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ASSOCIATIONS BETWEEN ECONOMIC INDICATORS AND PATENT APPLICATION FILINGS

Report Submitted to:

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In Cooperation With

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United States Patent and Trademark Office
Technology Center 2800

December 20, 2000

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Mr. Stewart Levy
Technology Center 2800
United States Patent and Trademark Office
2201 Crystal Drive
Washington, DC 20231

Dear Sir,

Enclosed is our report entitled Associations between Economic Indicators and Patent Application Filings. The project was carried out at the United States Patent and Trademark Office from October 29 through December 20, 2000. Initial work was completed in Worcester, Massachusetts, before our arrival in Washington D.C. Copies of this report are being submitted simultaneously to both Professor Heinricher and Professor Ma for evaluation. Upon faculty review, the original will be catalogued in the Gordon Library at Worcester Polytechnic Institute.

We appreciate the time you have devoted to us and wish you good luck in the future.

Sincerely,

Michael Sorrentino

Steven Gaynor

Gordon Deng

ABSTRACT

This report, prepared for Technology 2800 (TC2800) of the United States Patent and Trademark Office, provides information collected from a study of economic indicators and their associations with the numbers of patent applications. Research and Development spending and Gross Domestic Product are examined using the actual numbers and specific growth at the art unit level. Based on these results and observations, recommendations are then made on how to enhance these tests and avoid problem areas.

AUTHORSHIP

All sections of this report were written with contributions from Michael Sorrentino, Steven Gaynor, and Gordon Deng.

ACKNOWLEDGEMENTS

We would like to extend a special thanks to the following people for their help in the completion of this project:

Advisors	Professor Arthur C. Heinricher Professor Yi Hua Ma
Liaisons	Mr. Stewart Levy Ms. Josie Ballato

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ES.1 Introduction and Objectives

Growing numbers of patent filings in all divisions of the PTO require better planning in order to maintain a satisfactory evaluation process. The ability to estimate the number of patents to expect in the years to come for each art unit will provide a crucial advantage in manpower preparation. Not only how many patents applications to expect, but also knowing what kinds of patents applications to expect would allow the necessary placement and training of examiners in order to examine applications thoroughly and quickly.

The underlying goal of Technology Center 2800 for this project was to use economic data in an effective manner to predict the number of incoming patent applications. This led us to the formation of the group's goals. The first goal was to collect and organize patent application data for every art unit that makes up TC2800. Our second goal was to obtain Research and Development spending and Gross Domestic Product data. Finally, the third goal was to analyze these data sets by exploring actual and specific growth using statistical models.

ES.2 METHODOLOGY

The first and second goals of this project, regarding the collection of data, were completed through interviews and searches of patent data. The most difficult information to gather was the number of patent applications within art units of Technology Center 2800. A data mining program, Business Objects, was used to collect data and build "data histories" for the art u nits. Our interviews also asked which economic indicators were the best to use in our tests. Research and Development spending and Gross Domestic Product were chosen as our indicators. We also used R&D over GDP, which shows what is being spent over the resources available. The Bureau of Economic Analysis provided GDP for the electronics industry and the National Science Foundation supplied R&D spending for electronic equipment. Information for these categories was chosen because of its relevance to TC2800 and the products that it deals with.

Using actual and specific growth of all the data, we searched for associations and correlation. The Pearson Correlation Coefficient (r) and regression analysis were used to determine the quality of the model. From our results we were able to forecast and form conclusions and recommendations for TC2800.

ES.3 PRIMARY FINDINGS

The first tests conducted used actual and specific growths of the application data going back to 1995. In this case, R&D over GDP provided the best results. Overall, the indicator had an average (r) value of 0.69. R&D was the next best with an average (r) value of 0.53. GDP provided the worst (r) value with an average of 0.47. However, on an art unit basis, there were very good (r) values for each indicator.

We then used Business Objects to obtain patent application data going back to 1985, on these art units. When doing similar analysis, this time with a larger set of application data, all of the averages decreased greatly. GDP, however, now had the best (r) values and therefore we chose this as our primary indicator. Looking back at the initial tests, we chose ten art units. Then, using Business Objects, we searched for the patent application history of each art unit and using that data completed regression models for each art unit. The models used R&D, specific growth of R&D, GDP, specific growth of GDP, R&D and GDP together, and the specific growths of R&D and GDP together.

ES.4 Conclusions

Actual R&D, actual GDP, and actual R&D and GDP together all provide good models with which to predict. However, GDP proved to be the best model. It was the easiest to work with because the standard deviations of the coefficients were the smallest. This means that GDP was most consistent throughout all of the art units tested.

We also found that using the specific growth data provided very little association between any of the indicators and art units.

Chapter One
INTRODUCTION

Any large business faces the challenge of changing in order to keep up with the demand for their product. In the case of the United States Patent and Trademark Office (PTO), patents are their product. Applications for patents are received everyday by the PTO and put through a meticulous examination process. Every patent and its references, or prior art, must be checked to answer two questions: Is the work original and is the invention not an obvious extension of previous work?

1.1 The USPTO

Article I Section 8 of the United States Constitution states that it is the power of the legislative branch "to promote the progress of science and useful arts, by securing, for limited times to authors and inventors the exclusive right to their respective writings and discoveries." The "exclusive right to ones discoveries for a limited time" is the definition of a patent. The PTO was created and the first patent was granted in 1790.

Currently the PTO employs over five thousand full-time workers in order to perform its major functions. This bureau of the Department of Commerce examines applications for patents to be issued and trademarks to be registered. Over 6 million regular and 16 million international patents have been granted. This does not include the number of applications rejected, which may be almost equal to the number granted. For example, 288,811 patent applications were filed in 1999, but only 169,094 were granted.

There are six *technology centers* within the PTO. Each center examines applications for different types of technology. For example, Technology Center 2800 is responsible for patent applications involving "Semiconductors, Electrical and Optical Systems and Components." Each technology center is further organized into specific *art units*. Every art unit is made up of similar classes and subclasses. This classification system is designed to speed the evaluation process. It helps to ensure that the examiner has the appropriate expertise to evaluate the application, but it also simplifies the search for *prior art* when evaluating future patent applications.

The growing numbers of patent filings in all divisions of the PTO require better planning in order to maintain a satisfactory evaluation process. The ability to estimate, at the art unit level, the number of patent applications to expect in the years to come will provide a crucial advantage in manpower preparation. Knowing not only how many patents applications to expect, but also the areas in which to expect patent applications, would allow the necessary placement and training of examiners in order to examine applications thoroughly and quickly. Continually working to better the examination process, the PTO must decrease the time required to evaluate an application while increasing the thoroughness of this process.

The goal for this project was to study ways to use economic data to predict the number of incoming patent applications. The first step was to collect and organize patent application data for the art units that make up TC2800. The second step was to collect and organize economic data relevant to the technologies that TC2800 examines. Finally, the third step was to analyze connections and correlations between these data sets and to study statistical models that could be use economic data to predict patent application numbers.

1.2 Overview of Report

Chapter 2 of this report presents background information prepared by the project team to provide an understanding of the patent application process, the classification system, and economic indicators. In addition, this chapter describes previous studies done in the area of forecasting for incoming patent applications.

The Methodology, Chapter 3, discusses how the project group gathered the necessary data. Some basic methods of statistical analysis are also explained. The intent of the methodology is to provide a detailed explanation of the procedure used to obtain our final results.

Chapter 4 of this report, Results and Discussion, displays the results of the various tests that were conducted. Both phases of testing are discussed and the results of both are shown.

Chapter 5, Conclusions and Recommendations, summarizes the findings and points out strengths and weaknesses in the analysis. Recommendations are then made regarding paths that may be taken to continue this project as well as other recommendations concerning alternate approaches to this project.

1.3 The Interactive Qualifying Project

This project satisfies Worcester Polytechnic Institute's Interactive Qualifying Project (IQP) degree requirement. The IQP challenges students to evaluate, discover, and report on a subject matter relating technology and society. The project goal, to explore tools and methods using economic data to forecast numbers of patent applications, relates the economy of the country to the number of incoming patent applications. In effect, this is a relationship between the economy and the advancement of technology, therefore fulfilling the definition of the IQP.

Chapter Two
LITERATURE REVIEW

The purpose of this project was to explore tools or methods that use economic data to predict incoming patent applications. We gathered background information about existing methods by researching prior studies of existing tools and the types of economic data used in those studies. We focused on prior research that evaluated the association between economic and patent data.

This chapter includes a discussion of invention and some significant research from the past 50 years. We go on to explain the necessary components of a patent application and the application process. Also discussed is information about the types of economic data used in our project.

2.1 The Causes of Invention

To predict invention we need to know the causes of invention. Schmookler (1966) defines invention *as a new combination of pre-existing knowledge that satisfies some need.* Without needs, no problem exists. Without knowledge, these problems could not be solved. People invent what they *need* and what they *can*. Inventions may be drawn from a basic pool of scientific knowledge, but they are not just "new ideas" or "new applications," they must be useful and satisfy some need. In particular, a very important problem should draw the attention of many researchers and would increase the chance of solving the problem.

The first element of Schmookler's (1996) definition, emphasizing the novelty of the product, suggests that the conditions under which the inventor created the invention play an important role. Many chance factors such as "the stroke of genius" may lead to the creation of inventions. For example, every school child has learned the story of how Charles Goodyear accidentally discovered a way to make rubber strong enough for use in tires. These types of "accidents" are certainly not predictable. One of Schmookler's main points was that the vast majority of patents are not the results of accidents.

Schmookler's (1996) definition also suggests that an invention comes from wants or needs that an invention satisfies. The things that people invent are the joint product of what they want and what they know. People cannot invent all that they want and even if they were intellectually capable of inventing something, it does not mean that they will. This view is further clarified in Schmookler's (1996) definition of "inventive potential," which he describes as *the possible set of inventions at a given moment consist of those inventions, which somebody in the society could make with the talent he has and the knowledge that anybody has*. Therefore, inventions are not only new combinations of existing knowledge that satisfies some want, but the new invention must also be possible and probable. Someone must have the intellectual ability to create the invention. The induced invention becomes possible once the knowledge that led to the invention is created. This also implies that inventions are both "knowledge-induced" and "demand-induced."

Schmookler (1996) presents two hypotheses regarding the cause of invention:

1. Important inventions are typically induced by scientific discoveries.

2. Inventions are typically induced by the intellectual stimuli provided by earlier inventions.

These hypotheses may be "common sense," but people had not stated them this way. Schmookler (1996) pointed out that we usually hear about a scientific discovery that "led to" an invention or one invention that "led to" another. The term "led to" was interpreted by the two hypotheses. "Led to" could mean that the inventor used the knowledge embodied in the discovery of an earlier invention to make the second invention. Another interpretation of "led to" tied two inventions together. The existence of the first invention changed conditions, and these changes provided the motivation for a second, third, or many more inventions. The message again was that the vast majority of inventions have not been the results of accidents, but can be directly connected to observable and measurable causes.

2.2 Economics of Invention

Jacob Schmookler (1966) did the first major study of the economics of invention. When Schmookler died in 1967, he left behind a major unpublished body of work containing over four hundred sets of time series data on patents granted, classified by industry of use. His work also included a detailed description of the methods used in collecting and constructing these series. Schmookler searched for patents granted by subclasses. He then reclassified the patents by industry usage. This data and his methods were compiled into a book entitled *Patents, Invention, and Economic Change* in 1972. (Schmookler, 1972). His book, *Invention and Economic Growth* (1966) contained only a small portion of his total work.

For example, Schmookler (1966) studied the correlation between the number of technological workers and patents granted. The majority of the inventions around 1950 came from scientists, engineers, and skilled employees in industries making commodities or using industrial equipment extensively. He expected to find some association between the changes over time in the number of technological workers and changes in the number of patents. He also believed that the conditions stimulating or retarding growth in the number of technological workers were also likely to affect invention in the same way (Schmookler, 1966).

Some of his findings were particularly important to this project. The transfer of inventive attention into science-based fields during the nineteenth and early twentieth centuries introduces an increased reliance on men trained in science and engineering. His patent statistics reflected this shift. He demonstrated this by computing the correlation between the number of scientists and engineers per thousand workers per state, and the number of patents per thousand workers per state. He discovered a steady increased as shown in Table 2.1.

Table 2.1 Coefficient of Determination (r^2) of Patents per Thousand Workers and Scientists and Engineers per Thousand Workers, by State, 1900-1950

Year	r^2
1900	0.08
1920	0.28
1930	0.53
1940	0.74
1950	0.83

Data from his other research also showed that a decline in corporate patents issued from 1931 to 1945 correlated with the decline in the number of people employed in industrial research. However, there was no correlation in the same data for the post World War II period. The number of technological workers increased five or six times from 1938 to 1954, but the number of patents issued only increased by 23 percent from 1936 to 1960.

Later, Schmookler (1966) used another approach. He used *log Y minus trend log Y* as the deviation. He computed the deviation of the number of technological workers and the deviation of the number of patent applications and plotted the data in a time series. This resulted in the remarkable correlation shown in Figure 2.1.

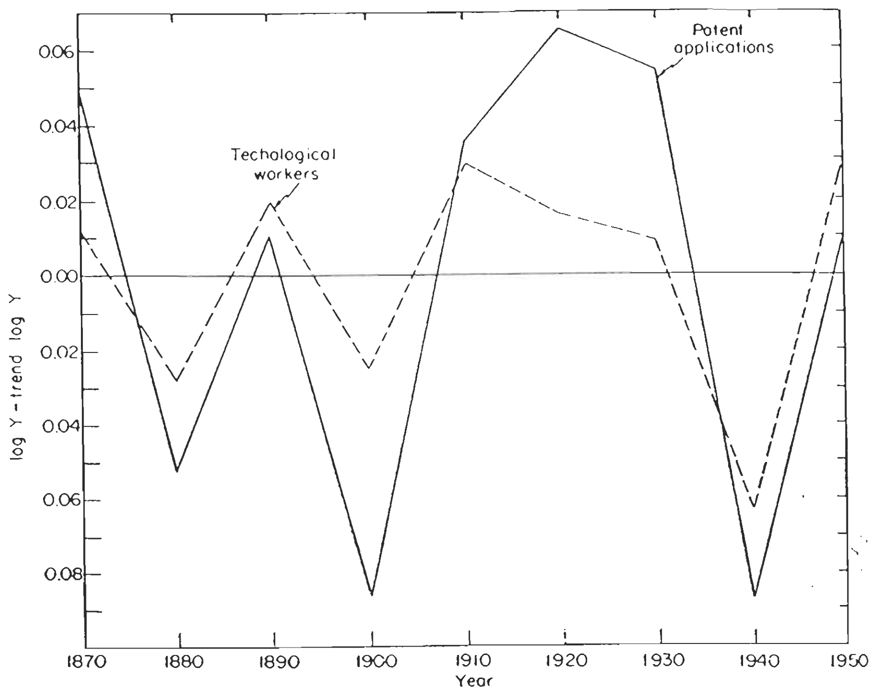


Figure 2.1- Technological Workers and Domestic Patent Applications, 1870-1950, Deviations from Trend (Logarithms)

One feature that stood out was that the sign of the slope for one series of data always corresponded to the sign for the other series of data.

Although Schmookler's results are clearly useful, we need to keep in mind that his information was dated. For example, his categories of technical workers included locomotive operators, and in modern times, locomotives were no longer common. The definition of a technical worker had changed. We took a similar approach in using time series and correlation coefficients to evaluate the data and study connections between patent applications and economic data.

A more recent study was Scherer's (1983) article *The Propensity to Patent*. He analyzed the relationship between R&D expenditures in 1974 and invention patenting by 4,274 narrowly defined lines of business in 443 US industrial corporations. He obtained R&D outlay data of 443 corporations from the Federal Trade Commission's Line of Business survey for 1974. This survey reported domestic sales, costs including R&D outlays, and financial variables broken down into 276 industry categories for these 443 corporations. He compared this data with the number of patents issued to the same 443 companies from June 1976 to March 1977. This gap in the year of R&D outlays and patents issued was to account for the 1-year lag in the patent examination process. He analyzed the association between patenting and the level of R&D expenditure first with Tobit analysis. Tobit analysis was used to create a regression line because it accounted for the large cluster of zero patents, among companies that spent little or nothing on R&D. (Jackson, 1996). This method proved unsuccessful because the Tobit estimates at low R&D levels were more severely biased than ordinary least squares regressions because of sensitivity to a non-normal error term distribution. Therefore, ordinary least squares regression was used instead. (Scherer, 1983).

His results showed that the probability that a company held patents increased systematically with company-financed R&D outlays, as did the number of patents received. He also discovered that within industries, the rise in patents granted was roughly proportional to R&D spending. (Scherer, 1983). Therefore, we should expect in our results an increase in the number of patents when increases in R&D expenditures occur.

