Econometric Modelling of Antitrust Environment and Patent Activity

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EXTENDED ABSTRACT

This paper examines the relationship between the antitrust environment and technological inventiveness in the US economy, where technological inventiveness is measured by patent activity. Although not all registered patents are commercialised into inventions, patent data provide a valuable source of information about technological efforts. Patenting is also very important as it is linked to an economic and legal environment which actively encourages and protects competition.

The US economy has been providing legal protection to inventors for more than 200 years now, and in the last 100 years or more it has also been a relatively highly regulated antitrust environment. The hypothesis tested in the study is whether antitrust enforcement activity, as measured by the number of civil filings of the US Department of Justice, has had a significant impact on the level of technological inventiveness in the US economy, after adjusting for other factors that have an impact on innovation, such as research and development expenditures and real economic growth. Impacts of civil antitrust case filings, criminal antitrust case filings and total US Department of Justice antitrust case filings on patent activity in the USA (based on data from the US Patent and Trademark Office) are estimated for the period 1953-2000.

During the above period, patent activity and R&D expenditure have exhibited increasing trends; while the growth rate in real GDP has not exhibited noticeable trending behaviour and unemployment rate peaked in the mid-1980s and subsequently declined in the 1990s. Criminal antitrust filings comprise 60% of total antitrust filings and they have not exhibited any discernible trends during the 1953-2000 period; while civil antitrust filings peaked in the early 1960s and early 1970s, then declined dramatically in the 1980s followed by a slight rise in the 1990s and gradual decline towards the end of the period.

Against this background, the estimated econometric models assume that technological inventiveness (for which the proxy is patent activity) is a function of past patent activity, US aggregate R&D expenditures, the rate of growth in real GDP, the overall US unemployment rate and includes antitrust enforcement variables (civil, criminal and total antitrust filings). The estimation is undertaken by weighted least squares and the Newey-West heteroskedasticity and autocorrelation consistent method is used to adjust for possible heteroskedasticity and/or serial correlation. All the models are estimated using the EViews 4.0 econometric software package.

A simple dynamic model that provided an adequate fit to the data is given as follows:

$$\text{Patent Success}_t = 20736 + 0.48 \text{ Patent Success}_{t-1} + 0.24 \text{ US R\&D}_t + 643 \text{ Real GDP Growth}_t - 1991 \text{ US Unemployment Rate}_t + 308 \text{ Civil Antitrust Cases Filed}_{t-1}$$

The empirical results show that civil case filings have a statistically significant impact on technological inventiveness.

Residual claimants of firms clearly understand the competitive landscape of the US economy in which they operate – when the US Department of Justice emits a signal to the market of robust enforcement intent, firms react by increasing their technological inventiveness. It might also be expected that civil antitrust filings would have a stronger impact than criminal antitrust activity on innovative activity as the civil cases involve firms that play according to legal rules.

1. INTRODUCTION

The aim of this paper is to examine the relationship between the antitrust environment and technological inventiveness in the US economy, where inventiveness is represented by patent activity. Patents by their nature are inventions[1] and studies indicate that only between 30 and 54% of all patented technologies complete the commercialisation process to become innovations (see for example Mattes et al., 2005). According to Rosenbloom (2000, p.1185), "patents provide data on technological effort, which is only one aspect of innovative activity"; nevertheless, this particular aspect of innovation is above all relevant when it comes to an economic and legal environment that actively encourages and protects competition. Hence, in this study we use patents as a proxy for technological inventiveness that feeds innovation following a linear technology-push interpretation of the innovation process (Meyer, 2002).[2]

Patent data have been widely used to describe innovation since the mid 1970s. More recently, Gallini (2002) explored the role of patents and patent portfolios in the competitive landscape. Marinova (1999, 2001) examined models of patents in the context of patents as an indicator of national technological strengths and capabilities. McAleer et al., (2002) analysed the time series properties of patent activity for the leading inventive countries by modelling the volatility inherent in monthly US patent shares. They have also studied various technological clusters, such as anti-pollution and environmental technologies (Chan et al., 2004, 2005), electronics and transport industries (Marinova and McAleer, 2002).

