Unionization, Consumer Demand and Economic Performance in the UK

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ABSTRACT

This thesis investigates the impact of trade unionism and consumer behaviour on economic performance in Britain. The economic performance measures used in this research are profitability and the level of R&D expenditures. Firm and plant level data are used in the investigation and the main findings are as follows:

Unionization, on average, impacts negatively on the profitability of UK firms, even after controlling for firm specific effects. However, the union effect on profitability has decreased dramatically over the 1980s and this may bear a relationship with the anti-union legislation that took place during that period in Britain. It also seems that the union effect depends a great deal on the prevailing bargaining structure, so that the industrial relations regime has an important say in the union capacity to extract rents.

In terms of the relationship between unionization and R&D expenditures, whenever human capital and technological opportunities are controlled for, the negative association present in the raw data completely disappears. This result is obtained using two completely independent data sets, one at the firm and the other at the plant level. Furthermore, some evidence was found, both in the firm and in the plant level data, of a non-linear (concave) relationship between unions and R&D investment.

The combination of supply and demand information, to analyze the interaction between consumers and firms in several markets, produced very interesting results. Demand elasticities, estimated using household level data, have a sizable and significant impact on firms' mark-ups, computed from company accounts data. Time-varying household characteristics provide a unique instrument set that can be used to identify the supply equation. Interactions of the demand elasticities with market structure variables tend to show that the effects of industry concentration and import penetration on profitability are stronger in industries where demand is elastic, which can be seen as evidence against the "collusion" explanation of the link between market structure and profitability.

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DECLARATION

1) No part of the thesis has been presented to any University for any degree

2) Chapter 4 of the thesis was undertaken as joint work with my supervisor John Van Reenen and David Ulph. As such, I contributed at least to 33% of the work. I would like to thank my co-authors for their permission to use this joint work. A statement from them confirming this is given below:

I confirm the above declaration referring to joint work I have carried out with Naercio Menezes Filho

David Ulph

I confirm the above declaration referring to joint work I have carried out with Naercio Menezes Filho

John Van Reenen

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Chapter 1

Introduction

The main aim of this research is to examine the determinants of the economic performance of British companies and establishments. Economic performance is viewed here as an important indicator of a country's living standards, alongside social and health indicators. The main measure of performance studied here is firms' profitability, but a detailed study of the determinants of firms and plants' R&D intensity in Britain is also provided . Profitability has a major role in this study chiefly for its dual characteristic. On the one hand, it is one of the most employed means of assessing companies' performance, reflecting their financial health and the market opportunities while, on the other hand, it indicates how sales revenues are being distributed among workers, managers and shareholders. R&D intensity, in turn, is one on the major indicators of the thrust of an economy towards future productivity growth, profitability and international competitiveness. The remaining of this section will expand on the motivation behind this research and explain the basic structure of it.

1.1 Motivation

This research is implicitly divided in two parts. In the first one, the focus is on the impact of trade unions on two measures of economic performance: profitability and R&D expenditures. The effect of trade unionism in the economic system can be analysed from two very different perspectives. The first one, with its emphasis on allocation, views unions as distorting the price signals through their use of monopoly power, which gives rise to inefficiencies in the allocation of resources. On the other hand, the more positive view focuses on the unions' role as facilitating the communication between workers and management, thereby improving economic efficiency. The views underlying the unions' impact on profitability also reflect two different, but not mutually exclusive, perspectives. If profitability is viewed in terms of measuring success and signalling future market perspectives, then unionism, by reducing profitability, would be damaging future employment and investment. This would also be the case if profitability is generating funds for cash-constrained firms to invest. On the other hand, unions may play an important role in the process of redistribution of part of the firms' excess surplus, perhaps achieved through restrictive practices in the product market by the use of monopoly power, to workers and their families, who, it could be argued, have a higher marginal utility of income than shareholders or managers.

Britain, in the 1980s, saw a number of legislative changes aiming at diminishing union power, as part of a more general anti-union climate prevailing in the country at the time. Therefore, whatever one's view about the impact of unionization on economic performance, it seems likely that this impact have changed in this period. Indeed, some evidence was produced showing that the wage gap between unionized and non-unionized workers was reduced in the 1980s and that the relative productivity growth of unionized firms also increased during that period (see the literature review in chapter 3). One of the aims of this research is to shed more light on those issues, by investigating whether the presence of unions really is associated with lower profitability and also by examining what happened to the union power, as measured by the union-non-union profitability differential, over the 1980s in the UK.

In terms of the relationship between unionism and R&D, if unions were found to have a negative effect on R&D intensity, the conclusion would perhaps be more straightforward, since that would signal bad future times in terms of productivity and growth, eventually leading unionized firms to bankruptcy. The main argument behind the reasoning that unions are bad for R&D is based on their rent-seeking behaviour. Firms know that, once investments have been executed, unions will have every incentive to extract the rents generated from them. This would reduce the optimal R&D investment level ex-ante. However, this prediction will not always hold true, once one relaxes the main simplifications of this basic model and incorporates a tournament R&D model and competition in the product market, for example.

The second part of this research deals with the impact of consumer demand on economic performance. This is an important subject, that has been all but neglected in the traditional applied industrial organization literature. The basic mechanism underlying the functioning of the product market is the interaction between supply and demand, that is, firms and consumers make their decisions simultaneously and, as a result, prices and quantities are determined by this interaction. Consumers that are very sensitive to price variations make even the most collusive group of firms impotent to increase their prices by a great extent. A simple monopoly model, for example, predicts an inverse relationship between demand elasticity and profitability. Nevertheless, empirical studies in the traditional Structure-Conduct-Performance literature have concentrated on supply-side factors such as concentration, market share, advertising and entry barriers, overlooking the other blade of the scissors. In the second part of this research, an effort is made to start rectifying this omission. In what follows, a brief description of the thesis is offered.

1.2 Layout of the Thesis

The first part of this thesis is divided in three chapters. Chapter 2 sets the stage for an examination of the union impact on profitability and R&D expenditures. Firstly, some game-theoretical bargaining models are briefly described and their application to the union-firm bargaining framework examined. The effects of modifying the scope of bargaining, introducing product market competition and different industrial relations regimes on the results of the basic model are also examined. Then, some representative studies that investigated empirically the relationship between unionization and profitability/R&D are reviewed. In doing this, the advantages of using firm instead of industry-level union data and the problems involved in controlling for endogeneity and fixed effects in the estimation procedure will be emphasized.

Chapter 3 proceeds to investigate the relationship between profitability and unionization. Firstly, a theoretical framework is developed that analyses the union impact on profitability. Necessary conditions are established for an increase in union's bargaining power to reduce the profit/sales ratio of two firms competing in the product market. The focus is then on the effects that different bargaining structures have on the union-non-union profitability differential. The empirical part of the chapter uses company level panel data and an industrial relations survey, carried out amongst managers of UK firms, to examine the union-profitability effect in the

1980s in the UK. It checks whether the union effect is robust to controlling for firm-specific fixed effects, examines the trajectory of this effect on a year by year basis from 1984-90 and finally inspects the role of multi-unionism and decentralization of bargaining in the union-profitability effect.

Chapter 4 investigates the relationship between unionism and R&D intensity. Firstly, it uses company and plant level data, together with the survey used in chapter 3, to empirically examine the effects of unionization on R&D expenditures. To the best of our knowledge this will be first such an attempt in Britain. Firstly, the raw correlation between union presence and R&D is examined at the firm level and the robustness of this correlation is examined, with the inclusion of a series of firm and industry level controls, especially those usually absent from U.S. studies, such as time-varying technological opportunities and firm-level skill composition variables. The chapter then proceeds to examine within-industry R&D models and the role of non-linearities in the union-R&D relationship. Finally, the robustness of the firm level results is checked with the use of a completely different plant-level data set. In the theoretical appendix a model is detailed, which incorporates product market and R&D competition into the traditional model (in which unions always reduce investments). It is shown that some of the predictions of the model are compatible with the results obtained in the empirical part of the chapter.

Chapter 5 begins the second part of the thesis, that deals with the relationship between consumer demand and economic performance. It aims at examining the relatively few studies that used information on the demand side of the economy to make inferences about the "monopoly power" of firms and/or industries. The survey focus on studies in the two main research lines of the recent industrial organization literature: the Structure-Conduct-Performance (SCP) line and the New Empirical Industrial Organization (NEIO) one. The chapter concludes with a critical analysis of the existing econometric methods used to estimate profitability equations with panel data, and an examination of the problem of measurement errors in the market share variable traditionally used in these equations.

In chapter 6 the demand estimation takes place. First, the main models estimated by the consumer behaviour literature in the past are reviewed and the Almost Ideal Model, used in the present study, is specified. Four groups of commodities are defined, and the parameters of each of these demand systems are estimated using data from the UK Family Expenditure Surveys from 1974 to 1992. Then, budget, compensated and uncompensated (time-varying) price elasticities are computed for each of the disaggregated products under analysis. Finally, the behaviour of the actual and predicted shares and of the estimated elasticities over time is investigated.

Chapter 7 aims at matching the demand side information to the supply side, in order to examine the effect that consumer behaviour may have on firms' mark-ups in the UK. In this chapter, the demand elasticities estimated in chapter 6 are used as independent variables in profitability equations. It is argued that the time-varying household characteristics provide a unique way to identify the supply equation. It is also shown how the relationship between price elasticities of demand and profitability can help to shade some light into the relationship between market structure and firms' performance.

Chapter 8 presents the main conclusions of the thesis, together with its main caveats and indications of future research to be carried out in the area.

Chapter 2

Unions and Economic Performance: A Survey

2.1 Introduction

This chapter surveys theoretical and empirical studies that investigated the relationship between trade unions and firms' economic performance. The chief way through which a union can influence economic outcomes within a firm is by bargaining with it on a series of issues. Therefore, the first step in this survey will be to review some game theoretical models that describe bargaining processes between two parties and find equilibrium solutions that depend on the structure of the games. It then examines models that apply this general framework to the bargaining process between firms and unions, deriving predictions relating to the effect of unionization on performance indicators, conditional on the scope of bargaining. Finally, it reviews studies that emphasize the importance of different structures of bargaining in shaping the outcome of the bargaining process. In the second part, the empirical evidence on the unions' impact on firms' performance indicators such as profitability and R&D investment will be investigated .

2.2 Bargaining Models

Models of union-firm bargaining are generally applications of a class of game theoretical models first described by Nash (1953). Bargaining models can be either static and axiomatic (originated with Nash, 1953), or dynamic and strategic (first analyzed by Rubinstein, 1982). Binmore (1982) describes the conditions under which the two types of models generate identical solutions. The differences and correspondences between these two types of models were also examined in details by Binmore, Rubinstein and Wolinsky (1986). The following draws primarily on their work.

The advantage of the dynamic non-cooperative models of bargaining is that the environment surrounding the game, the players' strategies and the bargaining process are described explicitly. The static approach assumes away these elements. The only information needed for the solution to be determined in the axiomatic approach are the players' utility functions and the utility levels that represent what has been variously called *status quo* points, disagreement pay-offs, threat points or fall-back positions.

In this class of game theoretical bargaining models, both parties have an incentive to reach an agreement. Binmore *et al* (1986) define two types of bargaining models, depending on what drives the players to reach a solution. The first is the bargaining model with time preferences, where the players are impatient to reach a solution, as they incur in losses associated with the continuation of the bargaining process. In this model, the players' utilities incorporate preferences towards time. The second is the bargaining model with an exogenous risk of breakdown, in which the solution is driven by the fact that the game can end due to exogenous factors and, if this happens, both parties will gain no more than their fall-back positions. In this model, players' preferences may differ with respect to their attitudes toward risk.

In order to describe a game, one needs to specify the form of it, the players' preferences and strategies and the *status quo* points. In the games to be examined in this thesis, the bargaining process takes place over time, consisting of a sequence of bargaining periods Δ. At each point in time, one of the players suggests one agreement and the other can either accept or reject it. If the other player accepts the proposition, the game ends. If she rejects, the game goes on to the next bargaining period and it is now her turn to propose an agreement. The players' strategies are sequences of rules that will govern the behaviour of each player at each stage of the game, and that may or may not depend on the entire history of the game.

In time-preference games, the players' preferences (preference orderings) are defined over the feasible set of solutions X , defined as:

$$X = \{(x_1, x_2) \mid x_1, x_2 \geqslant 0, x_1 + x_2 = 1\} \tag{2.1}$$

and over the time when the agreement can take place $T = [0, \infty)$. In these games, there is a unique perfect equilibrium outcome (described by Rubinstein, 1982) which is the acceptance of the first order (x_1^*, x_2^*), that satisfies a series of assumptions (stated in Binmore *et al*, 1986).[1] For example, if m_1 is the utility player *one* gets from the optimal deal (x_1^*, x_2^*) and m_2 is the utility player *two* gets from the same deal, it can be shown that, in equilibrium, assuming that $\Delta = 1$ and that the strategies are stationary [2]:

$$m_1 = m_2 = \frac{1}{1+\delta} \tag{2.2}$$

where δ is the discount factor: $\delta = e^{-\rho}$ and ρ is the discount rate.

Binmore (1980) derives the conditions under which, as the length of the bargaining period approaches 0, the equilibrium converges to the solution of the static Nash approach :

$$N = \arg\max_x (u_1(x) - s_1^0)(u_2(x) - s_2^0) \tag{2.3}$$

where s_1^0 and s_2^0 are the *status quo* points, in which each player will neither improve nor deteriorate her position as compared to the beginning of the game.