Research done by Joseph Rossman (1950) contained another significant discovery. Rossman first observed a cycle in a graph of monthly patent applications per year in an old *Journal of the Patent Office Society* article with patent data from 1913 to 1928. He noticed that high points and low points always occurred around the same time of year. No explanations were given for the appearance of this curve, so he decided to investigate this phenomenon. He plotted the data in a time series by year using the number of patent applications filed each month from 1922 to 1926 shown in Figure 2.2. He plotted the months on the X-axis and the number of patent as the Y-axis. In his analysis, he found a distinct cycle in each year. He found that a drop always occurred in mid-winter and a less pronounced drop in mid summer. In between the drops, he found that high points always occurred about April and again near the end of October. The uniformity of this cycle was quite surprising.

He tried to repeat this analysis with the number of patents granted, but no such similarity resulted. This could have been caused by delays in the application process or the resubmission of applications. This result may not apply to our project because we dealt with applications per year, but it is significant because there was another occurrence of this cycle.

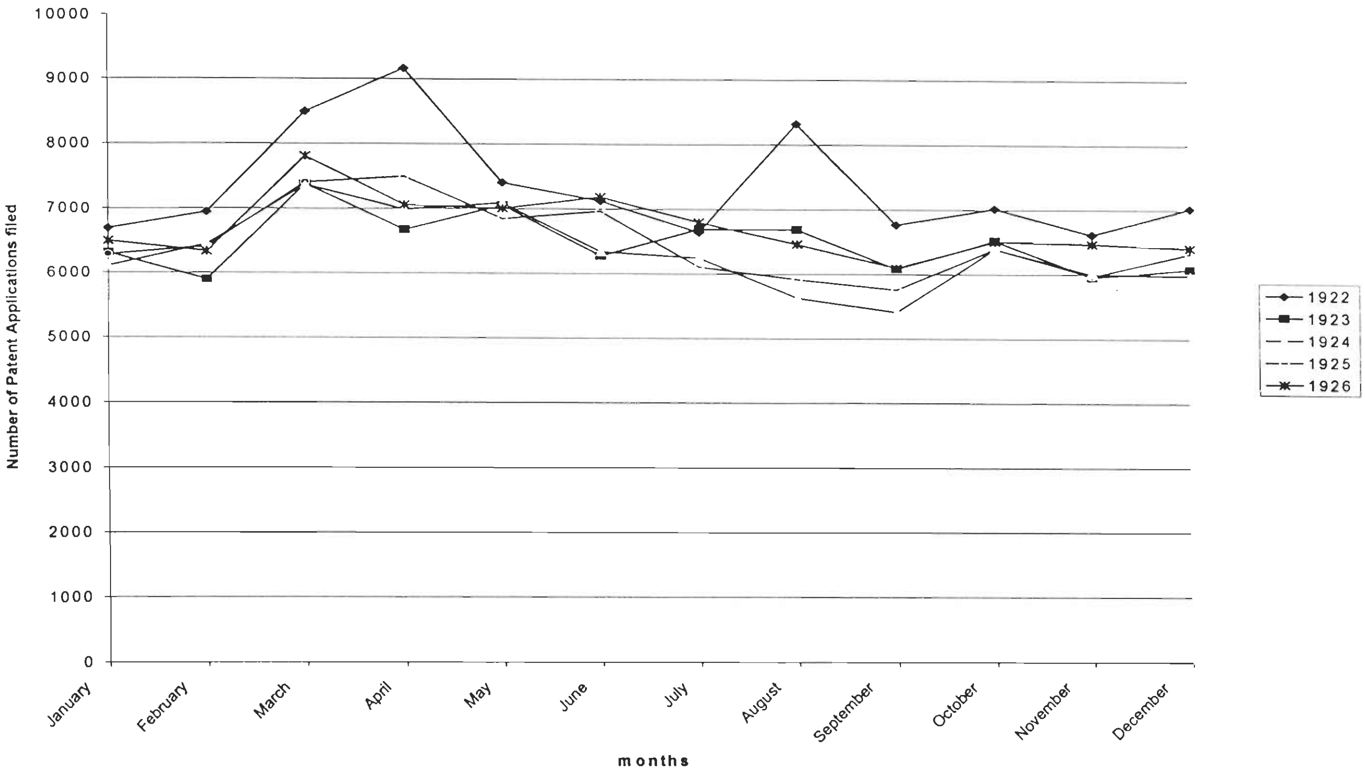


Figure 2.2 Number of Patent Applications Per Month

An article entitled *A Monthly Application Curve,* written by Aaron L. Applebaum (1950) noted the same type of cycle for patent applications from 1913 to 1920 shown in Figure 2.3. He created a similar time series graph of mechanical patents from pre-World War I to post-World War I.

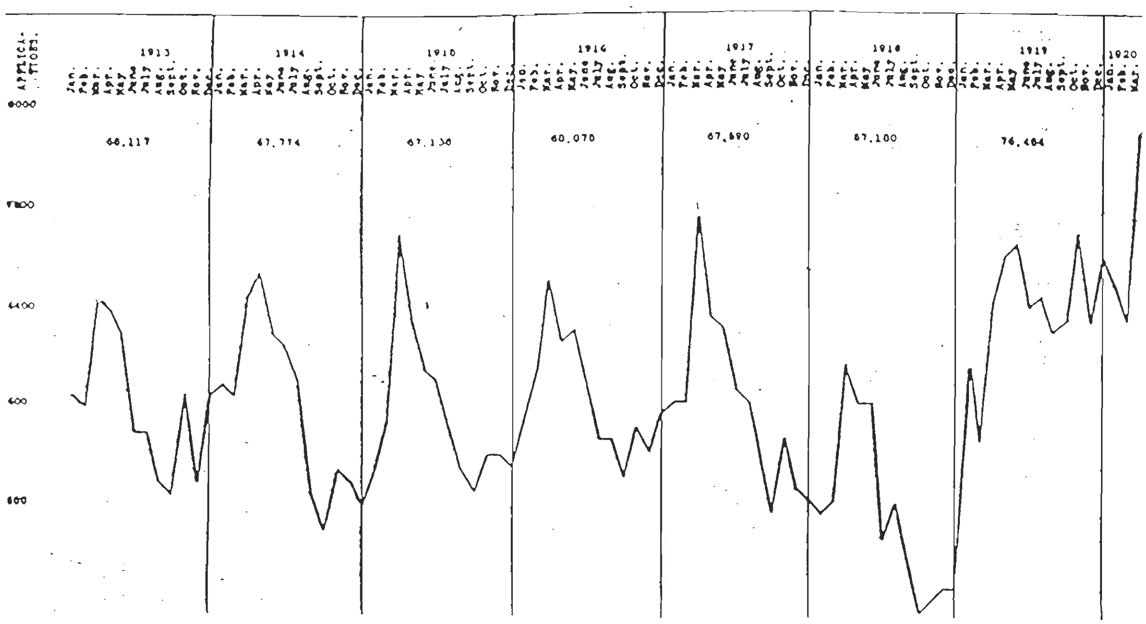


Figure 2.3 Monthly Applications for Mechanical Patents, Jan 1913 – Mar 1920

In his data, he found a low point in September every year and a high point in March every year. There was a marked decrease during the war period in 1918 but the high points still occurred in March and low points in September.

Edwin Mansfield (1981) has done many studies in the field of R&D, innovation, and technological change. Several findings emerged in his studies. First, he found that many firms tend to concentrate on short-term, technically safe R&D projects. Second, he found that when a firm's total R&D expenditures were held constant, its innovative output seemed to be directly related to the percentage of its R&D expenditures devoted to basic research. He also found that a firm's percentage of R&D expenditures appeared to be related to the firm's size. Large firms carry out larger shares of long-term R&D but smaller shares of short term R&D. This research pertained to the chemical and petroleum industries, but his research could call for further studies with industries related to the classes within TC 2800.

Russ Adams, a supervisor at the Patent and Trademark Office, performed more recent studies of patent application data. In the early 1980's, he evaluated the correlation between the Dow Jones Industrial average and application filings. He also modeled the application filings as a function of constant-dollar Gross National Product with various time lags. He did find a correlation, but there was an error of 20 percent when the model was used for prediction (Russ Adams).

Adams tried a completely different approach when he treated patent application data from 1936 to1970 as a "signal" and analyzed the frequency composition of the signal. (This is the same approach used when a physicist or engineer looks for "fundamental modes" in a vibrating system.) The signal was written as the sum of trigonometric functions (sines and cosines) and the equation was then used to predict filings from 1971 to 1986. This resulted in a prediction error of 15 percent.

2.3 Economic Data

Our research dealt with two types of economic data, *Gross Domestic Product* and *Research and Development spending*. We focused on economic data related to classes handled by TC2800. The data used in this project were the portion of the "global values" connected with the electronics industry.

2.3.1 Research and Development Spending

Corporate spending on Research and Development (R&D) was used because it recorded the amount of resources companies have committed to the solving the problems identified by Schmookler as one of the causes of invention. The funding put into R&D fueled the development of innovations, technological breakthroughs, and new products.

The first thing to be considered when selecting data, according to Walshe (1992), was that research and development spending was just a portion of the spending that contributed to the production of new products. There were other types of spending, such as design and production engineering that should to be taken into account (Pavitt et al., 1989). For example Pavitt et al. (1987) have shown that small firms with less than 1000 employees performed only 3.3% of business enterprise R&D in 1975 but accounted for about 35% of identified significant innovations over 1970-79. In other words, small companies which made a small contribution to national R&D figures made a disproportionately large contribution to patent application data.

One way to account for different factors in analysis is to look at relative size instead of the absolute size of the R&D spending. R&D has been assessed in relation to resources in past studies because observers wished to measure what a company or industry had invested in R&D. An economic indicator such as GDP provides a good resource base in relative assessment because it encompasses the whole economy. The R&D/GDP ratio took into account the fact that the larger the economy, the greater the supply of resources available for employment in any one sector of economic activity (Walshe, 1992).

2.3.2 Gross Domestic Product

The Gross Domestic Product (GDP) was the broadest measure of the health of an economy. It provided a measure of production within the national income and product accounts, and included the value of production within national borders regardless of whether the labor and property inputs were domestically or foreign owned.

Real GDP was an important indicator to track because it provided a broader view of each sector or industry than any other indicator. The data reflected company income as well as the flow of expenditure within each industry. GDP was also able to provide comprehensive information on supply and demand conditions because of the detail available in the reports. Again, the data used in this project was the portion of the national GDP connected with the electronics industry. (http://www.cftech.com/BrainBank/FINANCE/GDP.html)

2.4 Patent Data

It was important to distinguish between *patents granted* and *patent applications*. As noted earlier, most applications in a given year are not granted. The number of applications was a better measure of the actual workload in the PTO and the goal of this project was to forecast the workload for TC2800.

Firms have used patent literature to monitor technological advances in their field of business. Similarly, the PTO can use industry information, such as an industry's resources and spending, to identify areas in which to expect development.

Patent data does not reflect all innovations because not all inventors file an application for a patent. The most obvious reason for this is the company's desire to retain complete control of the invention for a period longer than the twenty years granted by the patent (Schmookler, 1950). Sometimes, firms protect their innovations with "industrial secrecy" (Walshe, 1992) and may keep this from the public rather than patent it (Keiper, 1923). The practice of trade secrecy could possibly affect the reliability of using patents data as a measure of invention.

Another issue to keep in mind is that companies do not use many of the patents issued each year for any commercial purposes. Some are used as "blocking" patents to stop innovation from advancing too quickly, or they are simply developed to keep the competition out (Sheperd, 1979). However, examiners still need to process the applications for these patents and for this reason should be included in the data.

When an application was filed, it was entered into the PTO's database. Only specification information about the application such as date of filing, inventor, and filing class and subclass was entered into the database. When an application was resubmitted changes are made to the claims and the number of resubmissions are noted on the cover, but the application specifications in the database remained the same.

2.5 TYPES OF PATENTS

Patents are associated with invention, but patents are not inventions. A patent does not give the inventor the positive right to make, use, or sell his or her own invention but rather grants to the inventor the negative right to exclude others from making, using, or selling the patented invention (Burge, 1984). There were three general categories of patents including, *utility patents*, *design patents*, and *plant patents*.

Utility patents were the most common and were issued for new inventions that function in a unique manner. This included useful processes, machines, and compositions of matter. Some additional examples were drugs, electronic circuits, semiconductors, processes, and other inventions of this sort. A utility patent had a life of twenty years if all fees are paid. The utility patent application-filing fee is paid when the inventor submits the primary application.

Design patents were different from utility patents. Rather than a new idea or invention, design patents were ornamental and focus on the visual shape and design of an object. Desks, lamps, and even computer icons have all been patented for their unique shape. These applications rely heavily on detailed drawings included in the application. Unlike a utility patent, a design patent's life is only fourteen years from the date of issue. There were application fees and issuance fees, but maintenance fees did not apply.

Plant patents deal with asexually reproducible plants and were not very common, especially in TC2800. The application filing fee and issuance fees again applied. They could last up to twenty years, but did not require maintenance fees.

All patent submissions and resubmissions required filing fees. Once an application had became a patent, the application issue fee is charged. The Patent and Trademark Office charged three maintenance fees to keep the patent "alive" for the twenty year span. Between three years and three years and six months after the grant of a patent, the first fee was due. It was currently $830 and renewed the life of the patent for four more years. The second fee of $1,900 was due between seven years and seven years and six months. This second fee also added four years to the life of the patent. The final maintenance fee was due before the eleven year six month mark. The final fee ensured the full twenty-year lifespan of a patent and was the largest at $2,910. If these fees were not paid, the patent expired, but it was possible to request a six-month grace period, in which case surcharges would apply.

2.6 Application Examination Process

The fees described above directly fund the examination process. Databases were needed to search previous patents in order to ensure the originality of a patent application. Applications were reviewed in sequential order based on the date received. Initially, the application was checked for completeness. If all parts of the application were present, the examiner moved on to investigate prior patents in order to determine if the invention was patentable.

The first office action usually took place around eighteen months after the patent application was received. It was rare that an application was approved to receive a patent on the first try. If the claims were rejected, the reasons for rejection were communicated to the inventor. The applicant now had six months to reply to the Patent and Trademark Office with revised claims.

The second office action was taken in response to a second examination. If the claims were now patentable then fees were collected and a patent was awarded. However, if the claims were rejected again it was considered a final rejection. Traditionally, the second rejection was the final rejection, but the inventor could appeal the decision of the examiner and have the patent reexamined (once again for a fee) or request a hearing involving the Board of Appeals within the Patent and Trademark Office. If the inventor could convince the Board of Appeals that the invention was not obvious and was original, then the board could award a patent. The system of appeals could continue through the Federal Circuit up to the Supreme Court, but it was very rare that it traveled this far.

Once an application passes all inspections and was awarded a patent, the Patent Office sent the applicant a notice of allowance. Now the inventor had three months to pay the final fees and correct any remaining problems. Once the fee was paid the patent was issued within five or six months and the grant with seal and ribbon was mailed to the applicant.

2.7 The PTO Classification System

The PTO created a classification system of 430 categories. One example of such a category would be food and edible materials. The 430 categories were then divided into 145,000 sub-categories. Keeping with our example, there were 800 sub-categories related to the category food and edible materials such as, citrus derived, dry mixed, and alcohol content. Note that technologies were not restricted to one subclass. A single patent application could be listed in several related subclasses. (Technology Assessment and Forecasting Product and Services Brochure)

Under the previously mentioned classification system, TC 2800 was given the title "Semiconductors, Electrical and Optical Systems and Components." The four branches of TC2800: TC2810, TC2830, TC2850, and TC2870/2880 were responsible for different kinds of technologies. (See Table 2.2)

Table 2.2 Branches of Technology Center 2800

2810	Semiconductors, Electrical circuits, Static memory, Digital logic
2830	Power generation, Music, Electrical components, Control circuits
2850	Photocopying, Recorders, Printing, Measuring, Testing
2870/2880	Liquid crystals, Optical elements, Optical systems, Fiber optics, Lasers, Electrical lamps, Registers, Optics, Measuring

Chapter Three
METHODOLOGY

The focus of this project was the connection between economic data and patent applications. Specifically, we needed to obtain the actual numbers of patent applications within Technology Center 2800 at the class and subclass level, research and development (R&D) spending numbers, and gross domestic product information related to technologies examined in TC2800.

The methods used in this project were similar to those used in previous studies done on a PTO wide scale. Our project, however, attempted to look at patent applications on a finer scale. Looking at the Art Units specific to Technology Center 2800, we were able to keep our findings pertinent to TC 2800 and not to the entire PTO. Previous studies may have determined the total number of applications to be expected by the entire PTO, but that would not be useful to TC2800. It would be useful if the study were able to break down the total by art unit, so that TC2800 could have hired and trained examiners for the correct areas.

3.1 Findings and Applications

The most difficult data to locate were the numbers of patent applications in the art units within Technology Center 2800. Some of the data were provided by Michael Tokar, a supervisory primary examiner. Using his own formulas and methods, he had obtained estimates for these numbers for the past five years. This was a difficult task because TC2800 has only been in existence for about two years. The classes and subclasses that make up TC2800 had to be traced back to their locations before becoming a part of TC2800. These numbers were used in an initial testing phase.