The hypothesis to be tested here is whether antitrust enforcement activity, as measured by the number of civil filings of the US Department of Justice, has had a significant impact on the level of technological inventiveness in the US economy, as presented by patent activities, after adjusting for other factors that have an impact on innovation, such as research and development expenditures (R&D) and real economic growth.

The United States Patent and Trademark Office (USPTO) has been collecting data on patent applications and patents granted (equivalently, successful patent applications) for an extended period, with some of the series dating back to 1790. The USPTO decomposes patent activity into domestic and foreign, as well as utility, design and plant patents. As such disaggregated patent data are available, we will examine some of these categories separately in the empirical analysis.

The plan of the remainder of the paper is as follows. Section 2 discusses the US antitrust environment and patent activity over time. Section 3 presents the data, discusses trends in antitrust enforcement, patent activity and economic growth in the USA over the past 50 years, and presents the model to be estimated. Section 4 discusses the empirical results. The impact of civil antitrust case filings, criminal antitrust case filings and total US Department of Justice antitrust case filings on patent activity in the USA are estimated for the period 1953-2000. Some concluding remarks are given in Section 5.

2. PATENT ACTIVITY AND ANTITRUST ENVIRONMENT

The US economy, with its large size and technologically advanced nature, offers the most potent example of the power of patent legislation which goes back as far as to the 1790s. There is considerable statistical evidence in support of the relationship between economic growth, R&D and patent activity (Freeman, 1992; Idris, 2003; Nelson and Winter, 1982). More recently, there has been significant growth in patent applications concomitant with the growth in knowledge activities in areas such as advanced materials, information technology, bioinformatics and nanotechnology. These activities have also contributed substantially to the level and rate of growth in real gross domestic product (GDP) of various countries and to creating new employment opportunities.

For more than 100 years the US economy has been a relatively highly regulated antitrust environment. The full force of competition laws regarding intellectual property has been enforced in relation to, for example, market segmentation (Hanks, 2003), market power (Pleatsikas and Teece, 2001), and even patent information dissemination (Ebersole, 2003). There are clear benefits from antitrust laws in the constant pursuit of new inventions and the early adoption of technological

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[1] Recently the World Intellectual Property Organisation (WIPO) (2003) has used "invention" and "patent" interchangeably in the sense that a patent is a granted exclusive right for the use of an invention, which is a novel product or process, or a novel technical solution to an existing problem. Industrial designs, which are the aesthetic, artistic or ornamental aspects of articles, are not considered to represent patents.

[2] For definition of technological innovation, please refer to the Oslo Manual (OECD, 1996).

innovations. An example of the profound impact of the US antitrust environment is the existence of the Internet (Mowery and Simcoe, 2002) or the capitalisation of research in the areas of monoclonal antibodies and other biotechnologies (Capitalising..., 1999).

On the other hand, strategic alliances, research partnerships and joint ventures have also been used to reduce the exposure to antitrust regulations in order to increase the propensity of firms to engage in costly high-tech R&D activities (Link et al., 2002; Teece, 1992). Hart (2001) argues that the history of antitrust policy in the USA exhibits major swings every few decades between favouring concentration and de-concentration. Such swings have had significant impacts on technological innovation, including the generation of new inventions and patents. This argument has been extended by Baumol (2001), for example, who argues that antitrust regulatory agencies and the courts should exercise extreme restraint in interfering with inter-firm coordination and joint decision making in relation to innovation.

In this conflicting background, this paper examines the relationship between the antitrust environment and technological inventiveness in the US economy, specifically whether US antitrust enforcement activity (as measured by criminal and civil filings) has had a significant impact on the level of inventiveness in the US economy, as measured by patent activity[3].

The impact of civil antitrust case filings, criminal antitrust case filings and total US Department of Justice antitrust case filings on patent activity in the USA are estimated for the period 1953-2000.

