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The Economic Profitability of Pharmaceutical Firms: Estimates Using the Case Recovery Method

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The Economic Profitability of Pharmaceutical Firms:

Estimates Using the Cash Recovery Method*

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Abstract:

The economic profitability of the pharmaceutical industry is a recurrent policy question. A central issue in answering this question is how to measure economic profit. The problems with commonly used accounting profit rates are well documented. The cash recovery method of estimating economic profitability is investigated and modified as a means to estimate profitability in the pharmaceutical industry on a firm level. The profitability estimates give a similar rank order to the accounting profitability rate, but have different magnitudes. Results using this method suggest little or no economic profits in the industry.

Key Words: Profitability, Pharmaceuticals, Market Performance

JEL: L1, L65

I. Introduction

> The unadjusted accounting rate of profit, as computed by the usual methods from balance sheets and income statements, is prima facie an absolutely unreliable indicator of the presence or absence either of monopoly power or of excess profits... (Joe Bain, 1941, p. 291)

The pharmaceutical industry is a recurring area for profitability analysis. Three out of every four years since 1960, the pharmaceutical industry has ranked first or second in after tax return on stockholders' equity in the United States (Scherer 1993, p. 98). This profitability has attracted much attention, including that of Congress. Beginning with the 1959-1962 Kefauver committee hearings, Congress has repeatedly investigated the pharmaceutical industry.[1] One of the main Congressional concerns has been the profitability of an industry with so much impact on health and quality of life. "Increases in real drug prices and perceived high prices for new drugs have been a concern of Congressional committees for more than thirty years." (OTA 1993, p. 3) What fuels these continuing investigations is the difficulties with accounting measures to determine profitability in the industry.

There is a large literature concerning bias in accounting profitability measures which culminates in Fisher and McGowan (1983). In synthesizing and extending the previous work on the subject, they allow the problems with accounting measures to be reduced to two main concerns: (1) measuring firm assets and (2) the timing of cash flows generated by those assets. While researchers such as Long and Ravenscraft (1984) have challenged Fisher and McGowan's sweeping conclusion, "There is no way in which one can look at accounting rates of return and infer anything about relative economic profitability"(p. 90), the need to recognize and adjust for accounting bias is now an accepted fact (Schmalensee, 1989). The theoretically correct measure of the profit rate is the internal rate of return (IRR) which is the discount rate that equates the investment and the cash flows (Fisher and McGowan 1983).

Even though there is a large literature enumerating the flaws of accounting profitability measures, seldom have all the problems been addressed in a single empirical method. The cash recovery rate is the quotient of the cash generated in a period and the investment from the previous periods that are still active. Ijiri (1978) proposes converting accounting aggregates to approximate firm cash flows and computing a cash recovery rate (CRR).[2] Using the CRR and a mathematical model of a firm, the cash recovery method (CRM), that incorporates firm growth, an IRR for a firm or industry can be

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[1] The Kefauver committee hearings led to the Kefauver-Harris Act of 1962. In 1978 Senator Kennedy began a series of hearings that culminated in the 1984 Waxman-Hatch Act. To coincide with the health care debate, the Office of Technology Assessment prepared a report on the industry (OTA, 1993).

estimated. Salamon (1982) improves the method by incorporating the time shape of cash flows and inflation. Ijiri (1979) and Salamon (1988) acknowledge that further work on the CRM is warranted. Both the mathematical model and the empirical parameters needed to implement the model require scrutiny.

Baber and Kang (1991) use the CRM basically as described by Salamon (1982) to estimate the economic profit rate of the pharmaceutical industry. This study was commissioned by the Office of Technology Assessment for the 1993 report Pharmaceutical R&D: Costs, Risks and Rewards. One of the main conclusions of the report is "Pharmaceutical R&D is a costly and risky business, but in recent years the financial rewards from R&D have more than offset its costs and risks" (p. 1). In other words there have been economic profits in the industry. Baber and Kang's analysis is one of the main bases for this conclusion. Unfortunately Baber and Kang, as well as other researchers who have used the CRM, have not used industry specific data in performing their analysis or incorporate the lag in R&D expenditures.

This paper makes a contribution to the literature by computing the profitability of a sample of R&D intensive pharmaceutical firms using firm level data on cash flows and industry data to compute the cash flow profile and uses these in a theoretical and empirically improved CRM. The first part of the paper discusses problems with accounting profitability rates and how the CRM handles them. The second section of the paper examines and solves theoretical and implementational problems with the CRM. Section three contains the industry specific analysis necessary to estimate profitability in the pharmaceutical industry, the profitability estimates for a sample pharmaceutical firms and sensitivity tests of the results. These estimates show the firms' cost of capital is closely correlated with the IRR estimates. This implies not only that the firms are earning little or no economic profit, but also lends credence to the CRM as a method of profitability estimation.