After the identifying art units to examine further, we followed Tokar's approach to find patent application data going further into the past. Each art unit is a collection of classes and subclasses. Using PALM, we were able to specify an art unit and identify the classes and subclasses within that art unit. We then searched for those classes and subclasses in PALM using Business Objects. By then regrouping the classes and subclasses into art units again, we obtained the number of patent applications for the current art units.

Classes and subclasses are always changing, combining, abolishing, and creating new classes and subclasses. This makes it difficult to track and identify the appropriate art unit for a group of patent applications. For example, when collecting patent application data for Art Unit 2851 we found classes being created, abolished, and shared over different art units. A search for class 396 returned the list of cases recorded in Table 3.1. Note that there is a great deal of variability in the data.

Table 3.1 Count of Cases for Class 396

Year	1985	1990	1992	1993	1994	1995	1996	1997	1998	1999
Cases	1	1	1	2	4	16	300	1246	760	697

Class 396 was created in 1997. Before class 396 existed, its applications were a subset of the applications in class 354. When new subclasses were added to class 354, it was abolished and renamed as class 396. Therefore, we searched the history of class 354, going back to 1985.

Table 3.2 Count of Cases for Class 354

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Cases	424	437	465	591	725	752	770	653	843	1053	1303	737	1

This shows an example of the creation and abolition of a class.

It was also possible for a class or subclass to have been split and shared over several different art units. Sometimes it was even possible for a class to be shared between technology centers. Class 355, also part of Art Unit 2851, was split in November of 1996. Subclasses were taken from class 355 which then became class 399. Class 399 was the only class found in Art Unit 2852, so when looking into the histories of these classes, we did not have complete historical data for either. In order to get the most accurate history we computed ratios. First, we added class 399 to class 355. We then took the 1997 to 1999 data for class 355 and divided each year by the same year in the combined 1997 to 1999 data. This gave a ratio for class 355 for each of these years. We then took the average of those three ratios and applied that average ratio to the combined data. By doing the same for the 399 data we were able to obtain histories for both classes. Appendix M shows these calculations.

3.2 Statistical Tools

In our project, we used several statistical methods to analyze and model economic and patent data. These tools were the Pearson Correlation Coefficient, Linear Regression, and Multiple Regression.

Correlation between two sets of data measures the strength of the linear relationship between two data sets. If a unit change in one variable always, or almost always, corresponds to the same magnitude of change in a second variable, then the two variables are highly correlated. If the data are plotted in pairs, the points will all lie on or close to a straight line.

The direction and magnitude of correlation is measured by the Pearson Correlation Coefficient, ***r***. The coefficient ***r*** is a dimensionless quantity that ranges from negative one to positive one. When ***r*** is plus or minus one, the two variables are perfectly correlated. When ***r*** is zero, the two variables have nothing in common. When ***r*** is negative, an increase in one variable usually corresponds to a decrease in the second variable. For example, the set of points (X,Y) = (0,3), (2,1), and (4, -1) all lie on the same line. The correlation coefficient for this set of data would be ***r*** = -1 (the slope of the line is negative).

We used the Pearson Correlation Coefficient in our project to analyze the correlation between the economic data and the patent data. The Pearson Correlation Coefficient has the following formula:

$$r_{xy} = \frac{n\sum XY - \sum X \sum Y}{\sqrt{\left[n\sum X^2 - \left(\sum X\right)^2\right] * \left[n\sum Y^2 - \left(\sum Y\right)^2\right]}}$$

X are the values from one data set, Y are the values from another, and n is the number of data points in each set. For example, with the data in Table 3.3 we obtained a correlation value of -0.97357. This value corresponds to the graph of the values in Figure 3.1. The data points, in the graph of the specific growth of applications as a function of the specific growth of R&D/GDP, almost lie on a straight line. Notice the negative slope of the line as shown in the negative value of the coefficient. This says that the *growth rate* for patent applications in AU2811 will tend to decrease with an increase in the *growth rate* of R&D/GDP.

Table 3.3 Specific Growth of Applications in AU 2811 and R&D/GDP by Year

Year	1996	1997	1998	1999
Specific Growth applications in Art Unit 2811	-0.15081	0.237705	0.156733	0.206107
Specific Growth of R&D/GDP	4.50340	1.40040	2.66910	1.56509

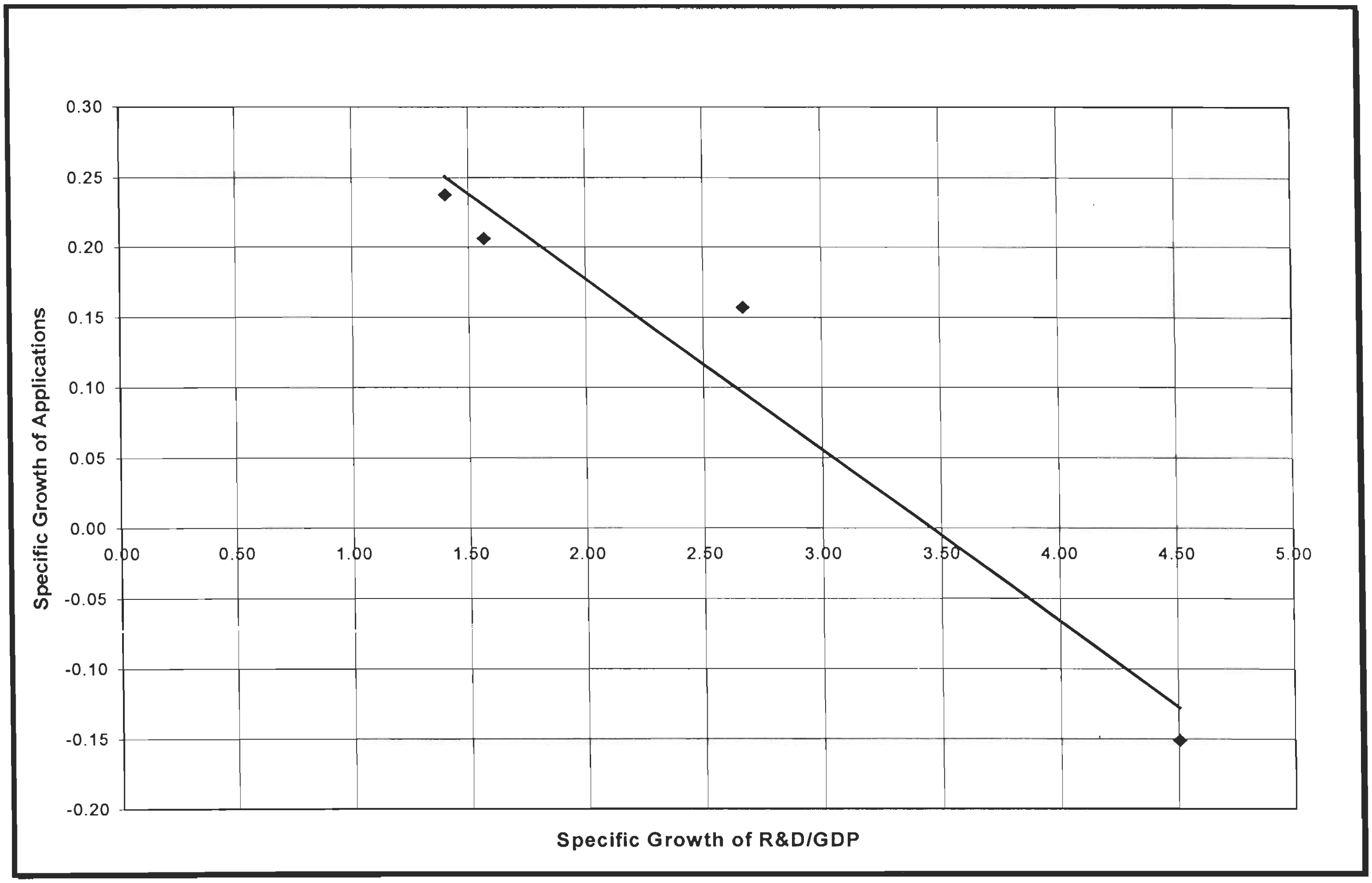


Figure 3.1 Specific Growth of Applications in AU 2811 and R&D/GDP by Year

3.2.1 Linear Regression

Linear regression is a statistical method used to fit a linear model to sets of data. It can be used to predict future values from past values by finding the best straight line through a group of data. The function in the electronic spreadsheet performs linear regression analysis using the "least squares" method to fit a line through a set of observations.

The least square method finds a straight line such that the sum of the squares of the vertical deviations from the points to the line is minimized.

This method of linear regression was used in our project to predict future values of data. The predicted values were y-values for given x-values. The known values consisted of economic data and patent data from 1985 to 1999.

3.2.2 Multiple Regression

Multiple regression assumes that one variable is a function of two or more other variables. For example, multiple regression was used to build a model for patent applications in an art unit based on both GDP and R&D spending data as independent variables.

3.3 Statistical Analysis

R&D spending for electronic equipment, obtained from the National Science Foundation (NSF) as well as GDP in electronic industries obtained through the Bureau of Economic Assessment (BEA) were tested for their effectiveness as indicators. We were unable to obtain 1999 data for both. We used a seven-year moving forecast, using the forecast function in Excel to determine this data. A 95% confidence interval determined the error in each forecast.

We were initially unable to obtain data prior to1995 for the number of applications within classes and subclasses. Since we were able to obtain numbers for 1995 through 1999, we used these numbers and sorted the classes and subclasses into art units. With the numbers of applications filed per year from 1995 to 1999, we were able to choose the art units we would use in our final analysis.

At this point, we had four data sets: R&D, GDP, R&D/GDP and application numbers per art unit by year. We computed percent change, or specific growth, per year for each data set. Working with specific growth allows the observation of the movement of the activity of the data. This also makes the data comparable on the same scale. Table 3.4 shows Art Unit 2856 and the application data that we had initially. Art Unit 2856 covers measuring and testing.

Table 3.4 Art Unit 2856 Application Numbers

Year	1995	1996	1997	1998	1999
AU 2856	998	978	1142	1059	1192

The specific growth of the application data are shown in Table 3.5.

Table 3.5 Specific Growth of Applications in AU 2856

Year	1996	1997	1998	1999
Specific Growth	-0.02004	0.16769	-0.07268	0.12559

Doing the same for R&D, GDP, and R&D/GDP, the specific growths over the same years were calculated. Using the spread sheet function for Pearson Correlation (r) we compared each indicator to the application numbers for the 1995 to 1999 data.

With (r) being on a scale from -1 to 1 those that were close to either -1 or 1 were useful to us. Therefore, the values close to zero show no correlation. To analyze the effectiveness of an indicator on the art unit data as a whole we calculated the absolute value of the (r) for each art unit so that large negative values did not negate large positive values. These values were then averaged to find the average of the correlations of that indicator for each art unit. The absolute values were also used to determine the median of this data. With the average and the median of each indicator's correlation to the art units on a whole we were able to visualize the effectiveness of that indicator for our data. A high average with a high median shows that using Pearson's Correlation, the data correlates well. In order to determine which art units we were going to do further analysis on, the top two (r)'s identified with each indicator were taken. Table 3.6 shows the (r) values for each indicator.

Table 3.6 Pearson (r) Values

Correlation w/ R&D	Correlation w/ GDP	Correlation w/ GDP/R&D
0.24183	0.97842	0.73434

Art units that had the best correlation were chosen and they were decomposed into classes and subclasses. Numbers for the past fifteen years of applications within these subclasses were obtained using Business Objects to search through PALM. The new application data for Art Unit 2856 is shown in Table 3.7.

Table 3.7 Application Data for AU 2856 from Business Objects

Year	# of Applications
1985	677
1986	693
1987	707
1988	797
1989	894
1990	947
1991	878
1992	815
1993	985
1994	1094
1995	1118
1996	1170
1997	1443
1998	1349
1999	1341

Once all of the new application data were collected, the indicators were tested for correlation using Pearson's Correlation Coefficient. The best indicator(s) for each group of data were then identified. GDP was the best indicator related to Art Unit 2856 and overall the best with all art units. Table 3.8 shows the (r) values for each indicator for Art Unit 2856.

Table 3.8 Pearson (r) Values for Art Unit 2856

Indicator	Pearson Value
GDP	0.635523209
R&D	0.22760653
R&D/GDP	0.069046959

The 1995-1999 data was then referenced to identify the fifteen art units that associated best with that indicator, GDP. The goal was to study ten art units in depth, but taking the top fifteen allowed art units to be eliminated if their field was not relevant, or if sufficient information could not be attained. The difficulty of obtaining this data, combined with the short time available, limited the number of art units to be tested to ten.

At this point we had actual data and specific growth for each of ten art units and for the best indicator, GDP, and the second best indicator, R&D spending. Regression statistics tables were then formed for each art unit using GDP by itself, R&D spending by itself and both indicators together. This was done using the spreadsheet application for data analysis. The information obtained from this was Pearson's (r), R^2, ANOVA table, and residual analysis. An example of this is shown in Table 3.9.

Table 3.9 Regression Output of GDP v. AU 2856

Regression Statistics					
Multiple R	0.969111862				
R Square	0.939177801				
Adjusted R Square	0.934499171				
Standard Error	63.96241015				
Observations	15				
ANOVA					
	Df	*SS*	*MS*	*F*	*Significance F*
Regression	1	821256.2645	821256.26	200.73775	2.78482E-09
Residual	13	53185.46887	4091.1899		
Total	14	874441.7333			
	Coefficients	*Standard Error*	*t- Stat*	*P-value*	
Intercept	$\boxed{33.41295115}$	69.77213881	0.4788867	0.6399737	
GDP	$\boxed{0.007684948}$	0.000542408	14.168195	2.785E-09	

The heavily outlined boxes contain the intercept, alpha, and coefficient, beta. For the example shown, beta is 33.4, and alpha is 0.00768. As shown in the table, the (r) value is .97, which is good because it is very close to one. It is also important to note the

Significance F value. In this case it is 2.78×10^9, which is below 0.05, meaning that this is a good model. However, this is not a measure correlation.

We also tested for lag times. This was done by moving the application data back one, two, and three years, and running regression statistics on them to find the correlation, and the significance of the model. This was done for every art unit for each indicator for one, two, and three year lag times. Table 3.10 shows and example of how we tested to see if the model was still good when lagged up to three years.

Table 3.10 Lag (1 year)

Year	AU 2856	GDP
1985	693	91,846
1986	707	92,827
1987	797	87,640
1988	894	96,619
1989	947	104,983
1990	878	105,717
1991	815	110,758
1992	985	107,683
1993	1094	120,979
1994	1118	139,279
1995	1170	146,872
1996	1443	153,181
1997	1349	166,047
1998	1341	168,311
1999	**Shifted ↑**	**Deleted**

If the regression of one year lagged data came back as a good model, it was indicating that we could take the present data and forecast one year ahead. To check this, we used the linear model to predict the 1999 data and compare it to the actual application number for 1999. We ran the forecast by using the following equation.

$$Y_t = \alpha + \beta_1 X_{t-1} + \Sigma$$

This equation shows a one year forecast. "Y" would be patent applications for year "t." Alpha (α) and Beta (β) are from a one year lag model. Alpha is the y-intercept and Beta is the coefficient of indicator, (X). The "t-1" denotes that the indicator value used is one year before the year of patent applications desired. Of course, there is error involved, and that is represented by the symbol, Σ. We ran the test for Art Unit 2856 and obtained the following results as depicted in Table 3.11.

Table 3.11 Art Unit 2856 Prediction of 1999 Applications

Art Unit	Forecast	Actual	%Error	Significant F
2856	1421.6294	1,341	6.0126	3.31E-06

The forecast predicted that in 1999, Art Unit 2856 would receive 1,422 applications. Art Unit 2856 actually received 1,341 applications, therefore, giving a six percent error.

Art Unit 2856 was used as an example to better explain the methods used throughout our testing. The remainder of our results is provided in the following chapter.

CHAPTER FOUR
RESULTS & DISCUSSION

In order to complete the necessary testing of indicators, we first had to obtain data specific to Technology Center 2800. This data includes patent application numbers and information on and about indicators. The indicators we chose to investigate were research and development spending (R&D), gross domestic product (GDP), and R&D over GDP, all specific to their respective electronic fields. Our interviews led us to these indicators as well as showed us how and where to obtain patent application numbers.

4.1 DATA: GROWTH AND SPECIFIC GROWTH

Our first interview was conducted with supervisory primary examiner Michael Tokar. He was able to supply us with patent application data going back to 1995. It was separated by the classes that form each art unit of TC2800. If a class is shared over multiple art units, the patent application numbers were proportioned to each art unit. This data was used in our preliminary testing. Our next interview was with Gus Mastrogianis from the planning and forecasting branch of the USPTO. There he suggested to us that from his studies R&D and GDP were the two best indicators. Finally, an interview with Richard Rouck, an Administrator for Search and Information Resources, introduced us to Business Objects, a data mining software tool. He showed us the searching capabilities of this program. This encouraged us to use this as our method of retrieving patent application data.

