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A Macro-Economic Model Providing Patent Based Company Financial Indicators and Automated Patent Valuations

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[some internet references edited]

Keywords: Patents, economic, financial, modeling, patent valuation, value

1. Richard A. Neifeld, Ph.D., Patent Attorney. I wish to thank my colleague, Martin Goffman, Ph.D. for useful discussions, and I credit him with the conception of the sector dependence alternative of the model. The implementation of the model is the subject of pending patent applications. I can be contacted regarding the macro economic model at .

Introduction

There is a growing interest in valuing patents and company patent portfolios because our economy is shifting from a tangible assets based economy to an intangible assets based economy [2], and capital allocation is based upon asset value. The business world has recognized that the intangible assets of many companies exceed the value of their tangible assets [3], and that patents are a substantial part of these intangible assets [4]. Despite the recognized value of patents, no generally applicable method has existed to value them, except for a labor and fact intensive micro economic analysis.

I developed a macro economic model for automatically valuing patents, which is presented elsewhere [5]. In this paper, I present some individual automated patent valuations and company-wide automated patent portfolio valuations resulting from the model (sections II and III), summarize the model (section IV), correlate results from the model for company-wide patent portfolios to market capitalizations of publicly traded companies and explain why those correlations show that certain basic assumptions of the model are valid (sections V and VI), discuss validating the model's individual automated patent valuations (section VII), and draw certain conclusions (section VIII).

II. Individual Automated Patent Valuations

I have implemented the macro economic model for automatically valuing patents in a programmed computer system, and I have used that system to automatically generate valuations for all enforceable non-expired U.S. patents. For example, valuations as of 1/1/01 provided by the macro economic model for ten patents appear in the following chart.

2. For example, the AIPLA recently formed a committee entitled "Management of IP Assets." One subcommittee of that committee is devoted to exploring patent performance metrics. Also see the discussion relating patents to national economies as a whole in Roy et al., "Global Assessment of Patents, R & D Investment and Economic Output: Part 1 - Macro Economic Comparisons at the Country Level" 79 JPTOS 110 (February 1997).

3. Smith et al., "Valuation of Intellectual Property and Intangible Assets," published by John Wiley & Sons, Inc., New York, NY, Copyright 1994, ISBN 0-471-30412-3.

4. The amount at risk in patent suits, and hence the value of patents in suit appears to have risen dramatically over the last twenty years. Coolley, "Overview and Statistical Study of the Law on Patent Damages" 75 JPTOS 515 (July 1993), reports on patent damage awards during 1982-1992. Coolley shows that there were only three damage awards over one hundred million dollars in 1982-1992, and seventeen awards in the ten to one hundred million dollar range. In contrast, the AIPLA "Report of Economic Survey 1997" page 70 indicated forty practitioners reporting patent infringement suits with amounts at risk of over one hundred million dollars, and one hundred and eighty six practitioners reporting patent infringement suites with estimated amounts at risk of ten to one hundred million dollars. Another measure of the increasing value placed on patents is the number of patents requested and the number granted versus time. The number of issued patents grew from sixty five thousand in 1982 to one hundred and twenty three thousand in 1997. See the "Fiscal Year 1997 Patent and Trademark Review," Table 6, at page 87.

5. Neifeld, "A Macro-Economic Model Providing Patent Valuation and Patent Based Company Financial Indicators," 83 JPTOS 211 (April 2001).

PN	TTL	ISD	ExpDate	ENF	Assignee	CFGDP	PVal
5289345	Opto-electronic device housing having self-healing elastomeric board mount with support pylonsele	2/22/94	2/22/11	0	BT&D Technologies Ltd.	\$1,268,262.87	\$0.00
5289346	Peripheral to area adapter with protective bumper for an integrated circuit chip	2/22/94	2/22/11	-1	Microelectronics and Computer Technology Corporation	\$2,228,650.95	\$936,054.36
5289347	Enclosure for electronic modules	2/22/94	2/22/11	-1	Digital Equipment Corporation	\$329,975.23	\$138,592.70
5289348	Shock absorbing rack system	2/22/94	2/22/11	0	Harold R. Miller	\$6,010,280.95	\$0.00
5289349	Integrated circuit card	2/22/94	2/22/11	-1	Sony Corporation	\$2,846,105.01	\$1,195,390.87
5289350	Pivotable holding mechanism for an optical element	2/22/94	2/22/11	-1	Sachtler AG munikationstechnik	\$656,042.26	\$275,543.92
5289351	Backlighting device	2/22/94	2/22/11	-1	Tosoh Corporation	\$1,270,251.38	\$533,517.53
5289352	Headlamp for motor vehicles	2/22/94	2/22/11	0	Robert Bosch GmbH	\$2,542,918.84	\$0.00
5289353	Device for nondetachably mounting a supplemental high mounted stop lamp or the like to a windowpane	2/22/94	2/22/11	0	Nippon Sheet Glass Co., Ltd. Koito Manufacturing Co.	\$5,831,871.28	\$2,449,440.79
5289354	Method for acoustic transmission of drilling data from a well	2/22/94	2/22/11	-1	Societe Nationale Elf Aquitaine (Production)	\$703,709.55	\$295,564.63

Automated patent valuations for all United States patents based upon the model are now available online at www.PatentCafe.com

At least one patent valuation purchased from the www.PatentValuePredictor.com service has been used as evidence of patent value in litigation [6]. In that case, the party relying upon the automated patent valuation did not have access to the patent assignee's financial data, and therefore did not have micro economic data necessary to independently evaluate the subject patent. Hence, the automated patent valuation was the best evidence available to them. There is a certain parallel to facts in that case and facts underlying many investment decisions. People who do not have access to a company's detailed financial data and licensing agreements relating to IP often make investment decisions regarding the company. In that type of situation, any reasonable quantitative number that can be placed on the value of the company's patent rights is useful.

III. Company Patent Portfolio Valuations

I have now implemented a database query that generates a company-wide patent data and valuation report. As an example, a report on "Exxon" (which report includes all assignees having their name starting with "Exxon") indicates that, as of May 08, 2001, companies whose names start with the word Exxon owned 2424 enforceable unexpired United States patents, that those patents had a total value of \$7.076 billion, and that the annual sales of the markets protected by those patents (CFGDP) was \$18.317 billion.

The report on "Exxon" is based upon assignee at issue data. Exxon Corporation and Mobil Corporation recently merged. Therefore, the report does not include patents assigned at issue to Mobil. A report generated based upon querying the database for "Exxon" or "Mobil" would include all patents naming either entity as the assignee.

6. The automated patent valuation was used in support of a business valuation in a Minnesota dissenters rights case. For details, see the June 27, 2001 press release at http://patentvaluepredictor.com/news_30apr2001.asp. Authorization from the attorney and his client in that case to disclose their use of the patent valuation was obtained.

Presumably, preexisting patents owned by both entities have now been re-assigned after issue to the new entity "Exxon Mobil Corporation." The database from which I generated the report should be updated by September 2001 to include this assignee after issue data to handle these complications.

Company patent portfolio valuations based upon the model are now available at www.PatentValuePredictor.com. Automated company patent portfolio valuations as well as reports containing the type of information shown in the figures in this article may be available in the next few months.

IV. Summary of the Macro Economic Model For Patent Valuation

The macro economic model has two components. First, the model includes a measure of the relative value provided by each patent. Second, the model includes a relationship between macro economic data that links the measure of the relative value provided by each patent to dollar values.

In the first step, the model defines the relative value of each patent based upon measures of properties of the patent indicative of value. The model defines the quantity RPN to be the relative measure of the value of the patent. RPN is a function of measures of properties of the patent that, from a patent attorney's perspective, indicate breadth of coverage, value of the subject matter covered, and likelihood of validity. Those properties include, for example, the lengths, type, and number of claims, the length of the disclosure, the field of technology, and the thoroughness of prosecution.

In the second step, the model relates the relative values of each patent to macro economic data to define quantitative valuations. The model assumes (1) that a certain fraction of GDP is for sales covered by all enforceable patents and (2) that the Covered Fraction of GDP covered by each patent (herein "CFGDP") is directly proportional to the RPN [7] for that patent. Those assumptions provide an equation with one unknown, which is the proportionality constant between the CFGDP and the RPN. Solution of that equation (which requires calculating the RPN for all patents) results in a value for CFGDP for each patent. The CFGDP is a nominal measure of sales protected by the patent. It is a nominal measure in the sense that it uses macro economic data (a fraction of GDP) in place of actual data for sales of products covered by the patent [8]. The substitution of CFGDP for actual sales data enables valuing a patent by applying income theory [9] to the patent's CFGDP and making certain simplifying assumptions [10].

