SIEPR Discussion Paper No. 06-034

Trade Marks and Performance in UK Firms: Evidence of Schumpeterian Competition through Innovation

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Paper for the DIME Conference on Intellectual Property Rights for Business and Society, September 14th and 15th 2006

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August 2006

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Keywords: trade marks, market value, productivity, manufacturing, services

J.E.L Classification: O30, L60, L80

* The database developed for analysis in this paper was compiled by Mark Longland at the Oxford Intellectual Property Research Centre (OIPRC), St Peter's College, working with the authors and with an earlier collaborator, Professor Derek Bosworth. Funding was received at various times from the ESRC, the Leverhulme Trust and the UK Patent Office. The development of the database, to include more service sector firms, was undertaken with the support of ESRC award RES-334-25-0002 under The Evolution of Business Knowledge Programme. We are grateful to St Peter's College for accommodation and administrative support for this research. An earlier version of this paper was presented at the 11th International Schumpeter Society Conference, Sophia Antipolis, June 2006, and we are grateful to participants at this event for helpful comments.

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Abstract

This paper uses a novel data set of the trade mark activity of UK manufacturing and service sector firms to investigate whether applications for trade marks are suggestive of product innovation, improving the profitability and productivity of firms. Data on both trade (and service) marks sought via the UK Patent Office (UKTM) and the European Community Office for Harmonisation of the Internal Market (CTM) are available. There was rapid growth in trade mark activity during the period covered by the data (1996-2000).

We first analyse Tobin's *q*, the ratio of stock market value to the book value of tangible assets, as the market value of the firm should reflect the expected future return on intangible assets. We explore the impact of undertaking any trade mark activity and also the effects of increasing trade mark intensity among those who do. The results indicate that stock market values are positively associated with R&D and trade mark activity by firms. We find larger differences between firms with and without trade marks for services than for manufacturing. We also find bigger differences in Tobin's *q* when the services firm is applying for Community marks, rather than just applying for UK marks. Increasing the intensity of Community trade marking appears to raise market value for both manufacturing and services, but this relationship weakened over the 1996 to 2000 period.

The second part of this paper investigates the relationship between trade mark activity and productivity, using a value added production function. The results indicate that firms that trade mark have significantly higher value added than non-trade markers (by between 10% and 30% across all firms). Our interpretation is that trade mark activity proxies a range of other, unobservable, firm-level characteristics including innovation that raise productivity and product unit values. We also analyse whether greater trade mark intensity raises productivity growth. Higher trade mark intensity has some positive association with productivity growth in services, but the results are relatively weak for manufacturing firms.

These results seem broadly consistent with those derived using the market value approach, suggesting that stock markets are efficient in estimating the likely benefits of new intangible assets, and that managers were not just seeking trade marks to follow a management fad, but could expect to receive real returns from innovative activity leading to new products requiring trade marks. Even so, the marginal returns to extra trade marks per firm were diminishing quite rapidly over the period, as indicated by our exploration of the interaction of time trends with trade mark intensity.

In the final section of the paper we examine interactions between firms IP activity to explore the nature of creative destruction and simultaneous growth via innovation. We find that, in the short run, greater IP activity by other firms in the industry reduces the value added of the firm, but this same competitive pressure has later benefits via productivity growth and this is reflected in higher stock market value. This describes the Schumpeterian process of competition through innovation restraining profit margins while increasing product variety and quality.

1. Introduction

The Schumpeterian description of the process of competition differs sharply from the price competitive paradigm of neoclassical economics, positing the view that firms compete through innovation, bringing to market new varieties and better qualities of products. This competitive innovation process incorporates creative destruction, as last year's models are replaced by newer and more attractive options for consumers. By these methods firms attract and retain their customer base without necessarily engaging in a strong degree of price competition. In this paper we seek to explore this process using firms' applications for trade marks as an indicator of the bringing to market of new brands of both goods and services.

The trade mark is a form of intellectual property (IP) that has received relatively little attention from economists. This is surprising, given that in recent decades the number of applications (and grants) of trade marks are around twice that of patents and these types of IP are used extensively by service sector firms, which cannot generally apply for patents for their service products. Furthermore, trade mark activity has increased rapidly in recent years, with a particular boom in the late 1990s. The objective of this paper is to examine the role of trade marks using a new dataset of the trade mark activity of large UK firms (1996-2000). We seek to answer the questions posed in the title in a number of different ways.

First, the paper analyses the extent to which trade mark activity is correlated with firm performance. Using standard econometric methodologies, so as to allow comparisons with prior research on patents, we assess the links between trade mark activity and market value and productivity. Second, since patents and R&D are much more common activities for manufacturing firms, we ask whether trade mark data have any specific value in assessing the role of innovation in services. In this paper we shall use the term 'trade mark' to cover both trade and service marks and in our empirical analysis we include applications for both categories of marks in the counts.

The service sector is now much more important than manufacturing in developed economies, and yet knowledge of the process of innovation and its measurement in service firms is weak. The time period 1996-2000 is particularly interesting since it witnessed a rapid growth in trade mark activity. Our data on large UK firms show the number of trade marks applied for almost doubled over the period, while national statistics show rapid growth in UK, EU and US trade marking. By examining the returns to trade marks we seek to explore why this rapid growth occurred and whether it represent any true additional value to society.

The structure of the paper is as follows. We first analyse the impact of trade marks on Tobin's q, the ratio of market value to the book value of assets, to gain a view of the expected future return on trade marks. The market value of the firm should move to reflect any increase in expected future profitability of the firm as long as stock markets are well informed. However that evidence alone does not permit us to distinguish between a favourable stock market response to genuinely innovative activity and a degree of over-reaction to new information by investors, which is not correlated with an underlying increase in performance. By examining whether there is evidence of a rise in value added associated with trade mark activity, this paper aims to provide some empirical analysis of which of these viewpoints has, on average, more validity.

In the final section of the paper we examine interactions between different firms' IP activity to explore the nature of the process of creative destruction and simultaneous growth via innovation. Creative destruction will mean that in the short run, greater IP activity by other firms in the industry reduces the value added of the incumbent firm. However in the medium term, this same competitive pressure has benefits via greater productivity and market growth in innovating sectors and this should be reflected in higher stock market values. This describes the Schumpeterian process of competition through innovation increasing product variety and quality for customers.

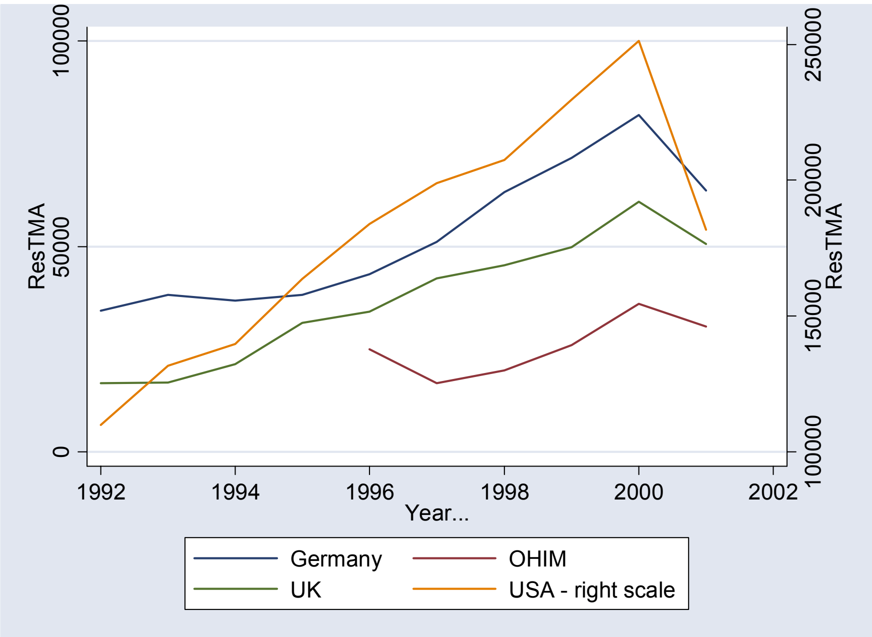
2. Background

2.1. Recent trends in trade mark activity

A trade mark is any 'sign' that can be used to distinguish a product or service. A sign can be any word(s), graphics, figures, images or similar that can act as a distinguishing feature. Trade marks can also be distinctive shapes, colours or sounds, although rather few such applications have been granted. For a UK company or individual there are two methods of obtaining trade mark protection in the UK. The cheapest method is to apply for a UK trade mark (UKTM) from the UK Patent Office. This will cost around 300 euros. An alternative route is to apply for a Community Trade Mark (CTM). The CTM was introduced in 1996 and is more expensive at around 2000 euros, but a CTM does cover all countries in the EU. In both cases the initial registration lasts for 10 years, at which time a renewal fee is payable (300 euro for UKTMs and 2500 for CTMs). Each trade mark application has to specify a class in which the trade mark is to be used. Multiple classes per single application are allowed, although there is a surcharge for more than three classes. Applications for trade marks are examined and then published, allowing a period of time for others to object, before full registration.[1]

Figure 1 shows trade mark activity for domestic resident trade mark applications made at the UK, German and USA offices and, in addition, the numbers of applications for the new Community trade mark (at the Office for the Harmonisation of the Internal Market, OHIM). Applications to OHIM could come from any country and, as seen, only began in 1996. As is clear, the initial year of the CTM shows a spike, as firms were allowed to convert existing national trade marks into CTMs. By way of comparison, the comparable figures for the total numbers of resident EPO patent applications are around half of the trade mark levels.