An alternative, to deal with asymmetric situations, is the generalized Nash maximand:

$$N = \arg\max_x (u_1(x) - s_1^0)\beta(u_2(x) - s_2^0)^{1-\beta} \tag{2.4}$$

In this case, the bargaining problem can be treated as a maximization of the objective function (2.4), which is a weighted average of union and firm's utilities, with weights depending on β. The asymmetry in these games can arise from: i) different players' preferences towards time;

[1] The proofs of these results will not be discussed here, as this would take this survey beyond its purposes.
[2] See Sutton (1986).

ii) who makes the initial offer; or iii) different bargaining periods for each player ($\Delta_i \neq \Delta_j$).

The first factor can either be totally incorporated in the preferences or each player can be allowed to have a different discount factor, reflecting different degrees of impatience. In the later case, it can be shown that $\beta = \rho_2/(\rho_1 + \rho_2)$. The second factor (asymmetry in the procedure) is somewhat counter-intuitive, but it vanishes as $\Delta \to 0$. In the third option, if both $\Delta_1$and Δ_2 approach 0, with their ratio remaining constant, then $\beta = \Delta_1/(\Delta_1 + \Delta_2)$.

Finally, outside options can be incorporated into the game by assuming that each time a player has to make a decision, she has the option of withdrawing from the process. In this case, the outside option will only affect the solution if one the parties strictly prefers this option to the equilibrium outcome (x_1^*, x_2^*) (see Binmore et al, 1986 and Sutton, 1986).

2.3 Application to Union-Firm Bargaining

The bargaining process between the union and the firm can be analyzed with the game theoretical tools briefly described in the previous section. Most of the applications of bargaining models to union-firm bargaining have drawn on Binmore (1980), and used directly the Nash Maximand (2.4) to derive the solution to the bargaining process. In order to do so, one has to specify the firm and union's utility functions, the disagreement pay-offs of both parties and the scope of the bargaining.

Union and Firm's Utilities

In describing the union's objectives, Oswald (1986) describes the most common approach as the "expected utility" one, where the union's utility function is described by:

$$U^e = \frac{n}{m}u(w) + \frac{m-n}{m}u(b) \tag{2.5}$$

where U is the union utility, n is firm's employment, m is union membership, w is wages and w_b is the level of unemployment benefit or alternative wage. In this specification, the union cares about all its identical workers, each one of them earning wages w with probability n/m and receiving the benefit or alternative wage with probability $(m-n)/m$.

Provided membership is held fixed, the expected utility specification is equivalent to:

$$U^u = nu(w) + (m - n)u(b) \tag{2.6}$$

In fact, it can be shown (see Booth , 1995) that $U^e = m * U^u$. Moreover, assuming that the union takes $mu(b)$ as given, U^u nests the wage-bill maximization ($U^w = wn$) and the rent maximization ($U^r = n[w - w_b]$) objectives as special cases.

The utility each worker derives from wages $u(w)$ is generally defined as being continuous, twice differentiable, $u^{'}(w) > 0$ and either $u^{''}(w) > 0$ or $-u^{''}(w)w/u^{'}(w) = r$, constant (see Dowrick, 1989). These conditions mean that the marginal utility of wage must be positive, and that, if $u(w)$ is not concave, it will exhibit constant relative risk aversion. For example, Svejnar (1986) assumes:

$$u(w) = \frac{w\kappa}{\kappa} \tag{2.7}$$

with $r = 1 - \kappa$ and $\kappa < 1(\kappa > 1)$ implying risk aversion (risk loving).

The firm's objective is generally assumed to be the maximization of its profits:

$$\pi = R(n) - wn - f \tag{2.8}$$

where R is total revenue and f are fixed costs.

The union's disagreement pay-offs $(\underline{U_i})$ consist of financial resources and solidarity funds [3], whereas the firm's one $(\underline{\pi_i})$ is the value of profits it can obtain from the operation of other plants, for example.[4]

2.3.1 Bargaining Scope

The bargaining between firms and unions can cover many economic variables. Economists have concentrated on analyzing the situations where bargaining can cover wages, employment, and

[3]Booth (1995) and Svejnar (1986) define the union status quo position as being equal to $u(b)$, the utility derived from the alternative wage. This seems more likely to stand as an outside option, given the discussion carried out above (see also footnote below).

[4]The definition of the *status quo* positions in union-firm bargaining models depends on the definition of the situation at $t = 0$. If it is the beginning of the bargaining process, then both firm and union will continue to receive their normal income. If, on the on other hand, it means a strike position, then the union's *status quo* position will depend on strike funds and the firm's one on the other revenue sources. The literature seems to adopt the second position and so will proceed on this assumption.

investment decisions [5]. The simplest case will be analysed first, that is, where firms and unions bargain over wages only.

Bargaining over wages only

In this case ("right to manage") the union and the firm bargain over wages in the first stage and then the firm sets employment unilaterally in the second stage. The resulting wages will be the solution to the generalized Nash maximand :

$$\arg\max_{w} \beta \ln[\pi(w) - \underline{\pi_i}] + (1-\beta)\ln[U(w) - \underline{U_i}] \tag{2.9}$$

subject to

$$R^{'}(n) = w \tag{2.10}$$

The first-order condition will yield:

$$\beta \frac{\pi_w(w)}{\pi(w) - \underline{\pi_i}} + (1-\beta)\frac{U_w(w)}{U(w) - \underline{U_i}} = 0 \tag{2.11}$$

This expression implicitly defines the resulting wage level as a function of $\beta, \underline{U_i}, \underline{\pi_i}$ and the parameters of the utility and revenue functions. In this model, wages and employment will be set in the labour demand curve and will vary with $\beta, \underline{U_i}$ and $\underline{\pi_i}$. A lower β (which can be interpreted in terms of the firm's relative impatience to reach an agreement) will imply higher wages and lower employment. The limiting cases are when $\beta = 0$ (monopoly union model) where the wage is determined by the union and $\beta = 1$, where the wage equals the competitive one.

Bargaining over wages and employment

It can be shown that the outcome of the "right to manage" model is not efficient. It would be possible for one of the parties to be better off without making the other worse off. This would happen if both parties were to bargain over wages and employment simultaneously (see McDonald and Solow, 1981). In this case, expression (2.9) is maximized with relation to both

[5] But see also Layard et al (1991) for a model where firms and unions can also bargain over effort.

wages and employment, generating the *contract curve* [6]:

$$R'(n) = w_b - \frac{u(w) - u(b)}{u'(w)} \tag{2.12}$$

The contract curve is defined by the locus of pairs (w, n) satisfying the property that the slopes of the isoprofit and union indifference curves are equal. Analysis of the contract curve yields interesting conclusions. Firstly, (2.12) shows that marginal revenue product of labour is less than the wage rate, by an amount equal to the union marginal rate of substitution of employment for wages. If the union is risk neutral, $R'(n) = w_b$ and the employment is set efficiently also from the society point of view.

By totally differentiating (2.12) with respect to wages and employment :

$$\frac{dw}{dn} = \frac{R''(n)u'(w)^2}{u''(w)[u(w) - u(b)]} \tag{2.13}$$

It can be seen that, since by decreasing returns $R''(n) < 0$, the slope of the contract curve will depend on the sign of $u''(w)$. If the union is risk-averse, that is, $u''(w) < 0$, the slope is positive and the union emphasizes the employment issue in the bargaining, to insure its members against unemployment. If the union is risk-neutral, the contract curve will be vertical, while risk-loving implies a negatively sloped curve, such as the usual labour demand one.

The solution of the bargaining problem, however, involves only one point if the contract curve. This point is achieved by the interaction between the contract curve and the rents division curve, obtained by differentiating (2.12) with respect to n (see Booth, 1995):

$$w = \frac{(1 - \beta)R(n)}{n} + \beta R'(n) \tag{2.14}$$

This curve is a weighted average of the average and marginal revenue product of labour curves, with weights given by the firm's "bargaining power" parameter β. The lower is β, the closer the solution is the average revenue product of labour curve, and the lower will be the value of profits associated with an isoprofit curve. In the case of the risk-neutral union, for example, employment is exogenously determined (by w_b) and wages will be equal to the competitive wage

[6]We are following the literature by that the union's status quo position is $u(b)$ and that the firm's one was normalized to zero (see Booth , 1995) and Svejnar (1986).

plus a share $(1-\beta)$ of the firm's profits per worker evaluated at w_b :

$$w = (1-\beta)\frac{(R(n) - nw_b)}{n} + w_b \tag{2.15}$$

Although bargaining over wages and employment would be more efficient for both parties, unions are not typically observed bargaining over employment (see Oswald, 1993). Some authors (see McDonald and Solow, 1981) have argued that bargaining over employment could be approximated by bargaining over manning levels. However, Layard et al (1991) argued that fixing the capital-labour ratio still allows the employer to alter the number of machines and shifts, ultimately determining the employment level.

Why do not unions and firms bargain over employment levels, if it would be efficient to do so? It could be that the median union member is unconcerned with employment (as in the case of lay-offs by seniority), so that the union has flat indifference curves in the labour demand region and efficient bargains are therefore on labour demand curve (see Oswald, 1993). It could also be that the perfect information assumption is too strong. If there is asymmetric information over future demand conditions, then in bad times firms would want to renege on the contract involving employment.

Bargaining over wages, employment and investment

The main difference between this case and the one analyzed in the previous section occurs in the case where investment is irreversible and the union cannot credibly sign contracts that will bind it to the level of wages and employment that will prevail after investment has occurred. Then, the only bargaining that can take place is over wages and employment (conditional on investment). The model extensively used to analyze this issues is Grout (1984) and the following draws on it.

Grout (1984) assumes that the shareholders are interested in maximizing their wealth and that the union is risk-neutral and wants to maximizes its income nw. The union's *status quo* position is given by the alternative wage nw_b, whereas the firm's one depends on the possibility of binding contracts. If binding contracts are possible, the firm's *status quo* position is normalized to zero, whereas if they are not, if falls by $(c-q)k$, where k is capital, c is the per unit purchase price of capital and q is its resale price $(q < c)$.

In the case of binding labour contracts with risk-neutral unions, the basic result (2.15) above is maintained:

$$w = (1-\beta)\frac{(R(n) - nw_b - kc)}{n} + w_b \tag{2.16}$$

with capital and labour being used efficiently and the union grabbing a percentage of the firm's profits per worker, depending on its bargaining power. However, if contracts are non-binding, Grout (1984) shows that the change in the firm's *status quo* position means that the firm behaves as if it faced a cost of capital equal to :

$$\gamma = \frac{c}{\beta} + q(1 - \frac{1}{\beta}) \tag{2.17}$$

This means that, although labour is still allocated efficiently, there is under-investment if $\beta < 1$, since in this case $\gamma > c$. Because a proportion of the investment costs is sunk, the union, once the investment has taken place, has every incentive to extract a proportion of the rents generated by it and this causes the shareholders to invest less. The wages are now going to be:

$$w = (1-\beta)\frac{(R(n) - nw_b - k\gamma)}{n} + w_b \tag{2.18}$$

The wage level is still decreasing in β, but could be higher or lower than in (2.16).

Multi-Unionism and Product Market competition

The survey now examines models in which a firm bargains with more than one union and may compete in the product market with other similar firms. In this manner it will be able to assess the impact that different industrial relations regimes and product market competition have on the results obtained so far.

The pioneer study in this area is that of Horn and Wolinsky (1986). In their bargaining model, each firm bargains with two different unions and, as long as agreement has not been reached, it meets unions A and B alternatively. In each such meeting, either the employer or the worker makes an offer and, if this offer is rejected, the bargaining process continues. If agreement is reached with one union but not with the other, the employer continues bargaining with the other union (two-person Rubinstein model) and may or may not start production with the available workers.

In this model, the firm maximizes profits and both unions maximize income (risk neutrality and no alternative wage). The firm's *status quo* position when agreement has been reached with only one union depends on whether it starts producing with only one type of workers or not. The unions status quo position is normalized to zero. The firm's revenue function is given by $R(n_a, n_b)$ and the two types of workers (each type represented by a different union) are complements if:

$$\frac{\partial^2 R(n_a, n_b)}{\partial n_a \partial n_b} > 0 \tag{2.19}$$

and vice-versa. The firm sets employment unilaterally in the first stage. In the second, the two unions decide whether to form an encompassing union or to bargain with the firm separately. In the third stage, bargaining over wages take place.

Horn and Wolinsky (1988) extend the strategic bargaining model of Rubinstein (1982) to deal with situations in which one party bargains with two other parties simultaneously. The first result that comes out of this model is that the unions will prefer to form an encompassing union if the total wage bill in this case is higher than the one in which they bargain separately with the firm.

The main result is that when the two types of labour are sufficiently close substitutes to each other, then the unions prefer to form an encompassing union. This happens primarily because, if the unions were to bargain separately, it would pay for the firm to start production with union A if an agreement is reached with it. Therefore, the firm's *status quo* position would increase when bargaining with union B. When the two types of labour are sufficiently close complements to each other, then the unions prefer to bargain separately with the firm. This is because the firm's status quo position would be zero in case of an agreement with only one union and because the bargaining position of each union does not take into account the losses imposed on the other union by disagreement.

Davidson (1988) developed a model in which 2 firms (i and j) compete in the product market and where the separate firm-level bargaining case is compared with the one where an industry-level union represents all workers in the industry. Dowrick (1992) generalizes Davidson (1988) model to take into account various industrial relations structures. The model used by both authors assumes that each firm bargains over wages with the union representing its workers in the first stage, and then it sets output and employment to maximize profits at a given wage level (right to manage model).