I. Accounting Profitability Rates and the CRM

Fisher and McGowan (1983) join a number of strands of the literature concerning accounting bias in profitability rates. In examining the return on assets measure, they identify the two main concerns: (1) correctly measuring the assets of the firm and (2) matching firm cash flows to the assets that generated them. These two larger concerns derive from five causes--inflation, intangible capital, depreciation, growth, and the cash flow profile (CFP) of the assets. Assets would be measured correctly, if the effects of inflation were incorporated, the existence of intangible capital was recognized, and a measure of economic depreciation were used. As firms grow and investments age, it is difficult to match cash flows and the

assets that generated them. The CRM was originated by Ijiri (1978, 1979, 1980) and developed by Salamon (1982, 1985) to correct the flaws in accounting profitability measures. The basic concept underlying the method is to convert accounting aggregates to a cash basis to measure assets and then match those assets to their cash flows they generate using a model of firm cash flow.

The main assumption in the CRM is a firm can be represented as a collection of projects that all have the same IRR, life, and CFP. In conjunction with this larger assumption the following assumptions are also necessary: the firm purchases a new project each year, the projects differ only in respect to scale (size), the project in a given year is the sum of investments made by the firm in that year. This mixture of projects or composite project is assumed to be stable over time.[3] The model allows for capitalizing intangible capital, bases depreciation of assets on cash flows, incorporates growth, and uses the CFP to match assets to cash flows.

The IRR estimated by the CRM is the rate of return generated by assets owned by the firm. This IRR can be compared to the cost of capital of the firm to judge whether the firm is earning economic profits. Since firms raise capital in a competitive capital market and potentially operate in an uncompetitive product market, this measure should show a positive economic profit if it is present.

Baber and Kang (1991) and Shinnar et al (1989) develop similar mathematical models. Baber and Kang start with two separate equations, one for the internal rate of return (IRR) and one for the cash recovery rate (CRR). By combining the two equations, the IRR can be estimated. Starting with the IRR equation each project can be thought of as requiring a one dollar investment at time zero and producing cash flows (CFP), $c_1, c_2, .. c_N$, from N years, the investment life. Following the usual caveats of this type of equation a unique IRR, r, can be obtained.

$$1 = \frac{c_1}{(1+r)^1} + \frac{c_2}{(1+r)^2} + \ldots + \frac{c_N}{(1+r)^N} \qquad \textbf{(1)}$$

Equation (2) defines the CRR in terms of the cash flows and the assets that generate them, CP, the composite project. Cash recovery, the numerator, is written as the sum of recoveries from previous projects. The firm's investment,

[3] As Ijiri (1979) points out, "A corporation invests in a variety of projects, each having a different cash recovery pattern (including a different economic life). However, if it is reasonable to assume that a mix of such projects as well as the cash flow pattern of these projects are reasonably stable over time, corporate investments may be regarded as a repeat investment in a given composite project with a given cash flow pattern over its life" (p. 261).

the denominator, is the sum of the CP that are currently active.

$$CRR_t = \frac{c_1 * CP_{t-1} + c_2 * CP_{t-2} + \ldots + c_N * CP_{t-N}}{CP_{t-1} + CP_{t-2} + \ldots + CP_{t-N}} \qquad \textbf{(2)}$$

In order to solve the above equations jointly for the IRR, one additional assumption is necessary. That the firm growth rate, G, is constant over time. This incorporates the increase in scale of the projects.[4] Using these assumptions, and writing the CFP in functional form, Q(K), the two equations can be combined to produce the following equation.

$$CRR_t = \left[\frac{Q_1(K)}{(1+r)^1} + \frac{Q_2(K)}{(1+r)^2} + . + \frac{Q_N(K)}{(1+r)^n} \right]^{-1} * \left[\frac{Q_1(K) * G^{N-1} + Q_2(K) * G^{N-2}}{G^{N-1} + G^{N-2} + ..} \right. \qquad \textbf{(3)}$$

Equation (3) implies that the IRR depends on: (1) the growth rate of investment, (2) the CFP (3) the life of assets, and (4) the CRR. The CRR and the growth parameter can be estimated from firm financial statements. Little work has been done on estimating the shape of CFP and the life of firm assets. Although a distributed lag model might be used to estimate the CFP from firm financial data, industry data on product cash flows or sales is a more fertile ground for examining the CFP.