Figure 1 Trends in trade marking



[1] Some trade mark applications are not registered due to invalid claims or oppositions. The UK Patent Office currently states that around 90% of trade mark applications are registered within 8 months (http://www.patent.gov.uk/tm/howtoapply/faq.htm). For Community trade marks, out of the 57,373 applications in 2000 there were 11,495 oppositions. Assuming half of oppositions resulted in registrations the approximate success rate is 90% also. The delay in getting a Community trade mark appears somewhat longer that a UK patent at around 15 months (based on 2004 data at http://oami.eu.int/en/office/stats.htm).

2.2. *The economics of trade marks*

It is useful to provide a very short overview of the various conceptual views of the role of trade marking. The first, and probably most dominant of these views on trade marks and performance, stems from Landes and Posner (1987).[2] Their basic argument is that trade marks have value since they help to solve the information asymmetry between seller and buyer: firms use trade marks to signal to consumers that the product is of a certain, consistent quality. In this way the 'search costs' of customers are reduced, the firm can charge a higher price, and the firm's profits increases. These types of models imply that there should be a positive association between the *stock* of trade marks a firm has and profitability. Furthermore, this view suggests that the rapid growth in trade mark activity in the late 1990s originated in a worsening of the informational asymmetry faced by consumers. To our knowledge there is not a literature that is concerned with *trends* in the extent of information asymmetry, but the discussion surrounding the economics of information and the Internet suggest that the extent of asymmetry could change (see Varian et al, 2004).

Although this basic argument from Landes and Posner (and others) is static, the models do highlight that trade marks may encourage firms to increase investment in improving the quality of their good(s). Viewed in this way, trade mark activity can be viewed as an element in the process of innovation. This suggests that trade marks can be a proxy for innovative activity, something that has been stressed by Mendonca et al (2004). In this paper they call for further attention to the use of trade mark data as a potential proxy for innovation. Thus, a second view of trade marks is that they proxy innovative effort, in the same way that R&D or patent data also proxy innovative effort. Clearly, in this case it is the current trade mark activity (i.e. a 'flow'), rather than the stock of trade marks held by a firm that is the relevant proxy.

Although the existing literature on trade marks tends to stress the benefits in terms of reducing information asymmetries, there is a further possibility that stems from the theoretical industrial organisation literature on brands, entry and barriers to entry. A traditional argument is that firms may use product or brand differentiation as a strategic barrier to entry by incumbents.[3] Theorists are interested in whether there is over- or under-provision of brands and products in terms of societal welfare, with the

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[2] A recent discussion of trade marks, included some information on US aggregate data, is in Landes and Posner (2003).

[3] Classic articles include Schmalensee (1978) and Shaked and Sutton (1982), but reviews are contained in modern textbooks (Tirole, 1988, Cabral, 2000).

result tending to depend on specific demand and (fixed) cost assumptions (e.g. Perry and Groff, 1986). From this perspective, the rapid rise in trade mark activity in late 1990s, although potentially beneficial to incumbent firms, is unlikely to be benign for society.

A final view of trade marking is simple that it has little inherent value but reflects how management practices, and fashions, change. To fix ideas, we shall call this the 'management fad' view. It is possible that the increased use of trade marks is largely due to changing management practices and, specifically, a rush by managers to copy rivals' activities, rather than any inherent value relevance for trade marks per se. Such a view also raises concerns over the possibility of reverse causation: managers of high productivity firms may have more discretionary funds and allocate some of these to copying the latest management fad. The empirical analysis can use lagged values of trade mark activity as a method to control for such endogeneity.

2.3. Data

The data for empirical analysis comes from the Oxford Intellectual Property Research Centre (OIPRC) database. This contains financial data on around 1,600 large UK firms to which information on IP activity has been matched. Most firms in the database have subsidiaries, hence to provide an accurate measure of their (consolidated) IP activity the parent and subsidiaries names were matched against the trade mark application name. The data appendix contains further details of this process and the nature of the database.

Table 1 Trade mark propensity and intensity

Sector	Percentage of firms trade marking			Trade marks per 1000 employees	
	UK TM	CTM	Both	UKTM	CTM
Agric., Mining	9.46	7.43	4.05	1.17	2.09
Manufacturing	41.64	33.18	23.83	33.57	10.46
Electricity, Gas, Water	51.4	27.1	25.23	6.92	1.99
Construction	25.52	6.77	5.73	1.88	1.03
Service sectors					
Finance	27.6	12.5	10.42	42.79	14.4
Real Estate	12.5	5.47	2.34	2.32	28.1
Wholesale	35.94	22.92	15.1	12.84	15.47
Retail	54.71	24.14	20.46	10.29	6.76
Hotels/Catering	44.74	13.68	11.58	23.25	268.51
Transport/Comm.	49.24	34.47	25.76	21.14	13.41
Business Services	29.17	19.68	12.07	52.14	43.42
Other Services	31.56	16.1	10.95	82.67	81.49

Notes: The table shows summary statistics for the 5283 observations in regression sample [1] in Table 2. The percentages and intensities are calculated direct from observations (i.e. all firm-year observations).

A detailed discussion of the trade mark data is contained in Greenhalgh and Rogers (2005a), but Table 1 contains some basic summary statistics. The table shows the average percentage of firms that trade mark in each year (1996-2000). Note that the propensity to trade mark varies substantially across sectors. The retail sector has the highest propensity to apply for UK trade marks (55% of firm-year observations), whereas only 12.5% of firms in real estate do so. Even so, service sector firms in several sectors are as active as manufacturing firms in UK marks. The propensity to apply for a CTM is lower than that for UKTM in all sectors and somewhat lower in services than in manufacturing. The last two columns of the table show the mean trade marks per year per 1000 employees. Again there are some very large differences in mean values across sectors.[4] In the analysis below an initial distinction is made between the full sample of firms (all sectors shown in Table 1), the manufacturing sector, and the service sector (all eight sectors including and below 'finance' in the table).

3. Trade mark activity and market value

3.1. Empirical specification

This section uses the data on the market value of a firm to assess the importance of trade mark activity. Theoretically, the market value is the expected value of future profits of the firm and has been used extensively in studies on innovation and performance (see Hall, 2000).[5] The starting point for many empirical studies on innovation and market value is Griliches (1981). This assumes that the market value (*V*) of the firm is given by

$$V = q(A + \gamma K)^{\sigma} \qquad [1]$$

[4] The 'hotels/catering' sector has a high mean value due to the presence of a firm called Chorion PLC. Information on this company in 2005 shows it to be a company that manages and owns brands, which accounts for its high trade marking. However, the financial data from Company Analysis classifies it as a 'drinking establishment' in 1996-2000. The influence of this firm on the regression results has been checked throughout the paper and, despite its high values, it does not have a notable effect on results.

[5] The possibility that share prices may deviate from the expected, discounted value of future dividends (profit distributions) has been investigated extensively in the finance literature (e.g. Froot and Obstfeld, 1991, Campbell and Kyle, 1993). Although these papers tend to focus on the possibility of aggregate stock market bubbles or mis-alignments, it is possible that such bubbles are sector-specific. In any event, the empirics below control for such a possibility by including time period dummies in regression analysis and by analysing whether relative valuations for trade mark activity varied over time.

where A is the book value of total tangible assets of the firm, K is the stock of intangible assets not included in the balance sheet, q is the 'current market valuation coefficient' of the firm's assets, σ allows for the possibility of non-constant returns to scale, and γ is the ratio of shadow values of intangible assets and tangible assets (i.e. $\frac{\partial V}{\partial K} \Big/ \frac{\partial V}{\partial A}$). Taking natural logarithms of [1], and using the approximation $\ln(1+K/A) \approx K/A$, [1] can be rearranged to

$$\ln V = \ln q + \sigma \ln A + \sigma\gamma \frac{K}{A} \qquad [2]$$

Note that the approximation becomes poorer the larger the value of K/A. The difficult problem for empirical studies is how to proxy K – the stock of intangible assets accumulated by the firm. Interpreted broadly, 'intangibles' can be related to brand names, process or product innovations, advertising, managerial skill, human capital in the workforce and other aspects of the firm. Although balance sheet data do, at times, contain a book value (accounting) value for intangible assets, there is widespread agreement that this vastly underestimates the true stock of intangible assets of the firm (see Data Appendix). As such, many studies of manufacturing firms use R&D expenditure (R) as a proxy for K, as this may be a good proxy for process and product innovations (e.g. Hall, 1993). Other studies use patents as a further proxy for such capital (e.g. Cockburn and Griliches, 1988).[6]

While R&D and patents may be appropriate for manufacturing firms, service sector firms have much lower levels of R&D and patents. It is also clear that intangible assets are extremely important to many service sector firms. This paper analyses whether trade mark activity can be used as a proxy for K or, put differently, does trade marking affect the valuation of a company? As has been noted, the approximation used to obtain [2] may be problematic, hence the empirical analysis also tests for the significance of a quadratic term for trade mark activity.

