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Measuring Competition in the UK Motor Insurance Markets

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Abstract

A variety of possible measures of competition in the UK motor insurance markets are explored to discover which correlate most closely with prices and profitability. The various measures appear to suggest that the private and commercial motor insurance markets are not necessarily as competitive as is commonly believed. Measures which focus on the behaviour of individual firms over time suggest that both short-run and long-run persistency of profits can be observed in most motor markets. Measures which focus on markets at a particular point in time suggest that competitive pressure varies over time and across markets, and has been decreasing in all markets since the mid-1990s.

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1. Introduction

Competition is the process whereby firms producing substitute products are induced to charge prices which are equal to their marginal costs. Competition should ensure that prices for similar products are uniform across the industry and that firms are unable to earn positive economic profits over the long run (that is, after repeated competitive interaction) and maybe not even in the short run.

However there is little reason to believe that the firms in any particular industry will act in a competitive manner when that competition involves repeated interactions over several time periods. This is because firms involved in dynamic competition will appreciate that the benefits to be gained from intensive competition on price are likely to be fleeting and may meet with a rigorous response from competitors, and they may therefore refrain from price cutting in order to be able to set prices above marginal cost[1]. Even though firms compete in a non-cooperative manner, they may still be able to charge prices in excess of marginal costs and earn positive economic profits by utilising a variety of strategic devices (such as 'tit-for-tat' price cutting, competitor price-matching, or 'never knowingly undersold') which make it in each firm's self-interest to refrain from aggressive price cutting[2]. Empirical research reveals that the firms in many industries continue to report positive profits over an extended period[3]. It follows therefore that a high degree of competitive pressure in any particular industry may not be observed over an extended period, and that any bout of intense competition that does arise is likely to be due to a short-term breakdown in firms' cooperative pricing strategies.

The purpose of this paper is to investigate and measure the extent of competitive behaviour in the various UK motor insurance markets. These markets form an interesting case study because information on costs and revenues for almost all the

[1] An insight first attributed to Edward Chamberlin (eg Chamberlin, 1933)
[2] For example, Tirole (1988) ch 6 describes this as 'tacit collusion'. Besanko, Dranove, Shanley & Schaefer (2004) ch 8 refer to 'cooperative pricing' which is likely to be more prevalent in concentrated markets.
[3] For example, see the review in Lipczynski, Wilson & Goddard (2005) ch 9.

competing firms is readily available[4], and is split by a number of sub-markets which exhibit substantial differences in market structure (number of firms, concentration, information asymmetries etc).

Another interesting feature of the UK motor industry is its pronounced cyclicality in profits and prices - with periods of high prices and profits being followed by ones of lower prices and underwriting losses. The so-called 'underwriting cycle' has frequently been attributed to variations in the intensity of competition[5] and we attempt to investigate this phenomenon further by exploring the relation between the measures of competition and the market cycle.

2. The UK motor insurance markets

The motor insurance market is the largest insurance market in the UK and some form of cover was purchased by over 27 million drivers in 2005. The various Road Traffic Acts require all motorists to be insured against their liability for injuries to others (including passengers) and for damage to property of others resulting from use of a vehicle on a road or other public place.

Motor insurance business is split between a number of sub-markets - principally private car (comprehensive and non-comprehensive) and motor cycle, and commercial vehicle (including fleets). The markets operate in rather different ways: the private car insurance market offers fairly standardised products and insurers are believed to compete mainly on price. The private market is also increasingly dominated by so-called direct-selling insurers and the share of intermediaries and brokers is in decline (Financial Services Authority, 2007, p18). The private car insurance market is frequently described as competitive, as there appears to be a large number of actively competing firms, frequent entry and exit, low concentration, and active price competition[6]. In contrast, the

[4] From the data provided to the Financial Services Authority, as summarised by Standard & Poors

[5] Thus Harrington & Niehaus (2003, p151) say that the cycle "can be described in terms of periodic soft and hard markets. Soft markets are characterised by numerous insurers seeking to write new coverage and by stable of even falling prices. Hard markets consist of reduction in supply of coverage and sharp price rises"

[6] Thus the regulator has recently reported that "the focus on price by both consumers and providers is not an issue we would wish to change by regulation, as the benefits of this probably outweigh any detriment given consumers' understanding and familiarity with what is a relatively standardised and straightforward

commercial motor market (which covers goods vehicles, commercial cars, passenger vehicles, agricultural and forestry vehicles, and vehicles of special construction) is still dominated by insurance brokers and there are fewer competing insurers with a higher degree of concentration than the private car market. Competition in the commercial motor market may be based on other factors such as insurer security, claims processing, flexibility etc as well as price.

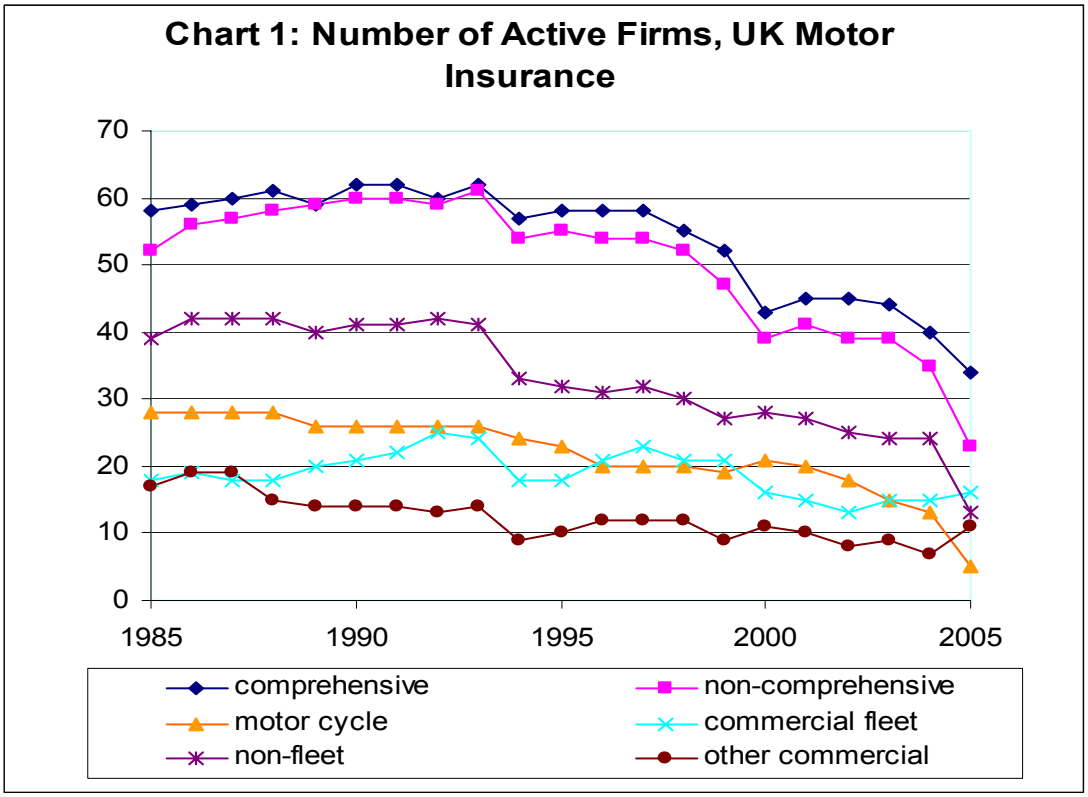


Chart 1 illustrates the number of UK licensed insurance companies operating in the main sub-markets over the period 1985-2005[7]. Data is taken from FSA Form 32[8], and shows the number of firms reporting positive gross earned premiums in the current year for six classes of motor business (Private: comprehensive, non-comprehensive, motor cycle; Commercial: fleets, non-fleets, other commercial). In almost all markets, the number of active firms appears to have declined over the period (as a result of the ongoing consolidation in the UK insurance market) and the concentration has therefore increased steadily (see Charts 2 and 3). Chart 1 also shows that the markets are characterised by a

product. The market for motor insurance works reasonably well in the interests of consumers.." (Financial Services Authority, soo7, p21).

[7] Data from a small number of Lloyd's motor syndicates and companies licensed outside the UK are therefore excluded

[8] Taken from Standard & Poor's Syn Thesys Non-Life, Version 10.1, 07 January 2007

pattern of entry as well as exit, and in any one year between 0 and 8 firms have entered the overall market while another 0-13 have exited.

Chart 2 illustrates the Herfindahl-Hirschman index (HHI, hereafter) computed as the sum of squares of the percentage market shares based on gross earned premiums in the current year. Many competition authorities regard an index in excess of 1800 as evidence that concentration may be high enough to indicate potential competition concerns[9]. The chart shows that, for the combined private car comprehensive and non-comprehensive markets, the index has been increasing steadily throughout the period but is well below the critical value. In the case of the combined commercial fleet and non-fleet markets, the index has also been rising and is currently around 1400. For the other commercial and private motor cycle insurance markets, the index indicates a substantial degree of concentration for most the period.

