Taxes		468.3	719.3	593.1	649.2	602.3	638.2	249.2	203.6	269.5	47.5
	Effective Tax Rate		34%	34%	34%	34%	34%	34%	34%	34%	34%	0%
	Net Income		909.1	1396.3	1151.3	1260.3	1169.1	1238.9	483.7	395.2	523.2	92.2
	Calculation of Tax Loss Carryforward											
	Net Loss		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Balance of Losses		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Working Capital:											
	WC Balance		394.9	610.1	528.4	482.1	450.1	457.6	205.6	176.0	206.3	74.4

Appendix D. Drug Determination Matrix

Year		Year => 1	2	3	4	5	6	7	8	9	10	11	12	13
1	Stage	Research	Preclinical	======>	======>	Phase I	Phase II	=======>	Phase III	======>	======>	Filing	=======>	=======>
	Rnd #1	0.76				0.51	0.54		0.34	0.62		0.71		Drug
	Rnd #2				0.00	0.72	0.35		0.81	0.83		0.15		Quality
	Rnd #3													0.22
	Drug #1	0	0	0	0	0	0	0	0	0	0	0		0
	Rnd #1	0.07				0.30	0.28		0.47	0.89		0.95		
	Rnd #2				0.18	0.49	0.05		0.49	0.93		0.91		
	Rnd #3													0.86
	Drug #2	1	1	1	1	1	1	1	1	0	0	0		0
	Rnd #1	0.84				0.27	0.68		0.50	0.97		0.42		
	Rnd #2				0.53	0.87	0.06		0.91	0.40		0.49		
	Rnd #3													0.81
	Drug #3	0	0	0	0	0	0	0	0	0	0	0		0
	Rnd #1	0.42				0.51	0.13		0.37	0.07		0.27		
	Rnd #2				0.35	0.98	0.68		0.75	0.85		0.16		
	Rnd #3													0.56
	Drug #4	1	1	1	1	1	1	1	1	1	1	1		3
2	Stage		Research	Preclinical	======>	======>	Phase I	Phase II	=======>	Phase III	=======	=======	Filing	=======>
	Rnd #1		0.84				0.00	0.68		0.93	0.63		0.19	
	Rnd #2					0.78	0.19	0.55		0.02	0.66		0.90	
	Rnd #3													
	Drug #1		0	0	0	0	0	0	0	0	0	0	0	
	Rnd #1		0.44				0.03	0.89		0.84	0.81		0.62	
	Rnd #2					0.49	0.54	0.30		0.16	0.46		0.59	
	Rnd #3													
	Drug #2		1	1	1	1	1	0	0	0	0	0	0	
	Rnd #1		0.41				0.19	0.67		0.08	0.89		0.34	
	Rnd #2					0.22	0.19	0.58		0.94	0.81		0.21	
	Rnd #3													
	Drug #3		1	1	1	1	1	1		1	0	0	0	
	Rnd #1		0.21				0.02	0.33		0.11	0.21		0.56	
	Rnd #2					0.66	0.87	0.84		0.16	0.35		0.27	
	Rnd #3													
	Drug #4		1	1	1	1	1	1	1	1	1	1	1	