II. Improvements to the CRM

1. Investment Flows

While the CRM, as outlined in the previous section and the literature, treats investment as a point input, most firms invest in projects that take many years to complete. Investment in most industries occur over a number of years. As stated earlier, if the above assumptions of the model are met, the firm's investment in any year are a composite of the individual projects purchased that year. The correct way to model the IRR for a firm, with this type of investment structure, is to capitalize the investment flows to the date of completion and discount the cash inflows. This would require rewriting equation (1) to be:

$$X_1 * (1+r)^M + X_2 * (1+r)^{M-1} + \ldots + X_M = \frac{c_1}{(1+r)^1} + \frac{c_2}{(1+r)^2} + \ldots + \frac{c_N}{(1+r} \qquad \textbf{(4)}$$

[4] To see a discussion of this assumption, see Taylor (1994).

X=investment
M= # of years of investment

Equation (4) discounts the investment flow to a common year, one year prior to the beginning of cash flows. While this method is theoretically correct, it would be difficult to implement using firm level financial data. A flow profile, i.e. index numbers, could be used, but the index numbers between the investment flow profile and CFP would have to be to the same scale. If the investment flows and the CFP of the representative asset were known, the IRR could be calculated without using firm financial data.

A second approach, to correct the CRM, that requires less direct information about firm investments, would be to sum the inputs to a given year and adjust the CFP to compensate. In effect, convert the flow such that it applies at a point. If this could be accomplished, then the earlier derived relationship between the CRR and the IRR could be used. The main information needed to make this method work is the length of the investment flow.

The applicability of the summation method is dependent on the sensitivity of the summation point, and the subsequent shift in the CFP, to the other parameters in the model. The summation point should not be overly sensitive to the shape of input profile, but more importantly, not significantly sensitive to the underlying IRR of the project.

In testing the robustness of the summation procedure, three investment profiles were used. The equations for the profiles, as well as the results of the tests, are shown in Table I.

Table I

The Sensitivity of Summation Points

Length	Flat Profile IRR				Increasing Profile IRR				Decreasing Profile IRR			
	.05	.10	.15	.20	.05	.10	.15	.20	.05	.10	.15	.20
12	6.3	6.6	6.9	7.1	3.2	3.4	3.6	3.8	8.4	8.6	8.8	9.0
11	5.7	6.0	6.2	6.5	3.1	3.3	3.4	3.7	7.6	7.7	7.9	8.1
10	5.2	5.4	5.6	5.8	3.0	3.1	3.3	3.5	6.7	6.9	7.0	7.2
9	4.7	4.8	5.0	5.2	2.8	2.9	3.1	3.2	5.9	6.1	6.2	6.3
8	4.1	4.3	4.4	4.5	2.6	2.8	2.9	3.0	5.1	5.2	5.4	5.4
7	3.6	3.7	3.8	3.9	2.4	2.5	2.6	2.7	4.4	4.5	4.6	4.6
6	3.1	3.1	3.2	3.3	2.2	2.3	2.3	2.4	3.7	3.7	3.8	3.8
5	2.6	2.6	2.7	2.7	1.9	2.0	2.0	2.1	3.0	3.0	3.1	3.1
4	2.0	2.1	2.1	2.1	1.6	1.7	1.7	1.7	2.3	2.3	2.4	2.4
3	1.5	1.5	1.6	1.6	1.3	1.3	1.3	1.4	1.7	1.7	1.7	1.7
2	1.0	1.0	1.0	1.0	.9	.9	.9	.9	1.1	1.1	1.1	1.1

Notes:

The columns contain the summation point for the profile length in first column and the IRR at the top of the column. For example, for the third column under the flat profile and length of six, the summation point is 2.8. Where two adjacent cells are underlined this shows where the summation point shifts periods.

The summation procedure requires thinking of the investment as a point input, placed in the mid-section of the original investment cycle. Rewriting the left side of equation (4) in the following manner:

$$X_1*(1+r)^M+X_2*(1+r)^{M-1}+...+X_M = \sum_{q=1}^{M} [X_q]*(1+r)^Z \qquad \textbf{(5)}$$

Z=summation point

Solving for Z, in equation (5), gives the summation year and the necessary adjustment to the CFP. For a flat profile with a length of three, Z equals two. In order to solve for Z in discrete time, iteration must be used. Using continuous compounding equation (5) can be rewritten as:

$$\int_0^M X_t\ e^{rt}\ dt = [\int_0^M X_t\ dt]e^{rZ} \qquad \textbf{(6)}$$

Equation (6) can be explicitly solved for Z. Equations (5) and (6) show the shape or duration of the CFP is only relevant to the summation point in its influence on the IRR. Performing a sensitivity analysis using various investment profiles, lengths and IRRs, shows the summation point is fairly stable. From the results of the sensitivity analysis, the maximum error in placement of the summation point, with knowledge of the profile and not underlying the IRR, is one year. The longer the profile the more the shape matters. For industries with relatively short profiles, two or three years, a small error, a summation point of zero verses one year, is introduced by ignoring the investment flows.