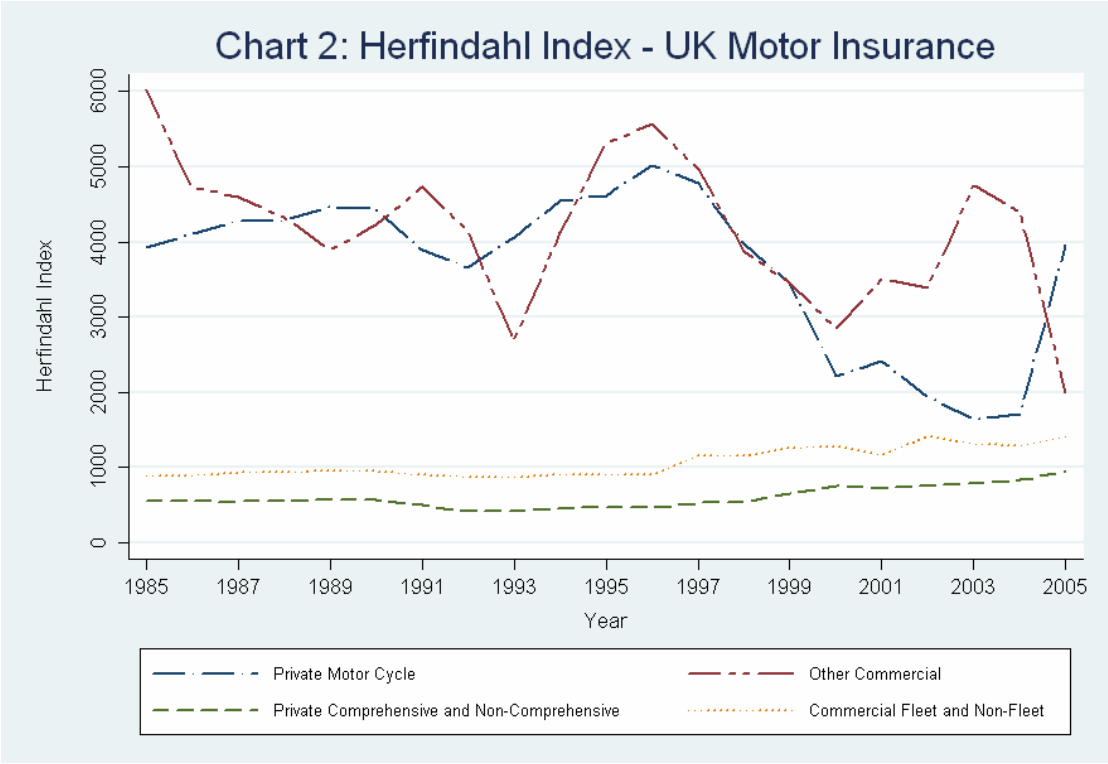
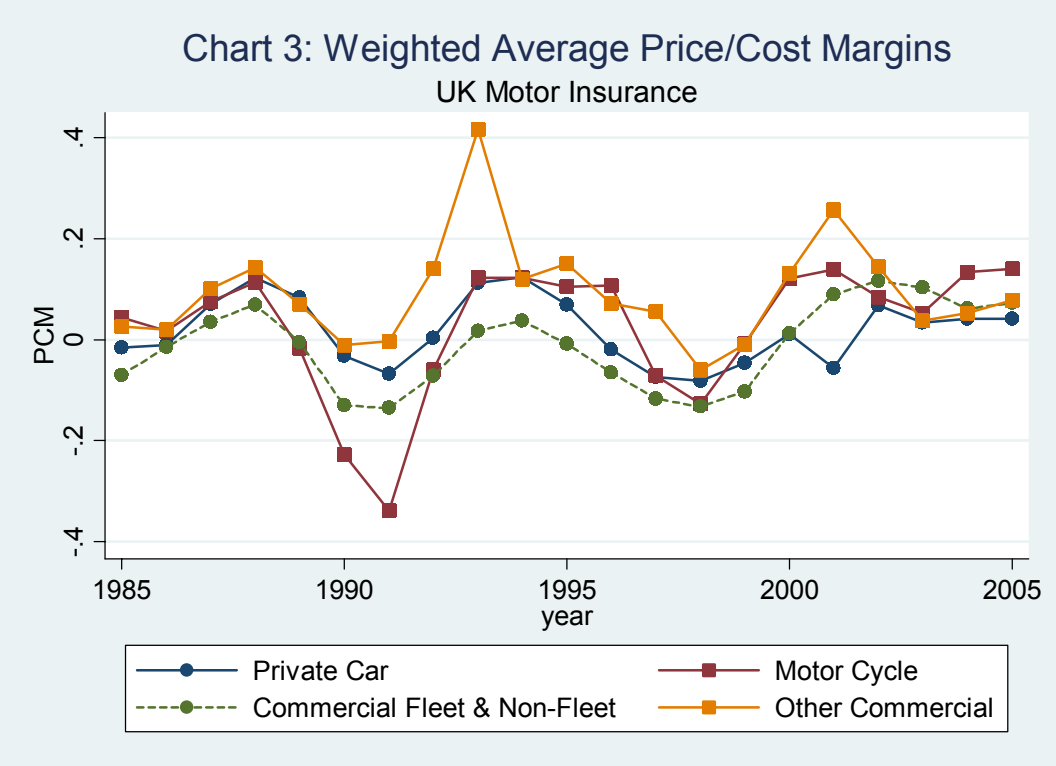


Chart 3 illustrates the industry weighted average price/cost margin for the four lines of UK motor insurance (see Section4 for a definition). In virtually every case, the markets demonstrate cyclical profitability (behaviour which is known as the 'underwriting cycle'), and the peaks and troughs in the four markets more or less coincide.

[9] But note the criticisms of the HHI in the section 3 below.



Up until 2005, the operation of the motor insurance market in the UK lay outside of the regulatory remit of the Financial Services Authority. However on 14 January 2005, the FSA introduced the Insurance Conduct of Business (ICOB) rules which regulate to a certain extent the market conduct of insurers and intermediaries, particularly in the private motor market (Association of British Insurers, 2006).

3. Measures of competition

Although competition has always been a prominent concept in the economics literature due to its positive effects on the functioning of the economic system, there is no consistent definition or robust measurement of it, and the most commonly utilised measures focus on market structure instead[10]. The theoretical literature has in fact

[10] Competition is thought to boost innovation (Martin, 1993; Aghion et al., 2001) and reduce the principal-agent problem by creating managerial incentives (Liebenstein, 1966; Hart, 1983; Hermalin, 1992; Schmidt, 1997).

parameterized competition in many ways, but the empirical measures commonly employed have often proved to contradict such parameters.[11]

3.1 Measures of Competition or Market Structure?

Recently, Boone (2000, 2004) and Boone *et al.* (2005) have pointed out that under the hypothesis of marginal cost differentials and one-product firms, the different parameterisations employed in the literature do share a common ground: competition improves market transparency. Customers can identify more clearly which company offers good value at low price, and consistently buy from the most efficient firms at the expense of the inefficient ones (the *reallocation effect of competition*). This reduces the profits of the least efficient companies, which in the long run are forced to exit the market (the *selection effect*).

Boone (2000) has suggested some ideal criteria for any measure of competition. Such measures should be monotone in competition, so that an increase in the level of competition should always increase. For practical reasons, two further conditions should be met: observability and observability in panel data. A long-established measure such as the concentration ratio (CR) fails to meet Boone's monotonic condition. An increase in the level of concentration within an industry is generally thought to make collusion (and/or cooperative pricing) easier among the incumbent companies. This in turn is expected to curb competition and its positive effects on social welfare. Yet, when the level of competition increases due for instance to a more aggressive interaction between firms, revenues tend to be reallocated from the inefficient to the efficient firms, leading to an increase in the concentration ratio.[12] Thus high values of concentration ratio do not necessarily mirror an uncompetitive environment, and the CR cannot be considered a consistent measure of competition.

Similarly, since market shares are directly dependent on the level of concentration, the Herfindahl-Hirschman index can be higher after an increase in the level of competition. This arises because an increase in competition which reallocates output towards more efficient firms is likely to increase concentration. This is in contradiction with the

[11] Changes in the level of competition are commonly parameterized through: changes in the entry fee that leads to an increase in the number of companies operating in a given market; changes in the expected competitors' response to a firm strategy variation; changes in the level of product substitutability; a switch from Cournot to Bertrand competition; a reduction in the production costs. See Boone (2000).
[12] Efficient firms are those with low marginal costs.

hypothesis that the HHI should be higher in those markets where concentration is high and competition restrained, leading to the conclusion that the HHI is not monotone in competition.

As far as price/cost margins are concerned, Boone (2000) shows that they usually decrease when competition increases. However, there could be circumstances where a strong reallocation effect involves a shift in business from inefficient firms (with low price/cost margins) to more efficient ones with higher margins: in this case, a rise in competition could raise the industry price/cost margin. Thus contrary to the theoretical assumptions, margins could increase as a result of an increased level of competition, and this makes the price/cost margin a non monotone measure of competition as well.

3.2 The Persistence of Profits Measure

The so-called 'persistence of profits' (POP) measures focus on the behaviour of individual firms over time after stripping-out common market movements. The POP measures (first pioneered by Mueller, 1977) are based on the dynamic behaviour of a firm's adjusted profit *rate* π^*_{it} where π_{it} is defined in this case as the price-cost margin ie $\pi_{it} = (TR_{it} - TC_{it})/TR_{it}$ and $\pi^*_{it} = \pi_{it} - \overline{\pi_t}$ where $\overline{\pi_t}$ is the (weighted) average industry price-cost margin in year t. Firm-level POP investigates short-run persistence in profits by estimating the autoregressive equation:

$$\pi^*_t = \alpha^i + \lambda^i \pi^*_{t-1} + \varepsilon_t \qquad [1]$$

for each firm *i*. The rationale of the model is that, in a competitive market (with few barriers to entry and/or exit), any abnormal profit will be eliminated by the forces of competition and should quickly disappear. Thus there should be little correlation between π^*_{it} and π^*_{it-1} and the parameter λ^i (which captures the short run persistence in profit across the industry) will be small. Lipczynski, Wilson & Goddard (2005) summarise the results of a number of studies where the average λ^i typically lies between 0.4 and 0.5 – indicating that competitive forces have failed to prevent profits from persisting above (or below) the norm.