There are relatively few previous studies that use trade mark data in this way. Bosworth and Rogers (2001) analyse Australian firm data in the mid-1990s but do not find a significant role for trade marking.[7]

[6] A review of these studies is contained in Hall (2000); a more recent empirical paper with further references is Hall and Oriani (2004).

[7] Greenhalgh and Longland (2001) analyse the impact of trade marking on wages and job creation in manufacturing firms. They found that trade marks had an impact in increasing wages in a model including firm fixed effects, suggesting some sharing of the revenue gains from trade marks.

A more recent study of 300 Australian firms observed from 1989-2002 by Griffiths and Webster (2004) found that the stock of trade marks was a significant determinant of market value, but with a smaller impact than either patents or registered designs; even so the value of a trade mark was rising over this period. Seethamraju (2003) analyses the value of trade marks in 237 US firms from selected industries in 1993-97, finding a positive role for trade marking on sales and also market values. The limited amount of analysis of the most common form of (registered) intellectual property right appears an anomaly, an issue also raised by Medonca et al (2004).

For empirical analysis, equation [2] is modified to the following form,

$$\ln\frac{V_{it}}{A_{it}} = \alpha_j + \alpha_t + (\sigma - 1)\ln A_{it} + \sigma\gamma\frac{R_{it}}{A_{it}} + \alpha_{TM}\frac{TM_{it}}{A_{it}} + \mathrm{X}_{it}\beta + u_{it} \qquad [3]$$

where i indexes a firm, j an industry and t a year; thus α_j and α_t are sets of industry and year dummies, R represents R&D expenditure, and TM represents trade marks. Note that the dependent variable is now the ratio of market value to tangible assets, which is commonly referred to as Tobin's q. The matrix X_{it} is a set of other control variables (defined below) and u_{it} is a standard error term. Note that [3] allows ln$q$ from [2] to vary across industries (the α_j) and over time (the α_t). Although [3] shows the influence of trade marking being dependent on a ratio (i.e. trade marks per tangible assets), the empirics below start with an analysis of a dummy variable for 'trade markers' versus 'non-trade markers'. Equally, the data contains both UK and Community trade mark data, which are considered separately.

The control variables, represented by the matrix X in [3], include dummy variables for being highly diversified, and for whether the firm has sales in Europe or North America, the sales growth of the firm, the debt to equity ratio, and the book value of intangible assets. These variables are described in more detail in the Data Appendix. In the current context, a key rationale for including these variables is to minimise the possibility that the trade mark variables are picking up the effects of increasing firm size, diversification or internationalisation, all of which may be attractive to shareholders.

3.2. Empirical analysis of market value

As the previous section indicates, there are various ways of using the trade mark data to assess its potential association with market value. Table 2 gives a range of specifications to explore this association. The first column uses trade mark activity dummy variables to look at the difference in market valuations between those firms that do apply to register trade marks and those that do not. This simple, dichotomous distinction is deliberately crude. It is clear that firms that trade mark may also have a range of other characteristics that are different from non-trade markers, and it may not be possible to control for all of these in the regression analysis. For example, some firms may have better managers that raise the expected (relative) profit and hence the market's valuation of the company. Since better managers may be more likely to use intellectual property, including trade marks, it is clear that the dummy for 'trade markers' could capture managerial ability. This example serves to remind us that it is often highly difficult to isolate the impact of one variable in complex situations; indeed, it is probably better to accept that generating value within a firm is the result of many factors acting in unison. Given this, the analysis of trade markers versus non-trade markers provides an extreme, upper bound on the value of trade marking.

Further regressions in columns 2 to 4 analyse the role of trade mark *intensity* for the full sample and for two sub-groups of manufacturing and services firms. Intensity is defined as trade marks per million pounds of tangible assets (i.e. the ratio shown in equation [3]). The use of trade mark intensity controls for the fact that large firms often have more trade marks than smaller firms. The results indicate whether variations in trade mark intensity affect market valuations. This can be viewed as a stronger test of the value of trade marks. However, as indicated above, differences across firms in trade mark intensity may proxy other firm characteristics, including a firm's general innovative activities, such as marketing expenditure or advertising. This means the coefficient estimates cannot be interpreted as a purely trade mark intensity effect.

There is a further potential problem with analysing the CTM data, since CTMs have only been available from 1996. Given this, many firms made a burst of applications in 1996, presumably including a large number of existing national trade marks, hence the first or second year of CTM applications may be atypical (see Greenhalgh and Rogers, 2005a). To explore these effects we examined a range of specifications using simple time dummies, suppression of particular years from the sample, and time trends interacting with specific variables to generate time varying returns to trade marks. In Table 2, columns 5 and 6 report the results for interactive trends.

Before turning to these detailed results for trade marks, we note that the results on the other control variables in Table 2 are generally in keeping with existing studies. The coefficient on ln(assets) is close to zero (constant returns), but it is significantly negative, suggesting that firm size does not greatly affect the Tobin's q ratio, but there are small diminishing returns to scale. The coefficient on R&D intensity is positive and significant across all three samples, although much larger for manufacturing. Firms that have sales in the US have higher q values and the positive coefficient on the growth of sales variable suggests that the stock market also places a premium on fast growing firms (note that all the regressions also contain 2-digit industry dummies that will control for industry-wide differences). The positive coefficient on the intangible assets ratio is as expected, but the fact that the coefficient is often well below one implies that the 'book value' of intangibles is a poor guide to the actual market value of this accounting entry.

3.3. Trade markers versus non-trade markers

Table 2 columns 1 to 4 shows two regression results for the full sample of firms, and further results for the manufacturing and service sector sub-samples.[8] In each case three dummy variables are entered to capture the potential impacts of trade mark activity. The first dummy variable shown equals one if the firm *only* filed for one or more UK trade marks in the year. The second dummy equals one if the firms is *only* a Community trade marker. The final dummy variable equals one if the firms filed for *both* a Community and UK trade mark in a given year. The creation of a dummy variable for firms that apply for both UK and Community trade marks is done as we do not wish to assume *a priori* that the gains from trade mark activity in both domains is the simple sum of the gains from applying via each route separately. With this parameterisation we can test whether this is the case or not. There is certainly substantial overlap within the data (for example, out of firms that applied for a UK trade mark around 44% also applied for a Community trade mark in the same year). The dependent variable for all regressions is Tobin's q (the natural log of tangible assets is included as an explanatory variable as a direct test of $\sigma = 1$).

As can be seen, all the coefficients on all trade marker dummies are highly significant in the full sample and in the service sector, with magnitudes varying from 0.22 to 0.52. In economic terms, the coefficient of 0.221 for UK marks for all firms implies that the Tobin's q of a services trade marker is around 25% higher than that of an equivalent inactive firm, while the coefficient of 0.503 for service firms active in both Community and UK marks raises q by 65%.[9]

The manufacturing sub-sample shows positive, but insignificant, coefficients on the Community and UK only trade mark dummies, but a positive coefficient of 0.207 for firms that use both trade marking routes (or a 23% gap in q in a given year). Thus trade mark activity creates greater differences between firms in services than in manufacturing in this period. Nevertheless, what is recorded here is new applications and

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[8] The split into manufacturing and services is justified by statistical tests. Using tests of the difference between coefficients across samples using dummy variable interactions shows that the coefficients on, for example, the Community, UK and 'both' trade mark dummies, the log of assets, and the R&D ratio are all different across service and manufacturing at the 1% level.

[9] The coefficient represents the difference in natural logs between trade markers and non-trade markers (i.e. $\ln q_{tm} - \ln q_n = \ln(q_{tm} / q_n) = 0.221$, hence $q_{tm} / q_n = e^{0.297} = 1.247$).

clearly most manufacturing firms will have a stock of historically registered trade marks, so for this reason the differences between firms due to recent activities are attenuated.

3.4. Intensity of trade marking and value

A second test of the influence of trade mark activity is to use the specification shown in equation [3], which hypothesises that the ratio of trade marks to tangible assets is the relevant explanatory variable[10]. Both Community trade mark and UK trade mark intensity ratios are included in the models reported in Table 2 cols. 2-4.[11] As has been discussed above, the fact that Community trade marks only started in 1996 means that the activity of some firms in that year may have been high. In terms of our empirical analysis, we can check the robustness of the results with and without 1996 in the sample.

The full sample results and the separate manufacturing and services analyses (Table 2, Col. 2 to 4) initially show no significant partial association between trade mark intensity and market value, although it is still the case that firms acquiring some trade marks have higher market values than inactive firms. However the investigation of time-varying impacts of trade mark intensity indicates that for Community trade marks there were initially positive effects on Tobin's *q*, but these were eroded as shown by negative trends in the coefficients, reflecting a reduction in the perceived benefits to increasing trade mark intensity during the period. Given that there was such a rapid rise in trade marks during the sample period, then on normal economic expectations this would imply that the marginal return to further trade marks would be declining. In addition there was a boom and bust associated with the 'dot-com' bubble of this period, which would have impacted on some service providers.[12] Interestingly, we found no evidence to suggest increasing returns to Community marks at the start of the period, which would have occurred if

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[10] In fact the derivation of [2] and [3] from [1] uses an approximation that is less accurate as the ratio of intangible to tangible assets increases. Given this, we also estimated a model with a quadratic term for trade marks to assets but we found in these versions that the coefficient on the quadratic term was insignificantly different from zero; hence these were removed from the set of explanatory variables.