2. Measuring the Parameters

In addition to examining the CRM mathematical model, how to measure empirically the CRR from firm financial data needs clarification. Since accounting data is not calculated on a cash flow basis, there is no theoretically exact empirical measure for the CRR. Any measure will be an approximation. The main discussion in the literature is how to incorporate current assets into the calculations.

Current assets and long-term assets are distinctly different in uses, financing and accounting. In lumping these very different assets together, they are forced to all have the same life, N, and the same CFP. Stark (1987) explains if current asset balances are present, the CRR is fundamentally unobservable. Each year current assets are drawn down by recoveries, sales, but are simultaneously increased by new investment. If you assume current assets (CA) are financed by current liabilities (CL), then CA should not be classified as an investment. Lee & Stark (1987) calculate the denominator of

the CRR, investment, as gross fixed assets.

The question remaining is how to define investment if CA are not financed by CL. Firm data from the pharmaceutical industry show these firms have large positive working capital balances, CA>CL. The portion of CA financed by long-term obligations, CA minus CL, should be considered investment and included in the denominator of the CRR. Based on the above arguments, investment is the sum of total assets minus CL plus depreciation (TASS-CL+ACCDEPR) and the capitalized value of intangible capital (RD) and in some cases advertising (ADV).

There is more agreement in the literature on measuring cash recovery, the numerator of the CRR. Operating income before depreciation minus taxes is the crudest measure. Since the effects of R&D and advertising may last for more than one year, the investment in intangible capital should be added to cash recoveries. Any decrease in working capital, $(CA_{t-1}-CL_{t-1})-(CA_t-CL_t)$=DELWC, should be considered a recovery. Recoveries will be defined as the sum of income from operations (INCBD), interest expense (INTEXP), changes in the working capital balance (DELWC) and investments in intangible capital (RD) + (ADV) minus taxes, calculated as the effective tax rate times income minus depreciation, (t*(INCBD-DEPR)). The equation for estimating the CRR is:

$$CRR = \frac{INCBD + RD + ADV + INTEXP + DELWC - t*(INCBD - DEPR)}{TASS - CL + ACCDPR + \sum RD + \sum ADV} \qquad \textbf{(7)}$$

III. Estimating the Rate of Return to Pharmaceutical

1. Sample

***COST OF CAPITAL PARA

The sample of pharmaceutical firms used in this analysis is, with the following exceptions, the group used by Myers and Shyam-Sunder (1991) and the Office of Technology Assessment's 1993 report, Pharmaceutical R & D: Costs, Risks and Rewards[5], as representative of the most R&D intensive firms. Firms such as Glaxo and Smith Kline Beecham PLC are excluded because of foreign accounting practices and currency conversion concerns. Four firms in the Myers and Shyam-Sunder sample merged during this period. In 1989 Bristol Meyers merged with Squibb as did A.H. Robins with American Home Products. The numbers from the post-merger restatement are used for these two firms. The data comes from Compustat for the years 1975-1991. The eleven firms in the sample and the variables used in the analysis are shown in Appendix A. Like Baber and Kang (1991), data previous to 1975 is not used because of the change in accounting rules for R&D.

In implementing the CRM, the three main aspects of the industry that need to be examined in order to parameterize the model are the CFP of pharmaceutical, the life of intangible capital, R&D and promotion expenditures, and the effective tax rate.

2. Cash Flow Profile

An important area where specific industry knowledge is needed to implement the CRM is the shape of cash flows generated by the assets of the firm. In previous work on the CRM, no one has used actual cash flow data to develop the CFP. Salamon (1982) calls for either more research into what firm or industry cash flows look like or suggests assuming that all firms have the identically shaped cash flows. Until now the second suggestion has been followed by researchers.

The profitability analysis will cover the years 1975 through 1991. Data on new chemical entities, NCEs, from 1970-1989 were obtained from IMS America. Sales of all new drugs during this time period are included, except for cancer drugs and those developed by or with non profit entities. There is an average of 12 years of data on most new chemical entities, most of which reach peak sales in this time. In order to estimate the entire product life cycle, I rely on estimates

