

An Empirical Look at Software Patents

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History

- In 1970 Software could not be patented in the U.S.
 - *Is software patentable subject matter?*
 - The Supreme Court initially said no—computer programs were mathematical algorithms
- But this prohibition eroded over time
 - By late 1970s, you could patent a new machine or process that relied on software
 - By late 1980s, the program need only cause a physical transformation
 - By mid 1990s, the program simply had to be useful
- New USPTO examination guidelines issued in 1996
- In Europe (I believe) the issue revolves around the requirement of a *technical effect*

Arguments in Favor of Software Patents

- Patent law should treat all technologies the same
 - The patent system should be “one-size-fits all”
 - Patent law should not be industrial policy
- Patents will encourage more innovation in software
 - Software is easy to duplicate
 - Copyright protection is too narrow
 - Providing additional rents will only stimulate R&D
 - Rapid growth of the industry is evidence in favor of patents
- This paper examines these arguments
 - Does the U.S. system treat software like any other technology?
 - Is patent protection for software associated with more R&D?

Rapid Growth in Software Patents

- No PTO definition, researchers must create one
- We do a keyword search of the patent specification
- Our measure is consistent with other research and manual examination
- We can link 40% of US patents to firms (using The NBER Patent Data File and Compustat)

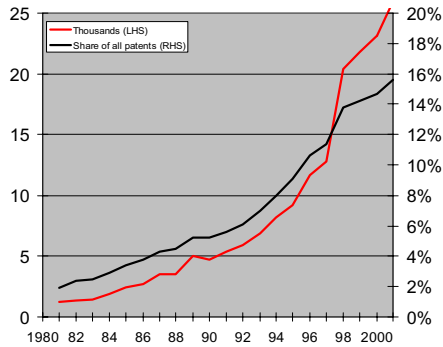


Table 2. Characteristics of Software Patents (1990-95)

| | Software | Other |
|--|----------|-------|
| Assignee type | | |
| Private Organization (firm) | 88% | 80% |
| Individual / unassigned | 11% | 18% |
| Government | 2% | 2% |
| U.S. assignee (if assigned) | 70% | 51% |
| U.S. inventor | 70% | 53% |
| Mean citations received | 9.7 | 4.6 |
| Number of claims | 16.8 | 12.6 |
| Percent of self-citations | 12% | 13% |
| Percent of patents owned by top 5 percent of assignees | 63% | 64% |

Table 3. Firm Characteristics by Patent Type (1990-99)

| Median | Software | Other Patents |
|----------------------------------|----------|---------------|
| Firm market value (million \$96) | 27,447 | 15,994 |
| Firm sales (million \$96) | 16,482 | 10,721 |
| Firm R&D (million \$96) | 1,153 | 550 |
| Newly public firm* | 0.9% | 1.6% |

*: Firms that first appeared in the Compustat file within the last 5 years.

Table 4. Software Patents by Industry (1995-99)*

| | Software patents | All patents | Patents /R&D | Programmers |
|------------------------------------|------------------|-------------|--------------|-------------|
| Manufacturing | 69% | 85% | | 10% |
| Machinery (SIC 35) | 27% | 17% | 2.5 | 3% |
| Electronics (SIC 36) | 22% | 22% | 2.8 | 2% |
| Other | 20% | 45% | 1.8 | 5% |
| Non-manufacturing | 31% | 15% | | 90% |
| Software publishers (SIC 7372) | 6% | 1% | 0.7 | 42%† |
| Other software services (exc. IBM) | 2% | 1% | 4.4 | |
| Other non-manufacturing | 3% | 3% | 2.8 | |
| Addendum: IBM | 8% | 3% | 4.7 | -- |

*: Except for IBM these proportions are based on patents matched to firms in Compustat.
 †: Includes IBM's domestic employment of programmers.

Results of Our Demand Analysis

- The relative cost of software patents has fallen
 - In the 1980s, they were more expensive than other patents
 - They are now significantly cheaper than other patents
- Higher software patent share is associated with larger patent portfolios
 - An additional software patent is associated with an increase of 2 patents in the target portfolio size
 - This is after controlling for many other variables
 - Result is consistent with models of strategic patenting
- US patent propensity increased by 40% since 1980
 - # patents/\$R&D (loosely speaking)
 - Half of the increase may be due to the rise in software patent share

Does our Data Support the Incentive Hypothesis?