V. Validating the Results of the Macro Economic Model Against Other Measures of Patent Value

There is no readily available source of individual patent valuation data against which to compare the automated individual patent valuations provided by the model. There is also no readily available source of company patent portfolio value data. However one readily available substitute for company patent portfolio value data is the

7. The equation is

$$C * RPN(1) + C * RPN(2) + C * RPN(3) + \dots + C * RPN(n) = K * GDP,$$

where $C * RPN(i) = CFGDP(i)$, and K is the fraction of GDP covered by patent rights.

8. Alternative implementations of the model use the macro economic values for total profits and assume that the sum of profits obtained by patents equal a certain fraction of the annual total of corporate profits.

9. Income theory values an asset based upon the flow of income the asset produces over its useful life by discounting future income derived from ownership of the asset to current value, based upon the time value of money.

10. See http://patentvaluepredictor.com/publ_30apr2001_article.asp at section II.

dollar values of market capitalizations of publicly traded companies. Moreover, if there is a correlation between individual automated patent valuations and the actual value of individual patents, then the correlation should increase as the number of patents involved in valuations increases [11]. Publicly traded companies usually own relatively large numbers of patents. Therefore, publicly traded companies are a good place to look for even a small correlation between the model's automated patent valuations and the real world value.

Of course, the market capitalization of a company represents a number of value factors. Therefore, I expect (1) that the fraction of any company's market capitalization residing in patent value and (2) that the correlation of the model's predicted patent portfolio value to market capitalization should vary from company to company, from industry to industry, and from time to time. Despite these anticipated correlation reducing factors, the charts I present in the figures below demonstrate a striking correlation between the trends in CFGDP of company patent portfolios and company market capitalization, across several industries, over various sizes of market capitalization, and over a ten year period.

I chose to compare market capitalization to a company's CFGDP instead of the company's patent portfolio valuation because CFGDP is a more direct measure of the immediate financial impact of patent protection than a calculated patent valuation. This is because CFGDP does not depend upon (1) the remaining period of enforceability of the patent, (2) the profit margin associated with sales covered by the patent, or (3) the Internal Rate of Return [12], whereas patent value determined using income flow theory does depend upon variables (1) - (3).

My results shown in the figures below indicate that the sum of the CFGDP for the portfolio of patents owned by a publicly traded company is an accurate measure of the breadth of the company's patent protection. Specifically, the figures show that, over a ten year period, the trend in the sum of CFGDP for each company's patent portfolio correlates to the trend in that company's market capitalization. More simply put, CFGDP and market capitalization "track." This correlation implies that the value of each company's patent protection, as measured by the model, is a significant enough factor to the company's total value that variations over time in the company's patent protection are reflected in variations over time in the company's market capitalization. This in turn implies that the CFGDP for the companies patent portfolio is correlated to the actual magnitude of the protection afforded by the underlying patent portfolio.

These results indicate that the sum of the CFGDP and RPN values for a company's patent portfolio provide useful quantitative indicators for business analysis [13]. For example, the sum of the CFGDPs or RPNs for the patent portfolios of competing companies can be compared to one another to determine which company has the stronger patent protection. In addition, the time dependence of a company's existing patent portfolio can be extrapolated into the future to see when significant drop offs in value will occur. Since the model does not require actual sales data, no company specific proprietary sales information is required to perform these types of analysis.

VI. Comparing CFGDP to Company Market Capitalization

A. Explanation of Data

The type of data displayed in figure 4 is representative of the data displayed in figures 1-20. Figure 4 shows dollar

11. See http://patentvaluepredictor.com/publ_30apr2001_article.asp at section IV, last paragraph.

12. Internal Rate of Return (IRR) is an accounting term used to define the time value of money.

13. Since GDP is time dependent, CFGDP of a single patent is also time dependent. RPN is not time dependent. The results shown in this paper do account for the time dependence of GDP on CFGDP.

amount in millions (y axis) versus time in years (x axis) for a company having a market capitalization in the middle of the range of market capitalization [14] of companies discussed herein.

Figure 4 shows dollar amounts for market capitalization of American Home Products (diamond data points) and the sum of the CFGDP for all patents in the patent portfolio of American Home Products (square data points) over the ten year period 1/1/90 to 12/31/00. In addition, figure 4 shows the CFGDP in an expanded scale (triangle data points) for easy comparison of the trend in CFGDP to the trend in the market capitalization.

The CFGDP data shown in each figure represents the sum of CFGDP for all patents having assignee-at-issue names associated with the subject company, certain subsidiaries of the subject company, and predecessors in interest to the subject company [15]. Each CFGDP data point represents the sum of CFGDP for all patents assigned at issue to the subject company that were in force on January 01 of that year. Variation over time in the CFGDP shown in each figure is based upon issuance of new patents, expiration of old patents, and variation of GDP over time.

The data shown in figure 21 is representative of the data shown in figures 21-23. Figure 21 shows the ratio of CFGDP to market capitalization on the y axis plotted against company market capitalization (in millions of dollars) on the x axis for values on 12/31/00. Figure 21 includes data for the eight medical technology companies shown in figures 1-8. Figure 22 includes data for the computer and electronics companies shown in figures 9-14. Figure 23 includes data for the heavy industry companies shown in figures 15-20.

B. Discussion of Figures

1. Medical Technology Companies

Figures 1-8 show data for companies involved in medical technology. Figures 1-8 show data for companies in order of descending market capitalization as of 12/31/00. These figures illustrate several trends.

First, in figures 1-8, observe that the ratio of the scaled CFGDP (triangle data points) to the market capitalization shows that the trend in CFGDP and the trend in market capitalization for each company have a significant correlation. This initial fundamental observation suggests (1) that the value associated with the scope of patent protection is a significant portion of these companies' value and (2) that the CFGDP is a significant relative measure of a company's patent protection. As a corollary, the RPN should also be a significant measure of a company's patent protection since variations in RPN only differ from variations in CFGDP by the time dependence of GDP.

Second, in figures 1-8, observe that the absolute value of the CFGDP is always much less than the market capitalization. Applying income flow theory to CFGDPs in this technology based upon the United States national average profit margin of eight percent results in company patent portfolio valuations that are only a small fraction (between one and ten percent) of the market capitalizations (with the exception of Chiron). However, the degree of correlation between the trend in the CFGDP and the market capitalization indicates that patent protected sales account for a substantial fraction of company profits in this industry, and the small fraction result is inconsistent with that indication. Possible explanations of this inconsistency include (1) the possibility that the model undervalues

14. Current market capitalization data was obtained from <http://finance.yahoo.com>. Stock data for the period 1990-2000 was obtain from <http://finance.yahoo.com> and used to extrapolate market capitalization to the 1990-2000 time period.

15. For example, the entity Bristol-Meyers Squibb has significant numbers of patents under names like Bristol Myers Squibb Co, Bristol Myers Squibb, and Bristol Myers Co. Honeywell merged with AlliedSignal. Exxon merged with Mobil. For each company shown in a figure in this paper, I checked for subsidiary companies and predecessors in interest with the Yahoo and Hoovers online services. I added the CFGDP values over the 1990-2000 time period only for those subsidiary companies that were one of the 10,000 companies obtaining the most United States patents over the 1974-2000 time period.

My initial data indicates that twenty eight percent of all United States patents are assigned or re-assigned after issue. The figures in this article do not account for CFGDP due to patent assignments after patent issuance.

CFGDP for patents in the medical technology field, (2) the fact that the profit margin in this industry is actually much larger than the United States national average profit margin, and (3) the fact that the currently implemented model does not account for the company's patent value attributable to non United States patents.

Third, in figures 1-8, observe that, for the largest companies, the market capitalization shows faster growth than does CFGDP. Both quantities trend upwards, but market capitalization trends upward at an increasing rate relative to the CFGDP. For example, in figure 1, which shows data for Pfizer, note that the rate of increase in market capitalization increases more rapidly than the rate of increase in CFGDP in years 1996-2000. The difference between the rate of increase in market capitalization and the rate of increase in CFGDP almost monotonically decreases with decreasing market capitalization (note the triangle and diamond data points sequencing from figure 1 to figure 8) and reverses sign for the smallest capitalization companies, Biogen and Chiron (Figures 7 and 8). As a consequence, the ratio of CFGDP to market capitalization as of 12/31/00 for the largest companies is relatively small, less than 0.1 for Pfizer, and that ratio increases almost monotonically with decreasing market capitalization to about 0.9 for Chiron.

These trends are reflected by figure 21. Figure 21 shows that the largest companies have the smallest ratios of CFGDP to market capitalization as of 12/31/00.