In competitive markets, with no barriers to entry or exit, any short-run profits will be competed away so that each firm's adjusted profit rate should converge towards a common long-run equilibrium adjusted price-cost margin (denoted $\mu^i = \alpha^i/(1-\lambda^i)$) of zero. Evidence of long-run persistence in profits (where not all firms have zero equilibrium

adjusted profit margins, or where the adjusted margins differ substantially between firms) may provide evidence of a weakness of competition.

3.3 The Relative Profits Measure

Boone (2000) has thus suggested an alternative measure, based on relative profits, which is consistent across the different ways in which competition can be parameterised in theory. The intuition behind it relies once again on the reallocation and selection effects of competition. If firms are symmetric except for their marginal cost levels and firms choose their strategies simultaneously and independently, a rise in competition is expected i) to reduce the profit of the least efficient company in the market, ii) to increase the profits of any firm with respect to the less efficient firm, iii) to increase the total variable costs of any firm relative to total variable costs of a less efficient firm. Efficiency is measured in terms of marginal costs, so that the firm with the highest marginal costs is the least efficient one. An important assumption is that companies have constant marginal costs, which means that total variable costs equal marginal costs times output. No vertical product differentiation is considered, as consumers are thought to gain the same utility from each product. In addition, each firm is assumed to produce only one symmetrically differentiated product. In light of this, an increase in competition is expected to lead efficient firms to use their cost advantage more aggressively, attracting more customers and increasing their share of market output to the detriment of the less efficient companies. In other words, when the industry moves to a more competitive environment, the profits of the more efficient firm are expected to go up relative to the profits of the less efficient one. Therefore, a measure that considers the profits of the relatively efficient firm over the inefficient one will be always increasing in competition. What is more, since RP considers the ratio between two firms at time, it is robust for a sub-sample of data. More precisely RP is defined as $\frac{\Pi(c_i, c_{-i}, \theta)}{\Pi(c_j, c_{-j}, \theta)}$, where $c_i < c_j$, that is i is the relatively efficient firm (with lower marginal cost c_i) and j is the relatively less efficient one.

One possible way to implement the Boone relative profits measure is to estimate the slope β_{1t} in $\ln(\Pi_{it}) = \beta_{0t} + \beta_{1t} MC_{it} + \varepsilon_{it}$ where MC_{it} is marginal cost and profit $\Pi_i = TR_i - TC_i > 0$ (Griffith, Boone & Harrison, 2005). The relationship is expected to be downward sloping ($\beta_{1t} < 0$), with the slope β_{1t} indicating to which extent the marginal cost is mapped

into the firm profits. The idea is that in a competitive environment, efficiency differences are mapped into profit differences, with β_{1t} expected to be large in absolute value (although its significance will naturally have to be taken into account). Griffith et al (2005) estimate each year's β_{1t} (the 'Boone beta') using ordinary least squares on cross-sectional data for each year of study, and assume that marginal costs are constant so that they can be approximated by average variable cost.

An interesting extension of the basic model can be obtained by including an unobserved individual effect to allow for heterogeneity in profits in a panel of firms[13]:

$$\ln(\Pi_{it}) = \beta_{0t} + \beta_{1t} MC_{it} + \nu_i + \varepsilon_{it} \qquad [2]$$

where β_{0t} are time-varying constants to pick out any pattern in profits over time, β_{1t} is the time-varying Boone beta, ν_i is the unobserved individual effect for firm i, and ε_{it} is the standard residual with the usual properties. A positive firm-specific component ν_i captures the possibility that some firms can earn persistent above average profits throughout the period of study, and is therefore analogous to the Mueller concept of persistent profits.

There are a number of limitations on the application of the Boone relative profits measure of competition. One difficulty arises in defining the relevant market: while a narrow definition enables the observer to gauge how relative profits perform, a too-broad definition might lead to a miss-estimation of the true extent of competition. Boone (2000) pointed out that these problems can prevent the use of RP for inter-industry comparisons of competition. However the analysis of competition over time within a given market should be more reliable since market definition problems are less likely to vary over time.

A particular problem arises in approximating unobservable marginal costs when there is the possibility of either economies or diseconomies of scale, since this will be a source of measurement error if average variable cost is used instead. To illustrate, we can write marginal cost as a multiplicative function of average variable costs $MC_{it} = AVC_{it}(1 - rts_{it})$ where rts_{it} is an index of returns to scale for firm i at time t

[13] Bikker & van Leuvensteijn (2005) also attempt to measure the Boone beta using a fixed effects panel data model

(Martin, 2002, p152). If there are economies of scale, average variable costs will be decreasing in output and $AVC > MC$ so that $1 > rts_{it} > 0$; on the other hand, if there are decreasing returns to scale, AVC will be increasing and $rts_{it} < 0$. Only if there are constant returns to scale, where $rts_{it} = 0$, will AVC=MC. Obviously, using AVC_{it} instead of MC_{it} in [2] introduces the unobservable term $-\beta_t rts_{it} AVC_{it}$ into the residual, which will naturally be correlated with the included independent variable AVC_{it} and hence bias the estimation of the Boone betas.

4. Data Description and Variable Definitions

The data forms an unbalanced panel from a total of 121 motor insurers for a period of 21 years between 1985 and 2005, for the following four sub-lines of UK motor insurance business using loss event-year accounted data: private car (comprehensive and non-comprehensive combined), private motor cycle, commercial vehicle (fleet and non-fleet combined), and other commercial vehicle. Data were obtained from the regulatory returns submitted annually to the UK insurance industry regulator, the Financial Services Authority (FSA) by UK-licensed property-liability insurance companies. Our sample was taken from the *Synthesys Non-Life* database (version 10.1) published by Standard & Poor's (January 2007) and represents the earliest and latest years for which complete data were available at the time the study was carried out.. Companies were included in the analysis if total motor net earned premiums and gross earned premiums by motor sub-line were strictly positive and if total motor net incurred claims, claims management costs and net operating expenses were non-negative.

Data on motor insurance appears in three main forms in the regulatory returns: Form 20 provides details on technical (ie revenue) account items for the current underwriting year[14] including net earned premiums, net incurred claims, claims management costs and net operating expenses – for all motor insurance sub-lines combined[15]. Form 23 gives data on the run-off patterns for net claims, but again for all motor combined. Finally Form 32 provides figures for gross premiums earned and gross claims incurred for the

[14] Data on adjustments for prior underwriting years are specifically excluded
[15] A split between private and commercial business has only been available since 2004

current underwriting year, detailed by sub-line of motor business – but not a split of claims management costs or operating expenses. No data is available on the volume of capital allocated by insurers to support the current year's motor business.

Estimated claims management costs by motor sub-line are allocated in proportion to net claims[16], and estimated operating expenses by motor sub-line are allocated in proportion to net premiums. The estimated profit by motor sub-line k is then given by $\Pi_k = TR_k - TC_k$ where:

$$TR_k = (gross\ premium_k \frac{total\ motor\ net\ premiums}{total\ motor\ gross\ premiums} + investment\ income_k) \quad [3]$$

$$TC_k = (gross\ claims_k \frac{total\ motor\ net\ claims}{total\ motor\ gross\ claims} + est\ claims\ management_k).discount\ \ factor + est\ operating_k \quad [4]$$

The investment income included in TR_k is computed as:

$$investment\ \ income_k = (gross\ premium_k \frac{total\ motor\ net\ \ premiums}{total\ motor\ gross\ \ premiums} - est\ operating_k).((1+i_{june})^{0.5} - 1) -$$

$$(gross\ claims_k \frac{total\ motor\ net\ claims}{total\ motor\ gross\ claims} + est\ claims\ management_k).p_0.((1+i_{june})^{0.375} - 1) \quad [5]$$

where p_0 denotes the estimated proportion of claims paid in the year of occurrence and i_{june} is the nominal yield on UK Government bonds of one-year duration at 30 June each year.

The *discount factor* in [4} is intended to adjust incurred claims and claims management costs to allow for future expected investment income on claims reserves and for the effects of prudent over-reserving in the accounting data. The *discount factor* is computed as:

$$discount\ \ factor = p_0 + \Omega \sum_{j=1}^{6} p_j (1+i)^{j-0.5} + \Omega p_{7+} (1+i)^{-9.5} \quad [6]$$

where p_j denotes the estimated proportion of claims j years after occurrence, i is the anticipated long-run investment yield[17], and Ω is the reserve adjustment factor to allow for over- or under-reserving. The proportions p_j are approximated from data in Form 23 showing the weighted average ratio for all motor insurers each year of net claims paid in

[16] ie claims management costs by sub-line=total motor claims management costs . (gross claims by sub-line /total motor gross claims)

[17] Approximated by a moving average of the yield on one-year UK Government bonds for the previous June, December, and next June *plus* a long-run equity premium of 2.5%

the current year *t* on business underwritten in year *t-j* to total claims paid and outstanding reported in underwriting year *t-j*. The reserve adjustment factor Ω in [6] is calculated as the weighted average ratio for all motor insurers in each year of total claims paid post accident year and outstanding (+IBNR) reported in year *t* to the initial outstanding claims and IBNR reserves, for business underwritten in year *t-5*: a value of Ω<1 denotes a scaling-down to allow for possible over-reserving.