The product market competition (second stage) takes place only between the two firms (that produce an homogeneous product) and takes the form of a Cournot-Nash model. There is only input and each worker produces one unit of output. Given the wages (determined in the first stage) it is possible to derive profit and labour demand functions, which are assumed to be decreasing in own wages and increasing in the other firm's wages.[7] Each union, on the other hand, maximizes a utility function increasing in own firm's wages and employment (which is a less restrictive assumption than risk-neutrality). Union utility is also assumed to increase in the other firm's wages, as a result of employment effects described below.

The introduction of competition in the product market means that the two bargaining procedures are not independent from each other. Suppose that an agreement has been reached between firm j and its union (B). For a given w_j, there will be a locus of Pareto efficient profits and utility points facing firm i and its union A. Higher values of w_j will enhance firm i's competitive position and shift that Pareto frontier outwards (increasing the size of the pie to be bargained over by union A). Although the bargaining situation is very complex (two simultaneous two-person bargaining problems with interdependent Pareto frontiers), Davidson (1988) shows that the solution depends only on what happens in the sub-games in which one firm and its union are still negotiating and the other wage has already been determined. It is also shown that as the discount factor tends to 1, the perfect equilibrium converges to the Nash bargaining solution:

$$w_i(w_j,\beta_i) = \arg\max_{wi} N^i(w_i, w_j, \beta_i) = (\beta_i)Ln[\pi_i - \underline{\pi_i}] + (1-\beta_i)Ln[U_i - \underline{U_i}] \tag{2.20}$$

The FOC for this maximization problem is:

$$\frac{\partial N^i}{\partial w_i} = N_i^i(w_i, w_j, \beta_i) = \beta_i \frac{\pi_i^i}{\pi_i - \underline{\pi_i}} + (1-\beta_i)\frac{U_i^i}{U_i - \underline{U_i}} \tag{2.21}$$

and the SOC :

$$N_{ii}^i = \frac{\partial N_i}{\partial w_i \partial w_i} < 0 \tag{2.22}$$

[7]This follows from the assumption that firms' products are strategic substitutes in the product market (see Davidson , 1988).

Expression (2.21) will define the two "wage reaction" functions: $w_i(w_j)$ and $w_j(w_i)$ whose intersection will define the equilibrium wages w_i^* and w_j^* . It can be shown (see Davidson , 1988 and Dowrick, 1992), that under certain conditions, this "reaction functions" will slope upwards, so that outward shifts in both of them will increase the equilibrium wages. Therefore, to check whether a change in the industrial relations structure do lead to an increase in wages shift the reaction functions outwards, it is necessary to compare the FOC in both cases, that is, the utility functions and the status quo positions in both situations.

Davidson (1988) shows, for example, that when the unions bargain separately with each firm, they do not take the effect on an increase in w_i on n_j into their utility functions and, therefore, they tend to bid for lower wages. Moreover, this effect also means that the unions' status quo position is strengthened in the industry level encompassing union. Therefore, a centralization of the bargaining from firm to industry level would tend to increase wages.

Finally, Dobson (1994) highlights the importance of the timing of the bargaining between one industry-wide union and two firms competing in the product market. It is assumed that the union first bargains with firm i, then (in the second stage) it bargains with firm j (only when an agreement has been reached with firm i) and, in the third stage, both firms are Cournot competitors in the product market. Dobson (1994) shows that firm i is in a better bargaining position that firm j, since, when the union comes to bargain with firm j, it already has a significant status quo position, whereas it has a zero level when negotiating with firm i . Moreover, if there are asymmetries between the firms (differences in "bargaining power", for example), the union prefers to negotiate with the "weaker" firm first in order secure a higher wage rate and use it to strengthen its status quo position when bargaining with the "stronger" firm.

2.4 Empirical Studies

This section reviews studies that empirically investigated the relationship between unionization and various aspects of economic performance. This does not intend to be an exhaustive survey of the literature. It will try to concentrate on the most representative studies in each area.

2.4.1 Unions and Profitability

All game-theoretical models surveyed above predict that an increase in the union's "bargaining power" will increase wages. An obvious empirical question is whether this impact is observed in practice. However, "bargaining power" is not usually observed. Thus, many studies have tried to estimate union power by measuring the wage premium unionized workers receive in relation to the non-unionized ones. There is huge literature on the union-non-union wage-gap. A recent comprehensive survey can be found in Booth (1995), that concluded that the gap has been found to be between 12% and 20% in the US. and between 3% and 19% in Britain.

A related question is about the impact that unionization might have on firms' performance indicators. It could be argued that the union effect on profitability, for example, could be inferred from the impact on wages since, for given prices, output and the level of other inputs, an increase in wages would always cause a reduction in profits. However, unionization does seem to have an impact on other factors, like productivity, for example [8]. Moreover, the profit/sales ratio is a better indicator (as compared to wage outcomes) of how total revenues are being appropriated by the different agents inside a firm (workers, vis-a-vis shareholders and managers), and may also be an indicator of the availability of internal funds for investment (see Bond and Meghir, 1995).

Studies Using Industry-Level Union Data

Empirical studies on the effect of unionization on profitability are much more sparse than the ones on union-wage effect, both in Britain and in the U.S. Initially, there was no firm level information available and the first studies were carried out using cross-sectional industry data on profitability and unionization. The controls traditionally used in industry-level profitability regressions include market concentration, advertising/sales ratio, capital/sales ratio and imports/sales ratio. Generally, the profitability data come from the US. Census of Manufactures or U.K. Census of Production and is measured as [(sales - payroll - cost of materials)/sales].

The main problem of using industry data is that the estimated union effect is an average one that conceals as many things as it reveals. If the magnitude of the union-profitability

[8] In the next chapter, a simple model will be developed, that shows under what conditions an increase in wages would reduce profitability.

effect is defined at the firm-level (which is plausible), then industries with the same level of union density can have very different profitability averages, depending on the distribution of workers across their firms. Moreover, when working with cross-sectional industry data, it is impossible to control for industry specific effects that might be correlated with the union variable utilized. Many studies use firm level data on profitability (and other controls), but unionization is defined at the industry level (see Connolly, Hirsch and Hirschey 1986, Hirsch and Connolly, 1987, Salinger, 1984, etc.). Clearly, the problems pointed out above are not attenuated by this procedure.

Freeman (1983) is one of the pioneers in this kind of study. He finds that unionization, measured by percentage of workers covered by union bargaining agreements [9], lowers the price-cost margin only in more concentrated industries. Karier (1988) uses data from 1965-80 and also reports results indicating that unionization (percentage of workers organized by industry) only reduces profitability in high concentrated industries. Voos and Mishel (1986) use a coverage measure of unionization and find that 100% coverage would reduce profitability by about 22 to 35% (depending on union exogeneity assumptions) as compared to industries with no workers covered by union contracts in 1972. Domowitz et al (1986) estimate that Freeman (1983)'s time-invariant measure union coverage impacts negatively on the profit/sales ratio, reducing it by around 25% at 100% coverage between 1958-81[10]. Finally, Connolly, Hirsch and Hirschey (1986) and Hirsch and Connolly (1987) use firm level profitability (and industry level union density) data to find that unions depress profits only in R&D intensive firms (see below). The divergence among all those results seems to confirm that the problems above may be interfering quite strongly with the results.

In Britain, Cowling and Waterson (1976) use union density data provided by the Industrial Relations Research Unit (University of Warwick) for 1958, 1963 and 1968 and report no union effect in a first-differences specification [11]. Finally, Conyon and Machin (1991) use time-unvarying data on union coverage to find that unionization tended to reduce industries' profit/sales ratio between 1983-86.

[9] These data were collected by the Bureau of Labor Statitics' Expenditures on Employee Surveys and are used in many other studies (see below).

[10] It is perhaps too strong to assume that unionization has remained stable during such a long period (Freeman's data is an average of the 1968, 1970 and 1972 values).

[11] Although the authors acknowledge that this may reflect bad measurement since "the problem of allocation of general union membership to constituent industries is a very difficult one" .

Studies Using Firm-Level Union Data

The use of firm-level data resolves the problems with industry data discussed above. However, it might still be argued that even the firm union effect is an average of the union effect on the profitability of each of the firms' plants. But it could be counter argued that measures of economic performance are generally analyzed at the firm-level and that industrial relations policies are also defined at this level. The next chapter will compare the union effect across firms with different unionization levels across their plants.

The use of cross-sectional data, however, does not enable the researcher to control for firm specific effects that might be correlated with unionization. It is possible, for example, that unions find it easier to organize in firms with lower management quality. It this is true, then an estimated union coefficient would also be capturing the management quality effect. The use of panel data would be appropriate to control for effects of this kind. However, it might still be the case that unions' effort to organize concentrate on highly profitable firms and that profitability varies across the business cycle. That would be another source of endogeneity that would not be taken care of by the use of panel data and would require a search for instrumental variables not correlated with the error term in the profitability equation [12].

Before the survey of firm-level studies, it is worth discussing the problems of measurement of profitability or supra-competitive rents. Fisher and MacGowan (1983) reported theoretical and simulation results showing that only in very favourable circumstances would the accounting rate of return provide reliable information about the economic rate of return. Since this study, many papers addressed the issue of how to improve profitability measures used in the industrial organization literature. Smirlock, Gilligan and Marshall (1984), for example, argue for the use of Tobin's q (ratio of market value to replacement cost of the firm) as a measure of future rents that relies on capital market valuation, incorporate information about risk, and minimizes any distortion introduced by tax laws and accounting conventions [13].

Shepherd (1985) however, points out that q ratios are a phenomenon of capital markets, not of the firm itself, being indirect measures subject to the influence of psychological factors.

[12] The next chapter of this dissertation will use panel data to deal with firm specific effects and experiment with instruments to address the endogeneity issue.

[13] A variant of the q-ratio if the *excess value* measure which is equal to (market value of shareholders' equity + book value of debt - book value of tangible assets)/sales.

Moreover, a series of steps are necessary to the calculation of q-values, including the use of debts and liabilities book values in the numerator and arbitrary depreciation and inventory adjustment methods in the denominator. Shepherd (1985) therefore concludes that "combining the two imperfect parts, the estimated q-ratio is more likely to be inferior to π than superior" (p.1206). Stevens (1990) tries to conciliate the two positions by stating that both measures are subject to many of the same measurement problems and that the differences in opinion reflects differences is academic training. While those trained finance prefer to adopt measures reflecting capital markets valuation, economists tend to prefer profitability measures. Macfarland (1988) found, using Monte Carlo techniques, that q estimates were neither consistently better nor consistently worse than accounting rates of return in detecting supra-competitive profits.

An early and very careful study using line of business data to assess the impact of unionization on profitability is Clark (1984). This study uses survey data on 900 product-line business of around 250 companies from 1970-80 in the US.. Those companies were asked about the percentage of employees in each business that were unionized and many questions related to competitiveness in the 4-digit SIC industry that the unit operated. The survey questions were complemented with company accounts and census of production data. Two measures of profitability were used : rate of return on capital and rate of return on sales. Unfortunately, there was no information on change of union status in the data set and so it is not possible to control for firm specific effects. Clarke (1984) finds that unionization is associated with a profitability decline of about 19% relative to the sample mean in specifications using both dependent variables. It is also found that this effect comes exclusively from the impact of unionization on the profitability of *low* market share firms (selling to less than 10% of the market).

Becker and Olson (1992) also use US. (cross-sectional) firm level data to examine the impact of unionization on profitability. In this study, the authors regress two different measures of profitability (price-cost margin and excess market value) on firm and industry level unionization[14]. The reported results indicate that the union presence impact negatively on both profitability indicators. Moreover, the results seem to be concentrated at lower levels of unionization, which the authors interpret as implying that the reduction in union influence is probably overstated

[14]Industry unionization is measured by the union coverage rate in the firm's primary industry while firm level unionization is estimated using the percentage of pension plan enrollees in plans negotiated through collective bargaining.

by the decline in union membership.

Hirsch (1991) uses information on union coverage from a survey conducted in 1987/88 amongst US. publicly-traded manufacturing sector companies operating in 1976. The union information used in most of this study is also time-invariant (1977) but the firm-level information is from 1968-80. With this information, Hirsch (1991) finds that a greater union coverage tends to reduce profitability as measured by Tobin's q (by about 20% on average), profits/capital (14%) and profits/sales (12%). It is also found that the union effect is particularly stronger in the chemicals, rubber, primary metals, non-electric machinery, motor vehicles, scientific equipment and lumber industries. In addition, it is found that union capture future returns (q) from R&D investments and both short and long term rents associated with firm and industry's sales growth. Finally, an attempt to control for firm specific effects is made, using independent data on union coverage for 1972. However, the results were disappointing (no union impact is observed in the first-differences specification) which, according to the author, reflects bad measurement since the union data in the two periods are not perfectly compatible.