Fourth, note that, over the course of their corporate lives through 12/31/00, Biogen had acquired about 90 patents, and Amgen about 260 patents. The fact that the CFGDP and market capitalizations of each of these two companies correlate to one another indicates that the macro economic model provide statistically significant results even when the company patent portfolio is relatively small. On the other hand, the patent portfolios of these companies are so large from a conventional business due diligence valuation perspective that it would be prohibitively expensive to individually evaluate every patent. Moreover, a single blockbuster patent may have significant financial effect on a company of this size. Thus, for small capitalization companies, the macro economic model's automated patent valuations can be used to provide both a concrete valuation and a predictor of future corporate performance.

2. Semiconductor Electronics and Computers

Figures 9-14 show data for companies involved in semiconductor electronics and computer technology in order of decreasing market capitalization. These figures illustrate several trends.

First, in figures 9-14, observe that the trend in CFGDP is highly correlated to the trend in market capitalization (compare triangle to diamond data points in each chart). This observation is identical to the observation drawn for medical technology companies, and it supports the conclusion that CFGDP is a reasonable predictor of patent value.

Second, in figures 9-14, observe that the ratio of CFGDP to market capitalization increases as market capitalization decreases, just like with the medical technology companies. This trend is shown by the data points in figure 22 for the companies in this industry. Also note (1) that the CFGDP of Advanced Micro Devices as shown in figure 14 actually exceeded its market capitalization on 12/31/00 and (2) that as I write this article in June of 2001 the Advanced Micro Devices share price has roughly doubled since 12/31/00. While anecdotal in nature, this observation suggests that unusually large CFGDP to market capitalization values anticipate an increase in stock price.

3. Heavy Industries

Figures 15-20 show data for various heavy manufacturing industries (Exxon in integrated petroleum, Ford, GM, and Johnson Controls in automotive, Honeywell in aerospace and automated controls, Bethlehem Steel in steel). Figure 23 shows the trend in ratio of CFGDP to market capitalization versus market capitalization for the companies shown in Figures 15-20.

I would intuitively expect patents to have little effect in the automotive industry. Surprisingly, the trends in CFGDP for Ford (figure 16) and GM (figure 17) each correlate to the trends in their respective market capitalization. The

values for CFGDP for Ford and GM are only a few percent of their market capitalizations. The only company in this set with apparently no patent protection was Johnson Controls (figure 19). Note that the stock price of Johnson Controls had been increasing over the last several years despite a continuous drop in its CFGDP. However, that observation is deceptive, since Johnson Control received 26 United States in the first six months of 2001. That equates to about one sixth of all patents Johnson Controls obtained since 1976, and it provides an increase in Johnson Control's CFGDP of roughly \$100 million. Thus, the CFGDP of Johnson Controls is currently greater that it was at any time during the 1990-2000 time period. In the case of Johnson Controls, it appears that market capitalization anticipated patent portfolio value.

Exxon-Mobil (figure 15) also has a CFGDP that is a few percent of its market capitalization. I had considered petroleum refining and production strictly a commodity industry in which there was little innovation, but the data proves me wrong.

C. How Does Patent Value Relate to Market Capitalization?

Figures 21-23 show that the ratio of CFGDP to market capitalization decreases as the market capitalization of companies increase, but it also shows that the CFGDP of an individual company usually correlates to the market capitalization of that company. These observations raise an important financial analysis consideration. Do changes in patent portfolio value for a company anticipate changes in the company's market capitalization? The correlation of CFGDP to individual companies would indicate that the answer is yes. The fact that the largest companies grew to become the largest companies while their CFGDP/market capitalization ratios decreased with time muddies the waters.

If changes in patent value do anticipate changes in market capitalization then the large market capitalization companies would appear to be overvalued and the small market capitalization companies would appear to be undervalued, if evaluated based solely upon their predicted patent value. However, other conclusions are possible and likely. For example, the smaller capitalization companies may have more patents that do not cover valuable products, i.e., the patent portfolios of the small capitalization companies may be poorly managed. Another obvious possibility is that significant value in the large capitalization companies resides outside of United States patents, such as in contracts, goodwill, and foreign patents. An indication that this possibility is likely comes from Hoovers' business profile of the behemoth company Pfizer, which concludes with the statement that "The firm is known for its massive sales force and marketing strength." Another possibility is that the behemoth companies may own in part or in whole a substantial number of subsidiaries whose patent portfolios did not show up in my data as associated with the behemoth companies [16].

In summary, I believe that the trend in CFGDP shown in figures 1-20 reflects the trend in the contribution of patent value to market capitalization, even though there are of course other real world factors at play. In any case, certain financial conclusions can be drawn solely from the patent data. For example, I conclude that, as of 12/31/00, the financial markets undervalued Chiron.

VII. The Effect of Blockbuster Patents on a Company's Future Financial Performance

The foregoing results show a correlation between the macro economic model's CFGDP measure of patent portfolios and the capitalization of relatively large capitalization companies on a company by company basis. They do not show the effect of a single patent on company performance since a single patent, even a very valuable patent, is usually of little significance to a very large capitalization company. However, an effect associated with the issuance of a very valuable patent may be inferred from changes in market capitalization occurring over a relatively long period of time surrounding the issuance of the patent. That time period would depend upon when products underlying the patent claims were developed and available, upon time for the market for those products to mature, and upon when the financial community recognized the value of the patent. Unfortunately, a myriad of other dependent factors exist, including issuance and expiration of other patents owned by the same

16. *Id.*

company, changing market conditions, and advances by competitors. Thus, a mathematical analysis to show the correlation between what are predicted by the model to be blockbuster patents is not currently feasible. However, the www.PatentValuePredictor.com web site does offer a service that identifies and values the most valuable (as determined by the model) patents issued each week and provides a ratio of the patent value or CFGDP for that patent to the company's market capitalization when market capitalization data is available.

I am contacting certain companies owning what appear from the macro economic model to be blockbuster patents to obtain from them what anecdotal evidence they are willing to provide regarding the value of those patents. If any of you represent a company that owns a blockbuster patent and you are willing to provide patent valuation information regarding the patent to me on a non-confidential basis, I would be pleased to speak with you.

VIII. Conclusions

I show that patent based financial indicators derived from the macro economic model provide a statistically significant correlation to company market capitalization, thus showing that the basic premises of the model relating to relative valuation of patents has statistical significance. This implies that the model's assumption that the measures of certain properties of the patent document are indicators of relative patent value is correct.

The qualitative results obtained by comparing the sum of a company's CFGDP to the company's total market capitalization for twenty companies, when considering the fact that many other factors add to market capitalization, indicate that automated patent valuations derived from the model are, on average, "within the ballpark" of what one would expect to be the contribution of patent portfolio value to total company value. However, the valuations could be refined to account for industry specific effects, for example, by adding in industry dependence to CFGDP or profit margin. Since a strong correlation exists between patent value and market capitalization, a least squares analysis could be performed on the patent valuation algorithm to maximize the correlation between CFGDP trend and market capitalization over a large number of companies. That analysis would result in the best fit for the coefficients of the patent measurement functions defining the RPN.

The results show that smaller companies have a relatively larger ratio of patent value to market capitalization than larger companies. This suggests that more of the value of smaller companies resides in the protective value of their patent portfolios. The results show that the relatively small number of patents owned by a small company are sufficient to provide a patent based predictor (e.g., CFGDP) of value that tracks the company's market capitalization. As a corollary, the model's valuations appear to be particularly useful for financial analysis of small capitalization companies. Specifically, the model's valuations may be used to identify individual blockbuster patents that should have a significant financial impact on small capitalization companies, as indicated by the ratio of the CFGDP of the individual patent to the market capitalization of the company.

Finally, there is no other readily available source of individual patent values. For quick and inexpensive patent valuations the macro economic model is the only game in town.

Figures Follow

Fig 1.