3. DATA AND MODEL SPECIFICATION

3.1. Data

The measures of technological inventiveness examined in this paper are total patent applications and patents granted (that is, successful patent application) to domestic companies (cf. www. gov/web/offices/ac/ido/oeip/taf/h_counts.htm). On average, 59.5% of total patent applications were successful during the 1953-2000 period.

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[3] According to Tyson (2001) and Hufker and Alpert (1995), the US patent and antitrust environment encourages the flow of technological information through cross-licensing. This paper however does not trace the use of patents.

The Department of Justice (DOJ) Antitrust Division tracks case filings in US District Courts in its Workload Statistics for both civil and criminal cases. We use the numbers of civil antitrust case filings, criminal antitrust case filings and total DOJ antitrust case filings as potential antitrust enforcement variables. The average shares of civil and criminal antitrust filings are 40% and 60% respectively.

The growth rate in real US GDP and the US unemployment rate are also examined as potential variables in the various empirical models. Data for GDP, consumer price index (CPI) and the unemployment rate were obtained from the Bureau of Economic Analysis (BEA), US Department of Commerce, for the period 1953-2001.

In the empirical models also use data from the National Science Foundation relating to total US R&D expenditures, which are given in $millions (cf. National Science Foundation, Division of Science Resources Studies (NSF/SRS), National Patterns of R&D Resources: 2000 Data Update, NSF 01-309, Arlington, VA, March 2001, available at http://www.nsf.gov/sbe/srs.nsf01309/start.htm).

Summary statistics of all data sets can be found in Marinova et al. (2005).

3.2. Model

The model to be estimated assumes that technological inventiveness (for which the proxy is patent activity) is a function of past patent activity, US aggregate R&D expenditures, the rate of growth in real GDP, and the overall US unemployment rate.

Graphs of the time series behaviour of the three antitrust variables for the years 1953-2000 are given in Figures 1a-1c. As criminal antitrust filings comprise 60% of total antitrust filings, it is not surprising that the two figures display similar patterns over time. It is interesting to note the increase in the average numbers of filings in the 1980s and 1990s.

The graph for civil antitrust filings indicates that antitrust enforcement peaked in the early 1960s and early 1970s, and then declined dramatically in the Reagan years in the 1980s. The Clinton years led to a slight rise in enforcement activity, with a gradual decline as the Bush policies started to prevail.

Figure 1a
U.S. Department of Justice
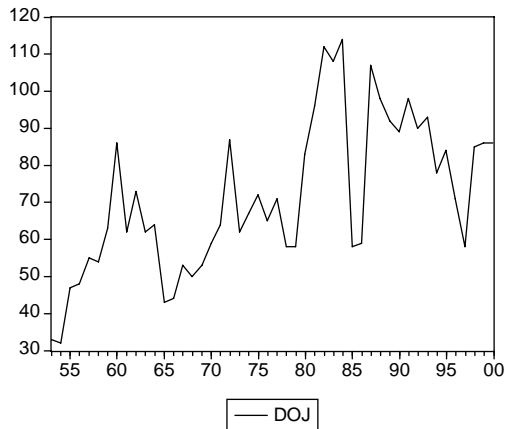Total Antitrust Filings
1953-2000

Figure 2a
Total U.S. Patent
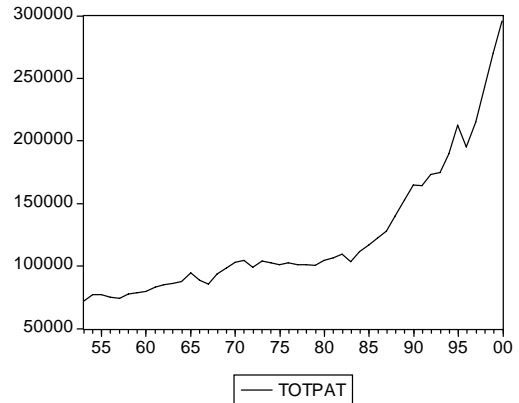Applications
1953-2000