Chart 4 summarises the annual changes in the proportions p_j by plotting the average duration of outstanding claims, computed as $duration = \sum_{j=1}^{6}(j-0.5)p_j + 9.5p_{7+}$. The average duration has increased from 0.8 in 1991 to nearly 2 in 2004 and appears to be cyclical. Chart 5 illustrates the average reserve adjustment factor Ω, which is also cyclical. Chart 6 shows the weighted average price-cost margin $\overline{\pi_t}$ for the whole UK motor market (with individual company margins weighted by their motor gross earned premiums) alongside the traditional (unadjusted or discounted) underwriting result as a proportion of premiums. Both variables display a pronounced cyclical pattern.

Chart 4: Average duration of outstanding claims

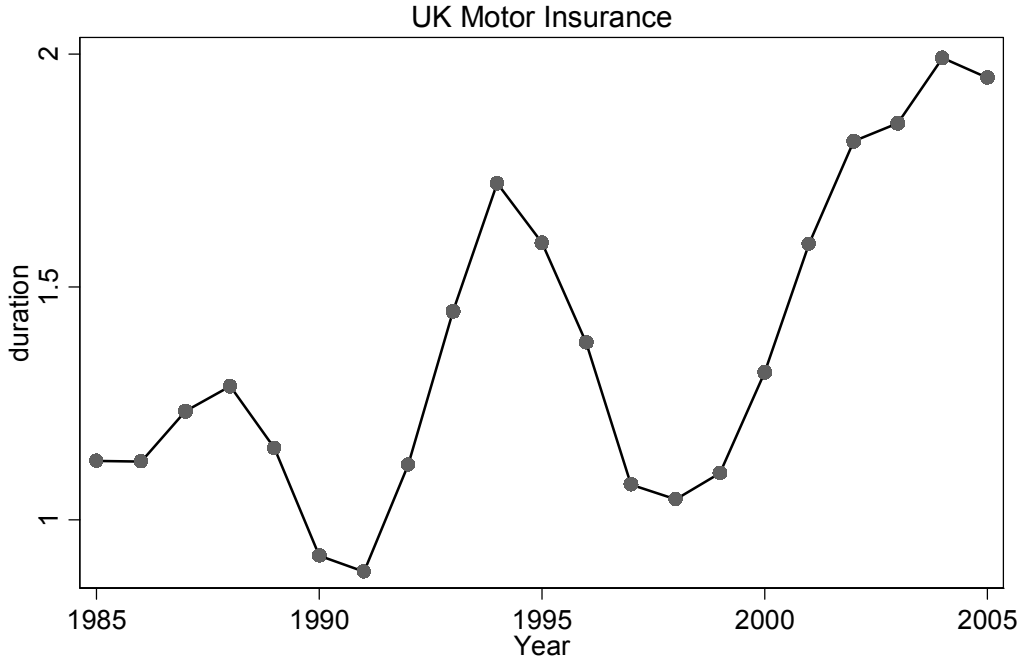


Chart 5: Average Reserve Adjustment

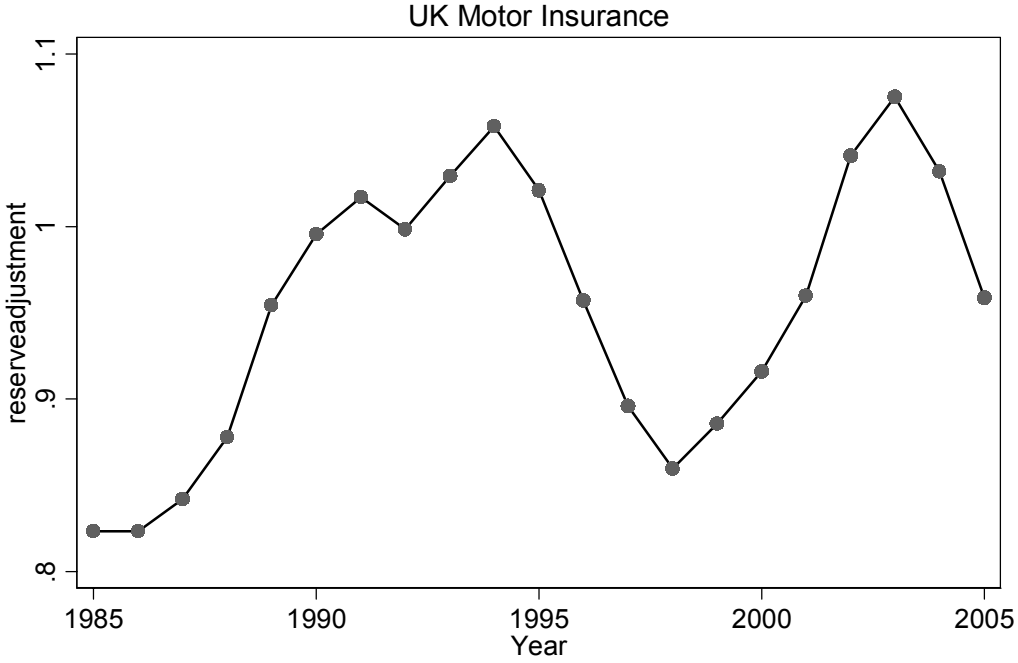
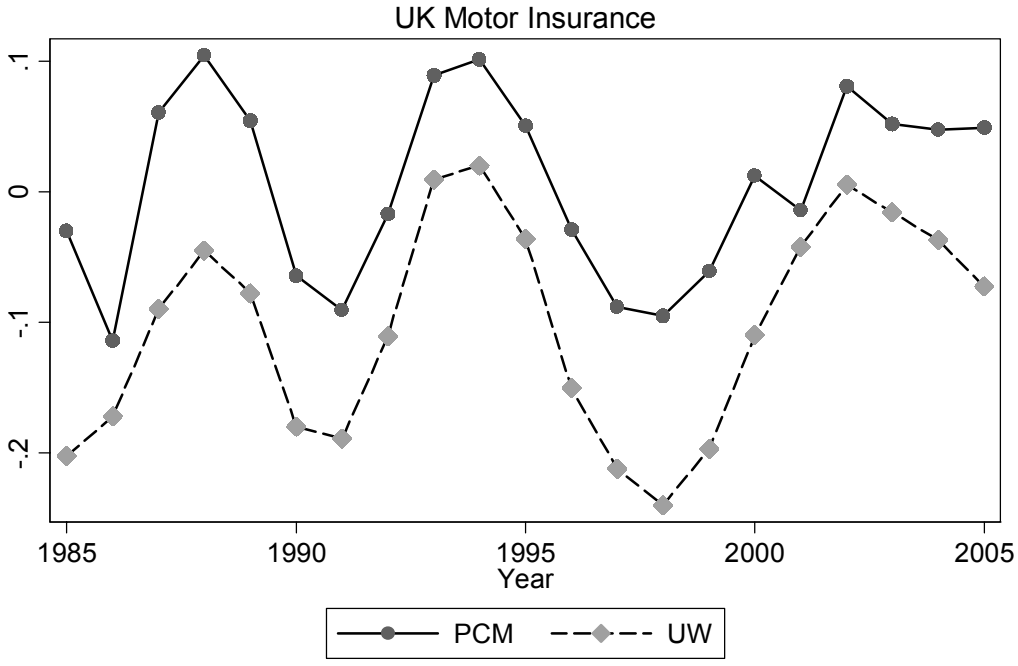


Chart 6: Average Price-Cost Margin and U/W Ratio



5. Results

5.1 Persistence Of Profits Measures

The results of the estimation of Equation [1] are illustrated in Table 1 for four lines of UK motor insurance: private car (comprehensive and non-comprehensive combined), private motor cycle, commerical (fleet and non-fleet combined) and other commercial[18]. The autoregressive relationship between current and lagged adjusted profits was estimated using OLS for each firm so long as there were at least 15 annual observations[19] during the period 1985 to 2005. The estimates of α^i and λ^i were then adjusted to zero if they were not at least 10% significant. Low values of λ^i and a small range for μ^i signify more intense competition.

The table suggest that the private car and commercial fleet & non-fleet insurance markets exhibit a mild degree of short-run persistence of profits, and all four markets demonstrate long-run persistence in that there is variation in the long-run equilibrium adjusted price-cost margin μ^i (although the majority of firms in each market have $\mu^i = 0$). Thus all four markets appear to lack the intensity of competition to prevent profits persisting from one-year to the next (the short-run measure) or to equalise long-run equilibrium profits. Charts 7-10 show the plot of each firm's value of μ^i against market share based on gross earned premiums: in general, the firms with the largest market shares are also the ones whose profits remain persistently above the norm in the long run. One weakness if this methodology however is that firms with a large market share are likely to be factored out of the computation because they dominate the calculation of the industry weighted average price/cost margins (for example, see Chart 9 where the two largest firms have zero persistency)[20].

The results suggest that the UK motor insurance markets may not be quite as competitive as is commonly believed, and a handful of firms in each market appear able to generate significant positive long-run equilibrium profits over-and-above the norm.

[18] Using *TR* and *TC* from [3] and [4] respectively
[19] 10 for Other Commercial
[20] In comparison, the alternative persistence of profits measure illustrated in Chart 16 shows the two dominant firms as also having positive persistent profits.