A study performed by the National Science Foundation (NSF) provided R & D spending data in many categories for the years 1985 through 1998 in 1996 dollars. We chose electronic equipment because it best compared to the type of applications evaluated by TC2800. From the Bureau of Economic Analysis web-site, we found GDP data in the field of electronics for the years of 1985 to 1998 in 1996 dollars. Again, this was chosen due to the relationship with the type of inventions TC2800 handles.

Working with the data we have gathered, tests were done to see which indicator had the best correlation with the number of patent applications. The data was organized into four categories: research and development spending in electronic equipment, gross domestic product in the electronic industry, research and development spending divided by gross domestic product, and the number of patent applications per art unit. The first three listed are the indicators.

The 1999 data for GDP and R&D was unavailable. Forecasts were done using the spreadsheet's regression forecast function to obtain this data. A 95% confidence interval tells us that the error in this forecast was ± 2807.34 or ± 10.57% for 1999 R&D and ±14837.2 or ± 8.16% for 1999 GDP.

We compared the specific growth rates and actual growths for each indicator with the specific growth and actual growth in the number of patent applications as well as the actual growths of each. The formula for specific growth is:

$$\frac{X_t - X_{t-1}}{X_{t-1}}$$

In this formula "X" is the data and "t" is the year of the data. For example, the formula for the specific growth of patent applications for the year 1995 would look like this:

$$\frac{\#\ \text{Applications}_{1995} - \#\ \text{Applications}_{1994}}{\#\ \text{Applications}_{1994}}$$

Graphs of each indicator, one showing specific growth over the years and the other the actual growth, are provided.

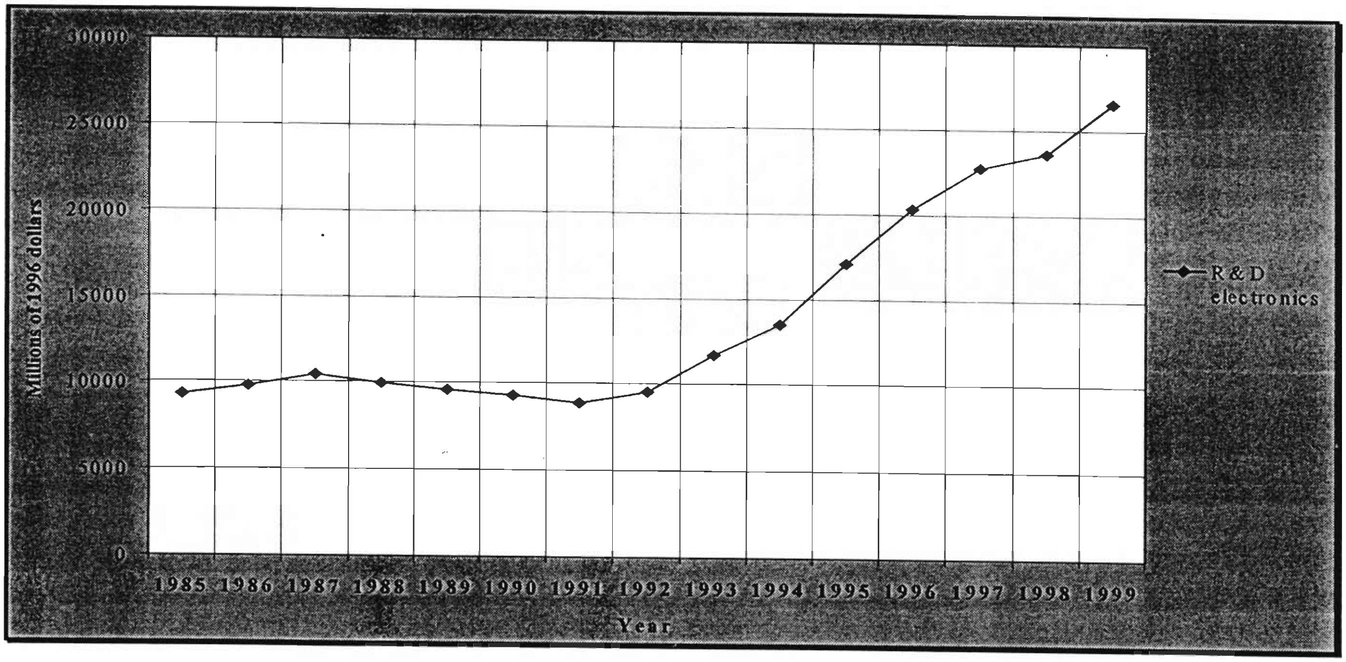


Figure 4.1a Research and Development Spending

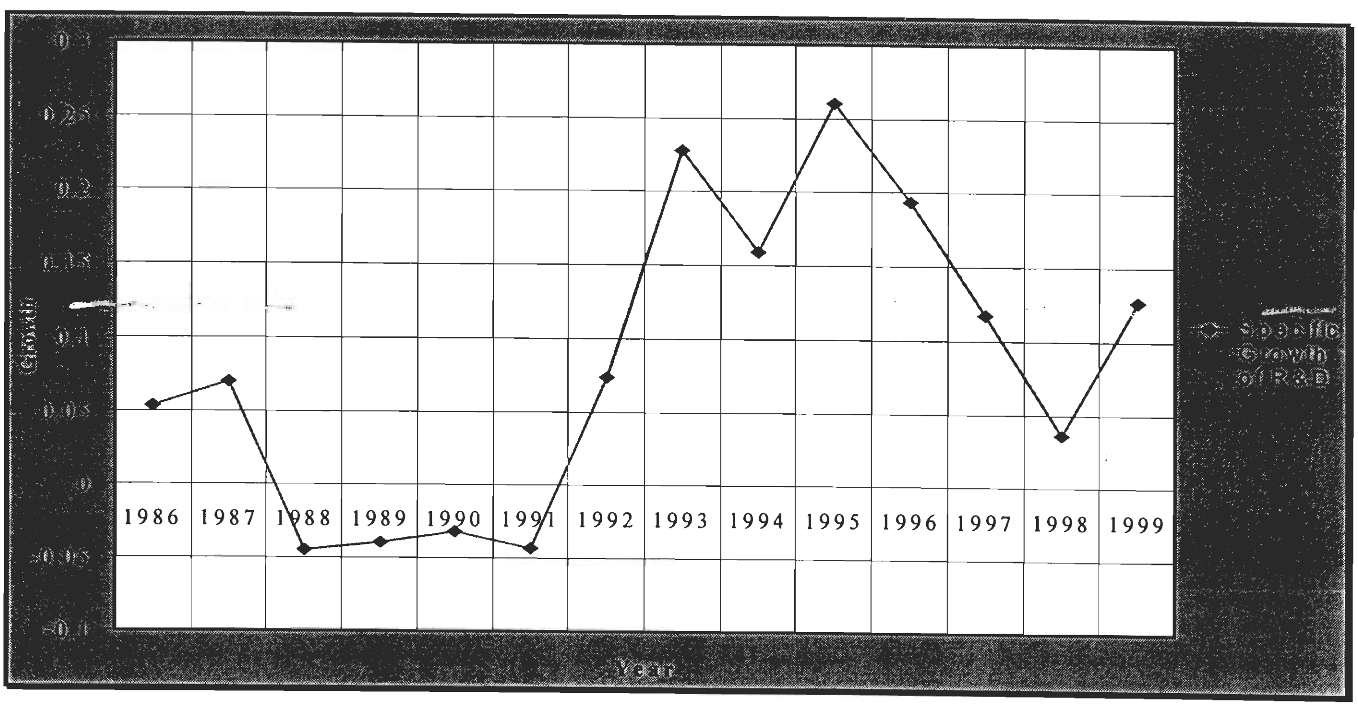


Figure 4.1b Research and Development Spending (specific growth)

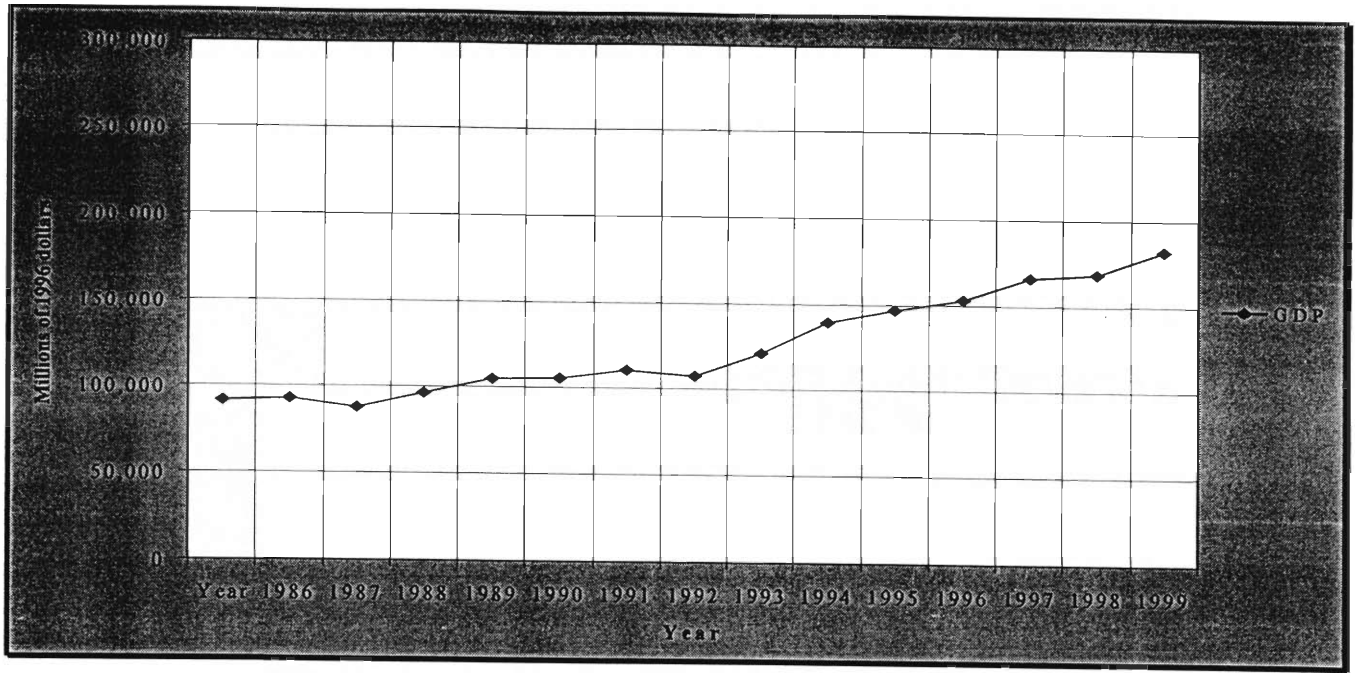


Figure 4.2a Gross Domestic Product

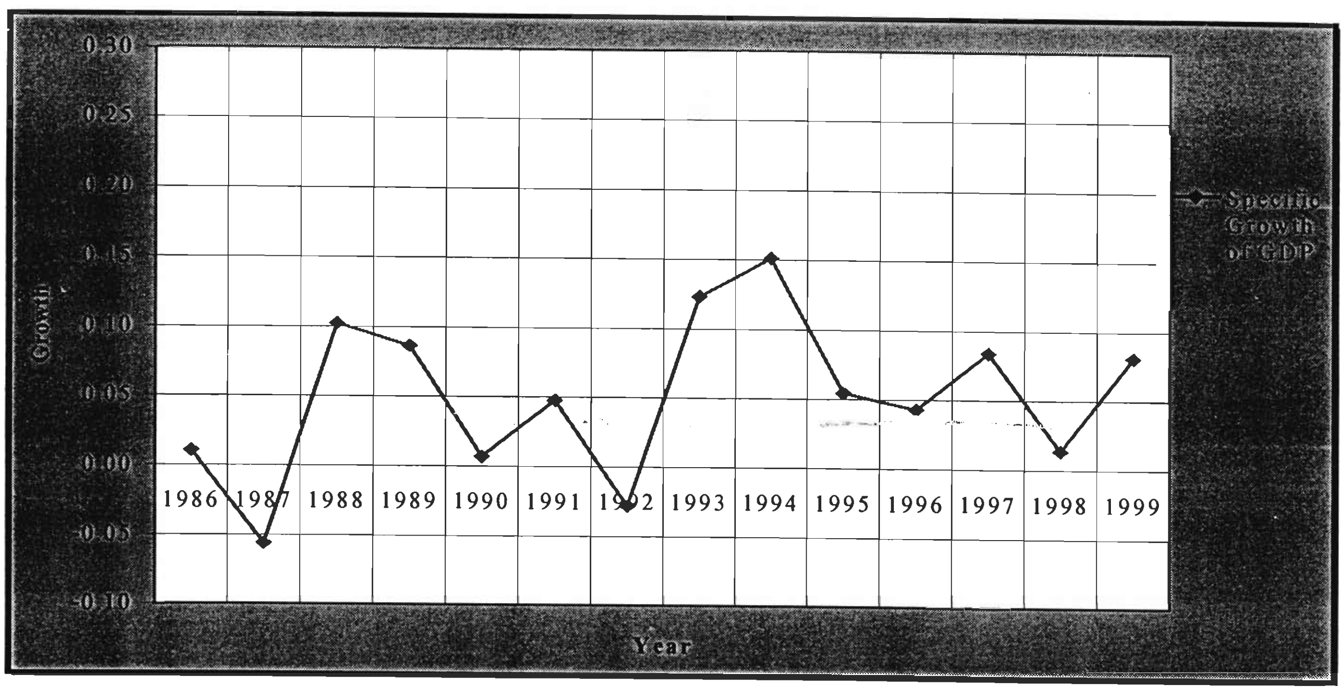


Figure 4.2b Gross Domestic Product (specific growth)

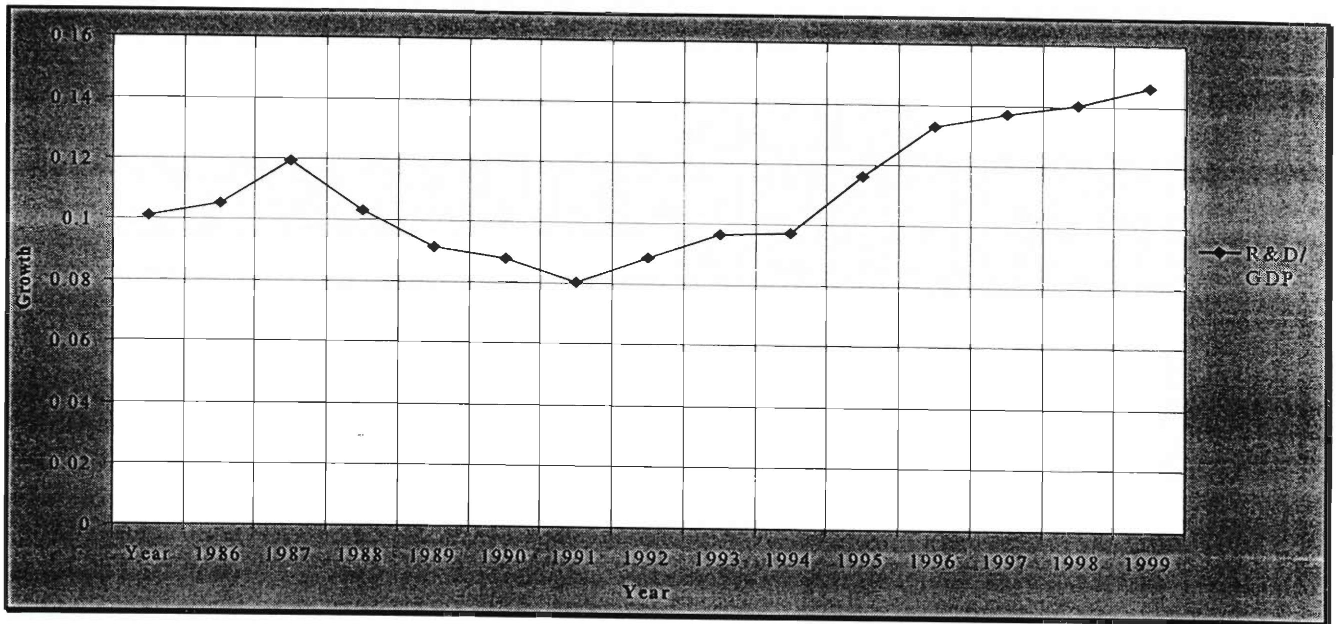


Figure 4.3a R & D over GDP

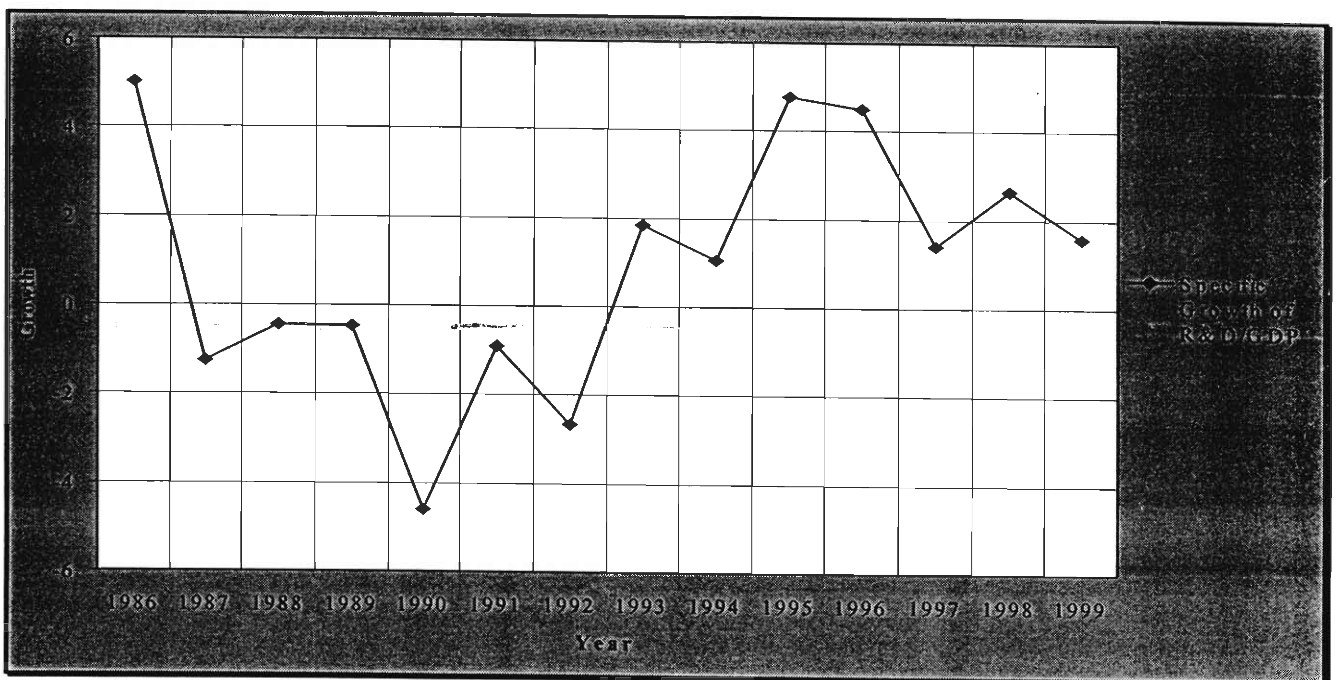


Figure 4.3b R & D over GDP (specific growth)