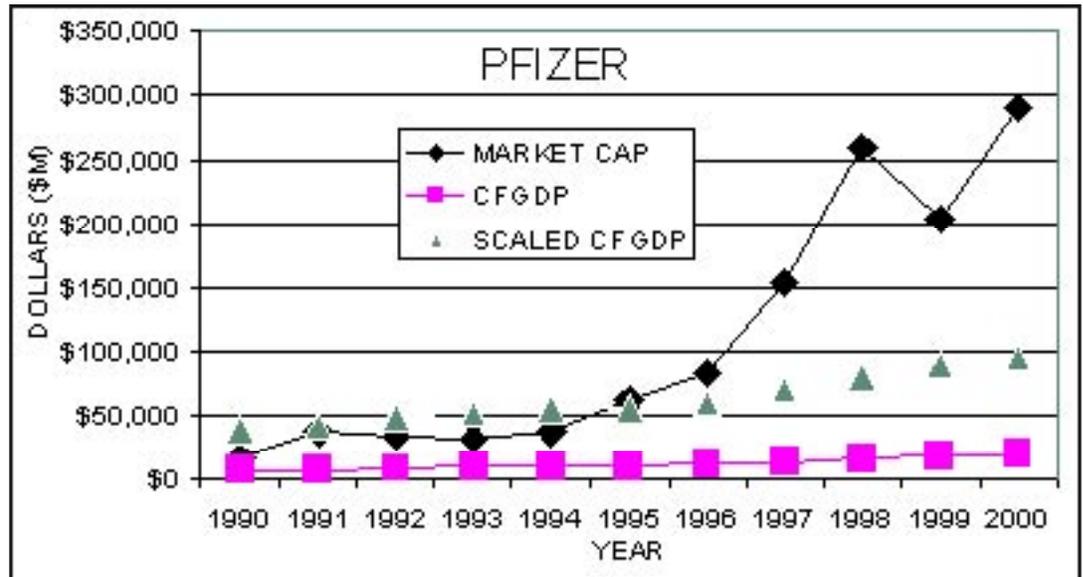


Fig 2,

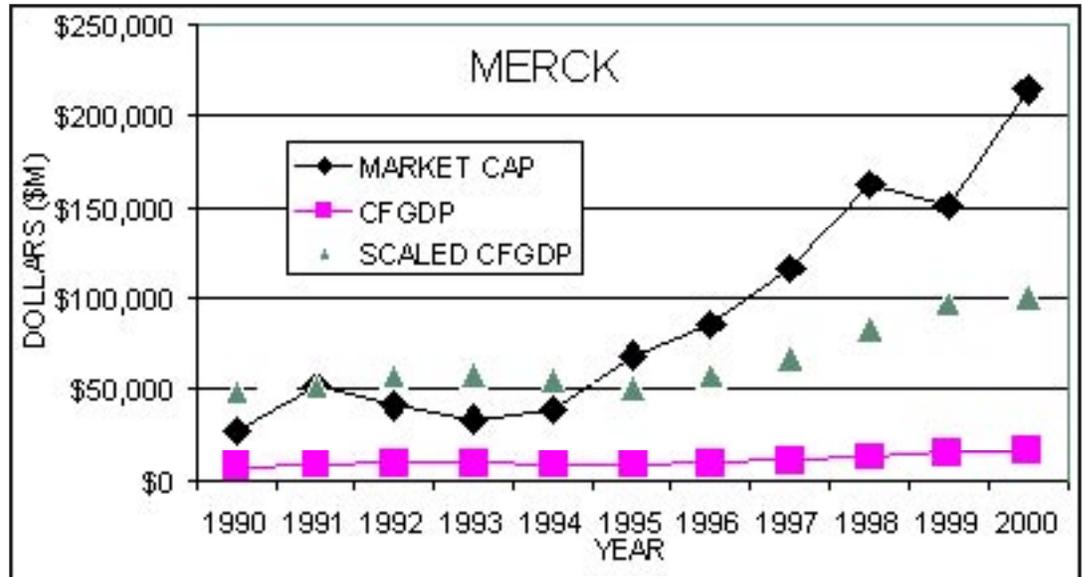


Fig 3.

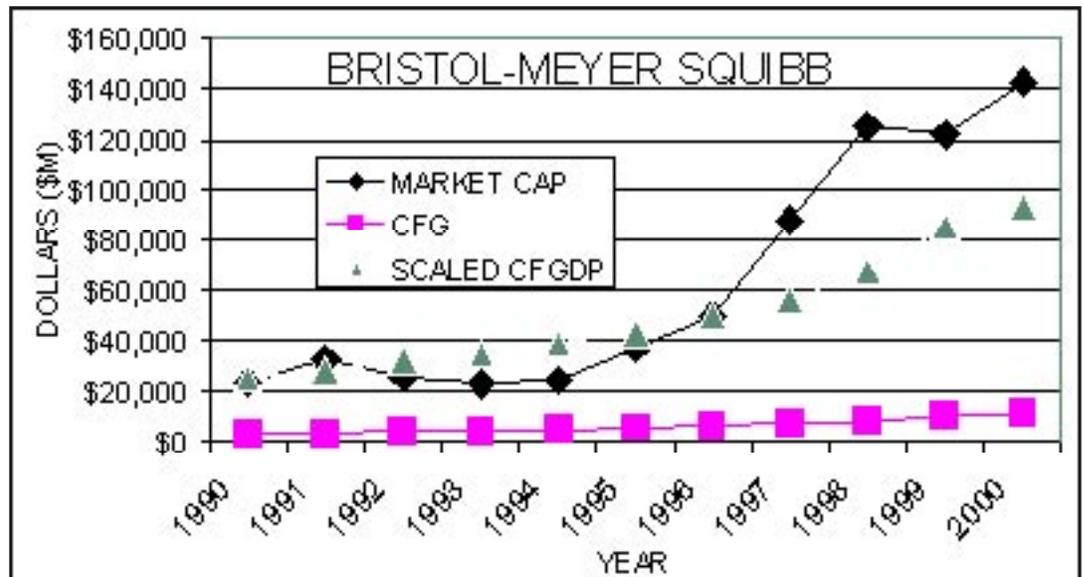


Fig 4.

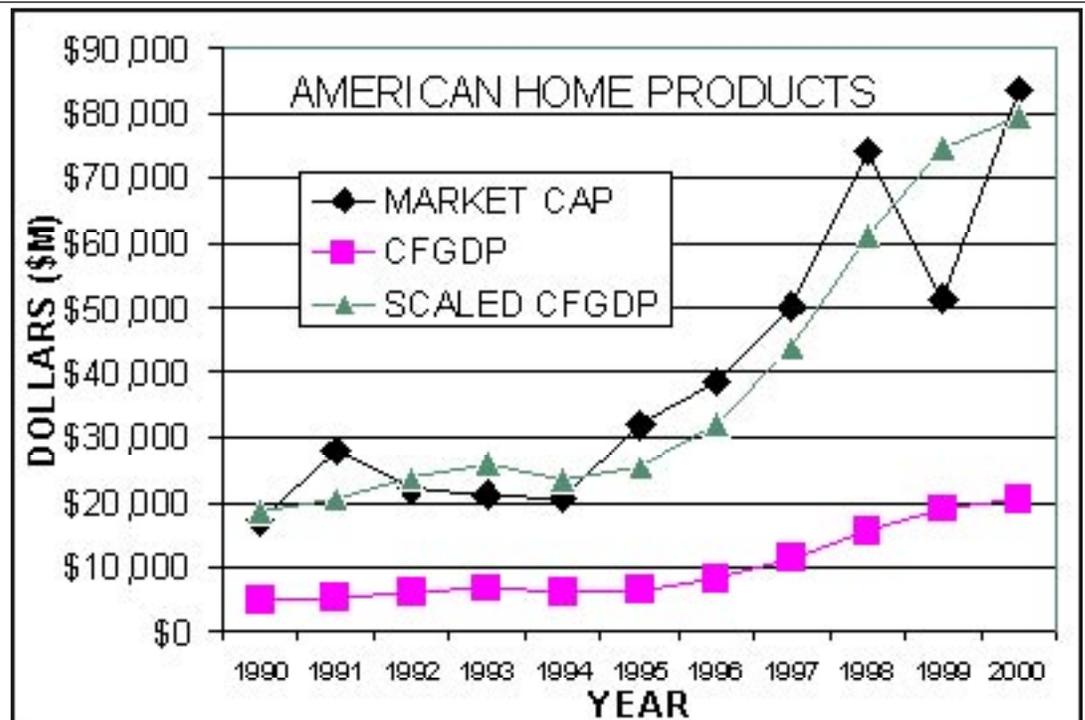


Fig 5.

