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Econometrics Project

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**Hypothesis and Motivation**

*I will test to see if there is a positive relationship between the number of patents filed in the US and economic well-being using OLS regression techniques.*

History has shown a trend of economic prosperity in nations with brainpower industries. This research may give us an idea of just how important growth of intellectual property is to sustained growth in a nation. The results of this work also will give insight to the benefits of placing strict guidelines on intellectual property and will allow us to determine the opportunity cost of countries like China who do not put the same value on protecting the rights of innovators. If the results of my study are conclusive, they could be used in the continuing argument for increasing the government subsidy on R&D.

**Literature Review**

This paper discusses the entrepreneurial activity that results from patents and the incentive to innovate so that new entrepreneurial opportunities can become available. These business ventures are the catalyst to investment, job creation and often improved efficiency of labor. The paper emphasizes the importance of intellectual property rights which creates incentive for innovation because it allows the innovator guaranteed ownership of their research for a certain time. This in turn increases the expected return on investment. “[Previous studies show] strong intellectual property rights laws and effective enforcement policies result in more rapid economic growth in countries with GDP greater than or equal to $3,400 (1980 dollars per capita)”. (Thompson)

Thompson goes into great detail predicting the differences in how patent activity affects economic growth for different types of countries based on, for example, restrictions on free trade, enforcement of intellectual property rights laws, political stability and educational attainment. Because this econometrics project is focusing only on the United States, this aspect of the paper is not as important. It should be noted for future research that each of these factors was found to be statistically significant in their respective effects in most instances. (Thompson)

The publication points out an issue that exists even in my own model: there are a number of steps between innovation and economic growth that are not accounted for. The entrepreneurial process is not entirely understood in this regard and the partial effects of innovation on new industry creation vs. improved efficiency of labor are still not distinguished. (Ye)

This paper used similar variables to the model in this project but instead of time-series chose to take a cross section of several countries. Ye found that wellbeing in a country measured by GDP is generally a function “G=kF(lgP)N, where G is Per Capita GDP, F is Gross Expenditure on R&D as % of GDP (GERD%), P is Patent applications, N is Internet users per 10,000 inhabitants, and k is a constant.” (Ye)

The difference in my model is that instead of patent applications, patents awarded is used instead since this makes more economic sense; i.e. if the patent is only applied for but not awarded then it may not contribute to an increase in technology since often patent applications are denied because too similar of a patent has already been filed and therefore has already shifted the production possibilities frontier.

**Economic Model and Data**

Wellbeing = β0+ β1 ln(Patents)+ β2 ln(Patentst-1)+ β3 ln(Patentst-2)+ β4 ln(GCI)+ β5 ln(GPI)

In this model the coefficients relating patents and investment to GDP are expected to be positive. This economic relationship is described in the Solow growth model which states that the primary causes of growth in our economy are efficiency of labor (technology) and capital. The logic follows that as patents are awarded, new technology is available to labor which in turn makes labor more efficient which increases potential GDP.

Instead of deriving some number for the total capital, government and private investment are used. The literature uses specifically R&D investment but this excludes capital and would presumably correlate with patents. Investment is superior in that it accounts for new capital and for replacing depreciated capital.

For thoroughness it is important to use several leading years of patents. This is because patents filed in a given year would logically add to GDP not only in their current year but in the years following as well. It is also important to recognize that there is an additional relationship with GDP and R&D expenditure where time periods of higher GDP may induce more funding on research which in turn will cause more patents.

Because reliable data on GDP, GCI and GPI is only available from 1930, the regression is limited back only this far.

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| --- | --- | --- | --- | --- |
| Symbol | Description | Source | β coefficient | t-stat |
| Wellbeing | Real GDP ($Billions 2005 chained) | http://www.bea.gov/national/nipaweb/GetCSV.asp?GetWhat=SS\_Data/Section1All\_xls.xls&Section=2 | - | - |
| ln(Patents) | Number of utility patents issued that year | <http://www.uspto.gov/patents/process/search/issuyear.jsp> | 1572.80349 | 1.77 |
| ln(Patentst-1) | Number of utility patents issued that year | <http://www.uspto.gov/patents/process/search/issuyear.jsp> | 511.82393 | 0.44 |
| ln(Patentst-2) | Number of utility patents issued that year | <http://www.uspto.gov/patents/process/search/issuyear.jsp> | 2096.90273 | 2.42 |
| ln(GCI) | Government consumption and investment ($Billions 2005 chained) | http://www.bea.gov/national/nipaweb/GetCSV.asp?GetWhat=SS\_Data/Section1All\_xls.xls&Section=2 | 622.00720 | 2.33 |
| ln(GPI) | Gross private domestic investment ($Billions 2005 chained) | <http://www.bea.gov/national/nipaweb/GetCSV.asp?GetWhat=SS_Data/Section1All_xls.xls&Section=2> | 950.46580 | 4.43 |
| Intercept | - | - | -51002 | -15.55 |