Year			14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	Stage		Launch	Launch I.i	Launch I.ii	Launch I.iii	Launch II.i	Launch II.ii	Launch II.iii	Launch III.i	Launch III.ii	Launch III.iii	Launch IV.i	Launch IV.ii	Launch IV.iii	
	Rnd #1															
	Rnd #2		0.25	0.58	0.51	0.17	0.67	0.88	0.41	0.10	0.56	0.69	0.50	0.51	0.76	
	Rnd #3		0.27	0.14	0.92	0.17	0.60	0.02	0.04	0.22	0.80	0.74	0.95	0.75	0.57	
	Drug #1		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Rnd #1															
	Rnd #2		0.02	0.73	0.88	0.18	0.89	0.05	0.03	0.38	0.76	0.94	0.21	0.91	0.58	
	Rnd #3		0.33	0.88	0.56	0.67	0.77	0.36	0.27	0.67	0.90	0.30	0.08	0.50	0.84	
	Drug #2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Rnd #1															
	Rnd #2		0.34	0.08	0.43	0.82	0.63	0.86	0.97	0.59	0.49	0.34	0.16	0.74	0.05	
	Rnd #3		0.50	0.98	0.46	0.42	0.73	0.28	0.43	0.37	0.65	0.83	0.40	0.04	0.07	
	Drug #3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Rnd #1															
	Rnd #2		0.38	0.20	0.31	0.15	0.93	0.69	0.02	0.57	0.35	0.22	0.75	0.41	0.22	
	Rnd #3		0.35	0.08	0.41	0.08	0.41	0.95	0.52	0.59	0.36	0.57	0.07	0.58	0.68	
	Drug #4		3.00	3.11	3.11	3.22	3.22	3.22	3.32	3.32	3.33	3.33	3.33	3.33	3.33	
2	Stage	========>	Launch	Launch I.i	Launch I.ii	Launch I.iii	Launch II.i	Launch II.ii	Launch II.iii	Launch III.i	Launch III ii	Launch III.iii	Launch IV.i	Launch IV.ii	Launch IV.iii	
	Rnd #1	Drug														
	Rnd #2	Quality		0.83	0.19	0.12	0.67	0.01	0.30	0.97	0.50	0.16	0.77	0.95	0.01	0.71
	Rnd #3	0.09	0.49	0.47	0.36	0.05	0.53	0.71	0.35	0.08	0.72	0.94	0.71	0.81	0.25	
	Drug #1	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Rnd #1															
	Rnd #2		0.21	0.65	0.50	0.92	0.30	0.46	1.00	0.84	0.96	0.06	0.09	0.11	0.35	
	Rnd #3	0.49	0.39	0.02	0.95	0.25	0.66	0.48	0.46	0.10	0.01	0.16	0.59	0.41	0.89	
	Drug #2	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Rnd #1															
	Rnd #2		0.60	0.36	0.94	0.83	0.73	0.84	0.69	0.76	0.69	0.31	0.66	0.06	0.88	
	Rnd #3	0.37	0.95	0.00	0.08	0.64	0.99	0.74	0.82	0.69	0.94	0.24	0.28	0.65	0.17	
	Drug #3	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Rnd #1															
	Rnd #2		0.06	0.81	0.50	0.77	0.87	0.43	0.80	0.62	0.39	0.44	0.54	0.43	0.46	
	Rnd #3	0.82	0.54	0.71	0.49	0.25	0.17	0.55	0.19	0.49	0.23	0.82	0.77	0.60	0.77	
	Drug #4	4	4.00	4.00	4.00	4.00	4.01	4.01	4.02	4.03	4.03	4.03	4.03	4.03	4.03	