Finally, Bronars, Deere and Tracey (1994) calculate firm-specific unionization rates for 560 US. firms using union contract data.[15] The authors address the important issue of measurement error in the union data by using Hirsch (1991)'s independent union information. They find that the covariance between the unionization measure they use (UBLS) and the one Hirsch (1991) uses is 56% of the variance of UBLS and this is an estimate of the true variation in unionization. The equivalent number for within-industries variation is 53 %. Finally, it is reported that an industry level unionization measure can account for at most 33% of total variation in union coverage by firms. In the empirical work using the coverage measure, Bronars *et al* (1994) use three different measures of profitability: (Tobin' s *q*, excess market value and profits/sales ratio) and average the data over two periods (1975-78 and 1979-82) to attenuate measurement error problems. They report results indicating that, with all the controls included, unions only seem reduce the profits/sales measure of profitability. The interpretation given is that although there is only weak evidence that unions directly decrease profits, the total union effect (without controls included) is strong and significant. The first difference results are again disappointing, with no significant union impact being estimated. However, the authors also point out that

[15]These data were reported to the Bureau of Labor Statistics.

first-differences of their union estimates will be even noisier measures of the true change in unionization and that therefore, the resulting estimates should be viewed with scepticism.

In Britain, the only firm level study of the impact of union presence on profitability to date seems to be Machin (1991) [16]. In this study the author uses information from a survey carried out amongst U.K. firms about whether unions are recognized or not for bargaining purposes for manual or non-manual employees. Using this time-invariant measure, Machin (1991) finds that union recognition is associated with 21% reduction in profitability as compared to an average non-unionized firm. It also reported that the ability of unions to capture a share of profits is stronger in firms with higher market shares.

In conclusion, it seems far to say that studies using firm level data, both in US. and in the U.K. seem to find a negative association between union measures and profitability using cross-sectional data. However, few studies appropriately controlled for firm specific effects and those that did could not detect an impact of changes in unionization measures on changes in profitability indicators.

2.4.2 Unions and R&D Investment

Fewer studies have concentrated on the analysis of the impact of unionization on R&D expenditures. In the U.S., researchers have used firm-level R&D information, whereas in Europe, to the best of our knowledge, there are no firm-level studies on this topic so far, only a few preliminary investigations using industry level data.

Studies Using Industry-Level Union Data

Connolly, Hirsch and Hirschey (1986) are among the first researchers to enquire into the relationship between unionization and R&D expenditures. The main motivation for their analysis is a model similar to the one developed by Grout (1984) and discussed above. R&D is seen as an intangible capital, the returns to which may be susceptible to union rent seeking. The extent to each a firm's returns to R&D investment are vulnerable will depend primarily on the patentability of R&D output. Valuable unpatented R&D output increases the firm's vulnerabil-

[16]Note that Blanchflower and Oswald (1988), Machin and Stewart (1990) and Machin and Stewart (1996) use plant level data to analyse the impact of unionization on qualitative financial performace indicators.

ity to union sharing in R&D returns, that is, in the absence of efficiency contracts, unionization acts as a distortionary tax decreasing firms' R&D intensity.

This hypothesis was tested by using R&D, unionization and their interaction in a excess value equation (see above) and by regressing R&D expenditures/sales (obtained from the Business Week) directly on unionization and other controls, on a sample drawn from the 1977 Fortune 500. The results on the R&D equation tend to show that unionization (measured as the proportion of union members in the firm's primary industry[17]) reduces R&D by 40% on average when union density rises from 0.2 to 0.5. Moreover, the authors report that R&D is reduced even more when the indirect effect of unionization (reducing the excess profits available to finance R&D) is included via an interaction between the union measure and the excess market value. Finally, it seems that the union effect is concentrated at small levels of unionization. It is necessary to stress however, that this study incurs in all the problems associated with using industry level data on unionization. Similarly, Allen (1988) uses Freeman (1983)'s unionization data to find (in a rather bare specification) that R&D/sales is 12% lower in full unionized industries as compared to the non-unionized ones.

In Britain, Ulph and Ulph (1989) use a sample of 33 British industries in 1972 and 1978 and information on the percentage of workforce covered by a union agreement, to find that the union impact of unionization on R&D/sales depend on the sector being analyzed. The results seem to indicate that union measures have a positive effect in low technology industries, but a negative impact in the high-tech ones

Addison and Wagner (1994) examine the correlations between union membership (measured from the 1989 Labour Force Survey) and R&D/sales. They report results again suggesting that there is a positive correlation between the two variables in the low-technology sector (that forms the major part of the economy), whereas no relationship is found in the other sectors. To provide additional insights into the causality of this relationship, Addison and Wagner (1994) correlate UK unionism with R&D intensity in Germany. The idea behind this exercise is that R&D activity in Germany would proxy for differences in technology opportunities across industries and is unaffected by UK unionism. A positive correlation between UK unionism and German R&D investment would sign that unions tend to concentrate on innovative industries

[17]This measure is obtained from the May 1975-77 Current Population Surveys by Kokkelenberg and Sockell (1985).

invalidating any causal interpretation of the relationship described above (see Freeman, 1992). Any such result would be strengthened by the finding of Schnabel and Wagner (1992) that no significant relationship exists between union density and R&D intensity in Germany, after controlling for human capital and various other factors, and by the fact that a strong correlation exits between the inter-industry structure of R&D intensity in both countries. The results of this experiment show a positive correlation between union membership in Britain and R&D intensity in German in low-tech sectors, suggesting that the association between industry level unionization measures and R&D do not seem to be a causal one.

On the basis of those experiments, it appears that there exists a negative relationship between industry union presence and R&D intensity in the U.S., but that this relationship is not so clear in the U.K.

Studies Using Firm-Level Data

Hirsch (1991) uses the union data described above and a measure of R&D/sales from the US. R&D Master File to find that a typical unionized firm with 43% union coverage will have R&D investments about 15% lower than a non-union company. The reported results also show that low levels of unionization are associated with significantly lower R&D investment, but the marginal impact of higher levels of coverage is modest.

Bronars, Deere and Tracy (1994) use the data described above to find negative effects of unionization on R&D/sales in the two cross-sectional periods they examine (1975-78 and 1979-82). The effect means that a 10% increase in unionization decreases R&D/sales by about 5 to 7%. The first-differences estimates are imprecisely estimated, but this could be reflecting measurement errors in the union variable utilized. In conclusion, it seems that, in the U.S., a significant presence of union members among the workforce does tend to decrease the amount firms invest firms invest in R&D.

In general, the studies surveyed here point to the existence of a negative relationship between of unionization on profitability, both in Britain and in the U.S., although the magnitude of the impact varies quite substantially from study to study. It is also the case that the use of panel data is still rare and it remains to be seen whether this effect is robust to controlling for unobserved firm-level heterogeneity. Finally, it would be interesting to observe what has happened to this relationship over the 1980s, a period that saw a continuing decline in unionization, both in the U.S. and in Britain. With relation to R&D expenditures, the recent U.S. studies tend to uncover a negative correlation between R&D and unionization. The absence of an European microeconometric study in this area is a lacuna that this research seeks to rectify.

Chapter 3

Unions and Profitability over the 1980s: Some Evidence on Union-Firm Bargaining in the UK

As seen in the last chapter, the impact of trade unions on profitability has been the subject of numerous theoretical and empirical studies. It is generally accepted as an empirical fact that the presence of unions tends to be associated with lower firms' and plants' rate of return. Few studies, however, have attempted to analyse the behaviour of this relationship over time, by making use of panel data to investigate the action of cyclicality and the possibility of change in structural factors underpinning the union impact.[1]

More recently, an interesting part of the economic literature has concentrated on the direct and indirect effects of the anti-union legislation in Britain during the 1980s on various industrial relations and economic indicators.[2] Overall it seems that unionised firms or establishments experienced relatively high productivity and low wage growth in the late 1980s, but not at the beginning of the decade.[3] Despite the importance of these institutional changes for the

[0] A version of this chapter if forthcoming in the *Economic Journal* (see Menezes-Filho, 1997).

[1] See Mishel and Voos (1992) for a survey on the relationship between unionisation and profitability and Hirsch (1991) for a study that uses U.S. panel data.

[2] During the period covered by our exercise (1984-1990) two changes in the law directly related to unions took place: the 1984 Trade Union Act and the 1988 Employment Act (see Metcalf (1990) for a discussion).

[3] See Stewart (1991), Gregg and Machin (1992), Stewart (1995) and Gregg *et al* (1993), *inter alia.*

bargaining scenario there has been no study so far exploring possible changes in the relative profitability of unionised firms as compared to non-unionised ones over this period.[4]

Since gaining power in 1979, the Conservative government has also stimulated an already existent move towards more fragmented bargaining, as part of a general policy of trying to generate a more flexible labour market (see Brown and Walsh, 1991). However, some studies (e.g. Layard, Nickell and Jackman, 1991) questioned the effectiveness of a policy of this sort, by demonstrating connections between the decentralization of the bargaining system and increasing rates of unemployment and wage inflation. One question examined here is: from the microeconomic point of view, has the fragmentation of bargaining had any impact on the bargaining power of firms and unions as measured by the union profitability differential?

Another related feature that has received some attention is the interaction between economic performance and the structure of multi-unionism. Marginson and Sisson (1988) underlined the importance that different forms of bargaining procedures may have in shaping various industrial relations outcomes. Machin *et al* (1993) were the first to take this into account in an empirical microeconomic framework, their finding being that plants where unions bargain separately with the firm tend to pay relatively higher wages. This paper tries to extend their work by using the firm as the unit of analysis.

In spite of the comprehensive literature on the effects of unionisation on profit margins, there are no published studies capturing the impact of changes in union status on changes in profitability, that is, controlling for firm specific fixed effects. In the following analysis a variable is utilised that indicates whether or not firms have partially or totally derecognized unions for bargaining purposes during the sample period to assess the importance of the union effect in a first-differences specification.

3.1 Theoretical Issues

Firms' and unions' bargaining procedure may be modelled (following Binmore, Rubinstein and Wolinsky, 1986) as a time-preference game with alternating offers in which the asymmetry between parties may arise from different discount factors, that is, different losses incurred with

[4] Note though that Machin and Stewart (1990) and Machin and Stewart (1996) have detected an improvement in union plants' relative financial performance.

the extension of the negotiation period.[5] The presence of recognized trade unions may signal to the firm that industrial action is likely to take place if delays in the process of reaching an agreement occur. In this case, an average unionised firm will end up with a lower profit margin than its otherwise identical non-union counterpart, for a higher part of its sales revenue will be appropriated by its workers, as a reflection of its impatience to settle without a strike. One of the effects of the anti-union legislation might be to increase the unions' uncertainty with relation to the occurrence and degree of participation in an industrial action. This in turn would tend to provoke an increase in unions' relative impatience to reach an agreement. A model will be developed below in which this increase in unionised firms' relative 'bargaining power' will be reflected in an increase in their relative rate of return.

Some recent models have appeared in the literature aiming at offering different predictions concerning the wages associated with different bargaining structures (see Horn and Wolinsky, 1988; Dowrick, 1989,1993; Davidson, 1988 and Dobson, 1994). In this section a simple two-stage bargaining model will be developed. In the second stage, two symmetric firms compete in the product market, while in the first stage they bargain with their unions over wages only. The aim is to investigate the effects of different bargaining scenarios on the firms' profit/sales ratio using a general model along the lines of Dowrick (1993).

3.1.1 Second Stage

In the second stage, firms i and j decide on their output levels, taking wages (determined in the prior stage) as given. Assume labour is the only input in the production process. Under these circumstances, it is possible to derive equilibrium profit (π^i), labour demand (L^i) and union utility (U^i) functions, which depend only on the (exogenous) wages (w^i, w^j). It is assumed throughout the analysis that [6]:

$$\frac{\partial \pi^i}{\partial w^i} < 0, \frac{\partial \pi^i}{\partial w^j} > 0, sign(\frac{\partial \pi^i}{\partial w^i} + \frac{\partial \pi^i}{\partial w^j}) < 0 \tag{3.1}$$

[5] As shown in Binmore (1982), under certain conditions the solution to this non-cooperative game is equivalent to the solution of the standard Generalized Nash product in which the resulting share of profits depends on the utility functions, discount factors and disagreement pay-offs of the parties, with outside options acting as a constraint .

[6] Some of these conditions may not hold when the products are strategic complements in the product market (see Dowrick and Spencer, 1994).

$$\frac{\partial L^i}{\partial w^i} < 0, \frac{\partial L^i}{\partial w^j} > 0 \tag{3.2}$$

$$\frac{\partial U^i}{\partial w^i} > 0, \frac{\partial U^i}{\partial w^j} > 0 \tag{3.3}$$

Define :

$$E^{wi}[\pi^i] = -\frac{w^i}{\pi^i}\frac{\partial \pi^i}{\partial w^i}, E^{wi}[L^i] = -\frac{w^i}{L^i}\frac{\partial L^i}{\partial w^i} \tag{3.4}$$

$$C^{wj}[\pi^i] = -\frac{w^i}{\pi^i}\frac{\partial \pi^i}{\partial w^j}, C^{wj}[L^i] = -\frac{w^i}{L^i}\frac{\partial L^i}{\partial w^j} \tag{3.5}$$

Proposition 1a: *an increase in own wage (holding rival's wage constant) will decrease firm i's profitability if* $E^{wi}[\pi^i] > E^{wi}[L^i] - 1$.

Proof : The proofs of all propositions are collected in the Theoretical Appendix.

This condition does not seem restrictive at all. If the labour demand is inelastic the condition is automatically satisfied: Arellano and Bond (1991) used UK firm level data to find a long-run elasticity of around -0.24. Also, a simple linear homogeneous Cournot duopoly model with $L^i = q^i$ and:

$$P = m - n(q^i + q^j) \tag{3.6}$$

has:

$$q^i = L^i = \frac{(m - 2w^i + w^j)}{3n} \tag{3.7}$$

and

$$\pi_i = n(q^i)^2 \tag{3.8}$$

so that:

$$E^{wi}[\pi^i] = \frac{4w^i}{3nq^i} \text{ and } E^{wi}[L^i] = \frac{2w^i}{3nq^i} \tag{3.9}$$

Proposition 1b: *an increase in both own and rival wages (in the same proportion) will decrease the firms' profitability if* $E^{wi}[\pi^i] - E^{wi}[L^i] > C^{wj}[\pi^i] - C^{wj}[L^i] - 1$. This condition will be called **C1**.