The next example shows the specific growth of GDP compared to the specific growth of applications in Art Unit 2821. The peaks and dips of each seem to match nicely. These are the types of associations that we were looking for during the initial testing phase. In this example, Pearson's r-value is 0.97.

See Figure 4.4.

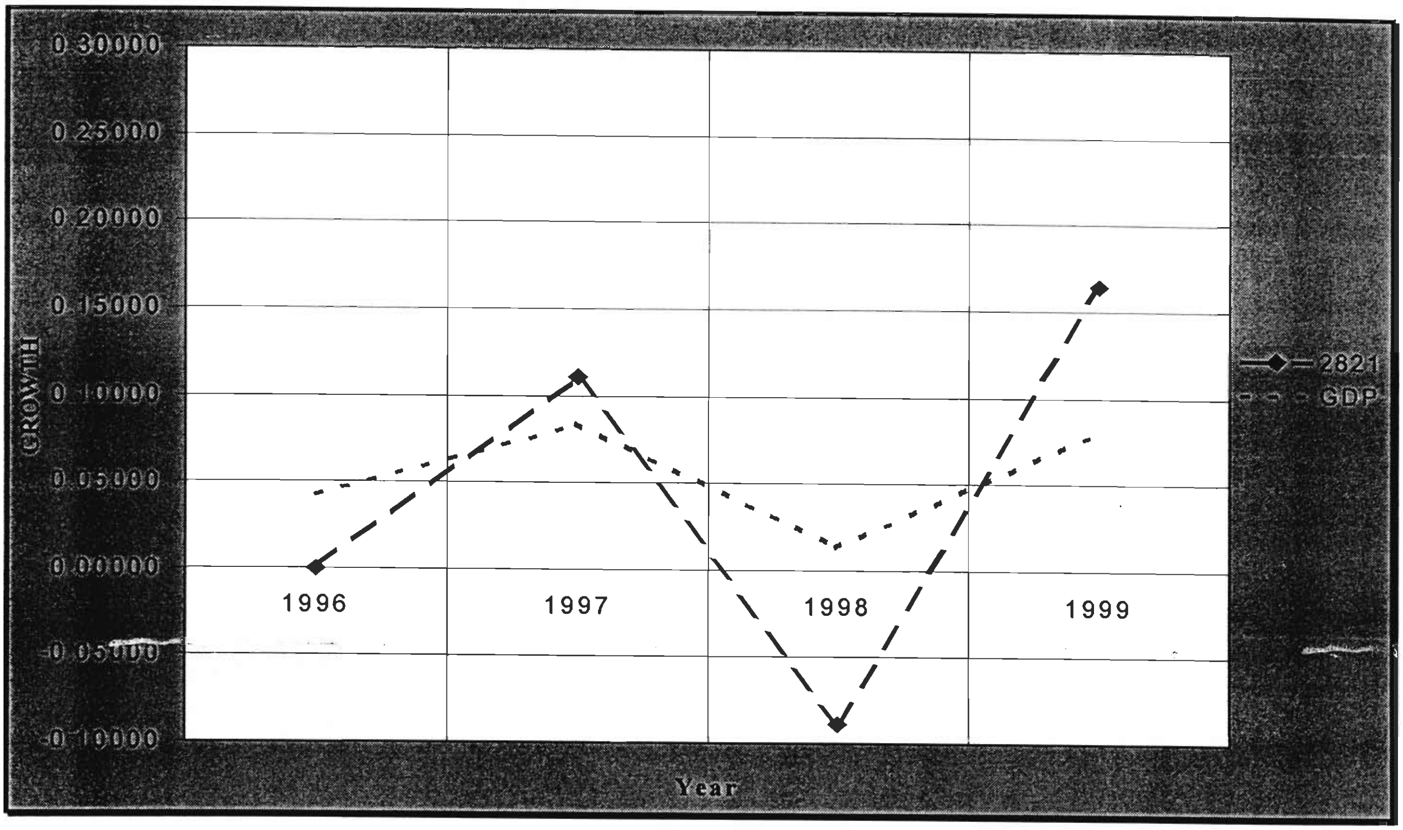


Figure 4.4 GDP (specific growth) vs. AU2821 (specific growth) (r-value = 0.97)

4.2 Initial Testing

The first tests conducted used patent application numbers supplied by SPE Michael Tokar. This data for patent applications went back to 1995. This supplied four specific growth points and five actual data points of patent applications. Using this information, we were able to compute the Pearson Correlation Coefficient (r) for each indicator for each art unit. The results shown in Table 4.1 are the average and the median of the correlations on all art units with each indicator.

Table 4.1 Average Pearson (r) Values for all Art Units

Specific Growth

	R&D	GDP	R&D/GDP
AVG	0.53448	0.47133	0.69190
MEDIAN	0.52193	0.43008	0.75795

Actual Data

AVG	0.75271	0.79686	0.66408
MEDIAN	0.84018	0.89898	0.71698

The decision was made that since the correlation with the actual data was much more consistent, it was more important to use the art units that correlated best with the specific growth data to test our indicators. With overall good correlations using the actual data, the chances were good such that whichever art units we chose we would get good correlations. This turned out to be true as seen in Table 4.2. This showed that only one out of our five art units chosen through the specific growth data had poor correlation in the 1995 to 1999 data.

Table 4.2 Actual Pearson (r) Values

Specific Growth

ART UNIT	R&D	GDP	R&D/GDP
2856	0.2418	0.9784	-0.7343
2852	0.7741	-0.1888	0.8691
2875	-0.8082	-0.4408	-0.2992
2851	0.3483	0.8877	-0.5753
2858	-0.1689	0.8266	-0.9489

Actual data

	R&D	GDP	R&D/GDP
2856	0.8378	0.8989	0.7218
2852	0.8631	0.8010	0.9204
2875	0.8490	0.8859	0.7440
2851	-0.2304	-0.1643	-0.3074
2858	0.6244	0.7486	0.4256

Using the specific growth data, R&D over GDP provided the best results. The average of the correlations between this indicator and patent application numbers was an r-value of 0.69, with a median r-value of 0.76. (This shows that most (r) values were above the average.) Art units 2852 and 2856 correlated to this indicator with r-values of 0.87 and 0.73 respectively.

Research and Development spending provided the next best results. The average of the correlations was and r-value of 0.53 and the median r-value was 0.52. Art units 2852 and 2875 correlated to this indicator with r-values of 0.77 and 0.81 respectively.

The worst overall correlation was found to be with Gross Domestic Product. It provided an average r-value 0.47 and a median r-value of 0.43. Art units 2851 and 2858, however, showed very good correlation. These art units showed r-values of 0.89 and 0.83 respectively.

Because of a lack of data on the specific number of patent applications, we were faced with a dilemma. Five years of patent applications were not enough to build and test our best statistical model. We took art units that correlated well for each indicator, chose two from each, and searched for patent application data that goes much further into the past.

In order to find application numbers per art unit, we divided the chosen art units into its classes and sub-classes, gathered application numbers for each, and then recombined them into art units. This was done using a program called Business Objects. It searched the data warehouse for applications by fiscal year in each class and sub-class. Section 3.1 of the Methodology explains how we dealt with splitting classes.

4.3 FURTHER TESTING

The entire process was now repeated with the new application numbers from the art units that showed correlation in the first tests: 2851, 2852, 2856, 2858, and 2875. Test that were done here were to find which indictors best correlated to the expanded patents data. This helped us get a more accurate view of how the indicators really performed to this data. The new application numbers were from 1986 to 1999.

4.3.1 Results of Specific Growth Testing

As seen in Table 4.3, the correlations made from the 1995-1996 data are not very reliable. The individual art unit correlations changed along with the overall conclusions and the rank of the indicators.

In contrast to the preliminary testing, GDP had the best correlation with the new patent application data. Art unit 2856 showed the best (r) with 0.64 and art unit 2851 was above average with an r-value 0.62 correlation. For this phase of testing, these were the best percentages found. Art units 2875, 2852, and 2858 yielded values of 0.45, 0.28, and 0.07 respectively. The average for GDP was 0.41.

Research and development spending remained the second best indicator, but did so with a very low average of 0.18. The best correlation, 0.33, was found to be with art unit 2875. However, R & D only correlated with art unit 2858 to the value of 0.03. Art units 2856, 2851, and 2852 yielded (r) values of 0.23, 0.17, and 0.13 respectively.

Preliminary analysis showed this indicator promising, but when applied it to more years of applications, it did poorly. The highest (r), 0.27, was with art unit 2875. Art units 2852 and 2858 showed correlation of 0.18 and 0.13 respectively, but could not keep the average from plummeting to 0.09. This indicator also provided a (r) value of 0.05 with art unit 2851 and 0.07 with art unit 2856.

Table 4.3 Specific Growth Data Correlations 1985-1999

	2851	2852	2856	2858	2875
R&D	0.1738	0.1271	0.2276	0.0339	0.3314
R&D/GDP	0.0493	0.1796	0.0690	-0.1257	0.2719
GDP	0.6179	0.2765	0.6355	0.0662	0.4503

4.3.2 Results of Actual Data Testing

When testing with the actual data, we found much better results as seen in Table 4.4. We found that GDP was again the indicator with the best association. It had an average the r of 0.89. The worst correlation came with AU2851 with an r of 0.81.

When testing against R&D the average of the r-values was 0.80. The lowest of those values was also AU 2851 with an r-value of .66. Again the same seven of the ten art units had r-values > 0.9.

The R&D/GDP indicator again perform poorly with this data. The average of the correlations for this indicator is 0.51. The results can be seen in Table 4.4.

Table 4.4 Actual Data Correlations for 1985-1999

	2851	2852	2856	2858	2875
R&D	0.6642	0.7274	0.9127	0.7659	0.9159
R&D/GDP	-0.3949	-0.4511	-0.6391	-0.4265	-0.6619
GDP	0.8075	0.8309	0.9691	0.8978	0.9491

4.3.3 Significance

At this point, we have very useful information. Although the specific growth data has proved to be less useful for correlation, it still helps us. We see in the actual data that GDP has the best overall correlation, with R&D behind it and R&D/GDP last by a significant amount. This order is also true of the specific growth data, thus helping to validate our findings.

4.4 Regression

As stated previously, GPD proved to be our best indicator. We returned to the original actual 1995-1999 data and chose twelve art units that correlated well with GDP and three that did poorly. We had a goal of ten final art units. So by choosing fifteen we allowed for five to be rejected for either not relating to our indicators, by being other than electronic or not having complete data. Three art units were rejected as they were not related to the electronic field. Two art units did not have complete data. We then did regression analysis on each of our final ten art units: 2816, 2821, 2851, 2852, 2853, 2856, 2858, 2874, 2875, and 2879. Models were done for the following:

- Specific growth of R&D with each of the art units
- Specific growth of GDP with each of the art units

- Specific growth of GDP and Specific growth of R&D with each of the art units
- Actual R&D with each of the art units
- Actual GDP with each of the art units
- Actual R&D and Actual GDP with each of the art units.

Regression models were analyzed using the spreadsheet function for regression analysis.

This returned r-values, r-squared values, the significance of the model, intercepts, and coefficients for our indicators.

Regression on the specific growth data had poor significance and correlation, as was expected. In addition, as expected, GDP was the most significant model overall with an average value of significant F of 0.29, which is still very poor. Any significant F less than 0.05 is acceptable. The summary of the regression with GDP is shown in Table 4.5.

Table 4.5 Specific Growth Regression Summary GDP

Art Unit	Sig F	r	r^2	Intercept	GDP Coeff
2851	0.0185	0.6179	0.3818	-0.03	1.9257
2852	0.3384	0.2765	0.0764	0.0309	0.8355
2856	0.0145	0.6355	0.4038	-0.0005	1.0601
2858	0.8220	0.0662	0.0043	0.0792	0.14744
2875	0.1060	0.4503	0.2028	0.0064	2.1432
2879	0.2309	0.3423	0.1171	0.0444	0.8060
2816	0.3012	0.2977	0.0886	0.1204	4.8847
2853	0.8187	0.0674	0.0045	0.0837	-0.1380
2821	0.0235	0.5990	0.3588	-0.0333	1.3177
2874	0.2485	0.3304	0.1091	0.7549	-4.3945

When using the actual data to do the same models we see much better results. The GDP model is our best model with an average Significant F of < 0.001. This is good. We can see the summary of this data in Table 4.6. Summaries of the "R&D" and the "GDP and R&D" models can be seen in Table 4.7 and Table 4.8 respectively.

Table 4.6 Summary of Models Using Actual GDP

Art Unit	Sig F	R	r^2	Intercept	GDP
2851	0.0003	0.8075	0.6521	-5.5926	0.0098
2852	0.0001	0.8310	0.6905	120.8814	0.0055
2856	<0.0001	0.9691	0.9392	33.4130	0.0077
2858	<0.0001	0.8979	0.8062	-81.9943	0.0066
2875	<0.0001	0.9491	0.9008	-269.6087	0.0080
2879	<0.0001	0.9368	0.8775	-216.5323	0.0070
2816	<0.0001	0.9140	0.8355	-1676.3808	0.0176
2853	<0.0001	0.9634	0.9282	-426.1272	0.0116
2821	<0.0001	0.9442	0.8916	80.6929	0.0056
2874	<0.0001	0.9664	0.9339	-1659.6311	0.0179

Table 4-7 Summary of models Using Actual R&D

		Current		Coefficients	
Art Unit	Sig F	R	r^2	Intercept	R&D
2851	0.0069	0.6642	0.4411	642.803	0.0411
2852	0.0021	0.7273	0.5290	460.072	0.0243
2856	<0.0001	0.9127	0.8330	473.532	0.0367
2858	0.0008	0.7659	0.5866	339.778	0.0287
2875	<0.0001	0.9159	0.8389	176.009	0.0393
2879	<0.0001	0.9611	0.9237	139.689	0.0362
2816	<0.0001	0.9500	0.9026	-792.439	0.0929
2853	<0.0001	0.9020	0.8136	240.005	0.0549
2821	<0.0001	0.9243	0.85433	385.973	0.0278
2874	<0.0001	0.9261	0.8577	-653.153	0.0874

Table 4.8 Summary of Models Using Actual GDP and Actual R&D Together

Art Unit	Sig F	R	r^2	Intercept	GDP	R&D
2851	0.0001	0.8795	0.7735	-668.503	0.0232	-0.0713
2852	0.0003	0.8579	0.7360	-98.2126	0.0098	-0.0235
2856	<0.0001	0.9698	0.9404	-11.2765	0.0085	-0.0048
2858	<0.0001	0.9457	0.8943	-423.785	0.0135	-0.0367
2875	<0.0001	0.9499	0.9022	-220.188	0.0070	0.0053
2879	<0.0001	0.9636	0.9284	44.78691	0.0016	0.0281
2816	<0.0001	0.9505	0.9034	-893.875	0.0018	0.0842
2853	<0.0001	0.9649	0.9310	-526.198	0.0135	-0.0107
2821	<0.0001	0.9477	0.8980	155.0024	0.0040	0.0079
2874	<0.0001	0.9666	0.9342	-1611.17	0.0169	0.0052

4.5 Lag Times

Tables 4.6 to 4.8 show that every model that we tested for the actual data with every art unit is significant. That, coupled with the good r-values, given shows that this data is useful if we would like to predict the application numbers for the art units for years to come. Our next tests were done with lag times.