**Findings**

In the model it made economic sense to include trailing periods, however, in the case of ln(Patentst-1) the t statistic was not very good. With the current model, including ln(Patentst-1), the adjusted r2 is .9303 and RMSE is 950.142 which is very good and implies that 93% of GDP can be attributed to patents and capital investment. Upon seeing the high error in of ln(Patentst-1) it was determined that the trailing patents were too highly correlated with the current years and were dropped from the model.

Wellbeing = β0+ β1 ln(Patents)+ β2 ln(GCI)+ β3 ln(GPI)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Symbol | Description | Source | β coefficient | t-stat |
| Wellbeing | Real GDP ($Billions 2005 chained) | http://www.bea.gov/national/nipaweb/GetCSV.asp?GetWhat=SS\_Data/Section1All\_xls.xls&Section=2 | - | - |
| ln(Patents) | Number of utility patents issued that year | <http://www.uspto.gov/patents/process/search/issuyear.jsp> | 3926.21 | 10.94 |
| ln(GCI) | Government consumption and investment ($Billions 2005 chained) | http://www.bea.gov/national/nipaweb/GetCSV.asp?GetWhat=SS\_Data/Section1All\_xls.xls&Section=2 | 876.07 | 3.16 |
| ln(GPI) | Gross private domestic investment ($Billions 2005 chained) | <http://www.bea.gov/national/nipaweb/GetCSV.asp?GetWhat=SS_Data/Section1All_xls.xls&Section=2> | 818.08 | 3.6 |
| Intercept | - | - | -49216 | -14.13 |

The new model has an adjusted r2 of 0.9194 which is technically not as good but because of the multicollinearity and high error of the first model, it may just be a coincidence that the adjusted r2 is higher. Hypothesis testing was conducted to determine if any of the variables or a combination of them in each model we conducted, including every combination thereof. It was the case that ln(Patentst-1) and combinations of it had high likelihood of not being useful to the model.

**Interpretation: An Economic Perspective**

The model brings up an interesting aspect of how patent activity relates to GDP. Intuitively it makes sense that GDP should hold a relationship between not only the current year but for a few years prior as newly patented technology has time to reach the market so that it may increase the productivity of labor. The reality is that because the market for new patent acceptance is so incredibly non-volatile, it does not matter if the model uses the current time period or the previous up to several periods back with almost no effect on the explanatory power of the model. This suggests that the model would be more informative if the data was lumped into decades instead of years so the volatility of the markets is greater. This would make relationships more apparent, decrease the error of multicollinearity and fits better in the long term growth models since the balanced growth path may take long periods to find equilibrium.

**Conclusions and Limitations**

The model follows the economic story presented by the contemporary growth model that capital investment and technology are the two primary factors that cause changes in GDP. The model shows that for relatively small changes in GDP, $818 billion investment by government, $876 billion investment by the private sector or 3926 patents filed will increase GDP by 1%. These numbers not only add more proof to the existing models that technology is a lead contributor to economic growth, but tell something about the efficiency of government. In order to have the same effect on GDP, government has to spend 7.1% more than the private sector.

The major limitation of this project is the lack of data; good data on GDP and investment only goes back eighty years. In 500 years from now I see very insightful study very similar to this except average patent activity per 10 year periods is used instead of annual which would allow the proper time for movements in growth patterns to equilibrium.

The question still remains of the erogeneity of patents filed with GDP. Economic theory tells us that GDP increases when the production possibilities curve shifts out which happens when technology improves. Thanks to this concept and Moore’s Law developed nations like the US have has consistent and exponentially increasing growth for the last fifty years. Yet, it is also reasonable that because GDP is high there is more funding available to invest into patent generating research. This is a topic of concern that should be explored in later editions to this study.

References

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