Year		Year => 1	2	3	4	5	6	7
1	Stage	Research	Preclinical	======>	======>	Phase I	Phase II	=======>
	Rnd #1	0.76				0.51	0.54	
	Rnd #2				0.00	0.72	0.35	
	Rnd #3							
	Drug #1	0	0	0	0	0	0	0
	Rnd #1	0.07				0.30	0.28	
	Rnd #2				0.18	0.49	0.05	
	Rnd #3							
	Drug #2	1	1	1	1	1	1	1
	Rnd #1	0.84				0.27	0.68	
	Rnd #2				0.53	0.87	0.06	
	Rnd #3							
	Drug #3	0	0	0	0	0	0	0
	Rnd #1	0.42				0.51	0.13	
	Rnd #2				0.35	0.98	0.68	
	Rnd #3							
	Drug #4	1	1	1	1	1	1	1
2	Stage		Research	Preclinical	======>	======>	Phase I	Phase II
	Rnd #1		0.84				0.00	0.68
	Rnd #2					0.78	0.19	0.55
	Rnd #3							
	Drug #1		0	0	0	0	0	0
	Rnd #1		0.44				0.03	0.89
	Rnd #2					0.49	0.54	0.30
	Rnd #3							
	Drug #2		1	1	1	1	1	0
	Rnd #1		0.41				0.19	0.67
	Rnd #2					0.22	0.19	0.58
	Rnd #3							
	Drug #3		1	1	1	1	1	1
	Rnd #1		0.21				0.02	0.33
	Rnd #2					0.66	0.87	0.84
	Rnd #3							
	Drug #4		1	1	1	1	1	1
3	Stage			Research	Preclinical	========>	========>	Phase I
	Rnd #1			0.11				0.64
	Rnd #2						0.26	0.24
	Rnd #3							
	Drug #1			1	1	1	1	1
	Rnd #1			0.26				0.47
	Rnd #2						0.54	0.45
	Rnd #3							
	Drug #2			1	1	1	1	1
	Rnd #1			0.60				0.58
	Rnd #2						0.67	0.71
	Rnd #3							
	Drug #3			0	0	0	0	0
	Rnd #1			0.56				0.25
	Rnd #2						0.33	0.08
	Rnd #3							
	Drug #4			1	1	1	1	1
4	Stage				Research	Preclinical	========>	========>
	Rnd #1				0.10			
	Rnd #2							0.35
	Rnd #3							
	Drug #1				1	1	1	1
	Rnd #1				0.48			
	Rnd #2							0.61
	Rnd #3							
	Drug #2				1	1	0	1
	Rnd #1				0.60			
	Rnd #2							0.53
	Rnd #3							
	Drug #3				1	1	1	1
	Rnd #1				0.99			
	Rnd #2							0.55
	Rnd #3							
	Drug #4				0	0	0	0

Appendix E. Revenue Payoff Matrix

Revenue Payoff Matrix

$ Millions/year

Adjustment Factors:

Competition: 0.75

New Indication: 1.25

Drug Quality		Path Code	Launch	Post Launch I.i	Post Launch I.ii	Post Launch I.iii	Post Launch II.i	Post Launch II.ii	Post Launch II.iii
Dog	0 New Ind's 0 Comp's	1.00	3.00	10.00	10.00	10.00	15.00	15.00	15.00
	0 New Ind's 1 Comp	1.01	2.25	7.50	7.50	7.50	11.25	11.25	11.25
	0 New Ind's 2 Comp's	1.02	1.69	5.63	5.63	5.63	8.44	8.44	8.44
	0 New Ind's 3 Comp's	1.03	1.27	4.22	4.22	4.22	6.33	6.33	6.33
	1 New Ind's 0 Comp's	1.10	3.75	12.50	12.50	12.50	18.75	18.75	18.75
	1 New Ind's 1 Comp	1.11	2.81	9.38	9.38	9.38	14.06	14.06	14.06
	1 New Ind's 2 Comp's	1.12	2.11	7.03	7.03	7.03	10.55	10.55	10.55
	1 New Ind's 3 Comp's	1.13	1.58	5.27	5.27	5.27	7.91	7.91	7.91
	2 New Ind's 0 Comp's	1.20	4.69	15.63	15.63	15.63	23.44	23.44	23.44
	2 New Ind's 1 Comp	1.21	3.52	11.72	11.72	11.72	17.58	17.58	17.58
	2 New Ind's 2 Comp's	1.22	2.64	8.79	8.79	8.79	13.18	13.18	13.18
	2 New Ind's 3 Comp's	1.23	1.98	6.59	6.59	6.59	9.89	9.89	9.89
	3 New Ind's 0 Comp's	1.30	5.86	19.53	19.53	19.53	29.30	29.30	29.30
	3 New Ind's 1 Comp	1.31	4.39	14.65	14.65	14.65	21.97	21.97	21.97
	3 New Ind's 2 Comp's	1.32	3.30	10.99	10.99	10.99	16.48	16.48	16.48
	3 New Ind's 3 Comp's	1.33	2.47	8.24	8.24	8.24	12.36	12.36	12.36
Below Average	0 New Ind's 0 Comp's	2.00	12.00	25.00	25.00	25.00	30.00	30.00	30.00
	0 New Ind's 1 Comp	2.01	9.00	18.75	18.75	18.75	22.50	22.50	22.50
	0 New Ind's 2 Comp's	2.02	6.75	14.06	14.06	14.06	16.88	16.88	16.88
	0 New Ind's 3 Comp's	2.03	5.06	10.55	10.55	10.55	12.66	12.66	12.66
	1 New Ind's 0 Comp's	2.10	15.00	31.25	31.25	31.25	37.50	37.50	37.50
	1 New Ind's 1 Comp	2.11	11.25	23.44	23.44	23.44	28.13	28.13	28.13
	1 New Ind's 2 Comp's	2.12	8.44	17.58	17.58	17.58	21.09	21.09	21.09
	1 New Ind's 3 Comp's	2.13	6.33	13.18	13.18	13.18	15.82	15.82	15.82
	2 New Ind's 0 Comp's	2.20	18.75	39.06	39.06	39.06	46.88	46.88	46.88
	2 New Ind's 1 Comp	2.21	14.06	29.30	29.30	29.30	35.16	35.16	35.16
	2 New Ind's 2 Comp's	2.22	10.55	21.97	21.97	21.97	26.37	26.37	26.37
	2 New Ind's 3 Comp's	2.23	7.91	16.48	16.48	16.48	19.78	19.78	19.78
	3 New Ind's 0 Comp's	2.30	23.44	48.83	48.83	48.83	58.59	58.59	58.59
	3 New Ind's 1 Comp	2.31	17.58	36.62	36.62	36.62	43.95	43.95	43.95
	3 New Ind's 2 Comp's	2.32	13.18	27.47	27.47	27.47	32.96	32.96	32.96
	3 New Ind's 3 Comp's	2.33	9.89	20.60	20.60	20.60	24.72	24.72	24.72