This condition does not seem restrictive either. In the Cournot model referred to in the footnote above:

$$E^{wi}[\pi^i] - E^{wi}[L^i] = \frac{2w^i}{3nq^i} \text{ and } C^{wj}[\pi^i] - C^{wj}[L^i] = \frac{w^i}{3nq^i} \tag{3.10}$$

3.1.2 First Stage

In the first stage each firm is bargaining with its union(s) over wages only. Dowrick (1993) (who draws on Davidson, 1988 and Binmore *et al* , 1986) shows that this can be analysed through a model of simultaneous games with alternating offers, which has as equilibrium:

$$w^i(w^j_,\beta^i) = \arg\max_{w^i} Z^i(w^i, w^j, \beta^i) = (\beta^i)Ln[\pi^i - \underline{\pi}^i] + (1-\beta^i)Ln[U^i - \underline{U}^i] \qquad (3.11)$$

where $\underline{\pi}^i$ and $\underline{U}^i$ represent the parties' disagreement pay-offs and $(0 \leq \beta^i \leq 1)$ is firm i' s bargaining power. The FOC for this maximization problem is:

$$\frac{\partial Z^i}{\partial w^i} = Z^i_i(w^i, w^j, \beta^i) = \beta^i \frac{\pi^i_i}{\pi^i - \underline{\pi}^i} + (1-\beta^i_i)\frac{U^i_i}{U^i - \underline{U}^i} = 0 \qquad (3.12)$$

and the SOC :

$$Z^i_{ii} = \frac{\partial^2 Z^i}{\partial w^i \partial w^i} < 0 \qquad (3.13)$$

Expression (4) will define the two wage reaction functions: $w^i(w^j)$ and $w^j(w^i)$ whose intersection will define the equilibrium wages w^{i*} and w^{j*} .

Proposition 2 (Dowrick (1993)): *A change in the structure of industrial relations from $Z^{Ii}(w^i, w^j)$ in (3.11) to $Z^{IIi}(w^i, w^j)$ will raise the equilibrium wage ($w^{iII*} > w^{iI*}$) if $Z^{IIi}_i(w^{iI*}, w^{jI*}) > 0$.*[7]

This means that, for this condition to be satisfied, Z^{IIi}_i evaluated at the equilibrium wages defined by Z^{Ii}_i must be strictly positive. In this sub-section, Dowrick (1993)'s framework will be used to analyse different industrial relations scenarios in order to derive predictions that can be tested using the data set described in the empirical analysis. The analysis will concentrate on the outcomes of the bargaining between firm i and its symmetric unions A and B that represent groups of workers a and b respectively, though as symmetry between the firms is also assumed, they also apply to firm j and its unions (C and D).

Case 1 - Competitive Labour Markets : In this situation both firms operate in competitive labour markets with no collective wage bargaining of any type. In this case, the wage is simply the competitive wage for both firms.

[7] The superscripts I,II, etc. are being used here to identify different bargaining regimes.

Case 2 - Collective Bargaining : In this new structure (II) both firms recognize unions for the purpose of collective bargaining. Firm i bargains with union A, while firm j bargains with union C. With the unions' and firms' disagreement pay-offs normalized to zero, the First-Order Condition (FOC) that implicitly defines the wage that the workers in plant A will get (w^a) is defined by:

$$Z_a^{II} = \frac{\partial Z^{II}}{\partial w^a} = \beta^i \frac{\pi_a^i}{\pi^i} + (1-\beta^i)\frac{U_a^A}{U^A} = 0 \tag{3.14}$$

Proposition 3: *A move to a collective bargaining situation where unions have some degree of bargaining power will decrease the firms' profit/sales ratio if condition C1 applies.*

The Cournot model with utility functions of the type:

$$U^i = w^i L^i \tag{3.15}$$

has, after solving for the first stage of bargaining:

$$w^i = \frac{m(1-\beta^i) + w^j(1-\beta^i)}{4} \tag{3.16}$$

so that

$$\frac{\partial w^i}{\partial w^j} = w_j^i > 0 \text{ and } \frac{\partial w^i}{\partial \beta^i} = w_{\beta^i}^i < 0 \tag{3.17}$$

and, after solving for w^i and w^j :

$$w^i = \frac{m(\beta^i - 1)(\beta^j - 5)}{(15 + \beta^i + \beta^j - \beta^i\beta^j)};\ w_{\beta^i}^i < 0 \tag{3.18}$$

$$q^i = L^i = \frac{2m(\beta^i - 1)(\beta^j - 5)}{3n(-15 - \beta^i - \beta^j + \beta^i\beta^j)};\ q_{\beta^i}^i > 0 \tag{3.19}$$

$$\pi^i = \frac{4m^2(\beta^i - 1)^2(\beta^j - 5)^2}{9b(-15 - \beta^i - \beta^j + \beta^i\beta^j)^2};\ \pi_{\beta^i}^i > 0 \tag{3.20}$$

and

$$(\pi/s)^i = \frac{2(\beta^i + 1)}{5 - \beta^i} \tag{3.21}$$

so that:

$$\frac{\partial(\pi/s)^i}{\partial \beta^i} > 0 \text{ and } \frac{\partial(\pi/s)^i}{\partial \beta^j} = 0 \tag{3.22}$$

Interestingly enough, under the functional form assumptions adopted here, the profit/sales ratio of one firm does not depend on the bargaining power of the other one.

Multi-Union Bargaining

Case 3 - Separate Firm-Level Bargaining : In this new scenario each firm has 2 plants (A and B for firm i; C and D for firm j) the workers of each plant are represented by a different union (indexed in the same way as the plants) and each firm bargains simultaneously but separately with each union. In this situation, firm i would be able to operate plant B should the union in plant A strike and vice-versa, so that there is an increase in firm i 's potential disagreement pay-offs.[8] The FOC is:

$$Z_a^{III} = \beta^i \frac{\pi_a^i}{\pi^i - \underline{\pi}^i} + (1-\beta^i)\frac{U_a^A}{U^A} = 0 \tag{3.23}$$

Proposition 4: *In the case of separate firm-level bargaining, the firms' profit/sales ratio increases if C1 applies.*

Case 4 - Joint Firm-Level Bargaining : Now the 2 unions (A and B) bargain jointly with the firm but remain independent of each other. In this case, the linking of the negotiations has curtailed the firm's advantage and we are back to case 2.

Proposition 5: *In the case of joint firm-level bargaining, the firms' profit/sales ratio falls if compared to case 3 and if C1 applies.*

Proof: Symmetric to the proof of proposition 4.

Case 5 - Separate Industry-Level Bargaining : In this scenario, firms i and j form an employers' association that bargain separately but simultaneously with unions $A-C$ and $B-D$.[9] It is important to notice that in order to continue with the multi-union case and maintain comparability, it is assumed that unions A and C remain as independent entities, although they are bargaining jointly with the employers' association.[10] In this case, there is an increase in firm i's disagreement pay-offs if compared to case 2, since the employers' association would be

[8] What is important here is the *threat* of strike and the streams of income that *would* accrue to both parties in the event of a strike, since in these games the equilibrium is reached through the acceptance of the first offer, that is, without strikes.

[9] This would be the case, for example, if plants A and C were located in the same industry.

[10] This means that even though an increase in the wage received by workers a may affect the utility of workers c, union A does not care. On the other hand, as the two firms form an association, firm j's profits will also have to be included in the maximand.

able to operate plants B and D should unions A and C strike and vice-versa. However, the internalization of the gain firm j would have, should the wage of workers a increase, means that the result is not as favourable to firm i. The FOC, after allowing for symmetry $((\pi^i - \underline{\pi}^i) = (\pi^j - \underline{\pi}^j))$ reduces to:

$$Z_a^V = \beta^i \frac{\pi_a^i + \pi_a^j}{2(\pi^i - \underline{\pi}^i)} + (1 - \beta^i)\frac{U_a^A}{U^A} = 0 \tag{3.24}$$

Proposition 6: *In the case of separate industry-level bargaining, the result in terms of the firms' profit/sales ratio is ambiguous if compared to the joint firm-level case, but profitability unambiguously falls if compared to the separate firm-level case and if C1 applies.*

Case 6 - Joint Industry-Level Bargaining : In this case, the employers' association bargains jointly with all the unions, which nevertheless remain independent of each other. Now the within-firm disagreement pay-offs disappear and the internalization effect remains. The FOC in this case is defined by:

$$Z_a^{VI} = \beta^i \frac{\pi_a^i + \pi_a^j}{2\pi^i} + (1 - \beta^i)\frac{U_a^A}{U^A} = 0 \tag{3.25}$$

Proposition 7: *In the case of joint industry-level bargaining, the firms' profit/sales ratio unambiguously falls if compared both to the joint firm-level case and to the separate industry-level case if C1 applies.*

Single-Union Bargaining

The single-union case has been much analysed in the literature.[11] The result is known to depend very much on the specific structure and timing of the negotiations. In this sub-section a general case will be examined in order to highlight the factors involved in the analysis. The single-union single-firm case is equivalent to Case 2 above.

Case 7 - Employers' Association and Industry-Level Bargaining : Now the negotiations are assumed to be centralized. An industry-wide union represents the workers of all plants in the negotiation with the employers' association. The equivalent FOC is:

[11] See Davidson (1988) or Dobson (1994), for example. Note though that their analysis concentrate on the case of an industry-wide union bargaining with independent firms. Proposition 8 below was briefly discussed in Davidson (1988) pp. 420-421.

$$Z_a^{VII} = (\beta^i)\frac{4(\pi_a^i + \pi_a^j)}{2\pi^i} + (1-\beta^i)\frac{4(U_a^A + U_a^B + U_a^C + U_a^D)}{4U^A} = 0 \tag{3.26}$$

Proposition 8: *In the case of single-union industry-level bargaining, the result is ambiguous in terms of the firms' profit/sales ratio if compared to the single-firm single-union case.*

3.2 Data and Econometric Methodology

The main data source to be used here is the result of a 1990 survey carried out amongst managers of UK firms operating in various sectors and related to a broad range of union arrangements over the 1980s. The questionnaire was sent to about 2400 firms and the rate of usable responses was around 32% (558).[12] These data were complemented by access to the Exstat database of company accounts.[13] After deleting observations with missing values in any of the key variables, we were left with 494 firms that operated for at least 4 continuous years during 1984-90 (responsible for a total employment of around 2.7 million workers in 1987). Among them, 56 % recognized unions in 1984, 14 % of which have partially or totally derecognized unions over the sample period (the vast majority of the derecognitions were partial).

Cowling and Waterson (1976) derive the following expression for the profit/sales ratio of a firm under constant returns to scale:

$$\frac{\pi_i}{s_i} = \frac{MS_i(1+\lambda_i)}{\eta_j} \tag{3.27}$$

where (MS_i) is the market share, (η_j) is the industry elasticity of demand and (λ_i) a conjectural variations term. Assuming that λ_i is a function of the number of direct competitors (C_{it}) that the firm faces in the main industry it operates,[14] specifications will be estimated of the form:

$$(\pi/s)_{it} = \alpha_0 + \alpha_j + \alpha_t + \alpha_1 Union_{it} + \alpha_2 MS_{it} + \alpha_3 C_{it} MS_{it} + \alpha_4 C_{it} + \alpha_5 KS_{it} + \varepsilon_{it} \tag{3.28}$$

[12] For a thorough analysis of the survey, see Gregg and Yates (1991).

[13] A Data Appendix is available on request. It contains a reproduction of the survey, descriptions of the variables used in the analysis, the balance of the panel and the distribution of firms across main industries. It is worth pointing out that the survey was retrospective and that the market share variable was constructed using information on the distribution of firms' sales across 6 different industries.

[14] In the survey managers were asked whether they faced less than 5 direct competitors in their main product market or not.

where α_j and α_t are industry and time dummies respectively, *Union* represents different bargaining structures (from the model developed above), *KS* is the capital/sales ratio (to control for the fact that entry may be driven by the rate of return on *capital*), and ε is an idiosyncratic error.[15] Table 3.1 presents the behaviour of the dependent variable - accounting rate of return

Table 3.1: **The Rate of Return on Sales (ROS) over Time**

Mean ROS	(1) All Firms	(2) Union Recognition (No Changes)	(3) Union Recognition (Derecognition)	(4) No Union Recognition	(5) (2 - 4)	(6) (3 - 4)
1984-90	0.081	0.070	0.092	0.091	-0.021	+0.001
1984	0.074	0.058	-	0.098	-0.040	-
1985	0.074	0.059	0.078	0.092	-0.033	-0.014
1986	0.081	0.070	0.085	0.091	-0.021	-0.006
1987	0.092	0.077	0.100	0.105	-0.028	-0.005
1988	0.093	0.079	0.113	0.104	-0.025	+0.009
1989	0.080	0.075	0.105	0.081	-0.006	+0.024
1990	0.069	0.069	0.099	0.063	+0.006	+0.033

on sales (ROS)[16] - over the estimation period and the comparison between firms with different bargaining conditions.[17] It is clear that although the non-unionised firms and those that derecognized unions had higher profit margins overall, the difference between the unionised and non-unionised firms had completely disappeared by the end of the period, while the firms that derecognized unions were continually improving their relative position. In what follows this result will be submitted to a more rigorous econometric analysis.