Table 1: Results of Persistence of Profits - Equation [1]

	Number of Firms with at least 15 annual observations	**Unweighted Average Short-run Persistency*** λ^i	**Long-run Persistency** ** μ^i	
			min	max
Private Car	25	0.32	-0.16	0.12
Motor Cycle	15	0.18	-0.48	0.25
Commercial Fleet & non-Fleet	18	0.27	-0.14	0.07
Other Commercial	9	0.14	0.00	0.13

* The smaller the value, the more effective is competitive in removing SR persistency
** The smaller the range, the more effective is competition in harmonising profits

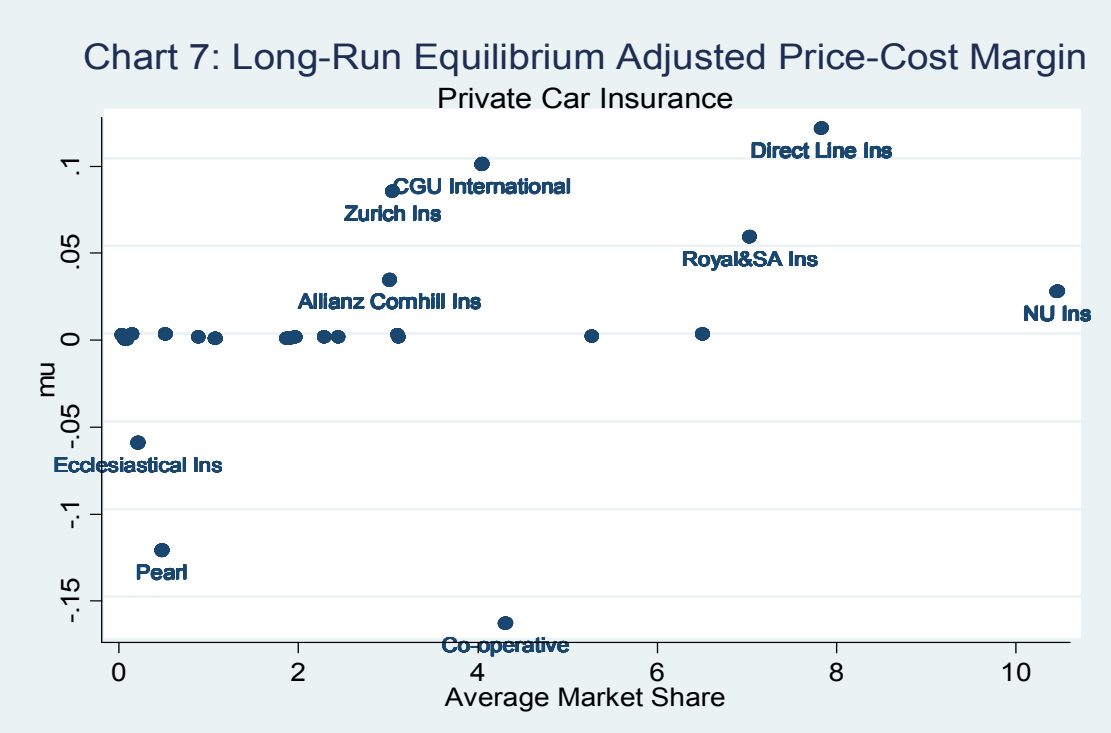


Chart 8: Long-Run Equilibrium Adjusted Price-Cost Margin

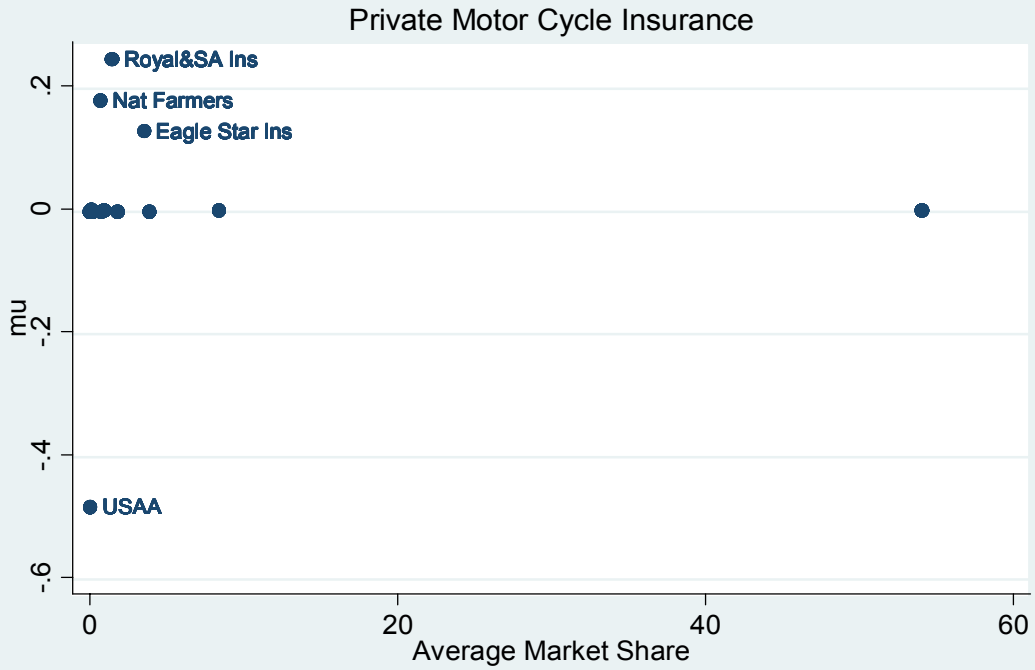
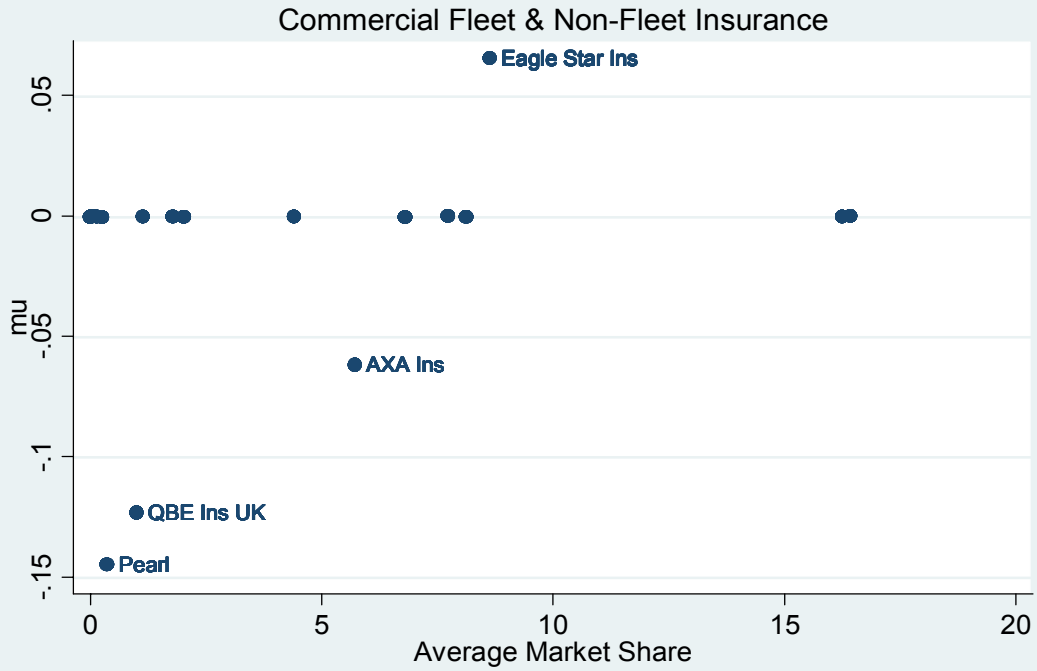
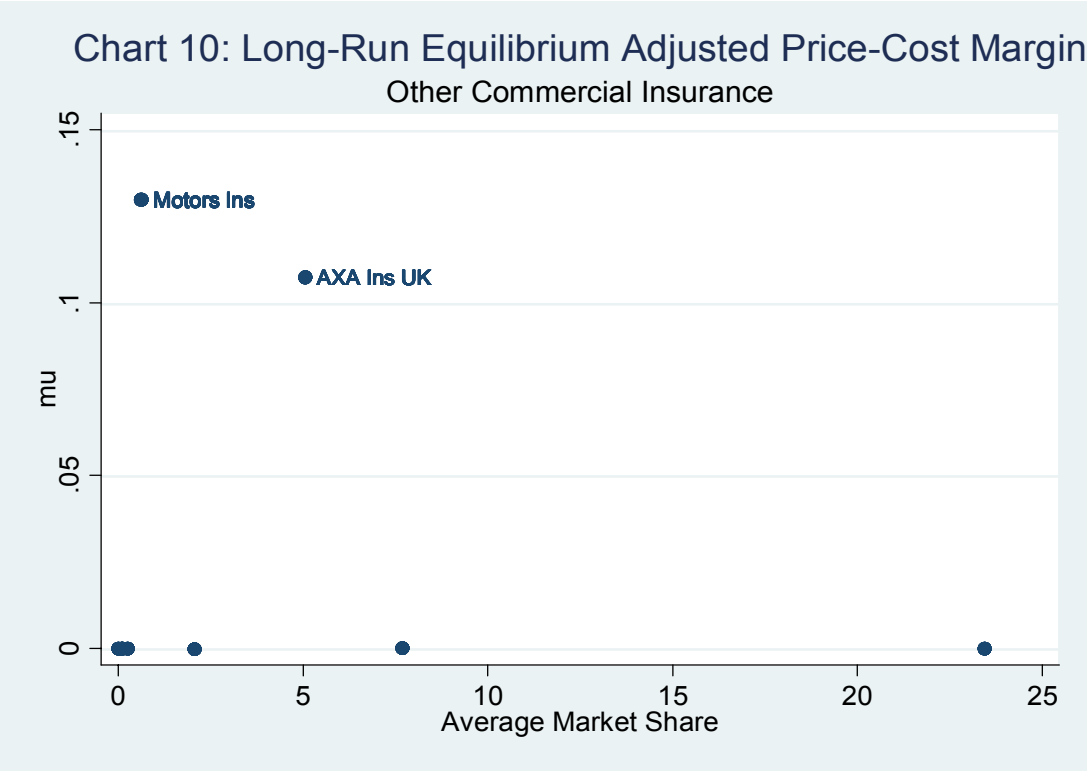