Revenue Payoff Matrix

$ Millions/year

Drug Quality			Path Code	Post Launch III.i	Post Launch III.ii	Post Launch III.iii	Post Launch IV.i	Post Launch IV.ii	Post Launch IV.iii
Dog	0 New Ind's	0 Comp's	1.00	25.00	25.00	25.00	15.00	15.00	15.00
	0 New Ind's	1 Comp	1.01	18.75	18.75	18.75	11.25	11.25	11.25
	0 New Ind's	2 Comp's	1.02	14.06	14.06	14.06	8.44	8.44	8.44
	0 New Ind's	3 Comp's	1.03	10.55	10.55	10.55	6.33	6.33	6.33
	1 New Ind's	0 Comp's	1.10	31.25	31.25	31.25	18.75	18.75	18.75
	1 New Ind's	1 Comp	1.11	23.44	23.44	23.44	14.06	14.06	14.06
	1 New Ind's	2 Comp's	1.12	17.58	17.58	17.58	10.55	10.55	10.55
	1 New Ind's	3 Comp's	1.13	13.18	13.18	13.18	7.91	7.91	7.91
	2 New Ind's	0 Comp's	1.20	39.06	39.06	39.06	23.44	23.44	23.44
	2 New Ind's	1 Comp	1.21	29.30	29.30	29.30	17.58	17.58	17.58
	2 New Ind's	2 Comp's	1.22	21.97	21.97	21.97	13.18	13.18	13.18
	2 New Ind's	3 Comp's	1.23	16.48	16.48	16.48	9.89	9.89	9.89
	3 New Ind's	0 Comp's	1.30	48.83	48.83	48.83	29.30	29.30	29.30
	3 New Ind's	1 Comp	1.31	36.62	36.62	36.62	21.97	21.97	21.97
	3 New Ind's	2 Comp's	1.32	27.47	27.47	27.47	16.48	16.48	16.48
	3 New Ind's	3 Comp's	1.33	20.60	20.60	20.60	12.36	12.36	12.36
Below Average	0 New Ind's	0 Comp's	2.00	65.00	65.00	65.00	40.00	40.00	40.00
	0 New Ind's	1 Comp	2.01	48.75	48.75	48.75	30.00	30.00	30.00
	0 New Ind's	2 Comp's	2.02	36.56	36.56	36.56	22.50	22.50	22.50
	0 New Ind's	3 Comp's	2.03	27.42	27.42	27.42	16.88	16.88	16.88
	1 New Ind's	0 Comp's	2.10	81.25	81.25	81.25	50.00	50.00	50.00
	1 New Ind's	1 Comp	2.11	60.94	60.94	60.94	37.50	37.50	37.50
	1 New Ind's	2 Comp's	2.12	45.70	45.70	45.70	28.13	28.13	28.13
	1 New Ind's	3 Comp's	2.13	34.28	34.28	34.28	21.09	21.09	21.09
	2 New Ind's	0 Comp's	2.20	101.56	101.56	101.56	62.50	62.50	62.50
	2 New Ind's	1 Comp	2.21	76.17	76.17	76.17	46.88	46.88	46.88
	2 New Ind's	2 Comp's	2.22	57.13	57.13	57.13	35.16	35.16	35.16
	2 New Ind's	3 Comp's	2.23	42.85	42.85	42.85	26.37	26.37	26.37
	3 New Ind's	0 Comp's	2.30	126.95	126.95	126.95	78.13	78.13	78.13
	3 New Ind's	1 Comp	2.31	95.21	95.21	95.21	58.59	58.59	58.59
	3 New Ind's	2 Comp's	2.32	71.41	71.41	71.41	43.95	43.95	43.95
	3 New Ind's	3 Comp's	2.33	53.56	53.56	53.56	32.96	32.96	32.96