[11] The correlation coefficient between Community trade mark intensity and UK trade mark intensity is 0.08 for the full sample, hence we do not feel that multi-collinearity is likely to be an issue. This said, regressions entering only Community trade marks and only UK trade marks have been run and the results are similar to Table 2.

[12] Omitting observations for the year 2000 makes both the UK and CTM intensity measures positively significant for services firms. In contrast, omitting 1996 made no difference to the significance of the CTM variable, although it does make the UK intensity variable significant in manufacturing, although there is no obvious interpretation of this

the initial 1996 registrations were inflated by marks already in use and so were adding less novelty value to the stock of intangible assets.[13]

4. Productivity and trade mark activity

4.1. Empirical specification

The advantage of the analysis in the previous section is that market value is a forward looking measure of performance. The disadvantage is that it relies on 'efficient markets' and can only be conducted on firms that are quoted on stock markets. This section investigates the link between trade mark activity and performance using data on value added. Specifically, the analysis investigates associations between trade marking in the current year and value added levels and growth rates in a subsequent year. Again, in order to aid comparisons, the methodology will be standard.

The first key relationship of interest here is the link between the firm's current net output, or value added, and its investment in intangible assets, or equivalently investment in knowledge. We can represent these ideas using a production function such as:

$$Y = AL^{\alpha_1}K^{\alpha_2}. \qquad [4]$$

Where *Y* is value added, *L* is labour (total employment), *K* is stock of tangible capital and *A* is a scalar representing knowledge. There is a large range of factors that affect the level of knowledge in the firm. The most commonly used proxies in empirical analysis are expenditures on R&D, patenting activity, spending on training or human capital measures, and data on information technology (IT) investment. The vast majority of analyses on production functions such as [4] are conducted on firms in the production sector and, within this, focusing on manufacturing. It is firms within this sector that traditionally invest in machinery and equipment and R&D, as well as being able to patent innovations. Empirical studies on service sector firms are less common. To encapsulate ideas, let us assume that *A* depends on,

$$A = f(R, P, HK, IT, TM) \;, \qquad [5]$$

where *R* is R&D, *P* is patenting, *HK* is human capital, *IT* is informational technology and *TM* is trade marking. Clearly, one main focus of this study is to analyse whether trade mark data can be used as a proxy for *A*, especially for service sector firms.

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[13] The results relating to increasing intensity of trade marking are all very sensitive to the inclusion or exclusion of a small number of outlying observations.

There is a tendency to think in terms of a rise in *A* as reflecting increasing production efficiency, via process innovation, when using this production function approach. However it is equally valid to envisage a rise in *A* as reflecting increasing product quality. A major feature of innovation by firms is that of product innovation, through the supply of new brands with superior characteristics. By such means firms hope to achieve a greater degree of product loyalty and thus to be able to set higher prices relative to costs. Higher sales will also aid capacity utilisation, assisting productivity directly. Given that our measure of *Y* is firm level value added, deflated by a measure of industry-specific but not firm-specific price, any degree to which the firm has increased its product quality and customer loyalty, and is thus able to raise its average unit value, will be captured in the measure of net output.

Various other practical issues need to be tackled in order to empirically implement equation [5] (see Greenhalgh and Rogers, 2005c, for a more detailed discussion); here we focus on trade mark data. A basic approach to the functional form of [5] is to construct indicator (i.e. dummy) variables for trade mark activity, as used above in the analysis of market value. The advantage of this approach is it provides a basic test of trade marking being associated with higher value added. The disadvantage is that trade marking could be correlated with a range of other (unobserved) firm-level characteristics, hence any association found is difficult to interpret. An alternative is to use the trade mark data in a more explicit functional form. In this paper we assume that the functional form of [5] is given by

$$A = R^{\beta_1} P^{\beta_2} TM^{\beta_5} \quad , \qquad [6]$$

which is a standard assumption (note that the exponents represent elasticities). Note that *IT* and *H* are absent from [6], since in this paper we have data for tangible assets, employment, R&D, patents and trade applications, but not for human capital or *IT* investment (although some *IT* investment will be included in tangible assets, *K*). Let *i* index a firm and *t* a year. Substituting [3] into [2], taking natural logs, and assuming that *H* and *IT* can be represented by a firm specific, time invariant effect (η_i), and adding an error term (u_{it}), yields

$$y_{it} = \eta_i + \alpha_1 l_{it} + \alpha_2 k_{it} + \beta_1 r_{it-1} + \beta_2 p_{it-1} + \beta_2 tm_{it-1} + u_{it} \quad , \qquad [7]$$

where the lower case represent logarithms. The error term can be thought of as having two components: $\mu_{it} + \varepsilon_{it}$. We define ε_{it} as measurement error in the data (created either by accounting issues or collection errors). The μ_{it} is a ‘shock’ experienced by, and known to, the firm, but not to the econometrician. If not controlled for, the presence of μ_{it} can bias estimates if it is correlated with the explanatory variables.

Specifically, there is a literature that shows how the 'shocks' (the μ_{it}) will affect the optimal choices of variables inputs.[14]

Our initial regression specification is based on [7] and uses the data as a cross section. Clearly this allows η_i and μ_{it} to enter the error term, which may result in biased coefficients. Nevertheless, the cross-sectional specification – or productivity levels specification – allows insight into the basic associations within the data. A more sophisticated analysis of [7] requires either fixed effects or first differencing, both of which would remove the firm specific effect. However, a fixed effects model may antagonise the simultaneity bias from $\mu_{it.}$ In addition, fixed effects are problematic since we do not have stock data on trade marks. Taking first differences of [7] yields

$$\Delta y_{it} = \alpha_1 \Delta l_{it} + \alpha_2 \Delta k_{it} + \beta_1 \Delta r_{it-1} + \beta_2 \Delta p_{it-1} + \beta_5 \Delta tm_{it-1} + \Delta u_{it} \ , \qquad [8]$$

which removes the fixed effects but still leaves us with first differences in the (logs of) trade mark stocks (and also R&D and patent stocks). A standard solution to this problem is to use the following (omitting the *i* index),

$$\Delta tm_{t-1} = tm_{t-1} - tm_{t-2} = \ln\left[\frac{TMA_{t-1} + (1-\delta)TM_{t-2}}{TM_{t-2}}\right] = \ln\left[\frac{TMA_{t-1}}{TM_{t-2}} + (1-\delta)\right] \approx \frac{TMA_{t-1}}{TM_{t-2}} \quad [9]$$

where TMA_{t-1} is trade mark applications in year t-1. The approximation for the last step in [9] is better the closer δ is to zero.[15] Also note that β_5 is an estimate of the elasticity of output with respect to trade marks (dY/dTM x TM/Y), hence we can re-write [8] as

$$\Delta y_{it} = \alpha_1 \Delta l_{it} + \alpha_2 \Delta k_{it} + \rho_1 \left[\frac{R\&D}{Y}\right]_{it-1} + \rho_2 \left[\frac{PA}{Y}\right]_{it-1} + \rho_5 \left[\frac{TMA}{Y}\right]_{it-1} + \Delta u_{it} \qquad [10]$$

where the ρ's represent marginal returns.[16] This empirical specification estimates the association between growth of value added and innovation intensity, as proxied by the ratio of R&D, patent application and

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[14] An important paper is Olley and Pakes (1996). Recent papers discussing their methodology and recent developments include Bond and Soderbom (2005) and Ackerberg and Caves (2004). This literature suggests that labour will be the variable factor, while capital (at time *t*) will not be influenced by ε_{it}.

[15] The δ is the depreciation rate on the stock of trade marks (or other proxy for *A*). Legally, a trade mark can be renewed indefinitely (as long as it does not become a 'common name in the trade'), implying δ is zero, but the economic rate of depreciation is likely to be positive as products lose their market appeal.

trade mark application to value added. Although we have analysed intensities with respect to value added (see Greenhalgh and Rogers, 2005c), in the empirics below we define the intensities with respect to employment, not value added, in order to minimise the correlation between the intensity variables and the equation error term.

A further issue to be considered prior to the empirical analysis is whether the data should be filtered. Some papers explicitly discuss how the data was 'cleaned' prior to analysis. For example, Hall and Mairesse (1995), on a study of R&D productivity at the firm-level, 'clean' their data by removing outliers in both growth rates and levels. Similarly, Los and Verspagen (2000) omit any firm with a year-on-year sales growth of greater than 80% (in any year of sample). In our analysis we have found that 'cleaning' the data dramatically improves the estimates in the first difference specification, while it has little effect on the pooled, cross-sectional estimators. Hence, for the first difference regression analysis, this paper follows Hall and Mairese by omitting observations that exhibit year-on-year growth of value added less than minus 90% and greater than 300% (the cut-offs for labour, capital and R&D growth are minus 50% and 200%). However, we do not systematically remove any observations based on trade mark (or patent) values, although we do investigate whether specific results are driven by outliers.