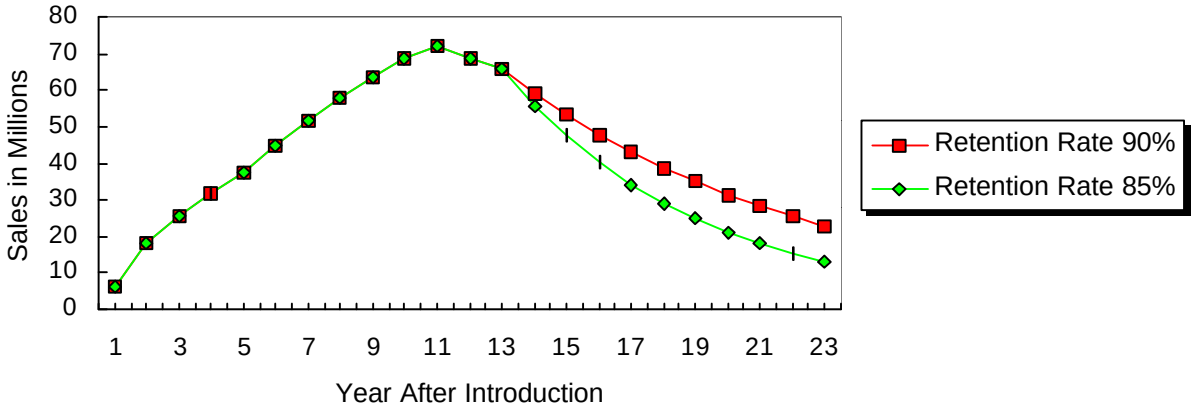
[5] Appendix C of OTA (1993) draws heavily on the Myers and Shyam-Sunder paper. The cost of capital estimates used in this analysis come from the Myers and Shyam-Sunder paper. Using the CAPM model they calculated the unleveraged beta and then adjusted for the individual firm debt ratio verses the market debt ratio.

made by Grabowksi and Vernon (1990, 1995) as to the length of the CFP. The four important pieces of information needed to construct these profiles are the slope of the profile, the timing of the peak, the rate of decay after the peak, and the length of the profile.[6] It is important to remember in this context the profiles are really only index numbers, i.e., what really matters is the shape. The basic method for estimating sales for the part of the profile on which data is not available is to extend the data up to peak sales using least squares regressions, if necessary, and then use a retention rate to project the sales in the remaining years.

Since NCEs will not begin to make significant contributions to a firm's cash flow until at least a couple of years after introduction, the CFPs for the NCEs introduced in the previous years are needed to investigate the profitability of a firm for the entire period. Therefore, the CFP to be used in the analysis of 1975-1991 financial data will be estimated from data from NCEs introduced between 1970-85 data.

[6] For more information on the change in the CFP of pharmaceuticals, see Taylor (1994).

Figure I
1970-1985 NCE Sales



The CFP, Figure I, is for 1970-85 introductions. Investigation by Grabowksi and Vernon (1990, 1993) and Jogelkar and Paterson (1986) look at the product life cycle of NCE's during different portions of this period. Grabowski and Vernon (1990) and Jogelkar and Paterson (1986) look at 1970s NCEs and show projected lives of 25 and 24 years respectively with peak sales in mid profile. Grabowski and Vernon (1993) look at 1980s NCEs and show a projected life of 20 years with peak sales in year 11. In this analysis NCEs are assumed to have a life of 23 years with peak sales in year 11. Sales are assumed to decay at a constant rate. Two different decay rates of 10 percent and 15 percent. In other words the year after peak sales are 90 or 85 percent of the previous years sales. In five years these drugs show a 40 and 50 percent lose in sales respectively. These rates are biased toward making the pharmaceutical more profitable. Grabowski and Vernon (1992) show that a number of NCEs lose 50 percent of the market share three years after losing patent protection. Both of these profiles are used in the analysis. The profile with the faster decay rate will be referred to as profile 1. Mattison, Trimble and Lasagna (1989) show that the length of the R&D for these drugs is between 9 and 14 years and that the amount of investment slowly increases each year. For the base case the summation point will be at year -5. The actual index numbers used for the CFP are given in Appendix A.

Adjusting for the summation point is important. For example, if the flow profile is used with no adjustment in the 1975-1991 analysis, a summation point of zero, the average IRRs change by over 2.5 percent. The firms' IRR changes by between 1.5 and 4 percent. The effect of incorporating the investment profile varies with a number of factors. High growth rates in conjunction with a high cash recovery rate minimize the effect of shifting the CFP. As the growth rate and CRR diverge, the effect of incorporating the summation point increases.

3. Intangible Capital

One of the most distinctive characteristics of the industry, and a large source of error in computing profitability, is the large investment in intangible capital. In 1991 the eleven firms in this sample spent a combined $7.237 billion on R&D. According to generally accepted accounting principles, R&D and advertising expenditures are treated as expenses (Baber & Kang 1991). In other words, they are subtracted from earnings in the year incurred. If current R&D and promotion generate future cash flows, they should be treated as assets.