Figure 1b
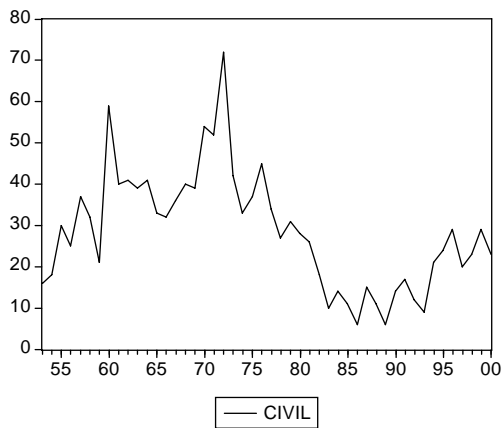U.S. Department of Justice
Civil Antitrust Filings
1953-2000

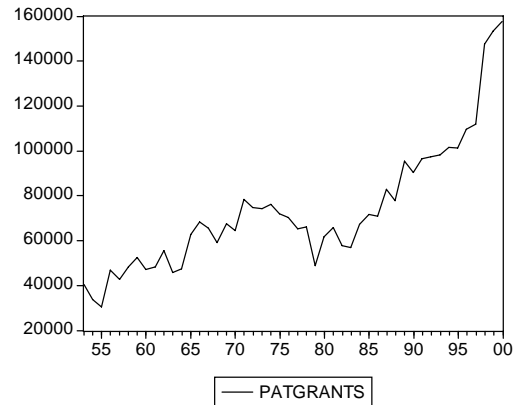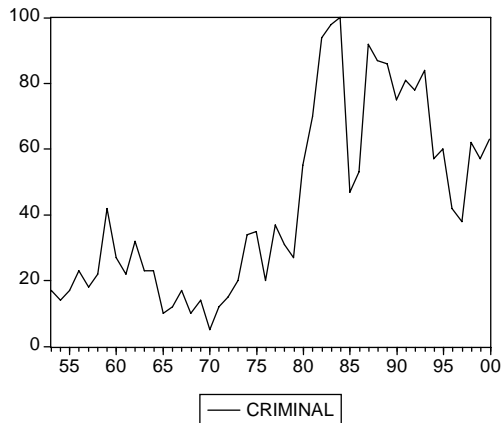
Figure 2b
U.S. Successful
Patent Applications
1953-2000

Figures 2a and 2b present the same graphical information for the two patent activity (or technological inventiveness) variables. They both have exhibited increasing trends over time. During 1953-2000, the real GDP growth rate has not exhibited trending behaviour that is discernible. The R&D expenditure has had a positive and significant trend over the entire sample period, while the unemployment rate peaked in the mid-1980s, and subsequently declined throughout the 1990s. These variables were found to be stationary processes.

4.   EMPIRICAL RESULTS

This section we estimate (using EViews 4.0) the econometric models of technological inventiveness (namely, the two patent activity variables) as a function of lagged inventiveness, the level of US R&D expenditure, the rate of growth in real GDP, the US unemployment rate, and the antitrust enforcement variables.

Figure 1c
U.S. Department of Justice
Criminal Antitrust Filings
1953-2000

As is standard practice, due to the potential departures from the standard assumptions, estimation of each of the models is undertaken by weighted least squares. The Newey-West (1987) heteroskedasticity and autocorrelation consistent (HAC) method is used to adjust for possible heteroskedasticity and/or serial correlation in order to yield robust and consistent estimates of the covariance matrix.

Equation (1) below was also estimated using a variety of count data models, which is discussed briefly in footnote 4. A simple dynamic model that provided an adequate fit to the stationary data is given as follows:

(1) Patent Success$_t$ = 20736 + 0.48 Patent Success$_{t-1}$ + 0.24 US R&D$_t$ + 643 Real GDP Growth$_t$ – 1991 US Unemployment Rate$_t$ + 308 Civil Antitrust Cases Filed$_{t-1}$

As can be seen in Table 1 below, we specified a range of models which included technological inventiveness activity, which can be measured as the number of total patent applications and the number of successful patent filings. These two models were then estimated with various specifications of the antitrust environment, including the total number of DOJ filings, and the numbers of civil case filings and criminal case filings.