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4.2. *Trade markers vs. non-trade markers*

The results from the firm net output regressions (estimating equation [7] directly) are shown in Table 3. The dependent variable is the log of value added. The capital and employment terms are lagged one period, as are the trade mark and patent dummy variables.[17] The coefficients of tangible fixed assets, employment, the book value of intangible assets, R&D incidence and R&D intensity are all correctly signed and significant, with the exception of R&D in services, which is reported by very few firms. We shall thus focus on the findings for trade marks, beginning with the results for the incidence of some trade mark activity.

To recap, it is probably not valid to interpret the dummy variable coefficients as causal, since trade mark activity is an indicator of other innovative activities, but despite this caveat, the results are thought

[16] Note that the exact derivation of [8] means, for example, the trade mark term is dY/dTM x TMAt-1/Yt-1 x TMt-1/TMt-2, (i.e. the last term does not cancel). This further approximation – and bias in estimate of rate of return – is ignored in the literature.

[17] For reference, the results using the contemporaneous trade mark dummies are very similar in significance and magnitude, suggesting that reverse causation is not a concern and that there is persistence in trade mark activity.

provoking. The coefficients on the dummy variables for trade mark activity show a large productivity premium for firms that apply for trade marks. For example, for service firms that applied for both UK and Community trade marks in a given year, their value added is around 47% higher than other firms. The premium for manufacturing firms that seek both UK and Community trade marks is lower (at 16%) than that for services. Manufacturing firms that are solely UK trade marking show no significant premium; in contrast, service firms that only acquire UK trade marks show a significantly positive productivity premium. The reverse is true for firms in these two sectors that are only registering Community marks. Note too that for both sectors the coefficient for engaging in both types of activity remains above the sum of the coefficients of solely one activity for all regressions, suggesting some added impact of being active in both.

Each of these findings relating to the trade mark activity dummy variables is robust to changes in the specification reflecting the inclusion or not of trade mark intensity and time trends. The results on the trade mark intensity measures are generally weak: the only significant coefficient is on UK trade mark intensity in the manufacturing sample. The last two columns in Table 3 show tests for time trends in the effect of intensities, with the results indicate no significant trends over the 1996 to 2000 period. Further analysis (not shown) has analysed the possibility of a trend excluding 1996 data, and then 2000 data. Overall, the results are basically the same. The exception is that the 1996-1999 data show a positive trend in the returns to community trade mark intensity in manufacturing.

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4.3. Productivity growth and trade marking

The section provides results for the specification shown in equation [10], although intensities are defined with respect to employment. This specification is concerned with any relationship between the growth of value added and the growth of labour and capital, as well as the intensity of trade mark activity. Specifically, equation [10] links trade mark intensity in the previous year with growth over the subsequent year. Running regressions using this specification we found that the coefficients on trade mark intensity, both UK and Community, were almost always insignificant. This led us to consider various other specifications. Table 4 shows the results from using the t-2 value of trade mark intensity and growth over the current period. This lag structure appeared to be the most successful, although as can be seen many of the coefficients are still insignificantly different from zero. As can be seen, the main result is the intensity of Community trade marking has a positive association with productivity growth in services (although when we allow for a trend this is not confirmed). UK trade mark intensity appears only to have an effect when we allow for a trend in the coefficient, which indicates a declining impact. As can be seen from the last row in table 4, the industry dummies are not significant in the manufacturing and services sub-sample regression. However, omitting the industry dummy makes little difference to the results on trade mark variables, although the positive coefficient on UK trade marks in manufacturing is now significant at the 10% level.

These results have been checked in various ways including: entering UK and Community trade mark separately; omitting high values of trade mark intensity; removing the year 2000 and 1996 from the data; and, using a quadratic term for trade mark intensity to assess any non-linear relationship. The main result from these is that entering the trade mark intensity variables separately does suggest a positive association in manufacturing, in contrast to the results shown in Table 4 for manufacturing.

5 The impact of industry IP intensity on individual firms

5.1. Empirical specification

We now turn to examination of the interaction between firms in the creation of new product varieties. In Schumpeterian mode, the description of the innovation process as one of 'creative destruction' acknowledges that there are individual gainers and losers within a competitive innovation process that is ultimately beneficial for society. While innovation by the firm is beneficial to its performance, rapid innovation by other firms within the product group or sector diminishes the firm's ability to profit from its own recent innovations in the short run. Just as a product innovation improves the size and loyalty of the firm's customer base, simultaneous introduction of new varieties by competitor firms will tempt these customers to defect to other firms' products. Nevertheless, this Schumpeterian competition for market share through innovation, reflected in IP activity, is likely to raise the productivity and profitability of all firms in the sector in the medium run, for example by raising the ability of the sector to compete in world markets for traded goods and services, or by satisfying a growing customer base for the expanding range of products.

In our analysis so far we have explored three measures of firm performance: Tobin's *q*, value added and productivity growth. To explore the impact of other firms' competing innovations, we now revisit each of these empirical equations to augment the explanatory variables with measures of the 'IP competition' within the sector. These measures are computed at the SIC 4-digit level as follows: for each firm and year, the trade mark or patent activity is summed for all other firms except the firm under observation. The resultant measure of IP intensity of other firms in the sector is obtained by a similar summation of the denominator scaling variables (SV), either assets or employment in these other firms, followed by the computation of the intensity ratio. The resultant measure of industry IP intensity (IIPI) is thus as follows:

$IIPI_{it} = \Sigma_j IP_{jt} / \Sigma_j SV_{jt}$ for all $j \neq i$ firms within the 4-digit SIC

Given the ideas of the Schumpeterian process of creative destruction and our earlier proposition that trade mark applications are proxies for the release of new product varieties, then entering (lagged) IIPI for trade marks in equation (7), which estimates the determination of value added in relation to (lagged) firm IP, might be expected to yield a negative coefficient. This would reflect the inability of the firm to maintain such a strong degree of customer loyalty to its new product variety in the face of parallel innovative activity by competitor firms. Such a finding would allay fears that the use of trade marks by firms is an anti-competitive device which contributes to high profits for incumbent firms. Taking the long view that this dynamic competitive process, of competition through innovation, raises productivity growth and improves long run profitability, the IIPI variables might rather exhibit positive coefficients in either the productivity growth equation or the Tobin's *q* market value regression.

In investigating patent publications by competitor firms, some other patterns of interaction may emerge. Patents are more likely than trade marks to be complementary assets, opening up prospects for cross-licensing agreements in many sectors. In this case positive spillovers may be observed even in current value added, leading to positive coefficients when industry patents are included as explanatory variables in any of the three performance equations.

5.2. Empirical results for industry IP activity

The analysis of current value added (presented in Tables 6a, 6b) shows that firms are generally engaged in a Schumpeterian competition with regard to new trade mark and patent applications, as higher industry IP activity reduces the firm's value added following the model of creative destruction. (Although European patents appear to exhibit positive spillovers in manufacturing, this result is strongly driven by outliers; re-estimation after trimming out the top 1% of observations on the industry patent variable reduces this to a negative but insignificant value.)

Table 6a - Impact of other firms IP activity on the single firm

– industry trade marks and firm value added (coefficients and t ratios)

Industry IP intensity	UK trade marks	Community trade marks
Full sample (6421)	- 0.67 (- 1.86)*	- 0.35 (- 1.85)*
Manufacturing (2073)	- 1.52 (- 2.00)**	- 0.42 (- 1.32)
Services (3783)	- 0.75 (- 1.73)*	- 2.94 (- 1.95)*

Notes: The industry IP intensity variable is the ratio of industry trade marks to industry employment, excluding the firm of observation. Industry trade mark variables have been added one at a time to the specification of Table 3, col.1. For the manufacturing sample the industry patent variables are also included.

Table 6b - Impact of other firms IP activity on the single firm

– industry patents and firm value added (coefficients and t ratios)

Industry IP intensity	UK patents	European patents
Full sample	- 8.22 (- 1.54)	- 6.14 (- 2.49)***
Manufacturing	- 0.87 (- 0.17)	4.13 (2.02)**

Notes: The industry IP intensity variable is the ratio of industry patents to industry employment, excluding the firm of observation. Industry patent variables have been added one at a time to the specification of Table 3, col.1, and the industry trade mark variables are also included.

In contrast to the short run competitive effects on value added, the impact of industry IP variables on productivity growth and on stock market value is almost uniformly non-negative. Focusing first on productivity growth (Tables 7a, 7b), the competitive pressure of high rates of trade marking in the industry is significantly positive for manufacturing productivity growth. This supports the idea of productivity improvement arising from the Schumpeterian competition among firms bringing new brands of products to market. However these effects are smaller and much less significant in services. The pressure of industry patenting has weaker and more divergent effects: positive although not strongly significant for UK patents and negative but insignificant for EPO patents.