The difficulty measuring the life of R&D or intangible capital in general is one of the reasons for not capitalizing and depreciating these assets. Studies by Clarkson (1977), Grabowski and Vernon (1990, 1993), Dimasi et al (1992) and the OTA (1993) all estimate or use estimates of the length of the investment process. If one compares the sum of tangible capital of the 11 firms in 1991, $73.589 billion, with the amount invested in R&D for the past 20 years, $51.905 billion, one can see the importance of R&D to the firms' capital stock.[7] Assuming that all the drugs that reach market follow basically the same investment and revenue profile, i.e. 10 years of investment and 20 years of the revenue, the mean life of R&D expenditures is approximately 25 years with a maximum of 30 years.[8]

Since it is necessary to have 25 years of R&D expenditures to capitalize, and the accounting procedures for R&D were modified in 1975, previous R&D expenditures must be estimated. Looking at the R&D expenditures by firms the general trend is clear. The expenditure on R&D grows logarithmically. The equation used to estimate previous R&D is simply the natural log of R&D equals a constant plus a time trend. Each firms' R&D expenditures are analyzed individually. Since the purpose in estimating R&D expenditures is to predict past expenditures, it is important to test for structural change in the series. The relationship significantly changes between the early 1970s and the late 1980s. In predicting the R&D expenditures of those firms, the data up from 1970 to 1985 are used.[9]

Another form of intangible capital that is important in the pharmaceutical industry is advertising or promotion. Since products can have lives of up to 25 years, the effects of promotion could be that long. The industry uses two main

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[7] Tangible capital is computed as the sum of total assets.

[8] For example, if the firm begins the 10 year investment cycle for a new drug every year. Then the firm will be investing in 10 drugs at different stages of completion every year. Therefore, the average of the firms investments will be half completed in any given year. This along with the sales profile gives an average life of investment of 25 years. Some portion of each year's investment will still be active in 30 years.

[9] Poirier (1976) and Suits et al. (1978) discuss the regime switching problem.

methods of promotion, journal and mail advertisements and personal visits by sales staff known as detailmen. The largest expenditure on promotion is the detailmen.

The question of a correct amortization rate for advertising began as an investigation into the measurement of advertising cumulative effects. Peles (1971) looks at three industries--beer, cigarettes, and passenger cars--and reconstructs demand functions for these industries. The rate of amortization is determined by measuring the effect of firm advertising expenditures on sales. The results of this model suggest depreciation rates of 30 to 50 percent.

Clarkson (1977) adjusts accounting profit rates by capitalizing intangible capital, R&D and advertising. He points out that a large portion of promotion expenditures are on direct personal interaction and therefore, those expenditures should have a durable effect. He assumes a three year life for advertising and promotion, but he indicates that this is a conservative assumption. Grabowski and Mueller (1978) assume a 30 percent depreciation rate, which is in line with the later results of Hirschey and Weygandt (1985). At a 30 percent depreciation rate a five year life would mean over three quarters of the investment would be dissipated. In conducting the profitability analysis, advertising will be capitalized for three years, five years, and expensed.

D. Taxes

Another significant issue, in computing corporate cash flows in the pharmaceutical industry is accounting for income taxes. From 1975-1991 the marginal statutory federal corporate tax rate was 46 percent in the early period and 34 percent after the 1986 tax reform, taking place in the 1987 fiscal year. State income taxes also play an important role. During this period, 46 states had corporate income taxes with maximum statutory rates ranging from 2.35 percent to 12 percent (Toolson and Nunamaker 1991).

In addition to the variation in the tax rates during this period, pharmaceutical firms have a number of tax credits and deferrals that cause their tax payments to differ substantially from the statutory rate in any given year.[10] In the corporate 10-K reports, firms show the portion of this year's income that will be subject to taxes and record a deferral to note the portion of this year's income which will be paid in tax in following years. Firms do not report payments of deferred taxes from previous years separately. The deferred income tax account is similar to the current asset account discussed earlier. Since previous deferred taxes are being paid at the same time as new deferred taxes are being generated, these two effects

[10] These credits and deferrals include the orphan drug credit, accelerated depreciation, the R&D credit, operations in countries and territories that give preferential tax treatment, such as Puerto Rico, Ireland, the Bahamas, and overseas income not returning to the United States.

cannot be disentangled using firm financial data. Baber and Kang (1991) calculate the cash flows from taxes by subtracting deferred income taxes shown from income taxes on the income statement. For the purpose of this analysis, income tax payments will be estimated using an effective tax rate. Following Grabowski and Vernon (1994) an effective tax rate of 35 percent on corporate income after R&D and depreciation expense is used. An assumption of a 32 percent effective tax rate as used in the OTA report is used in the sensitivity analysis.

E. Results and Sensitivity Tests

In addition to using the above assumptions about the CFP, R&D and taxes, a number of other assumptions are necessary in performing the profitability analysis. The growth rate is computed as the average growth in the sum of total assets and R&D minus depreciation for the years 1975-1991. The CRR recovery rate is computed using the formula shown in equation 7 and then averaged over the 17 years. Estimates for the growth rate, the CFP, and CRR are given for each firm in Appendix A.