When we lagged the application data back one, two, and three years we were able to see the data still correlated well with significant models with these lag times. These tests showed that the "GDP" and "GDP and R&D" models were he most resistant to the lags. R&D was very affected by the lag times. The summaries of this data can be seen in the appendix.

We then used our best model, GDP, and tested its forecasting ability. We tested a one, two and three year forecast to predict the 1999 art units information. Three of the final ten art units were chosen for this test: 2853, 2856, and 2858.

Our one year forecast, using the alpha and beta for a one year lag with the 1998 GDP, shows good results with errors below 20%. We see in Table 4-9 that as we try to forecast farther ahead that our error increases.

Table 4-9 Forecast Test Results

1 Year Forecast

Art Unit	GDP Value	Intercept	Coefficient	Forecast	Actual	%Error	Significant F
2853	168,311	-593.43722	0.01373607	1718.49368	1,471	16.8248591	1.63E-08
2856	168,311	3.54545181	0.00842538	1421.62944	1,341	6.01263519	3.31E-06
2858	168,311	-41.9562541	0.00676674	1096.96086	1,059	3.58459508	2.66E-04

2 Year Forecast

Art Unit	GDP Value	Intercept	Coefficient	Forecast	Actual	%Error	Significant F
2853	166,047	-799.220325	0.01643493	1929.75003	1,471	31.1862701	1.53E-05
2856	166,047	-71.395219	0.0096526	1531.39073	1,341	14.1976684	2.66E-04
2858	166,047	-99.6541269	0.00789759	1211.71648	1,059	14.4208197	3.13E-03

3 Year Forecast

Art Unit	GDP Value	Intercept	Coefficient	Forecast	Actual	%Error	Significant F
2853	153,181	-1323.49115	0.02252258	2126.53987	1,471	44.5642333	4.24E-03
2856	153,181	5.92033302	0.00940612	1446.7598	1,341	7.88663695	2.15E-02
2858	153,181	-297.627599	0.01052133	1314.04009	1,059	24.0831055	4.67E-02

4.6 Discussion

For the time we have been involved in this project, some consistencies appear in our observations. Two of the most apparent, have been problems with information location, and communication.

The biggest obstacle to overcome in this process was that there were no correct and absolute numbers of patent applications for each art unit. The numbers we did get are estimates.

A key part of looking at the future is examining the past. If this past data is not available it becomes very hard to get an accurate vision of the future. This problem is caused by changes. The system of tracking historical data depends on the classification system.

As previously noted, classes and subclasses are distributed between art units. When reorganizing, classes and subclasses are changed, deleted, added, and moved between art units. This causes a problem when trying to look back. When these changes are made they directly affect the history of classes and art units. To create a dependable source of data the tracking system must be changed.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

The first section summarizes the conclusions formed from the success or failure of each economic indicator used. The next section recommends different avenues, which TC2800 and the PTO should pursue, in order to conduct studies of this sort in the future. Questions were raised pertaining to the validity of the use of specific growth as compared to the actual numbers themselves. Problems such as that and others we faced as well as our general observations are discussed in the final section.

5.1 CONCLUSIONS ON INDICATORS

A general conclusion from all tests done is that the activity of patent filings is strongly associated with dependent upon certain economic factors. Thus dependence is apparent even when data is viewed at the art unit level.

The most useful result is that using actual GDP data gives the best results as an indicator for a forecast model. Our forecast tests using lagged regression proved useful up to one year. In our recommendations section ideas for different model types are shown to improve the forecast.

Along with significant models and good correlation, GDP is the "cleanest model." This means that GDP is the easiest to work with because the standard deviation of the coefficients between art units is very small. It is also the most resistant to time lags, staying the most consistent through the lag testing. We also see that with the time lag, GDP gives good correlation and good significance throughout time. This means that if the right model is chosen, GDP can give the best forecast for a one, two, and three-year time lag.

Simple statistical models for specific growth, however, were not useful. They did not yield good correlation and did not create significant models. We believe this for two reasons. One, the data itself is highly variable. Second, specific growth shows the movement of the actual data in a different manner. Actually, it shows the activity of the growth of the data set.

5.2 Recommendations

The biggest obstacle was gathering patent application data over the art units. Due to reclassifications over time, there is no reliable source of patent application data. This area if improved would greatly benefit the PTO. We recommend making improvements to the application monitoring system such that more accurate data can be gathered. One possible solution is to create a tracking system that goes beyond the current classifications.

Communication is important. The companies that apply for patents have useful information about their plans for filing. It would be beneficial to both sides if a system of communication was created that enables the PTO to prepare for these incoming applications. We recommend that this option be investigated more thoroughly.

Within the PTO, there is little communication between the divisions and branches. Collaborating between the different branches of PTO would save time and money and simultaneously expand resources available for solving problems. We recommend that opportunities for collaboration be taken more often.

Some other areas that might affect the patent application filings and need to be investigated are changes in law, government initiatives, cycles within years, and business strategies. Changes in how the patents are processes and the fee of the processing creates spikes in the data when everyone is trying to patent their invention before the new fee is implemented. Government initiatives seem to be a driving force in many areas of technological advancement. Many inventions come out of this type of driving force. The need to have better and better technology to stay ahead of competitors drives the government to spend significantly in this area. Looking for cycles within the year for patent application might be a useful to look into. For example, there may be monthly cycles that span years; an eighteen-month cycle would show up in our data. Another factor to look into is business strategies. For example, when a company comes through with a big new invention, they may immediately afterwards file "blocking patents." These adjust the claims slightly and try to get each adjustment patented in order to block other companies.

Where we ended this project, there are many paths to proceed. We have worked with only very simple models. Different models can be used and the data can be manipulated in many ways. For example, models that include patent application data as an indicator could work. Other forecasting models would also be useful. Data massaging such as log manipulations and smoothing may be useful. We as a project group do not have expertise in statistics and thus, were not able to proceed into these types of testing.

APPENDIX A

MISSION AND ORGANIZATION OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

A.1 BACKGROUND

To promote the progress of science and the useful arts by securing for limited times to inventors the exclusive right to their respective discoveries (Article 1, Section 8 of the United States Constitution), has been the role of the Patent and Trademark Office for over two hundred years.

Over five thousand full time employees work in order to carry out the functions of the PTO, which are the examination and issuance of patents and the examination and registration of trademarks. Fees the PTO request are used only in order to fund their operations.

A.2 MISSION STATEMENT OF THE PATENT AND TRADEMARK OFFICE

One of the fourteen bureaus of the United States Department of Commerce, the PTO processes patents and trademarks and spreads the related information. The PTO promotes industrial and technological progress in the United States and strengthens the national economy by:

- Administering the laws relating to patents and trademarks.
- Advising the Secretary of Commerce, the President of the United States, and the administration on patent, trademark, and copyright protection.
- Advising the Secretary of Commerce, the President of the United States and the administration on the trade-related aspects of intellectual property. (http://www.uspto.gov/web/menu/mission.html)

The mission of the Department of Commerce is to promote job creation, economic growth, sustainable development, and improved living standards for all

Americans, by working in partnership with business, universities, communities, and workers to:

- Build for the future and promote U.S. competitiveness in the global marketplace by strengthening and safeguarding the nation's infrastructure.
- Keep America competitive with the cutting-edge science and technology and an unrivaled base.
- Provide effective management and stewardship of out nation's resources and assets to ensure sustainable economic opportunities. (http://www.uspto.gov/web/offices/com/annual/1997/97repmis.pdf)

The PTO has established four goals in order to provide customers with a consistently higher quality of service in a timely manner.

Goal 1*: Reduce the PTO processing time.*

By hiring more examiners, processing times are being cut. In 1999 alone, eight hundred new examiners were hired, all with technical degrees. New publishing processes are being developed to reduce the number of patents waiting to be printed.

Goal 2*: Receive applications and publish patents electronically.*

Since 1998, the PTO has been developing the Electronic Filing System (EFS). Full electronic processing of patent applications is expected in 2003.

Goal 3*: Exceed customer's quality expectations through competent and empowered employees.*

Customer service desks have been placed in each Technology Center. An in-process review system was established to check examiners' office actions.

Goal 4*: Assess fees corresponding with resource use and customer efficiency.*

The patent business has collected more fees than necessary to cover its costs over the past few years. In an attempt to collect fees that matched expenses, the PTO supported Public Law 106-113 to reduce patent fees and increase trademark fees.

(http://www.uspto.gov/web/offices/com/annual/1999/99patents.pdf)

A.3 ORGANIZATION OF THE PATENT AND TRADEMARK OFFICE

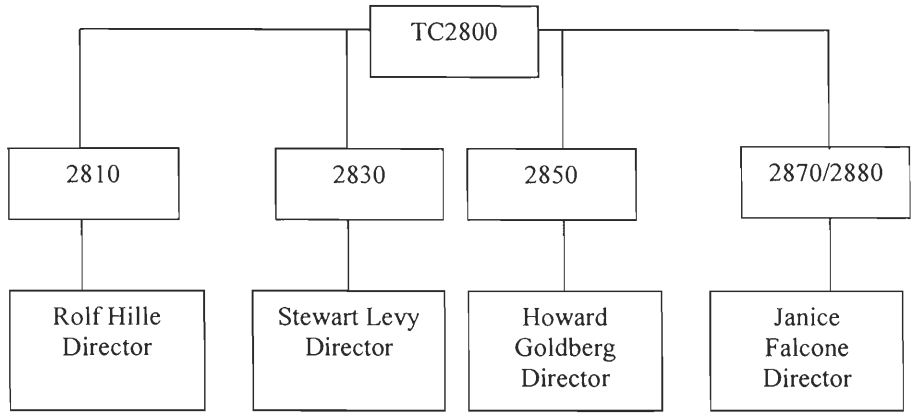
The United States Patent and Trademark Office is organized into six sub-organizations.

1. Under Secretary of Commerce for Intellectual Property and Director of United States Patent and Trademark Office.
2. Deputy under Secretary of Commerce for Intellectual Property and Deputy Director of the United States Patent and Trademark Office.
3. Chief Financial Officer and Chief Administrative Officer.
4. Commissioner for Patents.
5. Commissioner for Trademarks.
6. Chief Information Officer.

(http://www.uspto.gov/web/menu/offices.html)

All of these main subdivisions have other smaller branches. Directly under the commissioner of patents are the patent examining groups or technology centers. Technology Center 2800, the focus of this IQP, faces patent applications that deal with semiconductors, electrical and optical systems and components. TC2800 is broken down into four subsets. TC2810 directed by Rolf Hille, concentrates on semiconductors, electrical circuits, static memory, and digital logic. Stewart Levy, our primary liaison and director of TC2830, focuses on power generation and distribution, music, electrical components and control circuits. Howard Goldberg directs TC2850 in the fields of photocopying, recorders, printing, measuring, and testing. Liquid crystals, optical elements and systems, fiber optics, lasers, electric lamps, registers, optics and measuring are covered in TC2870/2880 and are headed by director Janice Falcone.

FIGURE A.1 Organization of TC2800



Legend

TC2800- Technology Center 2800: Semiconductors, Electrical Circuits, and Optical Systems and Components.

2810- Semiconductors, Electrical Circuits, Static Memory, Digital Logic

2830- Power Generation and Distribution, Music, Electrical Components, and Control Circuits.

2850- Photocopying, Recorders, Printing, Measuring and Testing

2870/2880- Liquid Crystals, Optical Elements and Systems, Fiber Optics, Lasers, Electric Lamps, Registers, Optics, and Measuring.

A.4 BUDGETARY TRENDS

The passage of the Omnibus Budget Act (OBRA) in 1990 changed how the PTO operated. Instead of being funded through taxes from the general fund of the treasury, the Patent and Trademark Office is now customer funded. User fees are now collected, but the PTO has no investment power. At the end of each year all fees collected must cover all outstanding balances with the Treasury. Patent fees represent three quarters of the total budget. OBRA expired at the end of 1998, but the U.S. Patent and Trademark Office Reauthorization Act was put into effect causing a six- percent decrease in patent fees. The act also allowed the PTO to adjust certain fees annually based on the fluctuation in the Consumer Price Index (CPI). The PTO will have eight hundred sixty eight million dollars in resources available to them throughout the fiscal year of 2000.

A.5 Project Relevance to Patent and Trademark Office

The Patent and Trademark Offices' mission statement vows to administer all laws pertaining to patent and trademarks. Additionally, a more strategic goal is to provide customers with the highest quality of service in all aspects of the PTO's operations. Hiring experts will improve the application process time and quality. It is important that an idea is proved unique beyond question before registering it.

Increasing numbers in patent applications and shortages of specialized technical workers calls for the PTO to look ahead into the future. Looking into the future to predict what technologies are emerging will allow the Patent and Trademark Office to hire experts in preparation of the incoming applications.

Proposed by the directors of Technology Center 2800, this project calls on us to discover and analyze data. The results of such analysis can be formed into recommendations to TC2800 as to what will be needed and changed in order to keep up with new technology.

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, DC 20231
www.uspto.gov

August 7, 2000

David DiBiasio, Ph.D.
Department of Chemical Engineering
Worcester Polytechnic University
100 Institute Road
Worcester, MA 01609-2280

Dear Mr. DiBiasio:

The US Patent and Trademark (USPTO) is witnessing explosive growth in patent filings in certain technologies. In order to prevent the backlog of applications for invention from growing exponentially along with the increased filings, the USPTO must attempt to estimate years in advance the number of new examiners to be hired in accordance with upcoming governmental budgetary processes and cycles. Underestimating the numbers of filings and the resultant failure to hire adequate numbers of examiners to handle the increased workloads leads to delays in the granting of patents which could potentially impact inventors and companies and slow the economic benefits derived from new innovations reaching the marketplace sooner.

Historically, the projections for patent applications have lagged behind actual filings. The USPTO is divided into broad organizations known as Technology Centers (TC), each of which have their own unique subjects for patents. TC 2800 encompasses many facets of technological innovation including semiconductors, electrical devices, motors, switches, telecommunications, measuring and sensing devices and many other diverse electrical/mechanical inventions. Certain sectors of the US market are responsible for large portions of the patent applications for TC 2800 and, in essence, these are our largest corporate customers. Since many of the details of corporate research and development are not known in advance to outsiders, it is not clear if there are industrial and/or economic indicators available to act as predictors of future innovations which lead to increased patent filings within TC 2800. We would like the assistance of your students in researching publicly available literature and statistics of the largest filers for patents in TC 2800 to determine if there are predictive factors tied to research and development budgets, economic indicators or any other factors which might help the management of TC 2800 in predicting the numbers of new examiners who would need to be hired to handle any new increases in patent application filings. Hopefully these forecasting factors will assist us in identifying areas of emerging technologies three to five years into the future.

We have more completely outlined our proposal, its projected tasks, potential sources for research, and recommended outcomes in the accompanying attachment. We look forward to the assistance your students will offer us and believe it will be a mutually educational experience for all.