Drug Quality			Path Code	Launch	Post Launch I.i	Post Launch I.ii	Post Launch I.iii	Post Launch II.i	Post Launch II.ii	Post Launch II.iii
Average	0 New Ind's	0 Comp's	3.00	30.00	85.00	85.00	85.00	140.00	140.00	140.00
	0 New Ind's	1 Comp	3.01	22.50	63.75	63.75	63.75	105.00	105.00	105.00
	0 New Ind's	2 Comp's	3.02	16.88	47.81	47.81	47.81	78.75	78.75	78.75
	0 New Ind's	3 Comp's	3.03	12.66	35.86	35.86	35.86	59.06	59.06	59.06
	1 New Ind's	0 Comp's	3.10	37.50	106.25	106.25	106.25	175.00	175.00	175.00
	1 New Ind's	1 Comp	3.11	28.13	79.69	79.69	79.69	131.25	131.25	131.25
	1 New Ind's	2 Comp's	3.12	21.09	59.77	59.77	59.77	98.44	98.44	98.44
	1 New Ind's	3 Comp's	3.13	15.82	44.82	44.82	44.82	73.83	73.83	73.83
	2 New Ind's	0 Comp's	3.20	46.88	132.81	132.81	132.81	218.75	218.75	218.75
	2 New Ind's	1 Comp	3.21	35.16	99.61	99.61	99.61	164.06	164.06	164.06
	2 New Ind's	2 Comp's	3.22	26.37	74.71	74.71	74.71	123.05	123.05	123.05
	2 New Ind's	3 Comp's	3.23	19.78	56.03	56.03	56.03	92.29	92.29	92.29
	3 New Ind's	0 Comp's	3.30	58.59	166.02	166.02	166.02	273.44	273.44	273.44
	3 New Ind's	1 Comp	3.31	43.95	124.51	124.51	124.51	205.08	205.08	205.08
	3 New Ind's	2 Comp's	3.32	32.96	93.38	93.38	93.38	153.81	153.81	153.81
	3 New Ind's	3 Comp's	3.33	24.72	70.04	70.04	70.04	115.36	115.36	115.36
Above Average	0 New Ind's	0 Comp's	4.00	60.00	170.00	170.00	170.00	350.00	350.00	350.00
	0 New Ind's	1 Comp	4.01	45.00	127.50	127.50	127.50	262.50	262.50	262.50
	0 New Ind's	2 Comp's	4.02	33.75	95.63	95.63	95.63	196.88	196.88	196.88
	0 New Ind's	3 Comp's	4.03	25.31	71.72	71.72	71.72	147.66	147.66	147.66
	1 New Ind's	0 Comp's	4.10	75.00	212.50	212.50	212.50	437.50	437.50	437.50
	1 New Ind's	1 Comp	4.11	56.25	159.38	159.38	159.38	328.13	328.13	328.13
	1 New Ind's	2 Comp's	4.12	42.19	119.53	119.53	119.53	246.09	246.09	246.09
	1 New Ind's	3 Comp's	4.13	31.64	89.65	89.65	89.65	184.57	184.57	184.57
	2 New Ind's	0 Comp's	4.20	93.75	265.63	265.63	265.63	546.88	546.88	546.88
	2 New Ind's	1 Comp	4.21	70.31	199.22	199.22	199.22	410.16	410.16	410.16
	2 New Ind's	2 Comp's	4.22	52.73	149.41	149.41	149.41	307.62	307.62	307.62
	2 New Ind's	3 Comp's	4.23	39.55	112.06	112.06	112.06	230.71	230.71	230.71
	3 New Ind's	0 Comp's	4.30	117.19	332.03	332.03	332.03	683.59	683.59	683.59
	3 New Ind's	1 Comp	4.31	87.89	249.02	249.02	249.02	512.70	512.70	512.70
	3 New Ind's	2 Comp's	4.32	65.92	186.77	136.77	186.77	384.52	384.52	384.52
	3 New Ind's	3 Comp's	4.33	49.44	140.08	140.08	140.08	288.39	288.39	288.39