- Test of the incentive theory: Is there a positive association between software patent share and R&D intensity?
- We explain R&D intensity (R&D/Sales) as a function of a firm's input costs
 - This is a standard economic approach – estimating cost shares as a function of input prices
- We include software patent share as an (inverse) measure of the cost of obtaining software patents
- We estimate an equation in 5 year differences
 - Controls for unobserved differences across firms
 - Controls for measurement error

Results for R&D Investments

| Dependent Variable | Δ (R&D/Sales) |
|---|----------------------|
| Δ Software Share (1985-89) | 0.024* (0.009) |
| Δ Software Share (1990-94) | -0.016 (0.007) |
| Δ Software Share (1995-99) | -0.072* (0.006) |
| Lag log sales | 0.000 (0.000) |
| Lag new firm | -0.002 (0.003) |
| Standard deviation of stock price | -0.013* (0.004) |
| Change in Debt | -0.002* (0.001) |
| Δ in log price of Capital | 0.000 (0.001) |
| Δ in log price of Labor | 0.057* (0.006) |
| Δ in log price of Energy | -0.006 (0.004) |
| Δ in log price of Materials | -0.017* (0.002) |
| Δ in log price of Services | -0.014* (0.005) |
| Δ in log price of Information Technology | -0.004 (0.005) |
| No. observations | 5,467 |
| R squared | 0.100 |

- Implies a 10-15% decrease in R&D/Sales
- Equivalent to a 10% decrease in private R&D
- Not necessarily a cause and effect relationship
- Result is not favorable for the naïve incentive hypothesis
- Result is consistent with models of strategic patenting

*: Significant at 1 percent level.

- Weighted least squares, all regressions include year dummies
- D are 5 year differences

Does the Use of Software Reduce R&D/Sales?

- Two mechanisms:
 - Software in products
 - Software in R&D
- IT price index includes software
- Other studies find the price elasticity of R&D is -1
- An increase in the share of programmers/employment is associated with more, not less R&D

| Dependent variable | $\Delta R \& D / Sales$ | | $\Delta R \& D / Sales$ | |
|----------------------------------|-------------------------|---------|-------------------------|--------|
| | 1 | | 3 | |
| Δs | -0.050* | (0.005) | -0.042* | (.005) |
| $\Delta s \times Large$ | | | | |
| $\Delta s \times SW$ related | | | | |
| Δ Programmers /Employment | | | 0.059* | (.010) |
| $\Delta \ln p$ Capital | -0.001 | (0.001) | -0.002 | (.001) |
| $\Delta \ln p$ Labor | 0.057* | (0.011) | 0.047* | (.011) |
| $\Delta \ln p$ Energy | -0.033* | (0.008) | -0.031* | (.007) |
| $\Delta \ln p$ Materials | -0.030* | (0.005) | -0.021* | (.005) |
| $\Delta \ln p$ Services | -0.001 | (0.007) | -0.022* | (.008) |
| $\Delta \ln p$ IT | 0.022* | (0.006) | 0.015 | (.006) |
| No. observations | 3,412 | | 3,396 | |
| R squared | 0.095 | | 0.106 | |

*: Significant at the 1 percent level.

- Weighted least squares, all regressions include year dummies
- D are 5 year differences, except for D programmers/employees (10 yrs)

Is The Result Driven by Large Firms?

- All firms are affected
- The effect may be bigger for large firms

| Dependent variable | $\Delta R \& D / Sales$ | | $\Delta R \& D / Sales$ | |
|----------------------------------|-------------------------|---------|-------------------------|---------|
| | 1 | | 4 | |
| Δs | -0.050* | (0.005) | -0.033* | (0.009) |
| $\Delta s \times Large$ | | | -0.025 | (0.011) |
| $\Delta s \times SW$ related | | | | |
| Δ Programmers /Employment | | | | |
| $\Delta \ln p$ Capital | -0.001 | (0.001) | -0.001 | (0.001) |
| $\Delta \ln p$ Labor | 0.057* | (0.011) | 0.057* | (0.011) |
| $\Delta \ln p$ Energy | -0.033* | (0.008) | -0.033* | (0.008) |
| $\Delta \ln p$ Materials | -0.030* | (0.005) | -0.029* | (0.005) |
| $\Delta \ln p$ Services | -0.001 | (0.007) | -0.003 | (0.007) |
| $\Delta \ln p$ IT | 0.022* | (0.006) | 0.021* | (0.006) |
| No. observations | 3,412 | | 3,412 | |
| R squared | 0.095 | | 0.097 | |

*: Significant at the 1 percent level.