Table 7a - Impact of other firms IP activity on the single firm

– industry trade marks and firm productivity growth

(coefficients and t ratios)

Industry IP intensity	UK trade marks	Community trade marks
Full sample (3177)	0.24 (1.13)	0.59 (1.68)*
Manufacturing (1093)	1.73 (1.75)*	0.71 (2.10)**
Services (1815)	0.15 (0.85)	0.64 (1.06)

Notes: The industry IP intensity variable is the ratio of industry trade marks to industry employment, excluding the firm of observation. Industry trade mark variables have been added one at a time to the specification of Table 4, col.1. For the full and manufacturing samples the industry patent variables are also included.

Table 7b - Impact of other firms IP activity on the single firm

– industry patents and firm productivity growth (coefficients and t ratios)

Industry IP intensity	UK patents	European patents
Full sample	4.13 (1.34)	- 0.82 (- 0.44)
Manufacturing	7.71 (1.52)	- 1.66 (- 0.56)

Notes: The industry IP intensity variable is the ratio of industry patents to industry employment, excluding the firm of observation. Industry patent variables have been added one at a time to the specification of Table 4, col.1, and the industry trade mark variables are also included.

So what is the view taken by the stock market of the overall net present value of this Schumpeterian competition for individual firms? Tables 8a and 8b show that significant positive evaluations of the effect on firms of high IP activity in the 4-digit industry are mostly reserved for patents, but for the full sample there is also a significant positive effects associated with UK trade marks. The sector results for services show these firms are not gaining any significant premiums due to higher levels of industry activity, but this is consistent with the negligible productivity growth impact seen above.

Table 8a - Impact of other firms IP activity on single firm

– industry trade marks and firm market value (coefficients and t ratios)

IIPI variable	UK trade marks	Community trade marks
Full sample (5283)	0.11 (2.17)**	0.02 (0.61)
Manufacturing (1926)	0.07 (0.71)	0.00 (0.07)
Services (2910)	0.08 (1.10)	0.40 (1.18)

Notes: The industry IP intensity variable is the ratio of industry trade marks to industry tangible fixed assets, excluding the firm of observation. Industry trade mark variables have been added one at a time to the specification of Table 2, col.1. For the manufacturing sample the industry patent variables are also included.

Table 8b - Impact of other firms IP activity on single firm

– industry patents and firm market value (coefficients and t ratios)

IIPI variable	UK patents	European patents
Full sample (5283)	1.02 (2.75)***	0.47 (2.49)***
Manufacturing (1926)	1.05 (2.22)**	0.13 (0.58)

Notes: The industry IP intensity variable is the ratio of industry patents to industry tangible fixed assets, excluding the firm of observation. Industry patent variables have been added one at a time to the specification of Table 2, col.1, and the industry trade mark variables are also included.

6. Conclusions

This paper has used a novel data set of the trade mark activity of UK manufacturing and service sector firms to show that applications for trade marks are suggestive of product innovation, improving the profitability and productivity of firms. Data on both trade (and service) marks sought via the UK Patent Office (UKTM) and the European Community Office for Harmonisation of the Internal Market (CTM) were matched to company financial data. There was rapid growth in trade mark activity during the period covered by the data (1996-2000).

We first analyse Tobin's *q*, the ratio of stock market value to the book value of tangible assets, as the market value of the firm should reflect the expected future return on intangible assets. We explore the impact of undertaking any trade mark activity and also the effects of increasing trade mark intensity among those who do. The results indicate that stock market values are positively associated with R&D and trade mark activity by firms. We find larger differences between firms with and without trade marks for services than for manufacturing. We also find bigger differences in Tobin's *q* when the services firm is applying for Community marks, rather than just applying for UK marks. Increasing the intensity of Community trade marking appears to raise market value for both manufacturing and services, but this relationship weakened over the 1996 to 2000 period.

The second part of this paper investigates the relationship between trade mark activity and productivity, using a value added production function. The results indicate that firms that trade mark have significantly higher productivity than non-trade markers, by between 10% and 30% across all firms and with even larger differences in service sector firms. Our interpretation is that trade mark activity proxies a range of other, unobservable, firm-level characteristics that raise productivity including innovation. We also analyse whether greater trade mark intensity raises productivity growth. Higher trade mark intensity has some positive association with productivity growth in services, but the results are relatively weak for manufacturing firms.

These results seem broadly consistent with those derived using the market value approach, suggesting that stock markets are efficient in estimating the likely benefits of new intangible assets, and that managers were not just seeking trade marks to follow a management fad, but could expect to receive real returns from innovative activity leading to new products requiring trade marks. Even so, the marginal returns to extra trade marks per firm were diminishing quite rapidly over the period, as indicated by our exploration of the interaction of time trends with trade mark intensity.

In the final section of the paper we examine the interactions between the IP activity of firms in 4-digit SICs to explore the nature of creative destruction and to examine if there is simultaneous growth through this process on competition via innovation. We find that, in the short run, greater IP activity by other firms in the industry reduces the value added of the firm, but this same competitive pressure has later benefits via productivity growth and this is reflected in higher stock market value. This precisely describes the Schumpeterian process of competition through innovation, creating some redundant products and restraining profit margins through entry but also increasing product variety and quality through time.

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Table 2 Market value regressions

Dependent variable ln(MV/Tangible assets)

					trends	
	Full OLS	Full OLS	Man OLS	Ser OLS	Man OLS	Ser OLS
Log of tangible assets	-0.066	-0.064	-0.036	-0.062	-0.03	-0.064
	(6.20)***	(5.92)***	(1.86)*	(4.48)***	(1.58)	(4.64)***
R&D expenditure in year (dummy)	0.207	0.207	0.173	0.264	0.158	0.266
	(4.47)***	(4.47)***	(2.57)**	(3.87)***	(2.41)**	(3.90)***
R&D expend / tangibleassets	1.268	1.257	3.214	0.939	3.345	0.932
	(3.47)***	(3.44)***	(3.83)***	(3.05)***	(4.11)***	(3.03)***
UK trademark only (dummy)	0.225	0.221	0.11	0.281	0.076	0.285
	(6.22)***	(6.03)***	(1.56)	(6.30)***	(1.13)	(6.37)***
Comm. trademark only (dummy)	0.334	0.316	0.067	0.521	0.054	0.546
	(5.46)***	(5.10)***	(0.69)	(6.53)***	(0.57)	(6.82)***
UK & Comm. in same year (dummy)	0.408	0.396	0.207	0.503	0.152	0.523
	(9.65)***	(9.14)***	(2.95)***	(8.33)***	(2.25)**	(8.67)***
Trade mark / tangibleassets (mill)		0.006	-0.102	0.021	-0.523	0.059
		(0.21)	(0.54)	(0.86)	(1.52)	(1.17)
trend x Trade mark / tangibleassets (mill)					0.239	-0.013
					(2.09)**	(0.72)
Comm. trade mark / tangibleassets(mill)		0.049	0.098	0.048	1.043	0.257
		(1.09)	(0.73)	(1.15)	(2.99)***	(3.43)***
trend x Comm. trade mark / tangibleassets(mill)					-0.3	-0.087
					(2.99)***	(3.07)***
High diversification (=1)	-0.062	-0.062	-0.026	-0.061	-0.026	-0.059
	(2.00)**	(2.00)**	(0.41)	(1.62)	(0.40)	(1.57)
Sales in Europe (dummy)	0.049	0.049	0.102	0.025	0.093	0.024
	(1.52)	(1.53)	(1.66)*	(0.62)	(1.53)	(0.59)
Sales in USA (dummy)	0.094	0.094	0.182	-0.029	0.19	-0.03
	(2.37)**	(2.38)**	(3.25)***	(0.48)	(3.40)***	(0.49)
Growth in sales (t, t-1)	0.236	0.235	0.325	0.168	0.316	0.178
	(4.22)***	(4.21)***	(2.89)***	(2.42)**	(2.82)***	(2.51)**
Debt / shareholders' equity	-0.008	-0.008	0.007	-0.029	0.009	-0.029
	(0.57)	(0.57)	(0.29)	(1.57)	(0.38)	(1.55)
Intangible assets / tangibleassets	0.182	0.181	0.628	0.138	0.599	0.139
	(2.30)**	(2.31)**	(9.54)***	(2.86)***	(9.03)***	(2.79)***
UK patent only (dummy)	0.08	0.082	-0.14		-0.116	
	(1.20)	(1.22)	(1.54)		(1.28)	
EPO patent only (dummy)	0.168	0.17	0.042		0.061	
	(2.21)**	(2.24)**	(0.46)		(0.67)	
Both UK and EPO patents (dummy)	0.152	0.154	0.104		0.131	
	(2.26)**	(2.29)**	(1.30)		(1.65)*	
Patent / tangibleassets(mill)	0.974	0.956	2.212		2.26	
	(1.07)	(1.04)	(2.79)***		(2.91)***	
EPO patent / tangibleassets(mill)	0.974	0.964	0.538		0.438	
	(2.28)**	(2.24)**	(0.83)		(0.69)	
Constant	0.272	0.231	-0.494	0.287	-0.591	0.356
	(1.14)	(0.96)	(1.46)	(0.93)	(1.78)*	(1.15)
Observations	5283	5283	1926	2910	1926	2910
R-squared	0.35	0.35	0.35	0.32	0.36	0.32
F test: Joint sig. of industry dummies	0.00	0.00	0.00	0.00	0.00	0.00
Industry dummies	0.00	0.00	0.00	0.00	0.00	0.00