Drug Quality			Path Code	Post Launch III.i	Post Launch III.ii	Post Launch III.iii	Post Launch IV.i	Post Launch IV.ii	Post Launch IV.iii
Average	0 New Ind's	0 Comp's	3.00	190.00	190.00	190.00	155.00	155.00	155.00
	0 New Ind's	1 Comp	3.01	142.50	142.50	142.50	116.25	116.25	116.25
	0 New Ind's	2 Comp's	3.02	106.88	106.88	106.88	87.19	87.19	87.19
	0 New Ind's	3 Comp's	3.03	80.16	80.16	80.16	65.39	65.39	65.39
	1 New Ind's	0 Comp's	3.10	237.50	237.50	237.50	193.75	193.75	193.75
	1 New Ind's	1 Comp	3.11	178.13	178.13	178.13	145.31	145.31	145.31
	1 New Ind's	2 Comp's	3.12	133.59	133.59	133.59	108.98	108.98	108.98
	1 New Ind's	3 Comp's	3.13	100.20	100.20	100.20	81.74	81.74	81.74
	2 New Ind's	0 Comp's	3.20	296.88	296.88	296.88	242.19	242.19	242.19
	2 New Ind's	1 Comp	3.21	222.66	222.66	222.66	181.64	181.64	181.64
	2 New Ind's	2 Comp's	3.22	166.99	166.99	166.99	136.23	136.23	136.23
	2 New Ind's	3 Comp's	3.23	125.24	125.24	125.24	102.17	102.17	102.17
	3 New Ind's	0 Comp's	3.30	371.09	371.09	371.09	302.73	302.73	302.73
	3 New Ind's	1 Comp	3.31	278.32	278.32	278.32	227.05	227.05	227.05
	3 New Ind's	2 Comp's	3.32	208.74	208.74	208.74	170.29	170.29	170.29
	3 New Ind's	3 Comp's	3.33	156.56	156.56	156.56	127.72	127.72	127.72
Above Average	0 New Ind's	0 Comp's	4.00	550.00	550.00	550.00	340.00	340.00	340.00
	0 New Ind's	1 Comp	4.01	412.50	412.50	412.50	255.00	255.00	255.00
	0 New Ind's	2 Comp's	4.02	309.38	309.38	309.38	191.25	191.25	191.25
	0 New Ind's	3 Comp's	4.03	232.03	232.03	232.03	143.44	143.44	143.44
	1 New Ind's	0 Comp's	4.10	687.50	687.50	687.50	425.00	425.00	425.00
	1 New Ind's	1 Comp	4.11	515.63	515.63	515.63	318.75	318.75	318.75
	1 New Ind's	2 Comp's	4.12	386.72	386.72	386.72	239.06	239.06	239.06
	1 New Ind's	3 Comp's	4.13	290.04	290.04	290.04	179.30	179.30	179.30
	2 New Ind's	0 Comp's	4.20	859.38	859.38	859.38	531.25	531.25	531.25
	2 New Ind's	1 Comp	4.21	644.53	644.53	644.53	398.44	398.44	398.44
	2 New Ind's	2 Comp's	4.22	483.40	483.40	483.40	298.83	298.83	298.83
	2 New Ind's	3 Comp's	4.23	362.55	362.55	362.55	224.12	224.12	224.12
	3 New Ind's	0 Comp's	4.30	1074.22	1074.22	1074.22	664.06	664.06	664.06
	3 New Ind's	1 Comp	4.31	805.66	805.66	805.66	498.05	498.05	498.05
	3 New Ind's	2 Comp's	4.32	604.25	604.25	604.25	373.54	373.54	373.54
	3 New Ind's	3 Comp's	4.33	453.19	453.19	453.19	280.15	280.15	280.15