Table 1: HAC Estimates of Innovation Variables with Antitrust Enforcement

Exogeneous Variable	Total Patent Applications	Successful Patent Applications	Logarithm of Total Patent Applications	Logarithm of Successful Patent Applications
Intercept	21138*	20736*	0.31	4.4*
Y(t-1)	0.76*	0.48*	0.96*	0.39
US R&D	0.24*	0.24*	0.028*	0.24*
Real GDP Growth Rate	585*	643*	0.002	0.017*
Unemployment Rate	-2425*	-1991*	-0.084**	-0.32*
Civil Antitrust Filings (t-1)	143*	308*	-0.021*	0.079*
Adjusted R^2	0.98	0.94	0.98	0.92

Note: Y(t-1) indicates the lagged dependent variable, * indicates statistical significance at the 5% level, and ** indicates statistical significance at the 10% level.

We also specified dynamic structures for the impact of the antitrust environment according to various lags. As indicated in Table 1, the results given in the simple dynamic model in equation (1) provide an adequate fit to the data. The best empirical model suggests that civil cases filed by the Department of Justice in Federal District Courts, lagged one period, have a positive and statistically significant impact on technological

inventiveness, as do R&D expenditure and the rate of growth in US real GDP[4].

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[4]   Interestingly, when we attempted to accommodate the "count" nature of the patent data by estimating poisson, negative binomial or exponential models by the maximum likelihood method, the civil filings antitrust variable continued to be robust in that it always had a positive and statistically significant impact on innovation.

When equation (1) was specified with criminal antitrust filings and total DOJ cases filed as explanatory variables, both were found to be weak exogenous controls for the variation in technological inventiveness. However, civil filings were robust in that they appeared to have a statistically significant impact in explaining variations in the patent activity variables, regardless of which patent variable was specified.

There are several possible factors leading to the apparent significant impact of civil antitrust case filings on technological inventiveness and consequently innovation. One explanation is that the prosecution of firms alleged to have broken antitrust laws may be construed as an important signal to the market. Such prosecutions send a deterrent signal to all agents that these unsatisfactory practices are not tolerated, which encourages them to seek legitimate ways of imposing their presence in competitive markets.

Growth in technological inventiveness activity through increased intellectual property is an indication of lawful behaviour, and has twin impacts on dealing with competition. First, it encourages capital formation and taking advantage of novelty and creativity. Second, it opens the route for cross-licensing of the patented technologies, and hence avoiding the penalties inherent in antitrust laws through legal means.

On the basis of these empirical results, civil antitrust filings are also seen as a mechanism for reinforcing the trustworthiness and power of the legal system, including the protection of intellectual property. The most significant finding from the analysis of the empirical data is that civil antitrust filings, which represent social values within American society, strongly encourage technological inventiveness and innovative behaviour that is the engine of economic improvement. The role of civil antitrust filings is more significant than either the number of criminal antitrust filings or the total number of antitrust filings by the Department of Justice.

CONCLUSION

This paper analysed the relationship between technological inventiveness (as measured by US patent activity) and the antitrust environment (as measured by the numbers of civil antitrust case filings, criminal antitrust case filings, and total US Department of Justice antitrust case filings). It was found that, after adjusting for other broad macroeconomic factors such as research and development expenditures and real economic growth, civil antitrust filings by the DOJ have a

statistically significant impact on the level of innovative activity.

Residual claimants of firms clearly understand the competitive landscape in which they operate such that, when the DOJ emits a signal to the market of robust enforcement intent, firms react by increasing their inventiveness. It might be expected that civil antitrust filings would have a stronger impact than criminal antitrust activity on innovative activity as the civil cases involve firms that play according to legal rules.

5. ACKNOWLEDGEMENT

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