Table 3 Productivity level regressions

Dependent value is ln(value added), with this defined as staff costs + net profit before tax

					Trends	
	Full OLS	Full OLS	Man OLS	Ser OLS	Man OLS	Ser OLS
Ln(tang fx assests) (t-1)	0.22	0.22	0.243	0.222	0.242	0.222
	(20.33)***	(20.32)***	(9.01)***	(16.89)***	(9.00)***	(16.85)***
Ln(employment) (t-1)	0.633	0.634	0.651	0.61	0.652	0.611
	(50.96)***	(51.01)***	(22.72)***	(40.38)***	(22.79)***	(40.49)***
R&D dummy (t-1)	0.079	0.079	0.077	0.017	0.075	0.017
	(2.73)***	(2.73)***	(2.29)**	(0.30)	(2.22)**	(0.30)
R&D/ employ (t-1)	0.007	0.007	0.015	0	0.015	0
	(2.07)**	(2.07)**	(4.14)***	(0.01)	(4.14)***	(0.01)
UK trade mark only (dummy) (t-1)	0.114	0.107	0.001	0.175	-0.005	0.176
	(4.76)***	(4.32)***	(0.02)	(5.33)***	(0.12)	(5.34)***
Comm. trade mark only (dummy) (t-1)	0.085	0.083	0.102	0.055	0.096	0.055
	(1.95)*	(2.03)**	(2.16)**	(0.78)	(2.02)**	(0.78)
Comm. & UK trade mark (dummy) (t-1)	0.281	0.274	0.152	0.385	0.144	0.383
	(9.51)***	(9.38)***	(3.97)***	(8.32)***	(3.58)***	(8.33)***
UK trade mark / employ (t-1)		0.246	1.558	0.084	1.252	-0.219
		(0.82)	(3.22)***	(0.25)	(0.70)	(0.15)
trend x UK trade mark / employ (t-1)					0.158	0.067
					(0.24)	(0.21)
Community trade mark / employ (t-1)		-0.009	0.847	-0.032	-1.224	-1.17
		(0.01)	(0.58)	(0.05)	(0.40)	(0.85)
trend x Comm. trade mark / employ (t-1)					0.628	0.299
					(0.72)	(0.87)
High diversification (=1)	-0.065	-0.065	0.001	-0.029	0.001	-0.03
	(2.90)***	(2.89)***	(0.03)	(1.02)	(0.02)	(1.03)
Sales in EU (dummy)	0.033	0.033	0.043	-0.003	0.042	-0.003
	(1.33)	(1.34)	(1.08)	(0.08)	(1.06)	(0.10)
Sales in USA (dummy)	0.129	0.13	0.173	0.109	0.173	0.11
	(4.41)***	(4.43)***	(4.92)***	(2.39)**	(4.93)***	(2.41)**
Ln(intangible assests)_t-1	0.014	0.014	0.017	0.011	0.018	0.012
	(5.34)***	(5.33)***	(4.52)***	(3.07)***	(4.57)***	(3.09)***
UK patent only (t-1)	0.04	0.041	-0.021		-0.019	
	(1.06)	(1.08)	(0.40)		(0.36)	
EPO patent only (t-1)	0.224	0.224	0.162		0.164	
	(4.84)***	(4.85)***	(3.28)***		(3.31)***	
Both UK and EPO patents (t-1_	0.223	0.223	0.192		0.194	
	(5.25)***	(5.26)***	(3.74)***		(3.77)***	
UK patents / employ (t-1)	-3.095	-3.127	8.834		8.579	
	(0.67)	(0.68)	(1.67)*		(1.62)	
EPO patents / employ (t-1)	-8.508	-8.494	-15.29		-15.204	
	(1.79)*	(1.79)*	(3.12)***		(3.10)***	
Constant	5.46	5.457	3.984	5.579	3.971	5.581
	(100.55)***	(99.93)***	(15.86)***	(82.47)***	(15.68)***	(82.33)***
Observations	6421	6421	2073	3783	2073	3783
R-squared	0.85	0.85	0.89	0.83	0.89	0.83
YearDummies	0.17	0.17	0.12	0.41	0.10	0.35
IndustryDummies	0.00	0.00	0.00	0.00	0.00	0.00

Table 4 Productivity growth regressions

Dependent variable is first difference of ln value added
intensitives specified with respect to employment, LAGGED TWO YEARS
These samples require 4 or more observations over 5 year panel period

				With trend interactior	
	FD Full	FD Man	FD Ser	FD Man	FD Ser
Ln(assets)_t - t-1	0.214	0.249	0.23	0.248	0.221
	(6.57)***	(3.04)***	(6.15)***	(3.04)***	(5.93)***
Ln(employees)_t - t-1	0.5	0.532	0.459	0.532	0.469
	(12.76)***	(6.18)***	(9.81)***	(6.17)***	(10.00)***
R&D/ employ (t-2)	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.90)	(0.42)	(0.63)	(0.54)	(0.64)
Ln(intangible assets)_t - t-1	-0.002	-0.002	-0.002	-0.002	-0.002
	(1.11)	(0.56)	(0.95)	(0.55)	(0.88)
UK trade marks / employ (t-2)	-0.023	0.467	-0.096	1.005	2.522
	(0.12)	(1.54)	(0.42)	(0.60)	(4.09)***
Trend x UK TM/employ (t-2)				-0.094	-0.503
				(0.24)	(3.56)***
Comm. trade marks / employ (t-2)	0.983	-0.154	1.238	-3.218	-0.984
	(1.65)*	(0.21)	(1.72)*	(1.02)	(0.39)
Trend x Comm. TM/employ (t-2)				0.744	0.442
				(1.07)	(0.96)
UK patents / employ (t-2)	7.178	5.821		5.707	
	(3.00)***	(1.51)		(1.46)	
Epo patents / employ (t-2)	-9.462	-5.364		-5.5	
	(1.14)	(0.61)		(0.62)	
Constant	0.016	0.049	-0.462	0.052	-0.464
	(0.11)	(1.22)	(0.91)	(1.29)	(0.91)
Observations	3177	1093	1815	1093	1815
R-squared	0.20	0.20	0.18	0.20	0.18
F test: Joint sig. of year dummies	0.00	0.00	0.00	0.00	0.00
Industry dummies	0.05	0.75	0.70	0.74	0.76

Data Appendix

The OIPRC database financial data for 1996 to 2000 come from Company Analysis (Extel Financial, 1996, and Thomson, 2001). The data include a standard range of balance sheet and profit and loss items, including sales, profits, assets and also, for some companies, R&D expenditure. The database allocates each firm to a 2-digit standard industrial classification (SICs), on the basis of its dominant activity, and also provides a list of 4-digit SICs in which it has significant activities.[18] For firms that are publicly quoted, the end of accounting period share price is available, which when multiplied by shares outstanding yields the major component of market value. Although the OIPRC database also contains information about patents, the focus in this paper is on trade marks. Greenhalgh and Rogers (2005a) show that use of patents in non-manufacturing sectors is limited. For the productivity analysis additional data on the 2001 and 2002 period were added from FAME (Bureau van Dyck).

As discussed in the main text, data on two different trade mark applications routes are available. The first is trade mark applications to the UK Patent Office, which offer protection in the UK (denoted UKTM). The second is applications for Community trade marks, made via the Office for Harmonization in the Internal Market (Trade Marks and Designs) (OHIM), which offers protection for all countries in the European Community. Community trade marks represent a uniform right valid across all European Community countries. It is possible to apply for a CTM even though an identical national trade mark is held.[19]

To create an accurate measure of trade mark applications by a firm it is important to check for applications both in the name of the parent firm and also all the firm's subsidiaries. In other words, since the financial data available are consolidated for an entire group of firms, the trade mark data must also be consolidated. This is done by using company structures from "Who Owns Whom" (Dun and Bradstreet International, 2001) to determine the family trees of the parent firms. The full trade mark application records were then searched for name matches (UK data from Marquesa Search System, 2002; CTM data from ESPACE, 2002).[20]

Data notes on key variables

Tobin's q. The ratio of market value to tangible assets. Market value is defined as: [share price (at end of accounting period) x ordinary shares outstanding] + creditors – current assets + debt. This is based on the approximation for Tobin's q in Chung and Pruitt (1993). This definition is based on the fact that in order to gain total control of the firm – and the rights to future profits – an investor would have to buy all shares, retire debt and payoff creditors (although they could use current assets). The correlation

[18] The database uses the US SIC system. 'Significant' is defined according to accounting conventions, see the explanation of diversification variable in data Appendix.

[19] Before the introduction of the CTM it was possible to register a national trade mark in other countries by using the 'Madrid Protocol' (administered by the World Intellectual Property Organisation). However, this required additional payments for each countries and, potentially, enforcement via each national legal system.