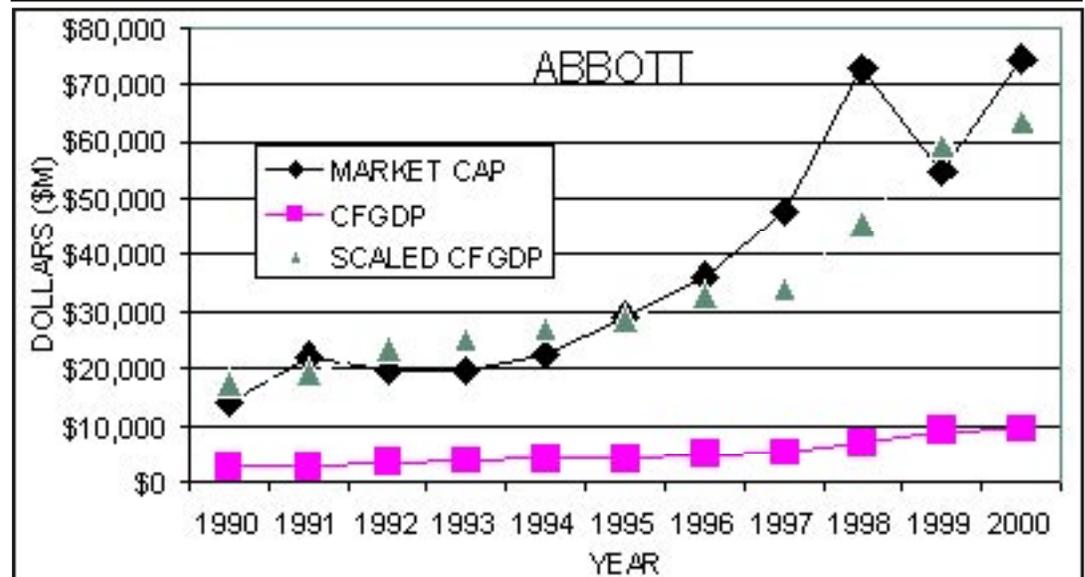


Fig 6.

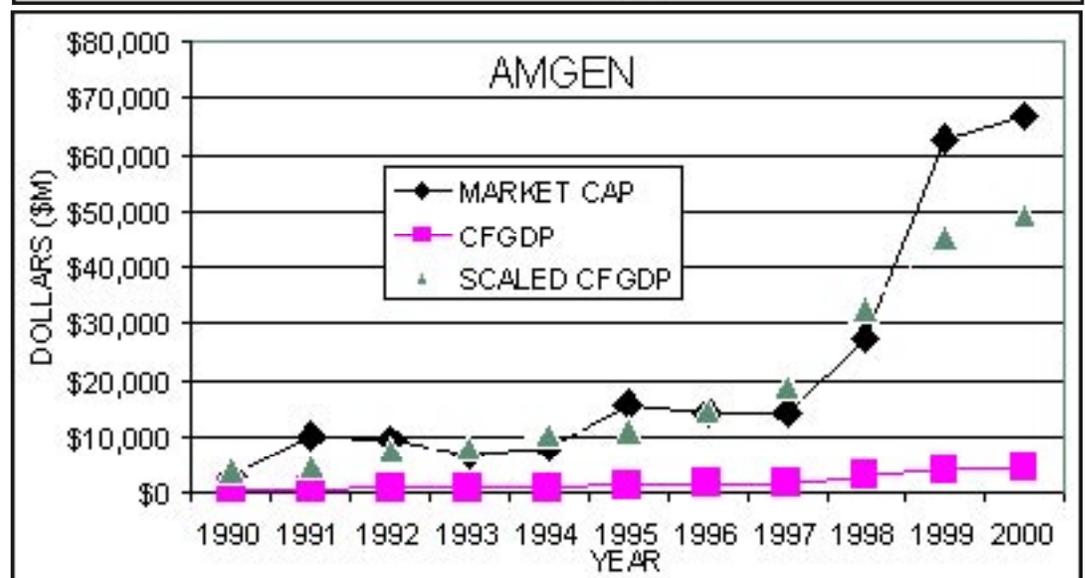


Fig 7.

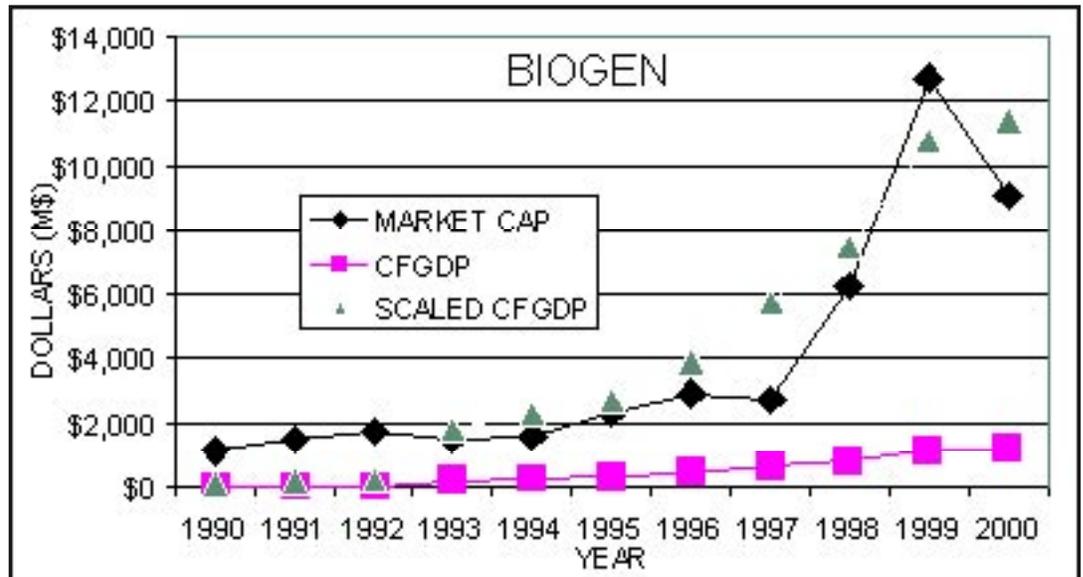


Fig 8.

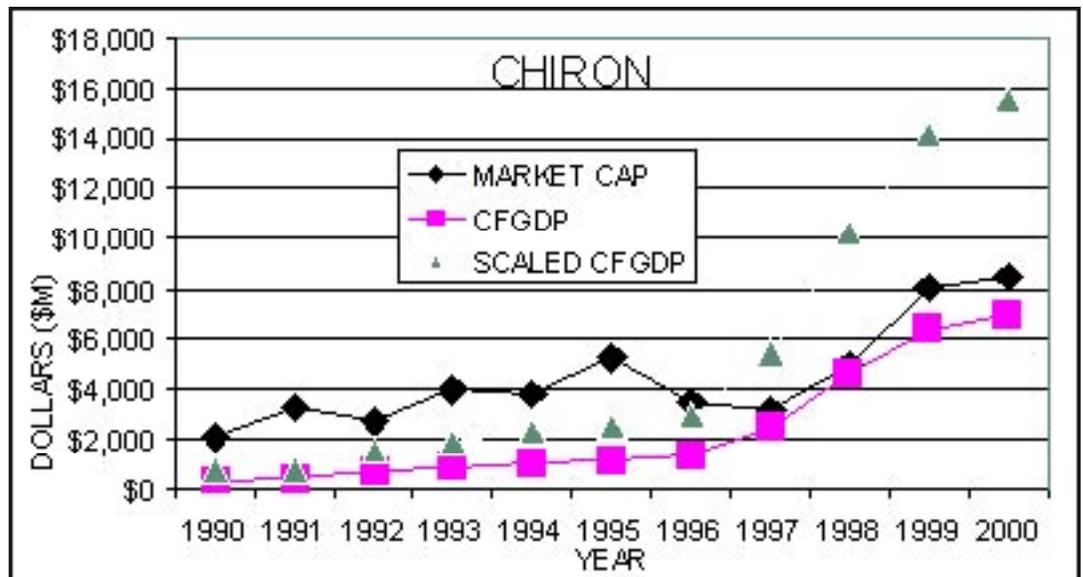


Fig 9.