[15] It is being assumed here that the demand elasticities are being captured by the industry dummies.

[16] There is an extensive literature on the choice of the dependent variable in profitability studies (see, *inter alia,* Scherer and Ross, 1990). Pre-tax profits/sales will be used here because it is the best proxy for the companies' profitability that is available in the company accounts.

[17] Only three firms completely derecognized unions in the sample period and they are assigned to column (3) although, strictly speaking, they are not unionised any more by 1990. Three firms that newly reconized unions are being treated as non-unionised until the year when their union density departs from 0.

3.3 Results

3.3.1 Pooled Sample

The results of the first set of estimated equations (using the pooled data) are set out in Table 3.2. Column (1) investigates the correlation between 'ROS' and union recognition after allowing for a constant term and time dummies. A union derecognition variable is also included to identify firms that changed their union status in the period.[18] It shows that on average unionised firms indeed tend to have significantly lower margins than non-unionised ones. Columns (2) and (3) indicate that this result is maintained if we include market share, a few competitors variable, the capital/sales ratio and (one digit main product) industry dummies.[19] In column (4) we include an interaction of market share and competition as indicated in the econometric methodology, which enters strongly and significantly. The 'few competitors' variable is now negative and significant and the results as a whole are in line with the findings of Mueller (1986) and Stevens (1990) using U.S. data. According to these results, to exert market power the firm must have a high share in a concentrated market. The results of column (4) suggest that the rate of return on sales of firms that recognize trade unions are lower by an average of 23% as compared to the average non-unionised firm. Hirsch (1991) has found a number of 14% using a similar specification applied to U.S. firms in the 1968-80 period and Machin (1991) of around 21% for British firms in 1984-85. Experiments with interactions between union recognition and the 'market power' variables (to check for evidence of some redistribution of monopoly rents) were performed without any significant result.

The serial correlation tests present evidence of persistent serial correlation, as expected in this kind of exercise, since the firms with higher than average unexplained profitability tend to be the same across periods. If this firm specific effect is uncorrelated with the included variables, then the OLS results are consistent but not efficient. It should be emphasized that all the reported standard errors are robust to any form of serial correlation that may arise from the fact that we are pooling series of observations of the same firm over time. The method used

[18]This variable is a dummy equal to one for each year between 1985 and 1990 for those firms whose managers reported a reduction in the number of plants recognizing unions at some point over that period not related to the closure of these plants.

[19]Using only the main industry sales to construct the market-share variable resulted in a very similar coefficient (standard error) to the one reported in column (2): 0.159 (0.060).

Table 3.2: **Pooled Sample (1984-1990)**

ROS	(1)	(2)	(3)	(4)
Union Recognition	-0.019	-0.023	-0.023	-0.022
	(0.008)	(0.008)	(0.008)	(0.008)
Union Derecognition	0.017	0.009	0.019	0.021
	(0.010)	(0.010)	(0.010)	(0.010)
Market Share	-	0.163	0.077	-0.042
		(0.061)	(0.079)	(0.108)
Less than 5 competitors	-	-0.009	-0.019	-0.022
		(0.012)	(0.012)	(0.012)
Market Share *	-	-	-	0.216
Less than 5 competitors				(0.110)
Capital /Sales	-	0.048	0.034	0.033
		(0.010)	(0.011)	(0.011)
Constant	0.084	0.073	0.182	0.185
	(0.009)	(0.009)	(0.058)	(0.058)
SE	0.01244	0.01152	0.01076	0.01074
Wald 1 (p-value)	6.57 (0.037)	38.53 (0.000)	23.97 (0.000)	43.20 (0.000)
Wald 2 (p-value)	24.45 (0.000)	28.66 (0.000)	26.86 (0.000)	26.72 (0.000)
Wald 3 (p-value)	-	-	44.12 (0.000)	44.76 (0.000)
SC1	5.220 (0.000)	4.875 (0.000)	5.116 (0.000)	5.119 (0.000)
SC2	4.479 (0.000)	4.098 (0.000)	4.312 (0.000)	4.313 (0.000)
Number of Firms	494	494	494	494
Sample size	3132	3132	3132	3132

Notes to Table

Dependent variable is Rate of Return on Sales (ROS). All standard errors (in brackets) are robust to both serial-correlation and heteroscedasticity. SE is the standard error of the regression. Wald 1 is a test of joint significance of reported coefficients, asymptotically distributed as Chi-Squared. Wald 2 is a test of joint significance of the time dummies. Wald 3 is a test of joint significance of the industry dummies. SC1 and SC2 are first and second order serial correlation tests, asymptotically distributed as N(0,1.)

(provided automatically by Arellano and Bond (1991)'s DPD software) is similar to Newey and West (1987) and allows for lags equal to the number of observations for each firm to be used in the procedure. However, if the individual specific effect is correlated with any of the right-hand side variables, then its coefficient will also be biased. One way of examining this is to look at first-differences specifications, a task to be performed below. The exogeneity of union recognition was tested for with the use of human capital variables (proportion of female and proportion of part-timers in 1990) as instruments. The resulting recognition coefficient (s.e.) was -0.063 (0.030) but a Hausman test did not reject the null of exogeneity ($\chi^2(21) = 1.04$). A regression using the average value of the variables in the whole period (to minimize measurement error problems) resulted in a recognition coefficient of -0.024 (0.009).

3.3.2 Union Recognition Effect over Time

Turning now to the main focus of the paper, Table 3.3 presents the results of estimates including interactions of the basic recognition variable (and of the controls) with year dummies. The results are quite striking. The union recognition effect has fallen dramatically from 1984 to 1990, even after controlling for the other determinants of profitability. It also seems that the fall in the union effect in the manufacturing sector was more concentrated at the beginning of the period. The percentage union profitability differential of -39 % in 1984 was reversed to +15 % in 1990. Fig. 1 illustrates this behaviour by plotting the estimated coefficients of the interactions against the years covered by our sample (the dotted lines represent the 95% confidence interval).[20]

The behaviour of the other determinants of profitability throughout the period also deserves some inspection. The coefficient on the capital/sales ratio showed a rather pronounced fall between 1984 and 1986 and remained roughly constant after that. There is some indication that the market power interaction and the negative 'absence of competition' effect appear to behave pro-cyclically, suggesting an interesting field of future research.

[20]We also estimated single cross-sections which produced very similar results (both in terms of coefficients and standard errors) to those reported in Table 3. The pooled results were presented instead because they are more efficient.

Table 3.3: **Union Recognition Effect over Time**

ROS	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Full Sample							
Union Recognition	-0.040	-0.039	-0.026	-0.029	-0.022	-0.002	0.010
	(0.011)	(0.011)	(0.010)	(0.010)	(0.012)	(0.010)	(0.011)
Market Share	-0.018	-0.060	-0.009	-0.079	-0.111	-0.039	-0.047
	(0.083)	(0.101)	(0.138)	(0.125)	(0.126)	(0.123)	(0.122)
Less than 5 competitors	0.010	-0.018	-0.009	-0.025	-0.039	-0.045	-0.016
	(0.013)	(0.017)	(0.014)	(0.017)	(0.027)	(0.018)	(0.014)
Market Share *	-0.114	0.351	0.153	0.228	0.284	0.289	0.213
Less than 5 competitors	(0.110)	(0.153)	(0.142)	(0.129)	(0.130)	(0.143)	(0.136)
Capital /Sales	0.088	0.051	0.033	0.033	0.028	0.031	0.020
	(0.022)	(0.014)	(0.012)	(0.014)	(0.006)	(0.008)	(0.022)
Manufacturing Only							
Union Recognition	-0.035	-0.037	-0.026	-0.010	-0.009	0.019	0.017
	(0.011)	(0.014)	(0.013)	(0.014)	(0.018)	(0.015)	(0.016)

Diagnostics	**Full Sample**	**Manufacturing**
Constant	0.084	0.090
	(0.009)	(0.015)
SE	0.01061	0.0083
Wald 1	140.29 (0.00)	39.95 (0.00)
Wald 2	22.27 (0.00)	23.23 (0.00)
Wald 3	42.30 (0.00)	1.19 (0.55)
SC1	5.082 (0.000)	3.066 (0.000)
SC2	4.269 (0.000)	4.051 (0.000)
Number of Firms	494	215
Sample size	3132	1383

Notes to Table

Pooled Regression - time dummies interacting with each variable.

See notes to Table 3.2.

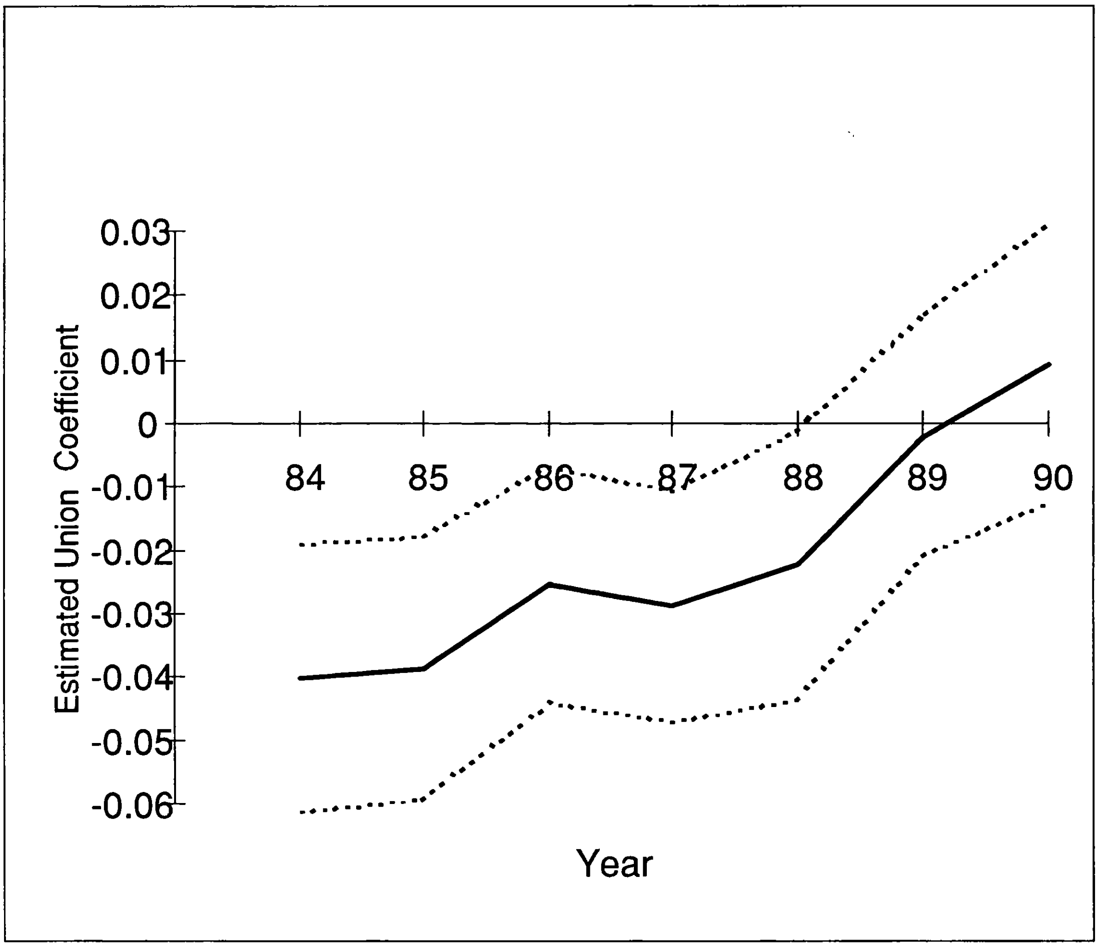

Figure 3-1: Union Effect on Profitability over Time

3.3.3 Different Bargaining Structures

From the results derived in the theoretical section, some variation in the union-profitability effect is to be expected, depending on the structure of the bargaining between unions and firms. In this sub-section those predictions will be examined. Column (1) of Table 3.4 shows that the union impact is stronger in firms with only one establishment vis-à-vis multi-establishment firms.[21] However, propositions 4 and 5 in the theoretical section showed that the advantage of the multi-establishment firms in terms of disagreement pay-offs tends to be offset in the joint bargaining case. Therefore in column (3) the multi-establishment firms were split into those bargaining jointly and those bargaining separately with their various unions. Interestingly, the union impact for the firms in the joint bargaining case is very close to the one for the single-plant firms, whereas the separate bargaining firms' coefficient is smaller than both of them.[22] Additional experiments (not reported) were performed using a variable indicating whether the unions were recognized in all of the firms' establishments or only in some of them. These experiments indicated that the union impact is stronger in the 'all-unionised' firms, that the joint-bargaining effect is also stronger in this sub-sample and that the single-union effect, although not significant in column (2), is strongly negative only if the 'all-unionised' firms are considered.

Column (3) shows that the influence the bargaining level has on profitability is very different in the multi-union firms as compared to the single-union ones, which was expected from the theoretical results. It seems that the union impact in the multi-union firms is much stronger when bargaining takes place at the industry level, while the opposite seems to be the case in the single-union firms. From the model developed in the theoretical section, the strongest negative effect on profitability should arise where unions bargain jointly and at the industry level (see proposition 7). Column (4) shows that this is indeed the case.[23] Furthermore, it seems the separate industry level case leads to lower profits than the separate firm level one (a result

[21] Adding interactions of union recognition with size variables (like employment) to the specifications did not affect the results in this Table. The information on the number of establishments refers to 1990 and no information on changes is available. Also note that the sample size was reduced due to missing values on some bargaining structure variables.