Thank you,

Rolf G. Hille

Rolf G. Hille, Director, Technology Center 2810

Stewart Levy

Stewart J. Levy, Director, Technology Center 2830

Howard Goldberg, Director, Technology Center 2850

Janice A. Falcone

Janice A. Falcone, Director, Technology Center 2870

APPENDIX B

SUMMARY OF TOKAR'S DATA AND SPECIFIC GROWTH

	Application Numbers per Year					Specific Growth of Applications by Year			
Art Unit	1995	1996	1997	1998	1999	1996	1997	1998	1999
2811	862	732	906	1048	1264	-0.15	0.24	0.16	0.21
2812	357	153	612	1014	1157	-0.57	3.00	0.66	0.14
2813	357	153	612	1014	1157	-0.57	3.00	0.66	0.14
2814	630	463	779	1058	1246	-0.27	0.68	0.36	0.18
2815	862	732	906	1048	1264	-0.15	0.24	0.16	0.21
2816	1205	1276	1351	1452	1397	0.06	0.06	0.07	-0.04
2817	1087	1606	1190	1525	1369	0.48	-0.26	0.28	-0.10
2818	892	740	1184	1440	1534	-0.17	0.60	0.22	0.07
2819	993	889	961	1194	1054	-0.10	0.08	0.24	-0.12
2821	1028	1028	1142	1041	1212	0.00	0.11	-0.09	0.16
2822	610	443	759	1031	1211	-0.27	0.71	0.36	0.17
2823	610	443	759	1031	1211	-0.27	0.71	0.36	0.17
2824	892	740	1184	1440	1534	-0.17	0.60	0.22	0.07
2825	610	443	759	1031	1211	-0.27	0.71	0.36	0.17
2831	874	752	988	1025	1239	-0.14	0.31	0.04	0.21
2832	870	995	1043	1094	1156	0.14	0.05	0.05	0.06
2833	893	816	973	1157	1347	-0.09	0.19	0.19	0.16
2834	1171	1115	1219	1419	1554	-0.05	0.09	0.16	0.10
2835	950	944	1114	1335	1466	-0.01	0.18	0.20	0.10
2836	793	747	889	1009	1152	-0.06	0.19	0.13	0.14
2837	1303	1187	1202	1214	1305	-0.09	0.01	0.01	0.07
2838	987	964	1156	1428	1291	-0.02	0.20	0.24	-0.10
2839	893	816	973	1157	1347	-0.09	0.19	0.19	0.16
2851	2108	1812	2271	1052	1980	-0.14	0.25	-0.54	0.88
2852	204	739	1125	1205	1049	2.62	0.52	0.07	-0.13
2853	694	670	812	838	920	-0.03	0.21	0.03	0.10
2854	1000	926	905	1032	1028	-0.07	-0.02	0.14	-3.88E-03
2855	998	978	1142	1059	1192	-0.02	0.17	-0.07	0.13
2856	998	978	1142	1059	1192	-0.02	0.17	-0.07	0.13
2857	181	187	195	287	32	0.03	0.04	0.47	-0.89

APPENDIX C
SUMMARY OF ACTUAL DATA CORRELATION USING TOKAR'S DATA

	Pearson Correlation Coefficient (r)			Coefficient Squared		
Art Unit	R&D	GDP	R&D/GDP	R&D	GDP	R&D/GDP
2811	0.81	0.89	0.66	0.65	0.79	0.43
2812	0.84	0.90	0.73	0.71	0.81	0.81
2813	0.84	0.90	0.73	0.71	0.81	0.53
2814	0.84	0.91	0.71	0.71	0.82	0.51
2815	0.81	0.89	0.66	0.65	0.79	0.43
2816	0.87	0.84	0.88	0.76	0.71	0.78
2817	0.36	0.21	0.53	0.13	0.04	0.28
2818	0.86	0.91	0.75	0.73	0.83	0.56
2819	0.45	0.49	0.37	0.20	0.24	0.14
2821	0.78	0.84	0.67	0.61	0.70	0.44
2822	0.84	0.91	0.71	0.71	0.82	0.51
2823	0.84	0.91	0.71	0.71	0.82	0.51
2824	0.86	0.91	0.75	0.73	0.83	0.56
2825	0.84	0.91	0.71	0.71	0.82	0.51
2831	0.83	0.91	0.68	0.69	0.84	0.46
2832	0.99	0.96	0.99	0.98	0.92	0.98
2833	0.86	0.92	0.73	0.74	0.84	0.53
2834	0.85	0.90	0.73	0.72	0.81	0.53
2835	0.91	0.95	0.82	0.83	0.89	0.67
2836	0.89	0.94	0.77	0.79	0.89	0.59
2837	0.00	0.15	-0.22	0.00	0.02	0.05
2838	0.77	0.79	0.72	0.60	0.63	0.53
2839	0.86	0.92	0.73	0.74	0.84	0.53
2851	-0.23	-0.16	-0.31	0.05	0.03	0.09
2852	0.86	0.80	0.92	0.75	0.64	0.85
2853	0.91	0.97	0.80	0.84	0.93	0.65
2854	0.28	0.36	0.14	0.08	0.13	0.02
2855	0.84	0.90	0.72	0.70	0.81	0.52

	Pearson Correlation Coefficient (r)			Coefficient Squared		
Art Unit	R&D	GDP	R&D/GDP	R&D	GDP	R&D/GDP
2856	0.84	0.90	0.72	0.70	0.81	0.52
2857	-0.39	-0.45	-0.27	0.15	0.20	0.07
2858	0.62	0.75	0.43	0.39	0.56	0.18
2859	0.73	0.78	0.63	0.54	0.61	0.40
2861	0.91	0.97	0.80	0.84	0.93	0.65
2862	0.56	0.65	0.43	0.31	0.42	0.19
2871	0.94	0.94	0.91	0.88	0.88	0.83
2872	-0.74	-0.73	-0.69	0.55	0.54	0.47
2873	-0.51	-0.53	-0.41	0.26	0.28	0.17
2874	0.91	0.95	0.81	0.83	0.90	0.66
2875	0.85	0.89	0.74	0.72	0.78	0.55
2876	0.87	0.94	0.73	0.75	0.88	0.54
2877	0.76	0.83	0.65	0.58	0.69	0.42
2878	0.83	0.90	0.69	0.69	0.80	0.47
2879	0.89	0.94	0.79	0.80	0.88	0.62
2881	0.83	0.90	0.69	0.69	0.80	0.47

	R&D	GDP	R&D/GDP	R&D	GDP	R&D/GDP
Average	0.67	0.71	0.58	0.61	0.68	0.47
Median	0.84	0.90	0.72	0.71	0.81	0.51

APPENDIX D

SUMMARY OF SPECIFIC GROWTH CORRELATION USING TOKAR'S DATA

	Pearson Correlation Coefficient (r)			Coefficient Squared (r^2)		
Art Unit	Correlation w/ R&D	Correlation w/ GDP	Correlation w/ R&D/GDP	Correlation w/ R&D	Correlation w/ GDP	Correlation w/ R&D/GDP
2811	-0.66	0.41	-0.97	0.43	0.17	0.95
2812	-0.33	0.44	-0.69	0.11	0.20	0.48
2813	-0.33	0.44	-0.69	0.11	0.20	0.48
2814	-0.63	0.31	-0.84	0.40	0.10	0.70
2815	-0.66	0.41	-0.97	0.43	0.17	0.95
2816	-0.21	-0.61	0.44	0.04	0.37	0.19
2817	0.18	-0.81	0.94	0.03	0.66	0.89
2818	-0.49	0.37	-0.76	0.24	0.13	0.57
2819	-0.87	-0.55	-0.21	0.76	0.31	0.04
2821	0.39	0.97	-0.61	0.15	0.95	0.38
2822	-0.62	0.32	-0.83	0.38	0.10	0.70
2823	-0.62	0.32	-0.83	0.38	0.10	0.70
2824	-0.49	0.37	-0.76	0.24	0.13	0.57
2825	-0.62	0.32	-0.83	0.38	0.10	0.70
2831	-0.31	0.72	-0.97	0.10	0.52	0.94
2832	0.80	-0.21	0.91	0.64	0.05	0.82
2833	-0.80	0.21	-0.90	0.64	0.05	0.82
2834	-0.95	-0.13	-0.71	0.91	0.02	0.50
2835	-0.89	-0.06	-0.71	0.80	3.37E-03	0.51
2836	-0.68	0.38	-0.96	0.47	0.14	0.91
2837	-0.53	0.44	-0.90	0.28	0.19	0.81
2838	-0.70	-0.38	-0.21	0.49	0.15	0.04
2839	-0.80	0.21	-0.90	0.64	0.05	0.82
2851	0.35	0.89	-0.58	0.12	0.79	0.33
2852	0.77	-0.19	0.87	0.60	0.04	0.76
2853	-0.23	0.72	-0.89	0.05	0.53	0.79
2854	-0.96	-0.62	-0.25	0.93	0.38	0.06
2855	0.24	0.98	-0.73	0.06	0.96	0.54
2856	0.24	0.98	-0.73	0.06	0.96	0.54
2857	-0.39	-0.72	0.38	0.16	0.52	0.15

	Pearson Correlation Coefficient (r)			Coefficient Squared (r^2)		
Art Unit	Correlation w/ R&D	Correlation w/ GDP	Correlation w/ R&D/GDP	Correlation w/ R&D	Correlation w/ GDP	Correlation w/ R&D/GDP
2858	-0.17	0.83	-0.95	0.03	0.68	0.90
2861	-0.23	0.72	-0.89	0.05	0.53	0.79
2862	-0.47	0.35	-0.72	0.22	0.12	0.52
2871	0.63	0.42	0.16	0.39	0.18	0.03
2872	-0.40	-0.23	-0.09	0.16	0.05	0.01
2873	-0.21	-0.22	0.07	0.04	0.05	0.01
2874	-0.69	0.09	-0.71	0.47	8.12E-03	0.50
2875	-0.81	-0.44	-0.30	0.65	0.19	0.09
2876	-0.52	0.56	-0.99	0.27	0.31	0.98
2877	-0.01	0.78	-0.74	0.00	0.60	0.55
2878	-0.38	0.54	-0.87	0.14	0.29	0.76
2879	-0.91	-0.01	-0.77	0.82	0.00	0.60
2881	-0.39	0.53	-0.87	0.15	0.28	0.76

	R&D	GDP	R&D/GDP	R&D	GDP	R&D/GDP
Average	-0.37	0.21	-0.52	0.35	0.29	0.55
Median	-0.48	0.33	-0.73	0.27	0.19	0.57

APPENDIX E
SUMMARY OF ACTUAL DATA USING GDP

Current

Art Unit	Sig F	r	r^2	Intercept	GDP
2851	2.72E-04	0.81	0.65	-5.59	9.85E-03
2852	1.24E-04	0.83	0.69	120.88	5.47E-03
2856	2.78E-09	0.97	0.94	33.41	7.68E-03
2858	5.55E-06	0.90	0.81	-81.99	6.63E-03
2875	6.81E-08	0.95	0.90	-269.61	8.01E-03
2879	2.71E-07	0.94	0.88	-216.53	6.95E-03
2816	1.89E-06	0.91	0.84	-1676.38	1.76E-02
2853	8.24E-09	0.96	0.93	-426.13	1.16E-02
2821	1.22E-07	0.94	0.89	80.69	5.59E-03
2874	4.77E-09	0.97	0.93	-1659.63	1.79E-02

Average	4.04E-05	0.92	0.85	-410.09	9.73E-03

1 year lag

Art Unit	Sig F	r	r^2	Intercept	GDP
2851	3.69E-03	0.72	0.52	150.39	9.23E-03
2852	9.51E-04	0.78	0.61	225.42	5.02E-03
2856	6.00E-07	0.94	0.88	42.09	8.06E-03
2858	5.38E-05	0.87	0.76	-23.81	6.59E-03
2875	4.05E-06	0.92	0.84	-256.49	8.37E-03
2879	2.83E-07	0.95	0.90	-272.46	7.79E-03
2816	4.59E-07	0.94	0.89	-1931.97	2.05E-02
2853	2.49E-08	0.96	0.93	-475.12	1.26E-02
2821	4.38E-07	0.94	0.89	6.19	6.43E-03
2874	3.42E-07	0.95	0.89	-1736.97	1.95E-02

Average	4.70E-04	0.90	0.81	-427.27	0.01

2 year lag

Art Unit	Sig F	r	r^2	Intercept	GDP
2851	3.15E-02	0.60	0.36	393.32	7.81E-03
2852	4.60E-03	0.73	0.53	350.79	4.35E-03
2856	1.50E-05	0.91	0.83	76.05	8.23E-03
2858	6.27E-04	0.82	0.67	75.36	6.19E-03
2875	2.30E-05	0.90	0.82	-256.23	8.84E-03
2879	1.15E-06	0.94	0.89	-332.95	8.66E-03
2816	1.89E-05	0.91	0.82	-1991.93	2.20E-02
2853	7.00E-06	0.92	0.85	-443.92	1.30E-02
2821	1.44E-05	0.91	0.83	-13.57	6.90E-03
2874	2.28E-06	0.94	0.88	-1804.74	2.11E-02

Average	3.68E-03	0.86	0.75	-394.78	1.07E-02

3 year lag

Art Unit	Sig F	r	r^2	Intercept	GDP
2851	1.11E-01	0.48	0.23	594.62	6.72E-03
2852	1.32E-02	0.69	0.47	398.57	4.28E-03
2856	4.33E-05	0.91	0.83	50.54	9.00E-03
2858	6.11E-03	0.74	0.55	176.26	5.77E-03
2875	3.22E-04	0.86	0.74	-286.00	9.63E-03
2879	2.87E-05	0.92	0.84	-401.57	9.75E-03
2816	4.73E-04	0.85	0.72	-2119.91	2.43E-02
2853	1.50E-04	0.88	0.78	-475.03	1.41E-02
2821	2.05E-04	0.87	0.76	-13.06	7.33E-03
2874	2.51E-06	0.95	0.90	-2048.27	2.45E-02

Average	1.32E-02	0.81	0.68	-412.39	1.15E-02

APPENDIX F

SUMMARY OF SPECIFIC GROWTH USING GDP

	Current					1 year lag				
Art Unit	Sig F	r	r^2	Intercept	GDP	Sig F	r	r^2	Intercept	GDP
2851	0.02	0.62	0.38	-0.03	1.93	0.45	0.23	0.05	0.10	-0.72
2852	0.34	0.28	0.08	0.03	0.84	0.16	0.41	0.17	0.13	-1.25
2856	0.01	0.64	0.40	0.00	1.06	0.61	0.16	0.02	0.07	-0.26
2858	0.82	0.07	0.00	0.08	0.15	0.94	0.02	0.00	0.08	0.05
2875	0.11	0.45	0.20	0.01	2.14	0.32	0.30	0.09	0.19	-1.43
2879	0.23	0.34	0.12	0.04	0.81	0.16	0.41	0.17	0.03	0.96
2816	0.30	0.30	0.09	0.12	4.88	0.03	0.59	0.35	-0.06	9.71
2853	0.82	0.07	0.00	0.08	-0.14	0.05	0.55	0.30	0.02	1.14
2821	0.02	0.60	0.36	-0.03	1.32	0.83	0.07	0.00	0.04	0.14
2831	0.53	0.18	0.03	0.05	-0.47	0.28	0.32	0.10	0.07	-0.84
2874	0.25	0.33	0.11	0.75	-4.39	0.62	0.15	0.02	0.63	-2.04
Average	0.31	0.35	0.16	0.10	0.74	0.41	0.29	0.12	0.12	0.50

	2 year lag					3 year lag				
Art Unit	Sig F	r	r^2	Intercept	GDP	Sig F	r	r^2	Intercept	GDP
2851	0.43	0.25	0.06	0.11	-0.81	0.34	0.32	0.10	0.09	-0.96
2852	0.66	0.14	0.02	0.07	-0.40	0.60	0.18	0.03	0.05	-0.46
2856	0.44	0.25	0.06	0.08	-0.42	0.96	0.02	0.00	0.05	-0.03
2858	0.87	0.05	0.00	0.07	0.12	0.00	0.79	0.62	0.16	-1.80
2875	0.85	0.06	0.00	0.10	0.29	0.26	0.37	0.14	0.21	-1.85
2879	0.66	0.14	0.02	0.08	0.31	0.16	0.46	0.21	0.14	-1.02
2816	0.61	0.16	0.03	0.30	2.69	0.27	0.36	0.13	0.77	-6.07
2853	0.78	0.09	0.01	0.07	0.19	0.08	0.55	0.30	0.15	-0.99
2821	0.73	0.11	0.01	0.08	-0.20	0.35	0.31	0.10	0.09	-0.57
2831	0.57	0.18	0.03	0.00	0.48	0.86	0.06	0.00	0.03	-0.16
2874	0.71	0.12	0.01	0.63	-1.62	0.36	0.30	0.09	0.42	4.02
Average	0.67	0.14	0.02	0.14	0.06	0.39	0.34	0.16	0.20	-0.90

APPENDIX G

SUMMARY OF ACTUAL DATA USING R&D

Current

Art Unit	Sig F	r	r^2	Intercept	R&D
2851	6.92E-03	0.66	0.44	642.80	0.04
2852	2.12E-03	0.73	0.53	460.07	0.02
2856	2.08E-06	0.91	0.83	473.53	0.04
2858	8.70E-04	0.77	0.59	339.78	0.03
2875	1.64E-06	0.92	0.84	176.01	0.04
2879	1.22E-08	0.96	0.92	139.69	0.04
2816	6.04E-08	0.95	0.90	-792.44	0.09
2853	4.28E-06	0.90	0.81	240.01	0.05
2821	8.47E-07	0.92	0.85	385.97	0.03
2874	7.25E-07	0.93	0.86	-653.15	0.09

Average	9.92E-04	0.86	0.76	141.23	0.05

1 year lag

Art Unit	Sig F	r	r^2	Intercept	R&D
2851	3.79E-02	0.56	0.31	764.50	0.04
2852	3.35E-03	0.72	0.53	506.39	0.02
2856	1.20E-05	0.90	0.81	475.99	0.04
2858	5.72E-03	0.70	0.48	403.67	0.03
2875	8.95E-06	0.90	0.82	177.00	0.04
2879	2.67E-08	0.96	0.93	113.54	0.04
2816	3.07E-06	0.92	0.85	-853.93	0.11
2853	1.17E-04	0.85	0.72	270.84	0.06
2821	3.72E-05	0.88	0.77	364.08	0.03
2874	3.72E-05	0.88	0.77	-646.39	0.10