Chart 9: Long-Run Equilibrium Adjusted Price-Cost Margin





5.2 Relative Profits Measure

The Boone relative profits measure of competition in Equation [2] cannot be estimated directly because of the unobservability of marginal costs. Instead, estimates were obtained by substituting $MC_{it} = AVC_{it}(1 - rts_{it})$ and specifying the unobservable returns-to-scale parameter as a function of company size $rts_{it} = \theta_t s_{it}$ where s_{it} is the natural logarithm of total assets after purging for any correlation with $ln(\Pi_{it})$ [21]. The resulting mixed effects model is therefore:

$$\ln(\Pi_{it}) = \beta_{0t} + \beta_{1t} AVC_{it} + \{u_t[s_{it} AVC_{it}] + \nu_i + \varepsilon_{it}\} \qquad [7]$$

where β_{0t} and β_{1t} are analogous to standard regression coefficients which can be estimated directly and the unobservable residuals are the terms in parentheses {}. The random intercepts $u_t = -\beta_{1t}\theta_t$ and unobservable components υ_i are not estimated directly,

[21] s_{it} was obtained as the residual from the ordinary least squares estimation of log(total assets deflated by the GDP deflator index) on y= $ln(\Pi_{it})$, y^2 , y^3, y^{-1}, $y*AVC_{it}$, and year dummies.

but can be predicted. Equation [7] is an example of a linear mixed model which includes both fixed and random effects (for example, see Searle, Casella & McCulloch, 1992) which can be estimated using maximum likelihood on the assumption that $u_t \sim N(0,\sigma_u^2)$, $\upsilon_i \sim N(0,\sigma_\upsilon^2)$, and $\varepsilon_{it} \sim N(0,\sigma_\varepsilon^2)$ [22]. The existence of constant returns to scale across all firms and years can be tested by H_0: $\sigma_u = 0$, while the null hypothesis of no persistency of profits can be tested by H_0: $\sigma_\upsilon = 0$. *TR* and *TC* are as defined in [3] and [4] respectively and $AVC = \frac{TC}{AR}$ for each line. The estimation results are provided in Table 2.

The corresponding 'Boone betas' can be estimated as $\beta_{1t} + u_t \bar{s}_t$ where $\bar{s}_t$ is the weighted average of s_{it} based on market shares, and an estimate of the returns to scale parameter in year t is then $rts_t = \frac{u_t \bar{s}_t}{(-\beta_{1t})}$. The Boone betas are graphed along with their 95% confidence intervals in Charts 11-14. The charts denote the extent to which relatively inefficient firms are punished with lower profits, so that negative value of the Boone beta (β_{1t}) can be interpreted as indicating the extent of competitive pressure. Estimates of the returns to scale parameter are illustrated in Chart 15 [23].

[22] The logarithmic specification of [7] necessitates the exclusion of all firms earning non-positive profits, however Griffiths et al (2005) note that there is no requirement that the sample be a balanced one.

[23] No measure is calculated in those circumstances where the coefficient β_{1t} is insignificantly different from zero.

Table 2: Mixed Effects Model [7]: UK Motor Insurance, 1985-2005

	Private Car		Motor Cycle		Commercial Fleet & Non-Fleet		Other Commercial	
β_{1t} (Boone beta)	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
1985	-9.038	1.680	-4.488	1.757	2.149	1.590	-3.154	1.850
1986	-8.652	1.501	-3.064	1.866	-0.059	1.722	-3.092	1.230
1987	-7.706	1.503	-1.780	1.341	-7.023	1.700	0.712	1.413
1988	-6.073	1.266	0.482	1.220	-7.288	3.145	-0.751	1.603
1989	-7.830	1.682	-0.848	2.143	-2.060	1.543	-2.201	1.161
1990	-8.481	1.269	-6.952	1.779	-4.695	1.955	-2.226	1.633
1991	-8.895	1.997	-7.129	1.734	-9.386	1.928	-1.323	2.022
1992	-6.174	1.995	-7.572	1.490	-8.224	2.906	-2.152	2.331
1993	-4.403	1.446	-4.951	1.381	0.238	0.819	-2.299	2.020
1994	-4.173	0.971	1.746	1.450	-4.825	1.434	-5.929	3.875
1995	-3.874	1.160	1.908	1.454	-6.131	1.632	-4.896	1.485
1996	-0.572	1.163	-0.680	1.489	-2.504	1.329	-6.017	2.275
1997	-3.353	1.955	-0.284	1.488	-3.551	2.031	3.572	7.785
1998	15.189	10.174	-0.546	1.556	1.138	3.171	-8.982	3.015
1999	-6.359	1.508	0.022	2.101	-0.643	1.259	3.717	2.349
2000	-1.077	0.666	1.770	1.285	-0.769	1.192	3.956	1.969
2001	-4.333	0.935	1.115	1.934	-1.609	0.908	0.789	3.197
2002	0.324	0.748	8.241	1.908	-0.968	0.741	-0.934	2.549
2003	-2.195	1.603	0.246	3.225	-0.076	0.858	-2.162	3.858
2004	-3.410	0.895	-1.936	2.315	0.635	1.871	-1.892	2.562
2005	-4.707	1.328	6.408	4.738	-6.279	3.208	7.298	5.045
β_{0t}								
1985	22.230	9.926	-2.180	1.808	-6.351	2.224	-0.907	2.351
1986	22.171	9.904	-3.323	1.854	-5.789	2.256	-0.797	2.068
1987	21.465	9.889	-4.627	1.576	1.646	2.304	-3.158	2.100
1988	20.336	9.859	-6.315	1.500	2.193	3.358	-2.274	2.178
1989	21.880	9.909	-5.131	2.024	-2.284	2.199	-0.910	2.020
1990	21.993	9.876	-0.239	1.650	-0.188	2.449	-0.805	2.154
1992	22.596	9.964	0.498	1.580	4.096	2.437	-1.447	2.231
1993	20.637	9.946	-2.043	1.541	3.207	3.089	-0.418	2.548
1994	19.613	9.864	-6.887	1.555	-4.572	1.884	-0.524	2.353
1995	19.672	9.816	-7.248	1.558	0.947	2.155	2.300	3.352
1996	18.839	9.825	-5.790	1.624	1.912	2.267	1.190	2.181
1997	15.418	9.859	-5.356	1.606	-1.053	2.078	1.983	2.563
1998	17.792	9.985	-5.415	1.599	-3.874	2.997	-4.949	6.787
1999	21.450	9.854	-5.505	1.677	-3.119	2.006	4.451	3.122
2000	16.026	9.812	-6.439	1.447	-2.948	2.024	-6.208	2.647
2001	19.799	9.781	-5.353	1.790	-1.008	1.882	-4.523	2.076
2002	15.475	9.845	-10.860	1.849	-1.861	1.834	-1.892	2.905
2003	18.255	9.934	-5.225	2.901	-2.104	1.880	-1.219	2.545
2004	19.093	9.851	-2.946	2.087	-2.535	2.359	-0.460	3.451
2005	20.402	9.899	-8.165	4.165	4.185	3.296	-6.447	4.087
constant	-8.806	9.819	9.132	1.245	8.668	1.794	7.300	1.912
N | # groups	565	48	293	24	306	25	175	14
Log likelihood	-738.1		-527.7		-475.3		-284.1	
Random Effects Parameters								
σ_v	2.601	0.199	2.126	0.286	3.139	0.292	1.905	0.259
σ_u	1.205	0.194	0.705	0.256	1.611	0.272	0.000	0.000
σ_ε	0.564	0.019	1.117	0.062	0.621	0.031	0.926	0.056

Chart 11: Boone beta (plus 95% confidence interval)

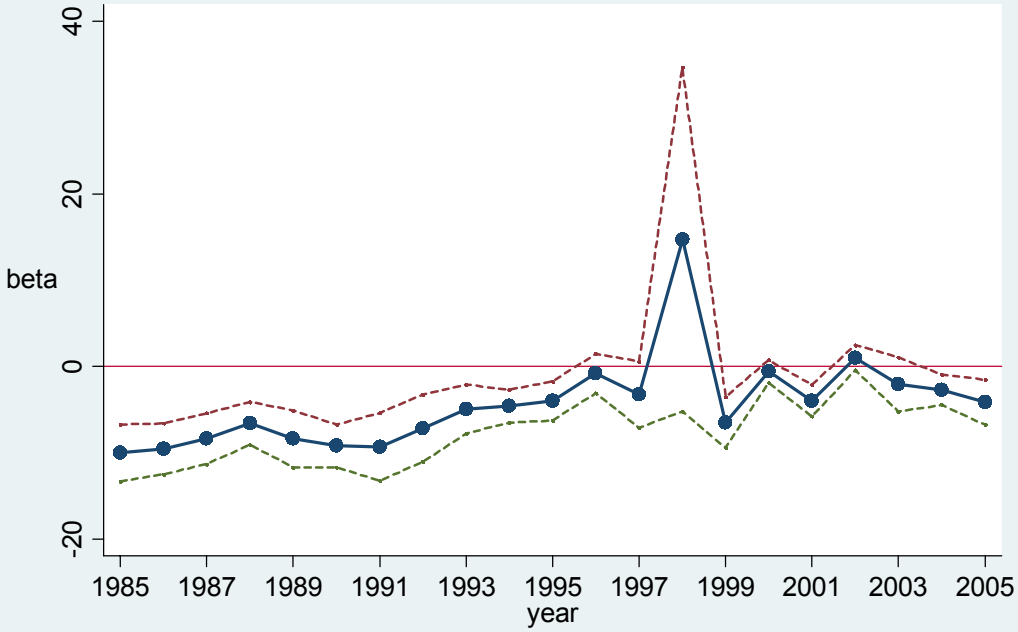


Chart 12: Boone beta (plus 95% confidence interval)