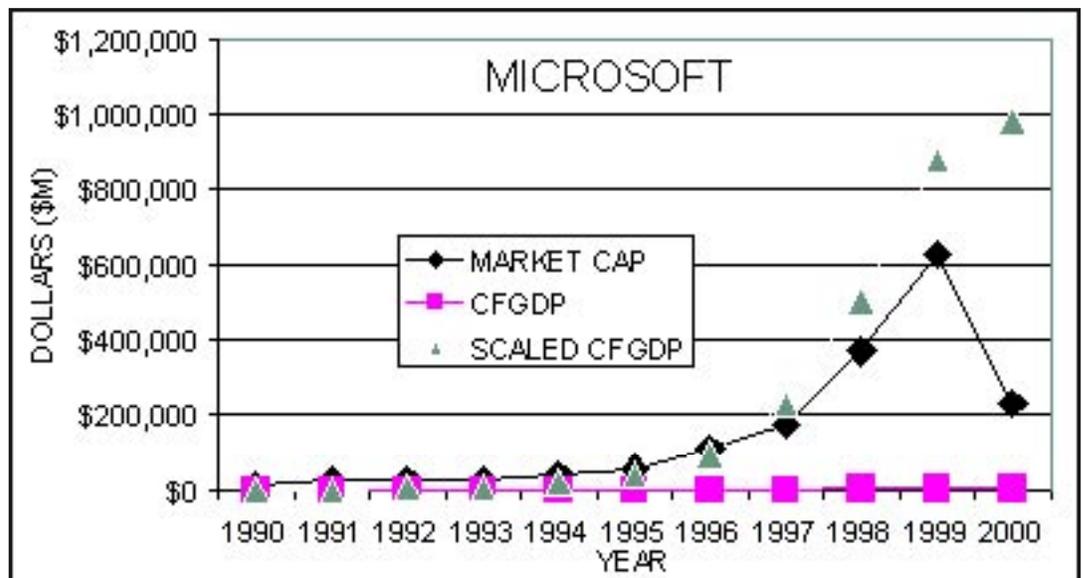


Fig 10.

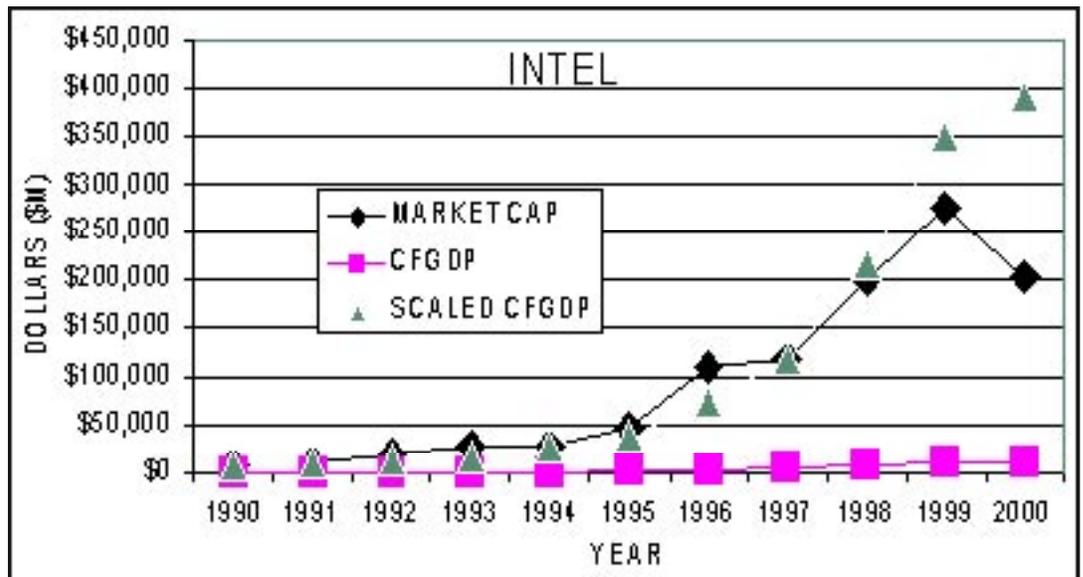


Fig 11.

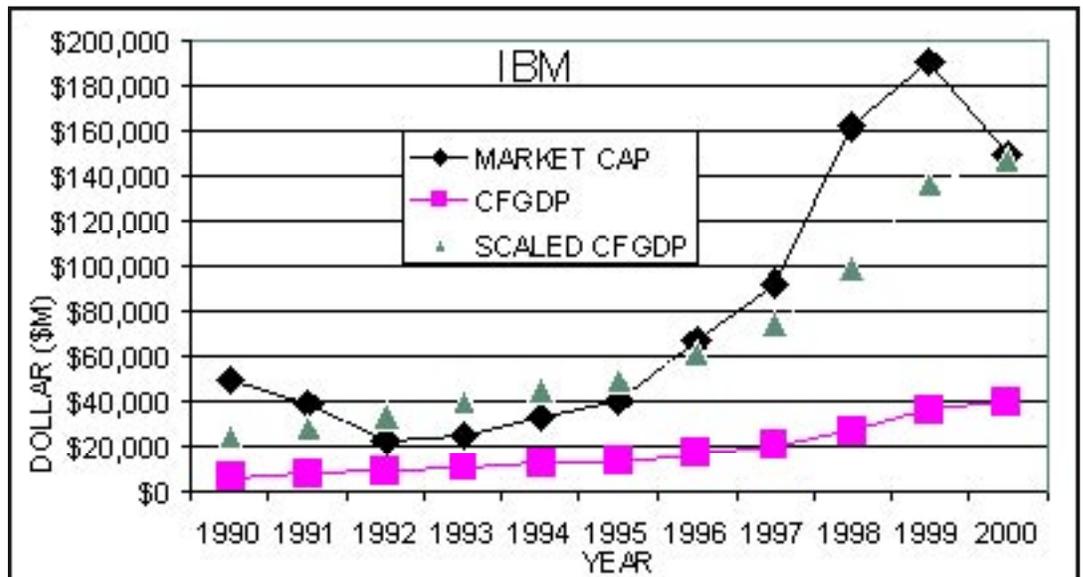


Fig 12.

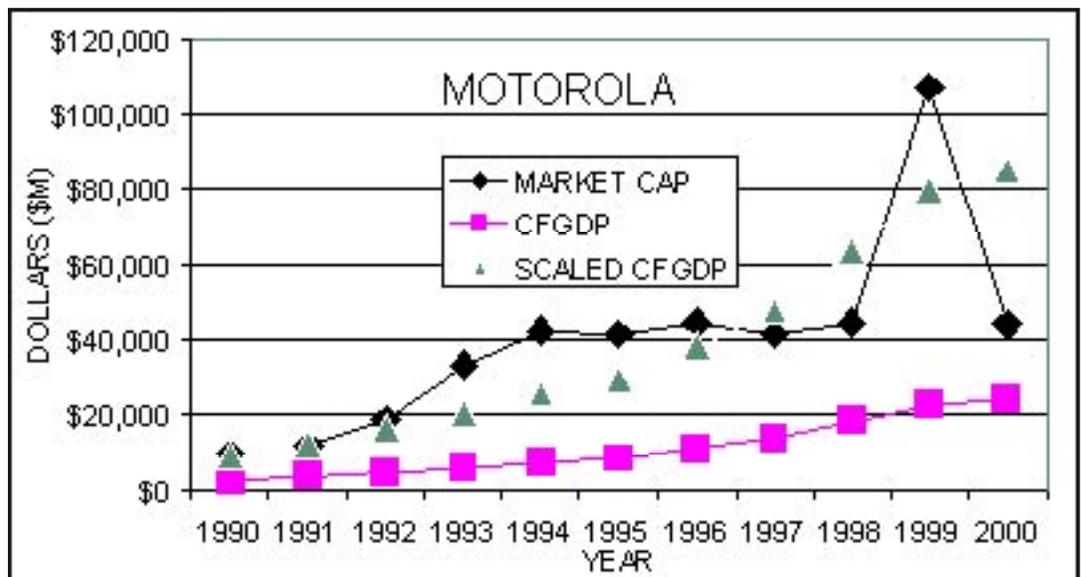


Fig 13.

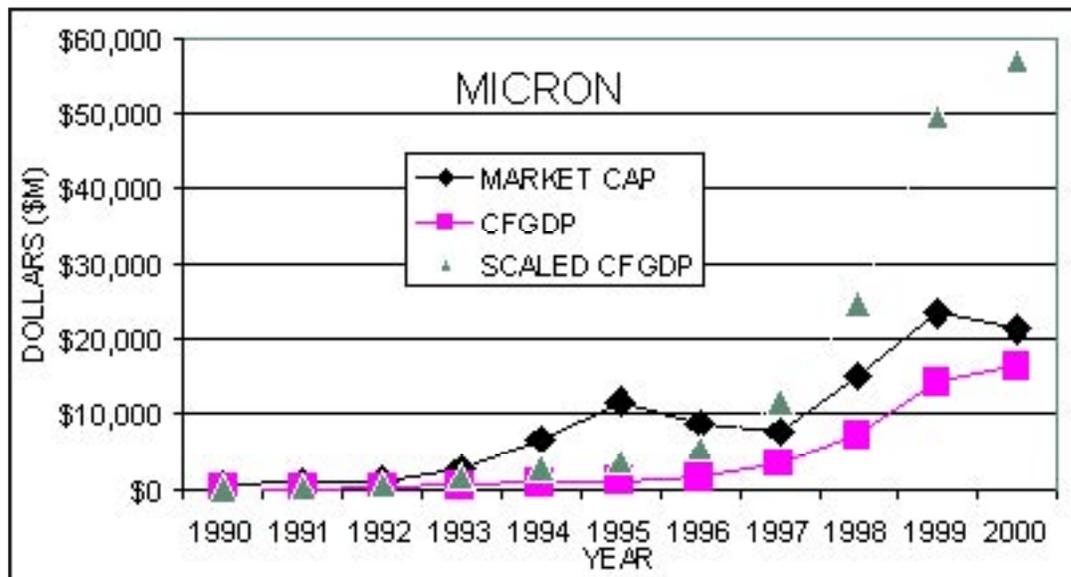


Fig 14.