- Weighted least squares, all regressions include year dummies
- Large firms have 5,000+ employees

Is The Effect Limited to the Software Industry?

- The effect is significant across all other industries
- The effect is about the same in the software industry

| Dependent variable | $\Delta R \& D / Sales$ | | $\Delta R \& D / Sales$ | |
|---|-------------------------|---------|-------------------------|---------|
| | 1 | | 2 | |
| Δs | -0.050* | (0.005) | -0.048* | (0.010) |
| $\Delta s \times Large$ | | | | |
| $\Delta s \times SW \text{ related}$ | | | -0.003 | (0.011) |
| $\Delta \ln p \text{ Programmers / Employment}$ | | | | |
| $\Delta \ln p \text{ Capital}$ | -0.001 | (0.001) | -0.001 | (0.001) |
| $\Delta \ln p \text{ Labor}$ | 0.057* | (0.011) | 0.057* | (0.011) |
| $\Delta \ln p \text{ Energy}$ | -0.033* | (0.008) | -0.033* | (0.008) |
| $\Delta \ln p \text{ Materials}$ | -0.030* | (0.005) | -0.030* | (0.005) |
| $\Delta \ln p \text{ Services}$ | -0.001 | (0.007) | -0.001 | (0.007) |
| $\Delta \ln p \text{ IT}$ | 0.022* | (0.006) | 0.021* | (0.006) |
| No. observations | 3,412 | | 3,412 | |
| R squared | 0.095 | | 0.095 | |

*: Significant at the 1 percent level.

- Weighted least squares, all regressions include year dummies
- Software related firms are those in SICs 35-36, 38, and 73

Other Robustness Checks

R&D/Sales is not a cost share

- We get similar (but noisier) results using R&D/Cost
- We get similar results when we substitute employment for sales

It's sample selection

- Not for public companies
- We can't say much about private ones

| Dependent Variable | 3 | | 4 | |
|----------------------------------|-------------------------|---------|-----------------------|--------|
| | $\Delta R \& D / Sales$ | | $\Delta R \& D / Emp$ | |
| $\Delta s \text{ (1985-89)}$ | 0.024* | (0.009) | 6.05 | (2.77) |
| $\Delta s \text{ (1990-94)}$ | -0.016 | (0.007) | 3.89 | (2.23) |
| $\Delta s \text{ (1995-99)}$ | -0.072* | (0.006) | -13.07* | (1.79) |
| $\Delta \log \text{ sales}$ | | | 1.15* | (0.29) |
| Lag log sales | 0.000 | (0.000) | | |
| Lag new firm | -0.002 | (0.003) | -0.17 | (0.94) |
| Stock std. dev. | -0.013* | (0.004) | 0.65 | (1.04) |
| Debt change | -0.002* | (0.001) | -0.39 | (0.31) |
| $\Delta \ln p \text{ Capital}$ | 0.000 | (0.001) | 0.49* | (0.19) |
| $\Delta \ln p \text{ Labor}$ | 0.057* | (0.006) | 19.44* | (1.96) |
| $\Delta \ln p \text{ Energy}$ | -0.006 | (0.004) | -3.49* | (1.29) |
| $\Delta \ln p \text{ Materials}$ | -0.017* | (0.002) | -5.26* | (0.77) |
| $\Delta \ln p \text{ Services}$ | -0.014* | (0.005) | -5.00* | (1.38) |
| $\Delta \ln p \text{ IT}$ | -0.004 | (0.005) | 3.14 | (1.45) |
| No. observations | 5,467 | | 5,595 | |
| R squared | 0.100 | | 0.065 | |

*: Significant at 1 percent level.

Conclusions

- Changes in software patent share explain a significant part of the increase in patent propensity since the 1980s
 - They explain about half of the rise in patenting over this time
 - Software patents have become relatively cheap
 - The *One-Size-Fits-All* hypothesis is rejected
- Over the 1990s, firms that increased their software patent share decreased their R&D intensity
 - The rise in software patenting is associated with a 10 percent reduction in private R&D
 - But this result does not establish causation
- The naïve version of the incentive hypothesis is rejected
 - But the results are consistent with models of strategic patenting and patent thickets (Bessen 2003, Hunt 2003)