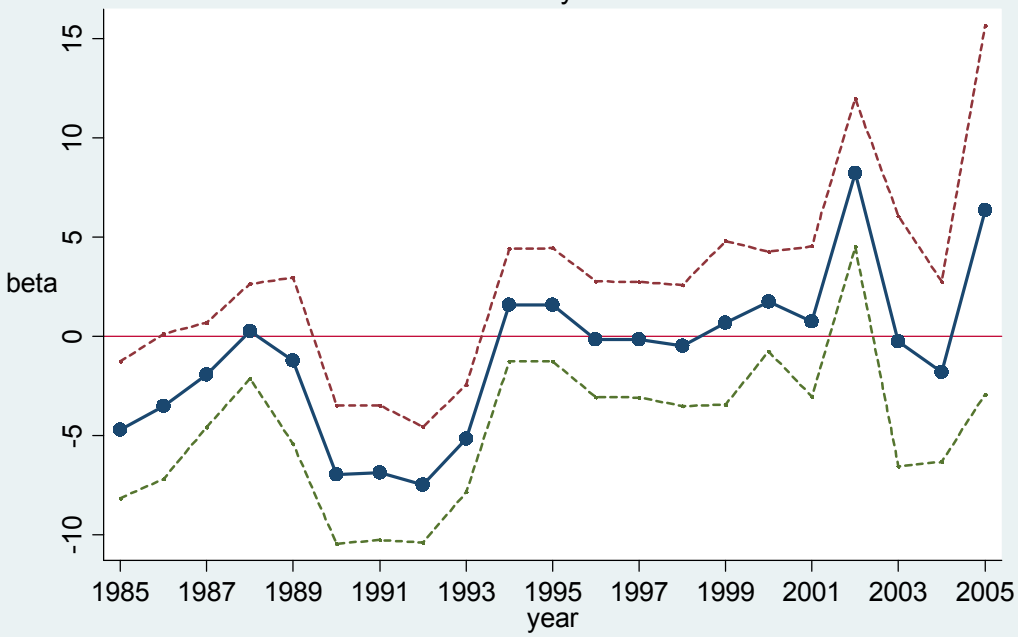


Chart 13: Boone beta (plus 95% confidence interval)

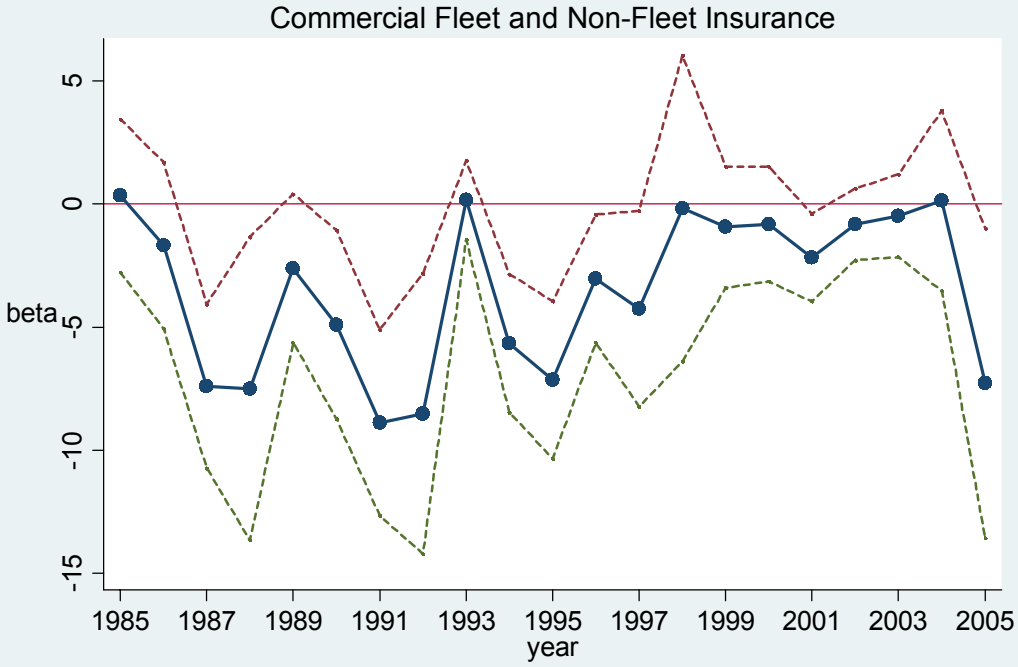
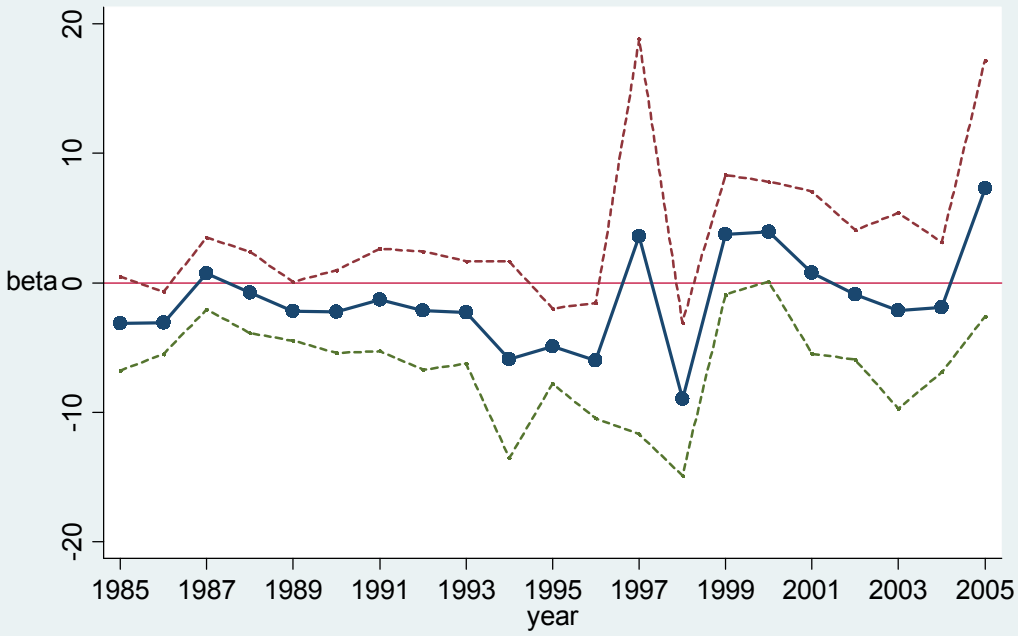


Chart 14: Boone beta (plus 95% confidence interval)



A number of interesting points emerge from the results of Table 2:

1. The Intensity of Competition

Competition appears to vary across the four motor insurance markets, and over time. In the case of the private car insurance market, Chart 11 the Boone beta values were consistently negative during the period 1985 to 1995 (indicating a decade of significant competition) although rivalry appeared to be weakening throughout – perhaps reflecting the rise in concentration identified in Charts 2. Since 1996 however, competition in the private car market seems to have been much more erratic. The picture is very different in the private motor cycle insurance where, aside from four years in the early 1990s, Chart 12 displays little evidence of competitive pressure.

In the case of the commercial fleet and non-fleet insurance market, Chart 13 shows a long period of erratic competition between 1985 and 1996, followed by several years of little competitive rivalry. On the other hand, the other commercial market of Chart 14 shows little evidence of competition except for a burst in the mid-1990s.

Taken together the results indicate that, although competition in the UK motor insurance market was a consistent feature prior to the mid-1990s, the intensity of competitive rivalry has since declined.