Table II contains the estimates of profitability for 1975-1991. On average the firms show no economic profit. Warner-Lambert shows a sizeable economic loss. The rest of the firms have profits between plus or minus three percent. The average profit of the group without Warner-Lambert is approximately 0.6 percent. Syntex and Bristol Myers Squibb have the highest average cost of capital and they also have two of the top five IRRs. Capitalizing advertising for this period increases the IRR estimates. Warner-Lambert's loss shrinks by 50 percent when advertising is capitalized. The Spearman rank test shows the hypothesis that the order of the IRRs and the cost of capital are related at the .05 level of significance. To the extent that these firms have investments in assets that do not follow the estimated CFP, the assets do not generate revenue for such a long period, these estimates are biased downward.

Table II

Profitability Estimates for 1975-1991

Firm	CFP	Cost of Capital[A]	IRR	IRR-COC	IRR-COC Adv 3 Yrs	IRR-COC Adv 5 Yrs
Abbott Labs	1	16.66	17.94	1.28	1.60	1.39
	2	16.66	18.01	1.35	1.62	1.48
American Home Prod.	1	15.64	16.55	0.91	1.81	1.20
	2	15.64	16.72	1.08	1.93	1.26
Bristol Myers Squibb	1	17.38	18.74	1.36	2.05	1.67
	2	17.38	18.83	1.45	2.13	1.73
Eli Lilly & Co.	1	16.91	15.94	-0.97	-0.73	-0.81
	2	16.91	16.01	-0.90	-0.65	-0.77
Johnson & Johnson	1	16.31	17.67	1.36	2.19	1.78
	2	16.31	17.75	1.44	2.24	1.86
Merck & Co.	1	15.90	17.84	1.94	2.32	2.11
	2	15.90	17.92	2.02	2.45	2.18
Pfizer	1	16.00	15.48	-0.52	0.08	-0.12
	2	16.00	15.57	-0.43	-0.02	-0.16
Schering-Plough	1	16.28	16.20	-0.08	1.12	0.80
	2	16.28	16.28	0.00	1.18	0.84
Syntex	1	19.07	22.45	3.38	3.76	3.46
	2	19.07	22.46	3.39	3.78	3.47
UpJohn	1	16.22	13.57	-2.65	-2.05	-1.85
	2	16.22	13.52	-2.60	-2.01	-1.82
Warner-Lambert	1	17.00	11.19	-5.81	-2.55	-3.49
	2	17.00	11.37	-5.63	-2.48	-3.32
Average	1	16.67	16.69	0.01	0.87	0.56
	2	16.67	16.78	0.09	0.93	0.69
Average w/o W-L	1	16.64	17.24	0.60	1.22	0.97
	2	16.64	17.32	0.68	1.27	1.09

[A] Cost of capital estimates are from Myers and Shyam-Sunder (1991).

Table III shows the base estimates of the IRR for 1975-1991 compared with the accounting profit rates, return on assets and return on equity. The critics of the industry always cite the high return on equity, which ranges from 16 to almost 30 percent. The return on assets on the other hand are in a number of cases one-half of the return on equity. Comparing the return on assets to the costs of capital would actually indicate economic losses. The rank tests shows that the order of firms based on returns on assets and return on equity gives the same ordering as the ordering based on the IRR estimates at the .025 and .01 level respectively.

Table III

Internal Rate of Return Estimates and Accounting Profit Rates 1975-1991

Firm	IRR	ROA	ROE
Abbott Labs	18.12	13.88	25.77
American Home Prod.	16.79	21.03	28.12
Bristol Myers Squibb	18.74	15.53	22.05
Eli Lilly & Co.	15.94	13.56	19.16
Johnson & Johnson	17.67	14.78	21.17
Merck & Co.	17.84	16.93	28.58
Pfizer Inc.	15.48	11.38	17.30
Schering-Plough	16.20	15.80	20.96
Syntex	22.45	17.45	27.14
UpJohn	13.57	11.96	18.48
Warner-Lambert	11.19	9.94	16.13

