ECON 6511: Advanced Applied Econometrics
Homework 5 Suggested Solutions

The goal of this assignment is for you to read and understand a reasonably sophisticated empirical paper. The assigned article is: "The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995" by Bronwyn H. Hall and Rosemarie Ham Ziedonis. (I think this is a terrific paper by the way, though you might find the topic dry.)

1. Preliminary stuff

   (a) What is a patent? What are the requirements for patentability of an invention in the U.S.? (2 sentences)
   Answer: A patent is a legal right to exclude others from using the invention that is patented for a period of 20 years. To obtain a patent, an invention must be "novel," "useful," and "nonobvious."

2. Based on the Introduction (pages 101-105):

   (a) What is the paper's main question or inquiry? (1-2 sentences)
   Answer: The paper is trying to understand why patent applications surged in the 1980s despite surveys of firms that indicate that patents are among the least effective means to appropriate the returns from research and development (R&D).

   (b) What do the authors contend the answer to this question is? (2+ sentences)
   Answer: The authors contend that the surge in patenting is related to the formation of the Central Appeal Court for the Federal Circuit (CAFC), which was more likely to uphold patent rights. This strengthening of patent rights induced firms at risk of being "held up" to file more patents to counter patent lawsuits that would threaten their production.

3. Based on Sections 2-3 (pages 105-108):

   (a) What institutional change occurred in the early 1980s? (1 sentence)
   Answer: The formation of the CAFC in 1982.

   (b) How did this affect the behavior of firms? Which firms in particular? (4+ sentences)
   Answer: To ensure freedom to produce (defend against patent litigation with countersuits) and improve bargaining positions, the strengthening of patent rights induced firms to "harvest" more patents from their R&D to build up large patent portfolios. This effect is likely to be stronger for firms with large capital investments (fabrication plants), and stronger for design firms, which do not have manufacturing assets and rely on patents to generate returns.

4. Based on Section 4 (pages 111-115):

(a) The authors are using panel data. What makes it a panel data set? Be specific. (1-2 sentences)

Answer: Their dataset contains 110 publicly traded U.S. semiconductor forms (cross-sectional dimension) between 1975 and 1996 (time dimension).

(b) What is the left-hand side variable, p_{it}, on the bottom of page 112? Be specific. (1 sentence)[1]

Answer: It is the number of (successful) patent applications by firm i in year t.

(c) What (right-hand side) variables are contained in X_{it}? List them.

Answer: log R&D spending, log employment, annual time dummies, log capital-labor ratio, entrant dummy, design firm dummy, Texas Instruments dummy, and age of firm.

(d) The authors are most interested in the coefficients attached to which variables? For each variable, explain in one sentence what a statistically significant variable in Table 1 (Column 4) would imply?

Answer: Main variables (in my opinion):

- log R&D: An increase in R&D increases the number of patent applications filed
- log P&E per employee: An increase in capital-labor ratio increases the number of patents filed

(e) What does the coefficient on Log P&E (per employee) in Table 1, Column 4 mean? Be specific. (1 sentence)

Answer: A 1% increase in the ratio of capital to labor is associated with a 0.603% rise in patents filed.

(f) How do the results in Table 2 support the authors' argument(s)? (3+ sentences)

Answer: After the CAFC was formed, and a "pro-patent" regime was established, the relationship between R&D and patent applications becomes insignificant, while a relationship between the capital-labor ratio becomes significant. This suggests that the surge in patenting was related to capital intensive firms building patent portfolios to defend against patent suits, and not because of a rise in R&D.

5. Based on Section 5 (pages 121-124):

(a) How and why do the authors control for patent quality? What do Figures 5 and 6 indicate about changes in patent quality? (3+ sentences)

Answer: The authors use forward citations (the number of citations received from

[1] Technical note: Hall and Ziedonis (2001) use a poisson specification which is appropriate when the left-hand side or dependent variable is "count data" which takes on values 0, 1, 2, 3, 4? and the likelihood of each value diminishes, i.e. 0 is more likely than 1 which is in turn more likely than 2 etc. For right-hand side variables that are in log-form, e.g. Log R&D and Log firm size, coefficients have an elasticity interpretation. So a 1 percent change in the right-hand side variable leads to a percent change in the left-hand side variable (in this case, patents). We will discuss the poisson model in the last lecture.

future patents) and claims to control or quality. Figure 6 indicates that citations per patent declined slightly during the 1980s, which suggests that firms were filing slightly lower-quality applications. When you exclude self-citations, there is an increase in the patent quality. Overall, there is no clear evidence of a decline or rise in patent quality.