Drug Quality			Path Code		Launch	Post Launch I.i	Post Launch I.ii	Post Launch I.iii	Post Launch II.i	Post Launch II.ii	Post Launch II.iii
Block-	0 New Ind's	0 Comp's		5.00	85.00	375.00	375.00	375.00	1200.00	1200.00	1200.00
Buster	0 New Ind's	1 Comp		5.01	63.75	281.25	281.25	281.25	900.00	900.00	900.00
	0 New Ind's	2 Comp's		5.02	47.81	210.94	210.94	210.94	675.00	675.00	675.00
	0 New Ind's	3 Comp's		5.03	35.86	158.20	158.20	158.20	506.25	506.25	506.25
	1 New Ind's	0 Comp's		5.10	106.25	468.75	468.75	468.75	1500.00	1500.00	1500.00
	1 New Ind's	1 Comp		5.11	79.69	351.56	351.56	351.56	1125.00	1125.00	1125.00
	1 New Ind's	2 Comp's		5.12	59.77	263.67	263.67	263.67	843.75	843.75	843.75
	1 New Ind's	3 Comp's		5.13	44.82	197.75	197.75	197.75	632.81	632.81	632.81
	2 New Ind's	0 Comp's		5.20	132.81	585.94	585.94	585.94	1875.00	1875.00	1875.00
	2 New Ind's	1 Comp		5.21	99.61	439.45	439.45	439.45	1406.25	1406.25	1406.25
	2 New Ind's	2 Comp's		5.22	74.71	329.59	329.59	329.59	1054.69	1054.69	1054.69
	2 New Ind's	3 Comp's		5.23	56.03	247.19	247.19	247.19	791.02	791.02	791.02
	3 New Ind's	0 Comp's		5.30	166.02	732.42	732.42	732.42	2343.75	2343.75	2343.75
	3 New Ind's	1 Comp		5.31	124.51	549.32	549.32	549.32	1757.81	1757.81	1757.81
	3 New Ind's	2 Comp's		5.32	93.38	411.99	411.99	411.99	1318.36	1318.36	1318.36
	3 New Ind's	3 Comp's		5.33	70.04	308.99	308.99	308.99	988.77	988.77	988.77