Average	4.72E-03	0.83	0.70	157.57	0.05

2 year lag

Art Unit	Sig F	r	r^2	Intercept	R&D
2851	1.84E-01	0.39	0.15	952.27	0.03
2852	1.49E-02	0.66	0.43	589.81	0.02
2856	3.22E-04	0.84	0.71	514.73	0.04
2858	1.90E-02	0.64	0.41	466.73	0.03
2875	7.65E-05	0.88	0.77	183.87	0.05
2879	9.94E-08	0.96	0.93	69.41	0.05
2816	4.07E-04	0.83	0.69	-813.11	0.11
2853	2.29E-03	0.77	0.59	333.26	0.06
2821	1.19E-03	0.79	0.63	378.62	0.03
2874	5.87E-04	0.82	0.67	-611.35	0.10
Average	2.23E-02	0.76	0.60	206.42	0.05

3 year lag

Art Unit	Sig F	r	r^2	Intercept	R&D
2851	0.59	0.17	0.03	1185.35	0.01
2852	0.10	0.50	0.25	661.16	0.02
2856	4.87E-03	0.75	0.56	539.39	0.05
2858	5.67E-02	0.56	0.32	516.26	0.03
2875	7.79E-04	0.83	0.69	140.81	0.06
2879	2.28E-05	0.92	0.85	4.86	0.06
2816	1.21E-02	0.70	0.48	-786.54	0.12
2853	2.03E-02	0.66	0.43	371.25	0.06
2821	1.43E-02	0.68	0.47	408.45	0.04
2874	4.75E-03	0.75	0.57	-659.36	0.12
Average	8.04E-02	0.65	0.46	238.16	0.06

APPENDIX H

SUMMARY OF SPECIFIC GROWTH USING R&D

	Current					1 year lag				
Art Unit	Sig F	r	r^2	Intercept	GDP	Sig F	r	r^2	Intercept	GDP
2851	0.55	0.17	0.03	0.04	0.31	0.84	0.06	0.00	0.06	0.11
2852	0.66	0.13	0.02	0.06	0.22	0.53	0.19	0.04	0.04	0.33
2856	0.43	0.23	0.05	0.04	0.21	0.27	0.33	0.11	0.03	0.32
2858	0.91	0.03	0.00	0.08	0.04	0.27	0.33	0.11	0.12	-0.41
2875	0.25	0.33	0.11	0.04	0.89	0.65	0.14	0.02	0.09	0.37
2879	0.18	0.38	0.15	0.04	0.51	0.29	0.32	0.10	0.04	0.41
2816	0.03	0.58	0.34	-0.07	5.39	0.12	0.46	0.21	0.08	4.21
2853	0.63	0.14	0.02	0.06	0.16	0.60	0.16	0.03	0.09	-0.19
2821	0.13	0.42	0.18	-0.01	0.52	0.84	0.06	0.00	0.04	0.07
2831	0.79	0.08	0.01	0.04	-0.11	0.25	0.35	0.12	0.06	-0.51
2874	0.36	0.27	0.07	0.69	-2.00	0.05	0.56	0.32	0.87	-4.26
Average	0.46	0.25	0.09	0.03	0.81	0.47	0.24	0.07	0.07	0.47

	2 year lag					3 year lag				
Art Unit	Sig F	r	r^2	Intercept	GDP	Sig F	r	r^2	Intercept	GDP
2851	0.76	0.10	0.01	0.08	-0.18	0.12	0.50	0.25	0.11	-0.84
2852	0.95	0.02	0.00	0.05	0.03	0.53	0.21	0.04	0.05	-0.30
2856	0.66	0.14	0.02	0.05	0.13	0.81	0.08	0.01	0.06	-0.08
2858	0.76	0.10	0.01	0.09	-0.13	0.59	0.19	0.03	0.09	-0.23
2875	0.74	0.11	0.01	0.14	-0.30	0.94	0.03	0.00	0.12	-0.08
2879	0.04	0.61	0.37	0.03	0.75	0.39	0.29	0.08	0.06	0.36
2816	0.25	0.36	0.13	0.16	3.34	0.55	0.20	0.04	0.62	-1.88
2853	0.95	0.02	0.00	0.08	-0.02	0.31	0.34	0.11	0.12	-0.34
2821	0.70	0.12	0.02	0.05	0.13	0.57	0.19	0.04	0.08	-0.19
2831	0.72	0.12	0.01	0.01	0.17	0.80	0.09	0.01	0.01	0.13
2874	0.06	0.56	0.32	0.90	-4.28	0.05	0.60	0.36	0.96	-4.40
Average	0.65	0.17	0.06	0.07	0.39	0.56	0.21	0.06	0.13	-0.35

APPENDIX I

SUMMARY OF ACTUAL DATA USING GDP AND R&D

Current

Art Unit	Sig F	r	r^2	Intercept	GDP	R&D
2851	1.35E-04	0.88	0.77	-668.50	2.32E-02	-7.13E-02
2852	3.38E-04	0.86	0.74	-98.21	9.89E-03	-2.36E-02
2856	4.45E-08	0.97	0.94	-11.28	8.59E-03	-4.81E-03
2858	1.39E-06	0.95	0.89	-423.78	1.35E-02	-3.68E-02
2875	8.73E-07	0.95	0.90	-220.19	7.02E-03	5.32E-03
2879	1.34E-07	0.96	0.93	44.79	1.68E-03	2.81E-02
2816	8.13E-07	0.95	0.90	-893.87	1.80E-03	8.42E-02
2853	1.08E-07	0.96	0.93	-526.20	1.36E-02	-1.08E-02
2821	1.12E-06	0.95	0.90	155.00	4.09E-03	8.00E-03
2874	8.10E-08	0.97	0.93	-1611.17	1.70E-02	5.21E-03

Average	4.78E-05	0.94	0.88	-425.34	1.00E-02	-1.64E-03

1 year lag

Art Unit	Sig F	r	r^2	Intercept	GDP	R&D
2851	4.15E-03	0.79	0.63	-386.33	2.09E-02	-6.55E-02
2852	5.47E-03	0.78	0.61	206.06	5.44E-03	-2.36E-03
2856	6.49E-06	0.94	0.89	97.89	6.85E-03	6.81E-03
2858	1.12E-05	0.94	0.87	-349.13	1.36E-02	-3.97E-02
2875	2.27E-05	0.93	0.86	-109.44	5.19E-03	1.79E-02
2879	1.14E-07	0.97	0.95	-46.92	2.91E-03	2.75E-02
2816	3.25E-06	0.95	0.90	-1645.61	1.43E-02	3.50E-02
2853	3.58E-08	0.98	0.96	-730.73	1.81E-02	-3.12E-02
2821	5.45E-06	0.94	0.89	-10.19	6.78E-03	-2.00E-03
2874	4.28E-06	0.95	0.89	-1803.20	2.10E-02	-8.08E-03

Average	9.67E-04	0.92	0.84	-477.76	1.15E-02	-6.16E-03

2 year lag

Art Unit	Sig F	r	r^2	Intercept	GDP	R&D
2851	2.78E-02	0.72	0.51	-113.70	1.99E-02	-7.33E-02
2852	2.18E-02	0.73	0.53	328.18	4.89E-03	-3.27E-03
2856	1.43E-04	0.91	0.83	82.07	8.09E-03	8.70E-04
2858	8.85E-04	0.87	0.75	-140.84	1.14E-02	-3.13E-02
2875	1.37E-04	0.91	0.83	-139.12	6.04E-03	1.69E-02
2879	2.42E-07	0.98	0.95	-113.51	3.42E-03	3.17E-02
2816	1.76E-04	0.91	0.82	-1998.00	2.22E-02	-8.78E-04
2853	1.21E-05	0.95	0.90	-735.40	2.00E-02	-4.21E-02
2821	9.31E-05	0.92	0.84	-97.20	8.90E-03	-1.21E-02
2874	1.63E-05	0.94	0.89	-2036.32	2.66E-02	-3.35E-02
Average	5.10E-03	0.88	0.79	-496.38	1.31E-02	-1.47E-02

3 year lag

Art Unit	Sig F	r	r^2	Intercept	GDP	R&D
2851	3.48E-02	0.73	0.53	139.78	2.07E-02	-9.76E-02
2852	3.50E-02	0.72	0.53	313.87	6.89E-03	-1.82E-02
2856	2.88E-04	0.91	0.84	-13.09	1.10E-02	-1.37E-02
2858	2.02E-02	0.76	0.58	87.88	8.50E-03	-1.90E-02
2875	1.47E-03	0.87	0.77	-180.73	6.38E-03	2.26E-02
2879	3.86E-05	0.95	0.90	-248.17	5.02E-03	3.29E-02
2816	2.58E-03	0.86	0.73	-2316.37	3.04E-02	-4.22E-02
2853	2.46E-04	0.92	0.84	-721.79	2.17E-02	-5.29E-02
2821	7.66E-04	0.89	0.80	-106.60	1.02E-02	-2.01E-02
2874	5.45E-06	0.97	0.93	-2327.56	3.31E-02	-5.99E-02
Average	9.54E-03	0.86	0.74	-537.28	1.54E-02	-2.68E-02

APPENDIX J

SUMMARY OF SPECIFIC GROWTH USING R&D AND GDP

	Current						1 year lag					
Art Unit	Sig F	r	r^2	Intercept	GDP	R&D	Sig F	r	r^2	Intercept	GDP	R&D
2851	0.07	0.62	0.38	-0.03	1.91	0.03	-0.76	0.26	0.07	0.09	-0.81	0.22
2852	0.63	0.28	0.08	0.02	0.79	0.10	0.22	0.51	0.26	0.10	-1.48	0.53
2856	0.06	0.64	0.41	0.00	1.03	0.07	0.39	0.41	0.17	0.05	-0.42	0.37
2858	0.97	0.07	0.00	0.08	0.14	0.02	0.53	0.34	0.12	0.11	0.25	-0.45
2875	0.20	0.50	0.25	-0.03	1.86	0.62	0.48	0.37	0.13	0.15	-1.69	0.60
2879	0.28	0.46	0.21	0.02	0.62	0.42	0.29	0.47	0.22	0.01	0.83	0.30
2816	0.08	0.60	0.36	-0.18	2.61	5.02	0.05	0.68	0.46	-0.24	8.39	3.06
2853	0.84	0.18	0.03	0.07	-0.23	0.20	0.08	0.63	0.40	0.04	1.29	-0.36
2821	0.04	0.66	0.44	-0.05	1.16	0.36	0.97	0.08	0.01	0.04	0.11	0.06
2831	0.82	0.19	0.03	0.06	-0.45	-0.05	0.37	0.43	0.18	0.09	-0.66	-0.42
2874	0.42	0.38	0.14	0.84	-3.73	-1.46	0.15	0.56	0.32	0.87	-0.22	-4.23
Average	0.40	0.42	0.22	0.00	0.94	0.68	0.26	0.42	0.20	0.04	0.58	0.39

	2 year lag						3 year lag					
Art Unit	Sig F	r	r^2	Intercept	GDP	R&D	Sig F	r	r^2	Intercept	GDP	R&D
2851	0.74	0.26	0.07	0.11	-0.77	-0.08	0.25	0.54	0.30	0.14	-0.67	-0.76
2852	0.90	0.15	0.02	0.07	-0.44	0.09	0.77	0.25	0.06	0.07	-0.36	-0.26
2856	0.62	0.32	0.10	0.07	-0.50	0.20	0.97	0.08	0.01	0.06	0.00	-0.08
2858	0.93	0.13	0.02	0.08	0.18	-0.15	0.02	0.79	0.62	0.16	-1.79	-0.02
2875	0.92	0.14	0.02	0.12	0.43	-0.35	0.54	0.38	0.14	0.20	-1.90	0.15
2879	0.12	0.61	0.37	0.03	0.01	0.75	0.16	0.61	0.37	0.11	-1.21	0.50
2816	0.51	0.37	0.14	0.10	1.41	3.17	0.53	0.39	0.15	0.84	-5.60	-1.22
2853	0.96	0.10	0.01	0.07	0.21	-0.05	0.18	0.59	0.35	0.16	-0.90	-0.23
2821	0.85	0.19	0.04	0.07	-0.27	0.16	0.62	0.33	0.11	0.10	-0.52	-0.13
2831	0.84	0.20	0.04	-0.01	0.43	0.12	0.94	0.12	0.01	0.02	-0.22	0.15
2874	0.18	0.56	0.32	0.90	0.12	-4.30	0.04	0.75	0.56	0.73	5.99	-5.11
Average	0.74	0.25	0.08	0.07	0.07	0.38	0.50	0.41	0.21	0.19	-1.32	-0.19

APPENDIX K

SUMMARY OF BUSINESS OBJECTS DATA

Applications Filed Per Art Unit Per Year

Years	AU2816	AU2821	AU2851	AU2852	AU2853
1985	97	726	650	404	567
1986	80	628	705	465	631
1987	89	531	760	598	644
1988	100	571	976	781	561
1989	88	671	1,121	825	654
1990	92	670	1,129	791	833
1991	100	612	1,173	791	874
1992	81	638	963	611	937
1993	104	795	1,318	854	1,070
1994	286	792	1,561	896	1,116
1995	1,210	959	1,886	998	1,401
1996	1,282	964	1,568	951	1,342
1997	1,480	1096	1,846	1,101	1,584
1998	1,484	980	1,359	1,074	1,578
1999	1,255	1058	1,360	922	1,471

Years	AU2856	AU2858	AU2874	AU2875	AU2879
1985	677	363	15	396	415
1986	693	411	23	445	496
1987	707	460	30	496	452
1988	797	525	24	563	497
1989	894	592	35	612	548
1990	947	752	47	679	560
1991	878	732	149	670	534
1992	815	709	503	387	477
1993	985	861	805	747	533
1994	1,094	837	916	809	571
1995	1,118	1,079	915	898	811
1996	1,170	904	912	928	788
1997	1,443	971	1260	947	873
1998	1,349	937	1452	1,125	1,042
999	1,341	1,059	1663	1,279	1,193

APPENDIX L
SUMMARY OF SPECIFIC GROWTH OF BUSINESS OBJECTS DATA

	Specific Growth of Applications				
Years	AU2816	AU2821	AU2851	AU2852	AU2853
1986	-0.18	-0.13	0.08	0.15	0.11
1987	0.11	-0.15	0.08	0.29	0.02
1988	0.12	0.08	0.28	0.31	-0.13
1989	-0.12	0.18	0.15	0.06	0.17
1990	0.05	0.00	0.01	-0.04	0.27
1991	0.09	-0.09	0.04	0.00	0.05
1992	-0.19	0.04	-0.18	-0.23	0.07
1993	0.28	0.25	0.37	0.40	0.14
1994	1.75	0.00	0.18	0.05	0.04
1995	3.23	0.21	0.21	0.11	0.26
1996	0.06	0.01	-0.17	-0.05	-0.04
1997	0.15	0.14	0.18	0.16	0.18
1998	0.00	-0.11	-0.26	-0.02	0.00
1999	-0.15	0.08	0.00	-0.14	-0.07

Years	AU2856	AU2858	AU2874	AU2875	AU2879
1986	0.02	0.13	0.53	0.12	0.20
1987	0.02	0.12	0.30	0.11	-0.09
1988	0.13	0.14	-0.20	0.14	0.10
1989	0.12	0.13	0.46	0.09	0.10
1990	0.06	0.27	0.34	0.11	0.02
1991	-0.07	-0.03	2.17	-0.01	-0.05
1992	-0.07	-0.03	2.38	-0.42	-0.11
1993	0.21	0.21	0.60	0.93	0.12
1994	0.11	-0.03	0.14	0.08	0.07
1995	0.02	0.29	0.00	0.11	0.42
1996	0.05	-0.16	0.00	0.03	-0.03
1997	0.23	0.07	0.38	0.02	0.11
1998	-0.07	-0.04	0.15	0.19	0.19
1999	-0.01	0.13	0.15	0.14	0.14

APPENDIX M

BUIDLING HISTORIES FOR SPLIT CLASSES

Year	Class 355	Class 399	355+399	355 ratio	Adjusted 355	399 ratio	Adjusted 399
1985	551		551	0.27	147	0.73	404
1986	633	1	634	0.27	169	0.73	465
1987	816		816	0.27	218	0.73	598
1988	1065		1068	0.27	285	0.73	783
1989	1125	1	1128	0.27	301	0.73	827
1990	1079		1080	0.27	288	0.73	792
1991	1079		1080	0.27	288	0.73	792
1992	833		834	0.27	223	0.73	611
1993	1161	4	1165	0.27	311	0.73	854
1994	1218	4	1222	0.27	326	0.73	896
1995	1347	15	1362	0.27	364	0.73	998
1996	1060	238	1298	0.27	347	0.73	951
1997	350	1101	1451	0.24	350	0.76	1101
1998	368	1074	1442	0.26	368	0.74	1074
1999	404	922	1326	0.30	404	0.70	922

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