[22] No difference was found between the joint and separate bargaining cases for the single-plant firms.

[23] Note though that only 6 % of the unionised firms in our sample present both characteristics, as opposed to 13 % with joint and establ/comp level, 9 % with separate and ind. level and 25% with separate and establ/comp level bargaining.

Table 3.4: **Different Bargaining Structures**

ROS	(1)	(2)	(3)	(4)
Union Recognition, Single-Establishment	-0.035 (0.011)	-0.035 (0.011)	-0.034 (0.011)	-0.030 (0.010)
Union Recognition, Multi-Establishment	-0.018 (0.009)	-	-	-
Union Recognition, Multi-Establishment, Multi-Union and Joint Bargaining	-	-0.032 (0.017)	-	-
Union Recognition, Multi-Establishment, Multi-Union and Separate Bargaining	-	-0.016 (0.009)	-	-
Union Recognition, Multi-Establishment, Single-Union	-	-0.012 (0.011)	-	-
Union Recognition, Multi-Establishment, Multi-Union and Industry Bargaining	-	-	-0.046 (0.012)	-
Union Recognition, Multi-Establishment, Multi-Union and Company Bargaining	-	-	-0.011 (0.011)	-
Union Recognition, Multi-Establishment, Single-Union and Industry Bargaining	-	-	0.007 (0.018)	-
Union Recognition, Multi-Establishment Single-Union and Company Bargaining	-	-	-0.023 (0.012)	-
Union Recognition, Multi-Establishment Joint and Industry Bargaining	-	-	-	-0.072 (0.017)
Union Recognition, Multi-Establishment Separate and Industry Bargaining	-	-	-	-0.029 (0.011)
Union Recognition, Multi-Establishment Joint and Company Bargaining	-	-	-	-0.011 (0.020)
Union Recognition, Multi-Establishment Separate and Company Bargaining	-	-	-	-0.004 (0.008)
Constant	0.225 (0.078)	0.226 (0.079)	0.229 (0.078)	0.226 (0.079)
SE	0.011168	0.011153	0.011077	0.011087
Wald 1	44.65 (0.00)	43.65 (0.00)	65.52 (0.00)	66.72 (0.00)
Wald 2	20.80 (0.00)	21.72 (0.00)	20.87 (0.00)	22.24 (0.00)
Wald 3	45.46 (0.00)	45.44 (0.00)	44.90 (0.00)	46.45 (0.00)
SC1	5.014 (0.000)	5.053 (0.000)	4.951 (0.000)	4.942 (0.000)
SC2	4.213 (0.000)	4.217 (0.000)	4.150 (0.000)	4.131 (0.000)
Number of Firms	452	452	452	452
Sample size	2883	2883	2883	2883

Notes to Table

All columns include dummy variables for firms that derecognized unions and for those that changed the bargaining structure in the period. All controls of Table 3.2 column (3) are included. See notes to Table 3.2.

consistent with proposition 6).[24] In general, it seems fair to conclude that the predictions from the bargaining model have been confirmed by the empirical exercises.

3.3.4 First Differences

The derecognition variable will now be used in an attempt to control for firm specific effects that have been omitted so far and might arguably have been responsible for part of the estimated effects obtained to date. In the place of the 'number of competitors' variable used in the levels regressions, two variables will be used (increase and decrease in competition) that reflect changes in the competition environment as perceived by the managers who answered the survey.[25]

In Table 3.5 the first-differences results are set out. The simplest specification is reported first and clearly firms that derecognized unions have had faster profitability increases over 1984-90 than the other firms. This effect is robust to the inclusion of the other controls in column (2) which were, in general, imprecisely estimated. However, an interaction between decreased competition and changes in market share entered strongly, providing further evidence that market share is only important in industries with few leading firms. In column (3) we control for potential endogeneity of changes in market share, capital/sales ratio and of the interaction variable using the standard GMM estimation procedure (see Arellano and Bond, 1991). Apart from an improvement in the capital/sales estimated coefficient, no other changes in the parameters were visible and, in particular, the derecognition variable is robust to all specifications.[26] Finally, column (4) sets out the results of a 'long-differences' specification (last - first year in the sample) to try to deal with measurement error in the derecognition variable.[27] They suggest a stronger derecognition effect, more in line with the results of the levels specifications.

As additional tests illustrating the robustness of these results, levels of (cash/liabilities) and (debt/equity) ratios lagged two and three periods were used as instruments for derecognition

[24] $\beta_{joint\&ind} = \beta_{sep\&ind} : \chi^2(1) = 7.47$, $\beta_{joint\&ind} = \beta_{joint\&com}$
$\chi^2(1) = 6.87$, $\beta_{sep\&ind} = \beta_{sep\&comp} : \chi^2(1) = 6.65$

[25] The managers were asked separately about changes in the *local* and *foreign* competition. However, these variables were grouped together as they were not significantly different from each other neither for the increase in competition case nor for the decrease one.

[26] One-digit industry dummies were included but were jointly insignificant (χ^2 (8) = 12.8). When used as intruments, no significant changes were noticed.

[27] The exact year between 1985 and 1990 when some of the unionised firms derecognized their unions is not known.

Table 3.5: **First-Differences (1985-1990)**

d (ROS)	(1)	(2)	(3)	(4)
Derecognition	0.006	0.006	0.005	0.027
	(0.002)	(0.002)	(0.002)	(0.012)
d(market share) [a]	-	-0.104	-0.106	-0.326
		(0.093)	(0.158)	(0.136)
Increase in competition	-	0.002	0.002	0.012
		(0.004)	(0.003)	(0.015)
Decrease in Competition	-	0.002	0.004	0.016
		(0.003)	(0.003)	(0.015)
d(market share) *	-	0.725	0.808	0.596
Decrease in Competition[a]		(0.342)	(0.422)	(0.321)
d(market share) *	-	-0.001	-0.066	0.007
Increase in Competition[a]		(0.136)	(0.200)	(0.209)
d(capital/sales) [a]	-	-0.006	0.062	0.059
		(0.010)	(0.042)	(0.021)
Constant	-0.004	-0.006	-0.006	-0.035
	(0.002)	(0.005)	(0.005)	(0.015)
SE	0.02749	0.02751	0.02860	0.01205
Wald 1	9.03 (0.00)	14.64 (0.04)	11.94 (0.10)	24.29 (0.00)
Wald 2	31.03 (0.00)	19.14 (0.00)	21.92 (0.00)	-
SC1	-1.361 (0.174)	-1.309 (0.190)	-1.810 (0.070)	-
SC2	-1.631 (0.103)	-1.633 (0.102)	-1.646 (0.100)	-
Sargan	-	-	59.70 (0.057)	-
Number of Firms	494	494	494	494
Sample size	2336	2336	2336	494

Notes to Table

Dependent variable is change in the rate of return on sales d(ROS). All standard errors (in brackets) are robust to both serial-correlation and heteroscedasticity. The Sargan Statistic is a Chi-Square test of over-identifying restrictions under the null of instrument validity. [a]*: Variables treated as endogenous in column (3). Instruments used are Xi(t-2) and Xi(t-3). Column (4) reports the results of a long-differences specification (see main text).*

with a resulting coefficient (s.e.) of 0.021 (0.031), but a Hausman test (using the results of column(3)) did not lead to the rejection of the exogeneity assumption (χ^2 (12) = 1.20).

Table 3.6: **Changes in Bargaining Structures**

d (ROS)	(1)	(2)	(3)
Change from Joint to Separate Bargaining	0.008 (0.004)	-	-
Decentralization of Bargaining	-	0.005 (0.002)	-
Decreasing Number of Establ. Recognizing Unions	-	-	0.009 (0.003)
Union Recognition - no Changes over 80s	0.006 (0.002)	0.006 (0.002)	0.007 (0.002)
Constant	-0.007 (0.005)	-0.007 (0.005)	-0.007 (0.005)
SE	0.02901	0.02901	0.02899
Wald 1	18.53 (0.01)	19.23 (0.00)	18.95 (0.01)
Wald 2	16.12 (0.01)	16.23 (0.01)	16.33 (0.01)
Wald 3	-	-	-
SC1	-1.087 (0.277)	-1.085 (0.278)	-1.091 (0.275)
SC2	-1.629 (0.103)	-1.629 (0.103)	-1.632 (0.103)
Number of Firms	452	452	452
Sample size	2130	2130	2130

Notes to Table

Dependent variable is change in the rate of return on sales d (ROS). All the controls of Table 3.5 column (2) were included.

See Notes to Table 3.5.

In Table 3.6 the levels results regarding different bargaining structures are shown to be robust to the inclusion of fixed effects. Firms that moved to separate bargaining patterns with different unions had an increase in their profitability over the period.[28] A move towards a more fragmented bargaining structure and a decrease in the number of establishments recognizing unions (the last being a type of derecognition) also seem to be associated with higher profitability. It is worth noting that all these effects are conditional on the increasing profitability due to the decreasing union effect over time and also that only a very small number of firms have incurred more than one of these changes in the period. This suggests that the results are not being driven by a broader re-structuring strategy taking place in a small group of firms in the sample.

[28]It must be emphasized that only 4% of the unionised firms in our sample experienced such a change, so that this result is only generalizable if viewed in conjuction with the results of the levels specification.

3.4 Discussion

Columns (1) to (5) in Table 3.7 examine whether any sort of cyclical behaviour of the union-profitability differential is driving the main results, and if so to what extent. Arguments can be found in the literature both supporting and rejecting a more pro-cyclical behaviour of the union wage differential. In line with the first, Stewart (1991) argues that rigidities in union-firm bargaining process imply that union wages tend to be less sensitive to economic fluctuations. On the other hand, the simple bargaining model outlined above would predict a fall in union wages in troughs following a lower probability of workers finding a temporary job and an increase in the availability of outsider workers for the firms (e.g. Shaked and Sutton, 1984). Column (1)

Table 3.7: **Union Profitability Effect: Cycle or Trend?**

ROS	(1)	(2)	(3)	(4)	(5)
Union Recognition	-0.021 (0.008)	0.005 (0.010)	-0.021 (0.008)	-0.051 (0.012)	-0.031 (0.016)
GDP-Growth	0.005 (0.001)	0.009 (0.002)	-	-	0.007 (0.002)
Union Recognition * GDP-Growth	-	-0.008 (0.002)	-	-	-0.004 (0.002)
Trend	-	-	-0.001 (0.001)	-0.005 (0.002)	-0.003 (0.002)
Union Recognition * Trend	-	-	-	0.007 (0.002)	0.006 (0.002)
Constant	0.169 (0.056)	0.156 (0.055)	0.190 (0.158)	0.206 (0.059)	0.173 (0.059)
SE	0.01073	0.01071	0.01077	0.01072	0.01068
Wald 1	72.00 (0.00)	72.73 (0.00)	43.90 (0.00)	73.83 (0.00)	101.39 (0.00)
Wald 2	-	-	-	-	-
Wald 3	41.98 (0.00)	45.00 (0.00)	45.29 (0.00)	45.57 (0.00)	44.88 (0.00)
Number of Firms	494	494	494	494	494
Sample size	3132	3132	3132	3132	3132

Notes to Table

Controls of Table 3.2, column (3) are included in all specifications.
See Notes to Table 3.2.

supports the view of a generally pro-cyclical behaviour of profit margins,[29] while column (2) suggests that unionised firms' margins are less so. Columns (3) and (4) show that unionised

[29] See Machin and Van Reenen (1993).

firms have had an upward trend in their profit margins over the 1980s and that this effect was not so clear amongst the non- unionised ones. Finally, the results of the last column wherein cyclical and trends indicators are put together suggest that, even after accounting for cyclical effects, the upward trend in the profitability of unionised firms during the late 1980s remains clear.

Some authors (see Metcalf, 1993 and Brown and Wadhwani, 1991) have emphasized the increasing product market competition in the 1980s as the driving force behind many changes in the indsutrial relations and economic performance. Although one cannot directly assess this view with the data in hand, an experiment was performed that compared the effects of increasing product market competition in the union sector with its effect in the sample as whole. The coefficient of the interaction of this variable with the basic recognition variable was proved *not* to be significantly different (at 10 % level of significance) from the coefficient of the variable alone in the 1984-90 period as a whole. This suggests that the expected negative effect on profitability of increasing competition was not significantly outweighed in the union sector by a decreasing capacity of unions to appropriate a share of firms' profits *as a direct result* of a more competitive product market environment.

3.4.1 Conclusions

This paper examined the impact of union recognition on the behaviour of the rate of return on sales of British firms between 1984-90. The main result is that the negative union effect on the profitability declined substantially over that period. This result seems to be consistent with the view that legislation changes have weakened the unions' "bargaining power". It also seems that the unionised firms have a less pro-cyclical profitability behaviour. On the basis of these results it can tentatively be predicted that an even better profitability comparison in favour of the unionised firms has taken place in the 1991/93 period, following the 1990 Employment Act and the deepening of the recession in the UK. As subsidiary results, it was found that the profitability of unionised firms is even lower where the firms have only one establishment and where different unions bargain jointly with the firm at the industry level. Furthermore, it was shown that the union effect persists in a first-differences specification.