Drug Quality			Path Code	Post Launch III.i	Post Launch III.ii	Post Launch III.iii	Post Launch IV.i	Post Launch IV.ii	Post Launch IV.iii
Block-	0 New Ind's	0 Comp's	5.00	1400.00	1400.00	1400.00	775.00	775.00	775.00
Buster	0 New Ind's	1 Comp	5.01	1050.00	1050.00	1050.00	581.25	581.25	581.25
	0 New Ind's	2 Comp's	5.02	787.50	787.50	787.50	435.94	435.94	435.94
	0 New Ind's	3 Comp's	5.03	590.63	590.63	590.63	326.95	326.95	326.95
	1 New Ind's	0 Comp's	5.10	1750.00	1750.00	1750.00	968.75	968.75	968.75
	1 New Ind's	1 Comp	5.11	1312.50	1312.50	1312.50	726.56	726.56	726.56
	1 New Ind's	2 Comp's	5.12	984.38	984.38	984.38	544.92	544.92	544.92
	1 New Ind's	3 Comp's	5.13	738.28	738.28	738.28	408.69	408.69	408.69
	2 New Ind's	0 Comp's	5.20	2187.50	2187.50	2187.50	1210.94	1210.94	1210.94
	2 New Ind's	1 Comp	5.21	1640.63	1640.63	1640.63	908.20	908.20	908.20
	2 New Ind's	2 Comp's	5.22	1230.47	1230.47	1230.47	681.15	681.15	681.15
	2 New Ind's	3 Comp's	5.23	922.85	922.85	922.85	510.86	510.86	510.86
	3 New Ind's	0 Comp's	5.30	2734.38	2734.38	2734.38	1513.67	1513.67	1513.67
	3 New Ind's	1 Comp	5.31	2050.78	2050.78	2050.78	1135.25	1135.25	1135.25
	3 New Ind's	2 Comp's	5.32	1538.09	1538.09	1538.09	851.44	851.44	851.44
	3 New Ind's	3 Comp's	5.33	1153.56	1153.56	1153.56	638.58	638.58	638.58

Appendix F. Actual Revenue Matrix

Actual Revenue Payoffs ($ Millions)

Year (Time) =>		11	12	13	14	15	16	17	18	19	20	21
Year of Discovery	Drug#	Launch 3.00	Post Launch I.i 4.00	Post Launch I.ii 5.00	Post Launch I.iii 6.00	Post Launch II.i 7.00	Post Launch II.ii 8.00	Post Launch II.iii 9.00	Post Launch III.i 10.00	Post Launch III.ii 11.00	Post Launch III.iii 12.00	Post Launch IV.i 13.00
1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	30.00	79.69	79.69	99.61	164.06	164.06	153.81	208.74	208.74	208.74	170.29
2	1		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4		60.00	170.00	170.00	170.00	262.50	262.50	196.88	309.38	309.38	309.38
3	1			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2			12.00	25.00	25.00	31.25	37.50	37.50	28.13	60.94	60.94
	3			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4			30.00	85.00	85.00	85.00	140.00	105.00	131.25	222.66	222.66
4	1				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2				3.00	7.50	5.63	4.22	6.33	6.33	6.33	10.55
	3				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	1					0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2					0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3					0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4					0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1						0.00	0.00	0.00	0.00	0.00	0.00
	2						30.00	85.00	85.00	85.00	175.00	175.00
	3						0.00	0.00	0.00	0.00	0.00	0.00
	4						0.00	0.00	0.00	0.00	0.00	0.00
7	1							0.00	0.00	0.00	0.00	0.00
	2							0.00	0.00	0.00	0.00	0.00
	3							0.00	0.00	0.00	0.00	0.00
	4							3.00	10.00	10.00	10.00	15.00
8	1								12.00	25.00	25.00	25.00
	2								22.50	63.75	63.75	63.75
	3								0.00	0.00	0.00	0.00
	4								0.00	0.00	0.00	0.00
9	1									0.00	0.00	0.00
	2									0.00	0.00	0.00
	3									0.00	0.00	0.00
	4									0.00	0.00	0.00
10	1										0.00	0.00
	2										3.00	10.00
	3										0.00	0.00
	4										0.00	0.00