[20] Further information on the construction of the original dataset to 1995 is given in Greenhalgh and Longland, (2001, Appendix Notes); and for the dataset extension from 1996 in Greenhalgh et al. (2003, Technical Appendix).

coefficient between this measure and the simple ln(share value) is 0.86. Tangible assets are defined as total assets less intangible assets.

Debt to equity. Defined as total debt to shareholders' funds as reported in balance sheet. Any negative values for ratio are set to zero. Also, any values greater than 9 (the 99th percentile of distribution) are replaced by average of previous and following period, if data available, or by previous or following period if not.

High diversification dummy. This equals one if the firm has activities in 3 or more distinct 4-digit SICs.

Value added: Value added is defined as total staff costs plus profit before tax. We have calculated other measures of value added but find this measure, given data constraints, preferable. There is sometimes a concern over whether to include the book value for depreciation in value added, since it may be only weakly related to the true economic rate of depreciation. We have calculated and analysed a measure of value added with depreciation and this is highly correlated t our measure (correlation coefficient 0.99). Also, some studies correct for interest paid and impute a value for the user cost of capital. The data available here do not contain interest paid. Previous analysis undertaken, using imputed interest payments (based on debt and market rates of interest) and user cost of capital, showed similar results.

Omitting high growth firms: A sub-sample of firms that excludes high growth firms was created for productivity growth analysis. This excludes firms with year-on-year growth in value added of greater than 300% and less than -90%. Also, firms with growth rates of labour, capital or R&D of greater than 200% and less than -50% are excluded. This follows Hall and Mairese (1995) criteria and leads to 562 firms being omitted (15% of the regression sample). In other work we have found that the main effect of omitting these firms is that the coefficients in the instrumental variable estimates become more significant and closer to theoretical predictions.

Price deflators: The ONS statistics produces industry-level data only for manufacturing industries and only from 1991 onwards. For the 1980s there are no industry-level deflators available. The value added measured is deflated by the overall manufacturing deflator (gross output measure) for 1988-1990 and then industry-level deflators are used (which are at the 2-digit SIC level). These data are on ONS web-site and are listed under producer prices (MM22). For non-manufacturing the GDP deflator is used (ONS, YBFY). All deflators are in constant 2000 prices.

Dummy for sales in Europe: This equals one if the accounts report a separate European sales figure. The UK's accounting standards (SSAP 25) sets down guidelines for reporting geographical sales data. In short, where sales, profits (losses) or net assets in an overseas region exceeds 10% of the total, a firm is obliged to report segment data. Given this, the dummy variable isolates firms with a 10% or above interest in Europe.

Dummy for sales in North America: This equals one if the accounts report a separate North American sales figure.

Intangible assets: This is the intangibles value as reported in the balance sheet. According to the accounting conventions, the value of intangibles can include goodwill, development costs, "brands, patents etc", "licences etc", deferred costs and player registrations. However, this is only done when there is a well-defined market value, which normally means that the firm must have purchased the asset from another firm. The current accounting advice states, "internally generated goodwill should not be capitalised and internally developed intangible assets should be capitalised only where they have a readily ascertainable market value." (http://www.frc.org.uk/asb/technical/standards/pub0109.html)

Patent data: The patent data are constructed in the same way as the trade mark data, see Greenhalgh et al. (2003) for full details.

Summary statistics

Variable	Mean	Std. Dev	Min	Max
Market value regressions (*n*=5283)				
ln Tobin's q	-0.0132	1.1897	-7.8268	6.2772
Log of tangible assets	17.9064	2.0137	10.5453	25.5997
R&D expenditure in year (dummy)	0.2889	0.4533	0	1
R&D expend / tangibleassets	0.0224	0.0894	0	3.2995
UK trade mark only	0.2014	0.4011	0	1
Community trade mark only	0.0672	0.2504	0	1
Both UK and Comm. Only	0.1732	0.3785	0	1
Comm. trade mark / tangibleassets(mill)	0.0436	0.3760	0	18.1818
UK Trade mark / tangibleassets (mill)	0.0857	0.5725	0	15.9363
High diversification (=1)	0.5875	0.4923	0	1
Sales in Europe (dummy)	0.6729	0.4692	0	1
Sales in US (dummy)	0.1957	0.3968	0	1
Growth in sales (t, t-1)	0.1522	0.4387	-5.8556	5.3613
Debt / shareholders' equity	0.5713	0.9043	0	8.8521
Intangible assets / tangibleassets	0.1491	0.8389	-0.3332	52.3060
UK patent only (dummy)	0.0553	0.2285	0	1
EPO patent only (dummy)	0.0483	0.2144	0	1
Both UK and EPO patents (dummy)	0.0746	0.2627	0	1
Patent / tangibleassets(mill)	0.0051	0.0439	0	1.6393
EPO patent / tangibleassets(mill)	0.0069	0.0549	0	1.4740
Patent / tangibleassets(mill)	0.0051	0.0439	0	1.6393
EPO patent / tangibleassets(mill)	0.0069	0.0549	0	1.4740
Productivity level regression (n=)				
Ln(tang fx assests) (t-1)	9.6411	2.5562	-1.8594	17.7365
Ln(employment) (t-1)	6.4322	2.1213	0	12.6313
R&D dummy (t-1)	0.2235	0.4166	0	1
R&D/ employ (t-1)	1.1256	5.0498	0	128.4063
UK trade mark only (dummy) (t-1)	0.1987	0.3991	0	1
Comm. trade mark only (dummy) (t-1)	0.0596	0.2369	0	1
Comm. & UK trade mark (dummy) (t-1)	0.1518	0.3589	0	1
UK trade mark / employ (t-1)	0.0070	0.0503	0	1.2088
Community trade mark / employ (t-1)	0.0031	0.0254	0	0.6667
UK patent only (t-1)	0.0509	0.2199	0	1
EPO patent only (t-1)	0.0357	0.1855	0	1
Both UK and EPO patents (t-1_	0.0615	0.2403	0	1
UK patents / employ (t-1)	0.0003	0.0047	0	0.3333
EPO patents / employ (t-1)	0.0005	0.0067	0	0.3333
High diversification (=1)	0.5602	0.4964	0	1
High diversification (=1)	0.5088	0.5000	0	1
Sales in USA (dummy)	0.1394	0.3464	0	1
Ln(intangible assests)_t-1	3.1364	4.4350	0	16.7268
Productivity growth regressions (*n*=3177)				
Ln(value added)_t - t-1	0.050	0.343	-2.296	1.318
Ln(assets)_t - t-1	0.057	0.236	-0.690	1.084
Ln(employees)_t - t-1	0.064	0.199	-0.693	1.059
R&D/ employ (t-2)	1.015	3.737	0.000	52.415
Ln(intangible assets)_t - t-1	1.099	2.952	-10.797	15.490
UK trade marks / employ (t-2)	0.006	0.047	0.000	1.111
Comm. trade marks / employ (t-2)	0.002	0.016	0.000	0.415
UK patents / employment (t-2)	0.000	0.003	0.000	0.071
EPO patents / employment (t-2)	0.000	0.001	0.000	0.028

Figure 2 Ln Tobin's q vs. trade mark intensity variables

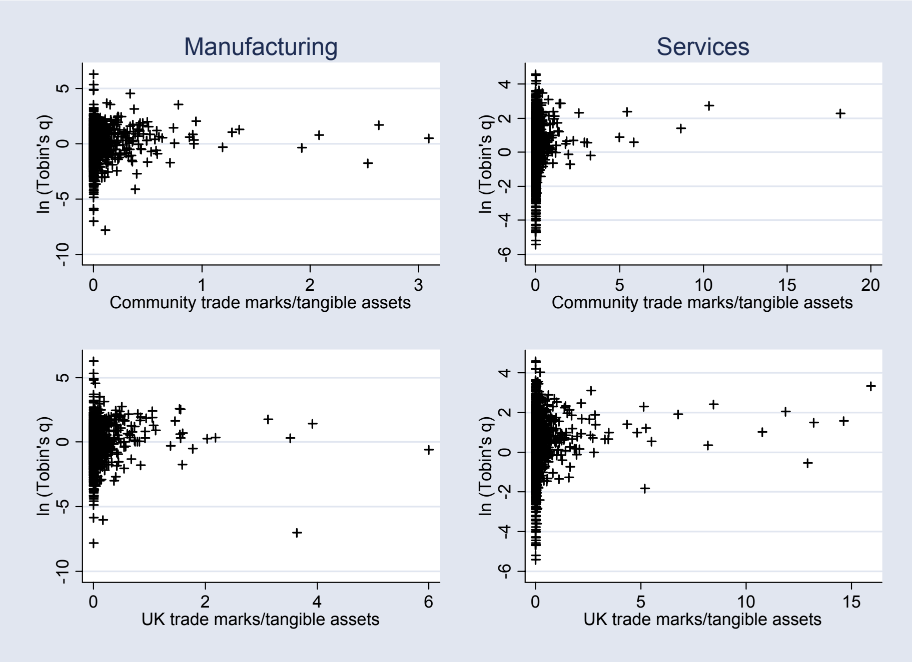

Figure 3 Ln value added vs. trade mark intensity variables