Table IV

Sensitivity Tests 1975-1991

		Internal Rate Of Return				
Firm	CFP	Tax=.32	CRR + 1%	G + 1%	CRR&G + 1%	CFP+1 yr
Abbott Labs	1	0.18	0.40	0.49	0.91	0.28
	2	0.18	0.41	0.49	0.91	0.30
American Home Prod.	1	0.24	0.36	0.46	0.82	0.50
	2	0.21	0.35	0.43	0.80	0.51
Bristol Myers Squibb	1	0.20	0.38	0.52	0.90	0.76
	2	0.19	0.38	0.50	0.89	0.36
Eli Lilly & Co.	1	0.20	0.44	0.48	0.92	0.22
	2	0.20	0.45	0.46	0.92	0.23
Johnson & Johnson	1	0.39	0.39	0.50	0.90	0.30
	2	0.39	0.40	0.49	0.89	0.32
Merck & Co.	1	0.21	0.40	0.51	0.91	0.30
	2	0.21	0.40	0.49	0.90	0.31
Pfizer	1	0.17	0.44	0.47	0.91	0.26
	2	0.16	0.44	0.45	0.90	0.68
Schering-Plough	1	0.20	0.43	0.48	0.91	0.35
	2	0.20	0.44	0.46	0.91	0.26
Syntex	1	0.23	0.40	0.56	0.97	0.10
	2	0.23	0.41	0.56	0.98	0.63
UpJohn	1	0.15	0.67	0.47	1.15	-0.24
	2	0.16	0.68	0.46	1.15	-0.26
Warner-Lambert	1	0.18	0.49	0.34	0.83	0.31
	2	0.18	0.50	0.31	0.82	0.34
Average	1	0.21	0.43	0.47	0.92	0.28
	2	0.20	0.43	0.72	0.90	0.32
Average w/o W-L	1	0.22	0.43	0.48	0.93	0.28
	2	0.20	0.43	0.77	0.91	0.32

The results of the sensitivity tests are shown in Table IV. The base IRR estimates for 1975-1991 are shown in the third column. Changing the effective tax rate from the 35 percent base rate assumption to 32 percent, as assumed by the OTA, increases the economic profit rate by approximately 0.2 percent. Increasing the CRR by one percent, which is an average increase of 5 percent over the base case, increases the economic profit rate by about 0.4 percent. A 1 percent increase in the growth rate, which is an average increase of 8 percent, raises the economic profit rate by 0.5 percent. Column seven of Table IV shows the combined result of an increase in the effective CRR and a increase in the growth rate. The average effect of these changes is a 0.9 percent increase in profitability. Changing the summation point by one year gives a slightly larger change in profitability than changing the tax rate. The sum of changing the CRR and growth separately has the same effect on the IRR estimate as changing both effects simultaneously. This is a useful feature of the CRM since it allows easier calculation of multiple parameter shifts.

The CRM is robust with respect to changes in the base assumptions. Using variants of the CFP, growth rates, cash recovery rates, taxes, and depreciation rates for advertising had effects of under 1 percent. The CRM is more sensitive to changes in the CFP than had been previously thought. By shifting the profile by five years and not changing the CFP causes up to a four percent and on average a 2.5 percent change in the IRR estimate.

The rank of firms by IRR estimates closely follow the rank of firms by the cost of capital estimates. The rank of firms by IRR estimates also statistically matched the ranking by accounting profit rates. This provides preliminary evidence that the accounting profit statistics may provide information on the relative economic profitability of firms. Applying the CRM to other industries, with the same detail as used in this study, would show if same type of ranking results are obtained.

While the CRM, with the theoretical modifications presented, works well, the need for industry specific data is apparent. When the method was first proposed, Ijiri (1978), the only data called for by the method were publicly available accounting data. It is clear from the results that industry specific data and knowledge are also needed. Firm-specific investment flows and cash flows as well as other industry specific concerns, such as taxes and intangible capital, are important when using the CRM.

With respect to the industry results, the estimates show the industry earning small economic profits between zero and one percent. This is in line with the results of Grabowski and Vernon (1993), a study looking at profitability on a product level, but significantly below the findings of the Office of Technology Assessment Report (1993). The results do not show the industry as ripe for regulation.

Appendix A

1. List of variables

Income before depreciation and taxes (INCBD)
Research and development expense (RD)
Interest expense (INTEXP)
Total assets (TASS)
Current assets (CA)
Current liabilities (CL)
Accumulated Depreciation (ACCDEPR)
Advertising Expense (ADV)
Depreciation Expense (DEPR)

2. Computed cash recovery and growth rates

		CRR	Growth
Abbott Laboratories	22.40	14.14	
American Home Products	24.11	9.85	
Bristol Myers Squibb	24.23	14.31	
Johnson & Johnson		22.40	13.60
Lilly (Eli) & Co.	19.28	12.78	
Merck and Co.	22.42	13.94	
Pfizer Inc.		19.39	11.69
Schering-Plough	20.03	12.63	
Syntex Corp.	24.20	21.17	
UpJohn Co.		16.46	11.90
Warner-Lambert	15.60	5.34	

3. CFP

Years	Profile	
	1	2
1	6.21	6.21
2	18.29	18.29
3	25.30	25.30
4	31.77	31.77
5	37.55	37.55
6	44.87	44.87
7	51.83	51.83
8	58.13	58.13
9	63.70	63.70
10	68.57	68.57
11	72.17	72.17
12	68.51	68.51
13	65.73	65.73
14	59.16	59.16
15	53.24	47.49
16	47.92	40.37
17	43.13	34.31
18	38.81	29.16
19	34.93	24.79
20	31.44	21.07
21	28.29	17.91
22	25.47	15.22
23	22.92	12.94

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