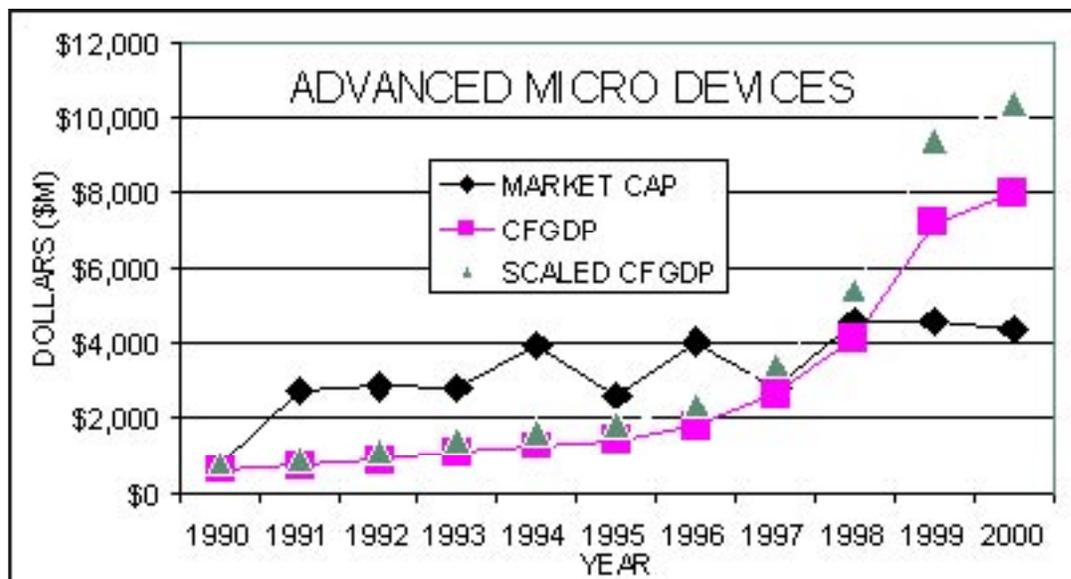


Fig 15.

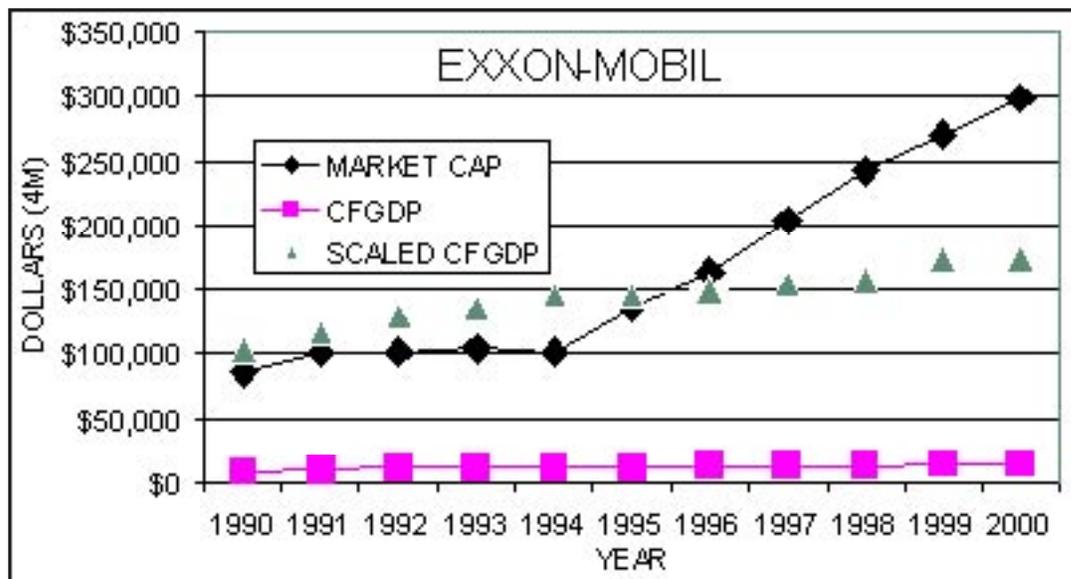


Fig 16.

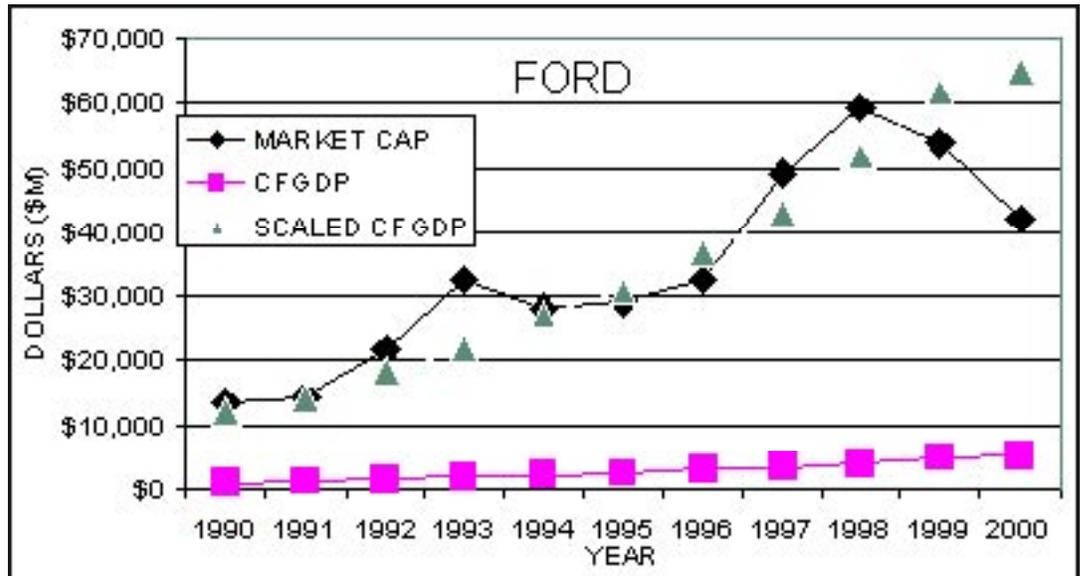


Fig 17.

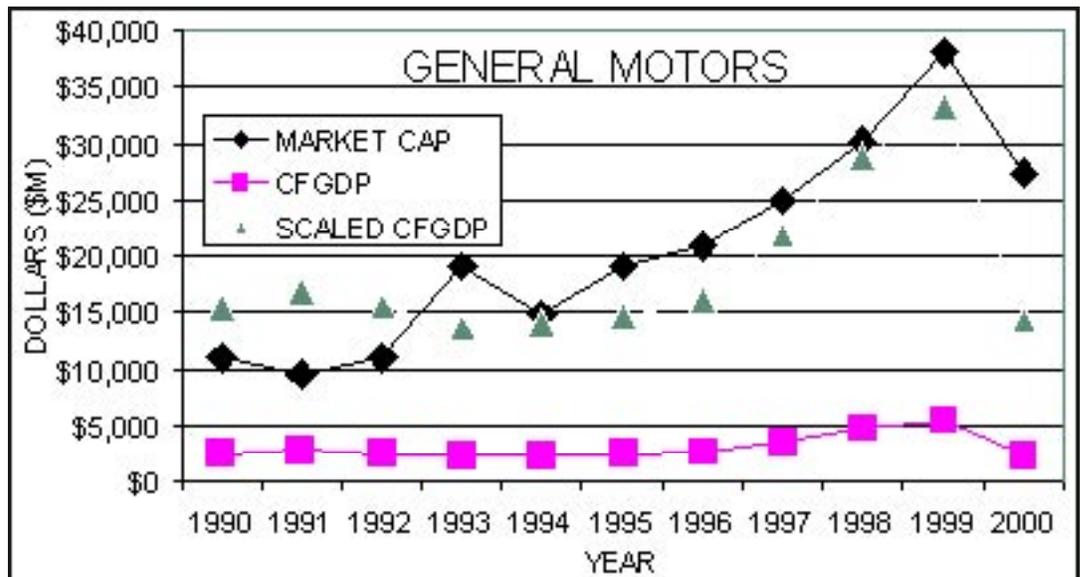


Fig 18.