2. Competition and the Underwriting Cycle

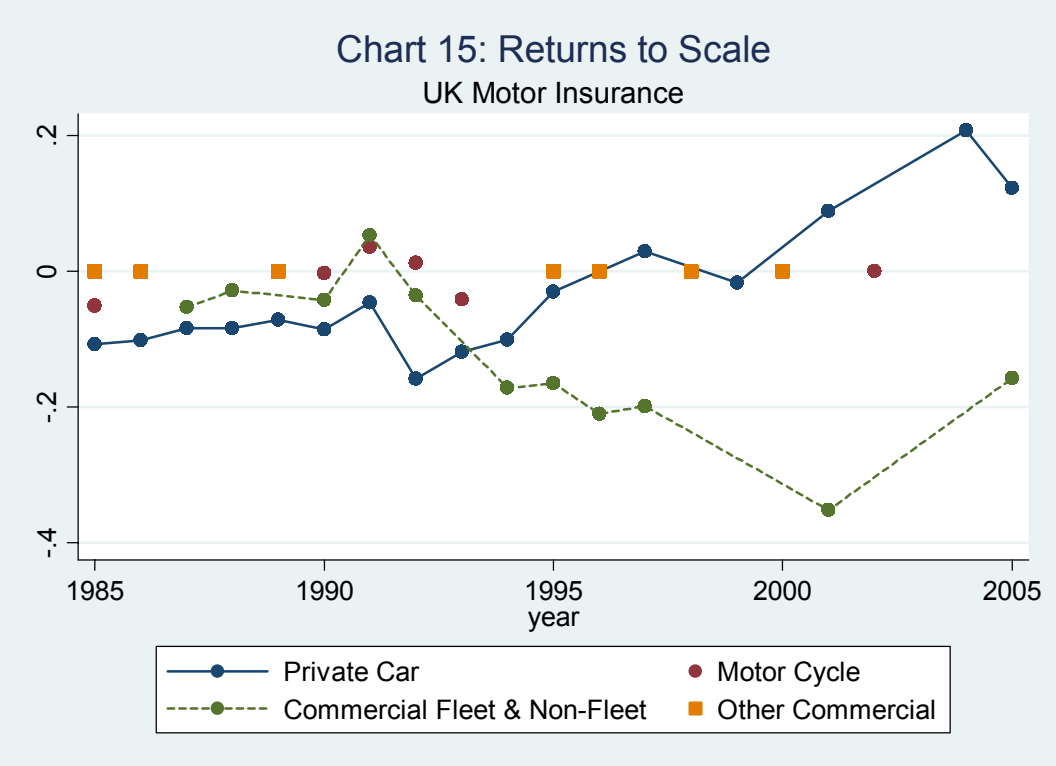
All four motor insurance markets display marked cyclicality in their price/cost margins (see Chart 3), and there is a degree of similarity in the price/cost margins across the four markets. However there is little evidence of any cyclicality in the competition measures in Charts 11-14, and the correlation between these measures across the four markets is less pronounced. This perhaps suggests that the similarities in price/cost margins across markets are not due to common competitive pressures, and that the cyclical nature of the aggregate price/cost margins is not driven directly by changes in competitive intensity[24].

[24] These results support the criticism of price/cost margins in section 3.1 that high margins are not necessarily an indicator of low levels of competition.

3. Returns to Scale

Estimates of the annual returns to scale parameters are provided in Chart 15. The results in Table 2 show that the null hypothesis H_0: $\sigma_u = 0$ can be rejected at the 95% level in every market except Other Commercial.

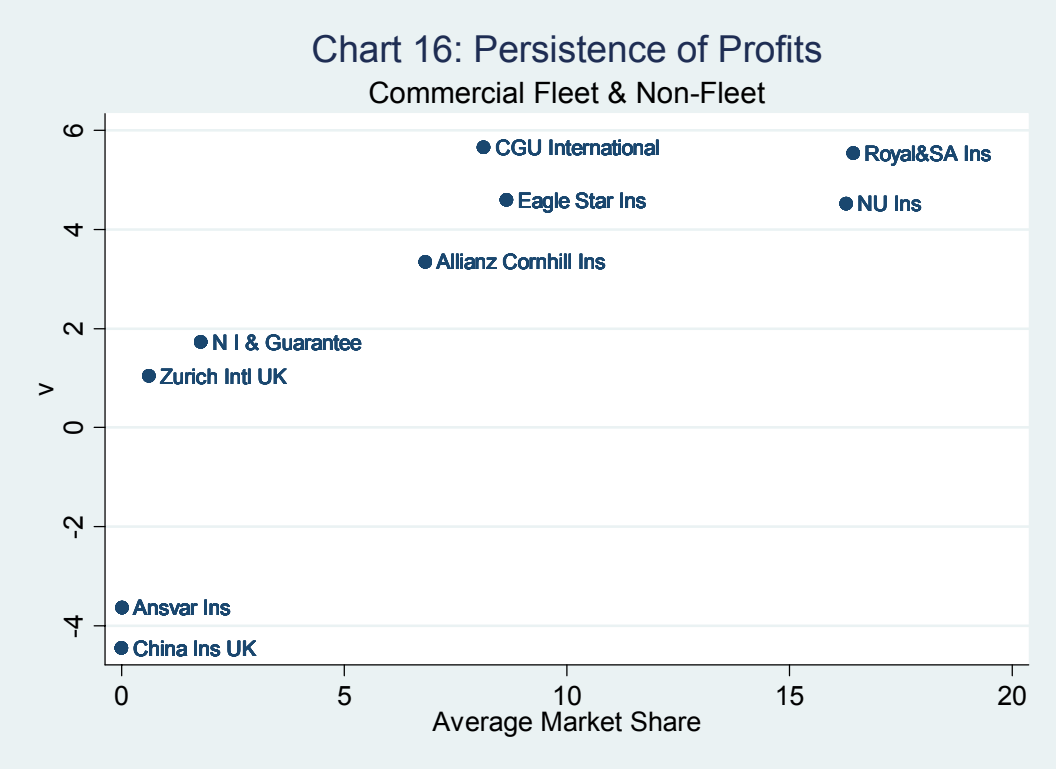
In the case of the private car insurance market, returns to scale appear to have been improving throughout the period and have been positive (denoting increasing returns to scale) since 1997. However the opposite appears to be the case for the Commercial Fleet and Non-Fleet market, where returns to scale have been worsening since the early 1990s and where there is evidence of diseconomies of scale (ie rts_t <0).



4. Persistence of Profits

Table 2 shows that the null hypothesis that companies do not earn non-zero long-run profits (ie H_0: $\sigma_v = 0$) is rejected in all four markets, indicating that there are persistent unobservable firm-specific factors that determine the level of profitability. Chart 16 illustrates the plot of the recovered value for v_i plotted against average market share for

insurers in the commercial fleet and non-fleet market with at least nine years of positive profits. The chart shows that the firms with the largest market shares are also likely to have positive long-run persistent profits (see also Chart 9). In all cases, the measure of persistent profits based on v_i identifies the same firms that are illustrated in Charts 7-10, with the additional advantage that firms with a dominant market share are not factored out of the persistency calculation.



6. Conclusion

A variety of possible measures of competition in the UK motor insurance markets are explored to discover which correlate most closely with prices and profitability. The various measures appear to suggest that the private and commercial motor insurance markets are not necessarily as competitive as is commonly believed.

Measures which focus on the behaviour of individual firms over time suggest that both short-run and long-run persistency of profits can be observed in most motor markets

after the market-wide cyclical effects have been removed. However an analysis of the long-run equilibrium price-cost margin and the firm-specific effects in the relative profits model suggests that a relatively small number of larger firms are able to generate above-the-norm profits on a sustained basis. The fact that some firms can earn positive profits over the long run suggests that there is insufficient competition to force them to lower their prices.

Measures which focus on markets at a particular point in time, without stripping-out the effect of any market-wide cycle, suggest that competitive pressure varies over time and across the markets for UK motor insurance. The Boone relative profits measure indicates that most markets were often competitive in the 1990s, but that the intensity of competitive rivalry appears to have lessened subsequently. In the private car insurance market for example, this relaxation in competitive pressure seems to have occurred over a period where the larger firms appear to have gained some benefits from increasing returns to scale. On the other hand, in the commercial fleet and non-fleet markets, the reduction in the intensity of competition appears to be concurrent with a worsening of the firms' returns to scale.

References

Aghion, Philippe, Christopher Harris, Peter Howitt, and John Vickers. (2001) Competition, imitation and growth with step-by-step innovation, *Review of Economic Studies*, 68(3), 467-492.

Association of British Insurers (2006) *Market impacts of regulating general insurance*, March, London

Besanko D, Dranove D, Shanley M and Schaefer S (2004) *Economics of strategy*, John Wiley & Sons, Hoboken NJ

Bikker J and van Leuvensteijn M (2005) An exploration into competition and efficiency in the Dutch life insurance industry, CPB Discussion Paper 48, Netherlands Bureau for Economic Policy Analysis, September

Blundell R and Bond S (1998) Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics*, 87 115-143.

Boone, Jan. (2000) Measuring product market competition, CEPR Working Paper 2636.

Boone, Jan. (2004) A new way of measuring competition, TILEC Discussion Paper 4.

Chamberlin, E (1933) M*onopolistic competition*, Harvard University Press ,Cambridge, MA

Financial Services Authority (2007) *ICOB Review Interim Report: consumer experiences and outcomes in general insurance markets*, March, London

Griffith R, Boone J and Harrison R (2005) Measuring competition, AIM Research Working Paper 22, August, ISSN 1744-0009

Hart, Oliver D. (1983) The market mechanism as an incentive scheme, *Bell Journal of Economics*, 14, 366-382.

Hermalin, Benjamin E. (1992) The effects of competition on executive behavior, *RAND Journal of Economics*, 23, 350-365.

Leibenstein, H. (1966) Allocative efficiency v. X-efficiency, *American Economic Review,* 56, 392-415.

Lipczynski J, Wilson J and Goddard J (2005) *Industrial organization: competition, strategy, policy*, 2nd ed, FT Prentice Hall, Harlow

Martin, Stephen. (1993) Endogenous firm efficiency in a Cournot Principal-Agent model, *Journal of Economic Theory*, 59, 445-450.

Martin, Stephen. (2002) *Advanced Industrial Economics*, Blackwell, Mass., 2nd ed.

Mueller, D (1977) The persistence of profits above the norm, *Economica*, 44, 176, 369-380

Schmidt, Klaus M. (1997) Managerial incentives and product market competition, *Review of Economic Studies* 64, 191-213.

Searle S R., Casella G and McCulloch C (1992) *Variance Components*, Wiley, New York

Tirole J (1988) *The theory of industrial organization*, The MIT Press, Cambridge, MA