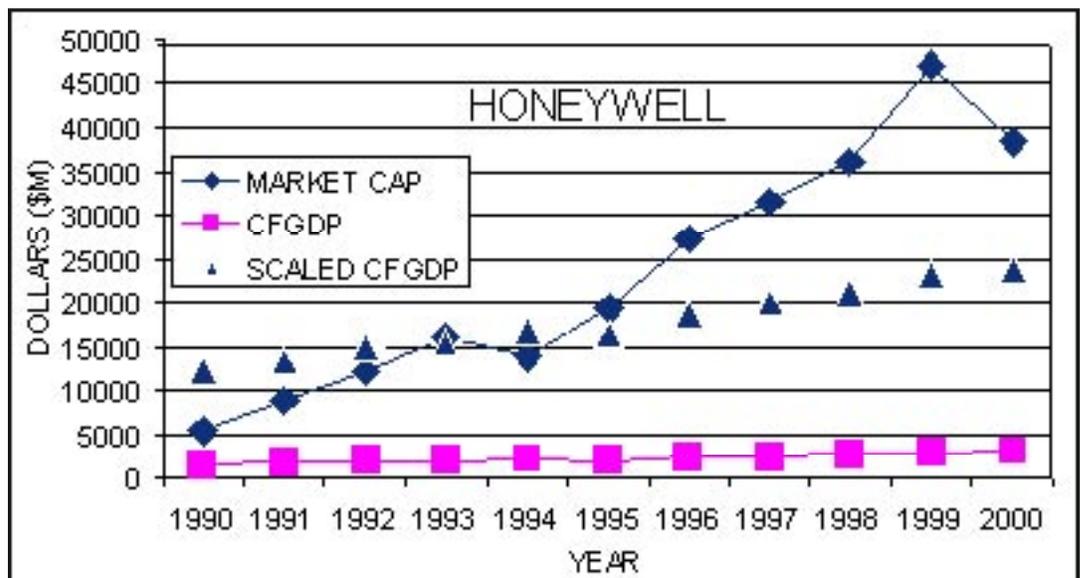


Fig 19.

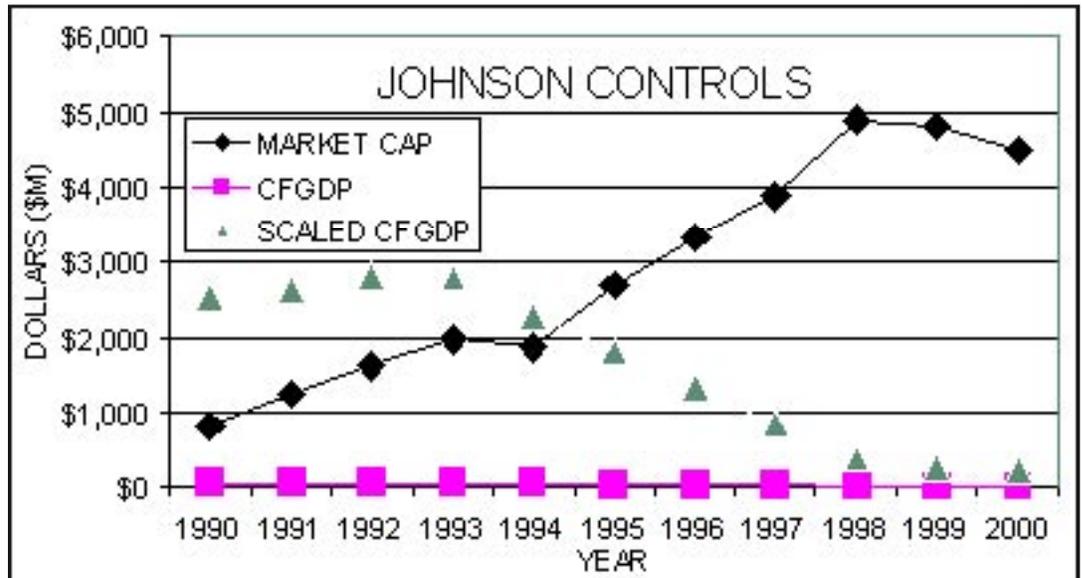


Fig 20.

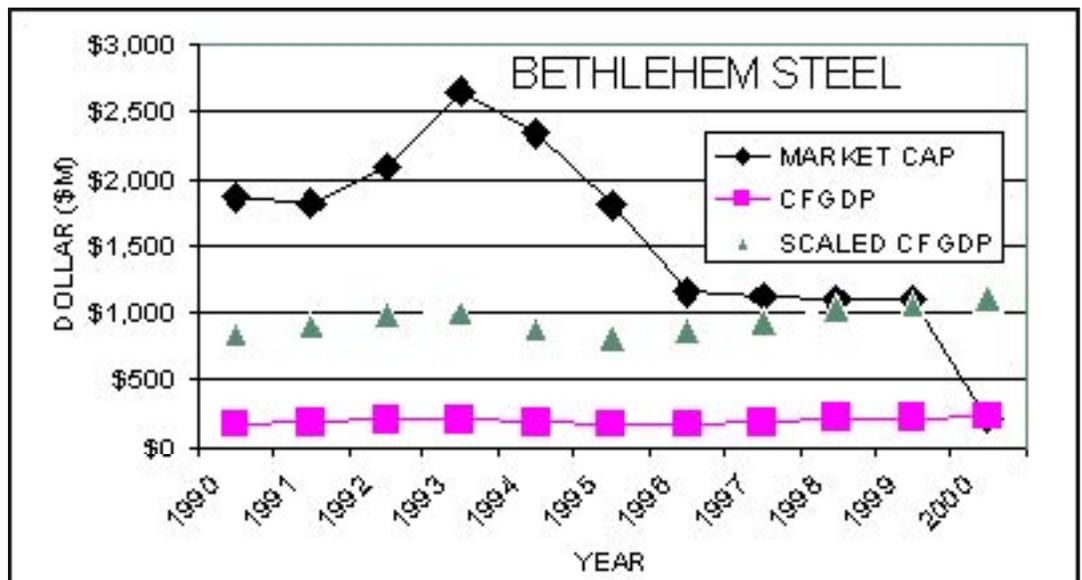


Fig 21.



Fig 22.

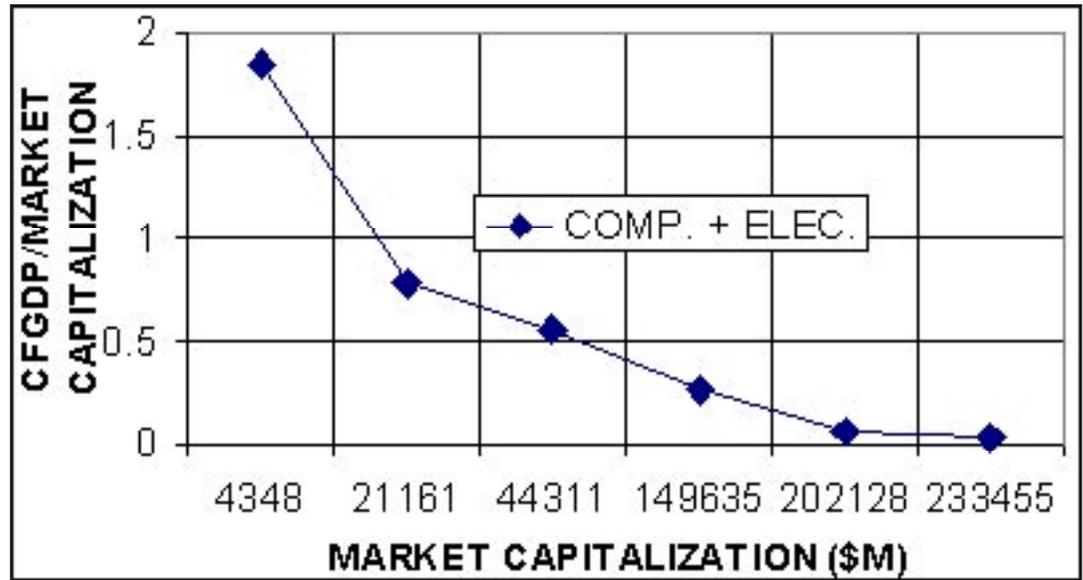


Fig 23.