3.5 Appendix

3.5.1 Theoretical Appendix

Proof of Proposition 1a:

Define the profits/sales ratio as :

$$\pi/s^i(w^i, w^j) = \frac{\pi^i(w^i, w^j)}{\pi^i(w^i, w^j) + w^i L^i(w^i, w^j)} \tag{13}$$

Then:

$$\frac{\partial(\pi/s)^i}{\partial w^i} = \frac{\frac{\partial \pi^i}{\partial w^i}(\pi^i + w^i L^i) - \pi^i(\frac{\partial \pi^i}{\partial w^i} + w^i \frac{\partial L^i}{\partial w^i} + L^i)}{(\pi^i + w^i L^i)^2} \tag{14}$$

As the denominator is positive, the expression will be negative if the numerator is negative.

***

Proof of Proposition 1b :

Total differentiating the profit/sales function, we have:

$$d(\pi/s)^i = \frac{\partial \pi/s^i}{\partial w^i} dw^i + \frac{\partial \pi/s^i}{\partial w^j} dw^j \tag{15}$$

If $dw^i = dw^j > 0$, then : $d(\pi/s)^i < 0$ if :

$$\frac{\partial \pi^i}{\partial w^i}(\pi^i + w^i L^i) - \pi^i(\frac{\partial \pi^i}{\partial w^i} + w^i \frac{\partial L^i}{\partial w^i} + L^i) < \frac{\partial \pi^i}{\partial w^j}(\pi^i + w^i L^i) - \pi^i(\frac{\partial \pi^i}{\partial w^j} + w^i \frac{\partial L^i}{\partial w^j}) \tag{16}$$

***

Proof of Proposition 2 :

Represent a marginal change in the industrial relations' structure by '$d\theta$' and make $Z^i(w^i, w^j, \beta^i)$ also a function of θ . Then :

$$\frac{dw^i}{d\theta} = \frac{\partial w^i}{\partial \theta} + \frac{\partial w^i}{\partial w^j}\frac{dw^j}{d\theta} = w\theta^i + w^i_j \frac{dw^j}{d\theta} \tag{17}$$

Assuming symmetry[30] and solving :

$$\frac{dw^i}{d\theta} = \frac{w\theta^i}{1 - w^i_j} \tag{18}$$

Now, given SOC :

$$sign\frac{\partial w^i}{\partial \theta} = sign - \frac{Z^i_{i\theta}}{Z^i_{ii}} = signZ^i_{i\theta} \tag{19}$$

Assuming the stability condition for a symmetric Cournot equilibrium holds ($|w^i_j| < 1$) :

$$sign\frac{dw^i}{d\theta} = sign\frac{\partial w^i}{\partial \theta} = signZ^i_{i\theta} \tag{20}$$

Hence, by integrating over the range $[\theta^I, \theta^{II}]$ and subject to the continuity conditions described in Dowrick (1993), a discrete change in the bargaining structure that increases the value of Z^i_i and Z^j_j will increase $w^i(w^j)$ and $w^j(w^i)$ thereby increasing w^{i*} and w^{j*} .

***

Proof of Proposition 3 :

In the bargaining framework analysed here, each party will always get a least the equivalent to its outside option, which act as a constraint to the solution. This means that the union workers will get at least the wage in the competitive sector. Now , given SOC:

$$sign\frac{\partial w^a}{\partial \beta^i} = sign(-\frac{Z^{II}_{a\beta^i}}{Z^{II}_{aa}}) = signZ^{II}_{a\beta^i} \tag{21}$$

and, given the assumptions stated in the main text:

$$Z^{II}_{a\beta^i} = \frac{\pi^i_a}{\pi^i} - \frac{U^A_a}{U^A} < 0 \tag{22}$$

***

Proof of Proposition 4:

Evaluate Z^{III}_a (w^i, w^j), that is, compare Z^{III}_a with Z^{II}_a :

[30] That is : $w\theta^i = w\theta^j$ and $w^i_j = w^j_i$. See Dowrick (1993) for the proof of the general case.

$$Z_a^{III} - Z_a^{II} = (\beta^i)\frac{\pi_a^i \underline{\pi}^i}{\pi^i(\pi^i - \underline{\pi}^i)} < 0 \tag{23}$$

given the assumptions stated in the main text and the fact that the outcome of the bargaining must be higher than the fall-back position. Then apply Proposition 2 and condition **C1**.

***

Proof of Proposition 6:

a)

$$Z_a^{V} - Z_a^{II} = (\beta^i)\frac{\pi^i \pi_a^j - \pi_a^i(\pi^i - 2\underline{\pi}^i)}{2\pi^i(\pi^i - \underline{\pi}^i)}? \tag{24}$$

b)

$$Z_a^{V} - Z_a^{III} = (\beta^i)\frac{\pi_a^j - \pi_a^i}{2(\pi^i - \underline{\pi}^i)} > 0 \tag{25}$$

***

Proof of Proposition 7:

a)

$$Z_a^{VI} - Z_a^{II} = (\beta^i)\frac{\pi_a^j - \pi_a^i}{2\pi^i} > 0 \tag{26}$$

b)

$$Z_a^{VI} - Z_a^{V} = (\beta^i)\frac{-\underline{\pi}^i(\pi_a^i + \pi_a^j)}{2\pi^i(\pi^i - \underline{\pi}^i)} > 0 \tag{27}$$

***

Proof of Proposition 8 :

$$Z_a^{VII} - Z_a^{II} = (\beta^i)\frac{2\pi_a^j + \pi_a^i}{\pi^i} + (1 - \beta^i)\frac{U_a^B + U_a^C + U_a^D}{U^A}? \tag{28}$$

***

3.5.2 Empirical Appendix

In Table 8, the main results including the lagged dependent variable are presented, in the light of the persistence of profitability literature (see Mueller, 1990). The derecognition variable is

Table 3.8: **Dynamics**

ROS	Levels (OLS)	Levels (GMM)	First Differences (GMM)
Union Recognition	0.002	0.002	-
	(0.002)	(0.002)	
Derecognition	0.006	0.006	0.003
	(0.003)	(0.003)	(0.001)
Market Share [a]	0.006	-0.005	-0.010
	(0.030)	(0.031)	(0.147)
No (Less) Competition	-0.005	-0.005	0.003
	0.004	(0.004)	(0.003)
Market Share *	0.048	0.065	0.637
No (less) Competition [a]	(0.032)	(0.040)	0.727
Capital /Sales [a]	0.008	0.008	0.036
	(0.004)	(0.005)	(0.022)
More Competition	-	-	0.001
			(0.003)
ROS (t-1) [a]	0.761	0.760	0.458
	(0.043)	(0.043)	(0.141)
Constant	0.036	0.036	-0.005
	(0.013)	(0.015)	(0.005)
SE	0.004672	0.004672	0.003397
Wald 1	728.48 (0.00)	666.97 (0.00)	25.81 (0.00)
Wald 2	25.87 (0.00)	23.36 (0.00)	17.49 (0.00)
Wald 3	9.83 (0.27)	10.06 (0.25)	-
SC1	0.658 (0.511)	0.658 (0.511)	-2.010 (0.040)
SC2	-1.627 (0.104)	-1.627 (0.103)	-1.460 (0.140)
Sargan	-	64.11 (0.37)	63.65 (0.17)
Number of Firms	494	494	494
Sample size	2994	2994	2336

Notes to Table

Dependent Variable is Rate of Return on Sales (ROS). All Standard Errors (in brackets) are Robust to both Serial-Correlation and Heteroscedasticity. (a): Variables treated as endogenous. Instruments used are Xi(t-1) to Xi(t-3) in column(2) and Xi(t-3) to Xi(t-6) in column (3).

significant throughout the different specifications. Also note the very high estimated coefficients on the lagged profitability (less so when specific effects are controlled for). The positive union recognition effect in the levels specifications reflects the fact that unionised firms experienced a higher than average profitability growth in the period, since including a lagged dependent variable is an alternative to including changes in profitability as the dependent variable, where the coefficient of the lagged term is allowed to be different from one.

Data description

EXSTAT Data **Rate of return on sales**: profit before tax (C34) / total sales (C31).

Capital / sales: Total net tangible assets (C91) / total sales (C31).

Cash-liabilities ratio: cash and equivalent (C111) / total liabilities (C158).

Debt-equity ratio: [loan stock of parent company (C138) + loan stocks of subsidiaries (C139) + bank loans and overdrafts (C148) + Other loans (C141)] / [ordinary share capital (C123) + preferred share capital (C122) + other capital (C124) deferred taxation (C134)].

3.5.3 Descriptive Statistics

Market Share Variable

Generating a market share measure from company accounts has many well known difficulties, such as the fact that firms operate in more than one industry and that in the non-manufacturing sector the industry sales figures are not generally available. In this study we obtained information on the distribution of sales of firms across up to 6 different industries from Datastream Database for 1985 and assumed it constant over 1983-1990. We then constructed the total sales figure for the 2-digit industries by summing the sales of 2607 Datastream firms across two digit industries for each year . Unfortunately the Datastream data set was only available up to 1987. For the years from 1987 to 1990 we summed the sales of 1477 Exstat firms using the same procedure as above.

We calculated the MS of the firm in each of its operating industries, then calculated the weighted average MS (using proportion of sales as weights) in each year. The relevant total sales figures were from Datastream firms for each year between 1983-1987 and Exstat after 1987. Because of the smaller sample of Exstat firms, we scaled up the 1987 total industry sales (based

Table 3.9: **Descriptive Statistics**

Exstat Variables	**Mean (S. D.)**	**Mean (S.D.)**
Variable	**Levels**	**First-Differences**
Rate of Return on Sales	0.081 (0.112)	0.004 (0.074)
Market Share	0.011 (0.043)	0.001 (0.012)
Capital/Sales	0.339 (0.621)	0.011 (0.216)
Debt-Equity Ratio	5.381 (93.376)	0.642 (123.784)
Cash-Liabilities Ratio	0.181 (0.321)	0.004 (0.246)

Survey Variables	**Number of Firms**	**Percentage of Firms**	**Percentage Union Firms**
Levels			
Union Recognition	265	54	
Rec and 1 Establishment	33	7	12
Rec and more than 1 Est.	232	47	88
Rec,more than 1 Est and Rec in all Est	88	18	33
Rec,more than 1 Est, Rec in all Est and Firm Level Barg	54	9	17
Rec,more than 1 Est, Rec in all Est and Non-Firm Level Barg	34	7	13
Rec,more than 1 Est and Rec in some Est	144	29	54
Multi-Union	153	34	68
Joint Bargaining	55	12	26
Separate Bargaining	98	22	44
Industry Level Bargaining	64	14	29
Firm/Est. Level Bargaining	161	36	62
Joint and Industry Level Barg	15	3	7
Joint and Firm/Est Level Barg	40	9	18
Separate and Ind Level Barg	24	5	11
Separate and Firm/Est Level Barg	74	16	33
Changes			
Derecognition	36	7	14
Increasing Competition	443	70	
Decreasing Competition	34	7	
Joint to Separate Bargaining	8	2	4
Decentralization of Bargaining	50	11	22
Decreasing Number of Est Rec Unions	25	6	11

Table 3.10: **Balance of the Panel**

Union Recognition	(84)	(85)	(86)	(87)	(88)	(89)	(90)
Yes	173	195	218	227	221	214	186
Percentage	(44)	(44)	(46)	(46)	(47)	(48)	(45)
No	221	248	258	262	253	233	223
Percentage	(56)	(56)	(54)	(54)	(53)	(52)	(55)
Total	394	476	476	489	474	447	409

Table 3.11: **Distribution of Firms Across Main Product Industries**

Industry Number	Industry Name	Number of Firms
1	Energy and Water Supply	18
2	Manuf Metals, Minerals and Chemicals	45
3	Metal Goods and Engineering	101
4	Other Manufacturing	109
5	Construction	31
6	Distribution	101
7	Transport and Communication	22
8	Finance	54
9	Other Services	13

on Datastream) each year after 1987 by the percentage Exstat difference between the relevant year and 1987 (where we had both Datastream and Exstat) in order to avoid inconsistence between the 1984-87 and 1988-90 numbers.

The correlation between the constructed MS and the one calculated using the Total Sales figure from the Census of Production (manufacturing sector only) was 0.90.

Survey Questions The survey was structured to ask respondents details of union presence in 1984 and 1990 and changes in union presence for two time periods (1980-84 and 1985-90).

i) **Union Recognition**: Does your company recognizes trades unions for the purposes of bargaining over wages and conditions in any of your establishments?

ii) **Closed Shop**: Does your company have an agreement with any trades union (s) that some or all of the work force would normally be members of a trade union in order to get or keep their jobs?

iii) **Less than five competitors**: In your company's major U.K. product market or markets how many direct competitors does your company face:none, more than 5 or less than 5?

iv) **Number of establishments**: Does your company have more than one establishment in the UK?

v) **Recognition in all establishments**:Does your company recognize trades unions for the purpose of bargaining over wages and conditions in some or all of your establishments?

vi) **Number of manual unions**: Does your company recognize more than one trades union for the purpose of bargaining over wages and conditions for your manual employees?

vii) **Bargaining organization**: Do the unions negotiate: jointly or separately?

viii) **Level of bargaining**: What was the most important level of negotiations which affected your workforce in their most recent pay settlement?

ix) **Changes in recognition**:

1) *Unions recognized in 1990*: Over the years of 1980-84 (1985-90) was there a net change in the number of your company establishments that recognized trade unions for the purposes of bargaining over wages and conditions other than as a result of the opening or closure of establishments?

2) *Unions not recognized in 1990*: Over the years of 1980-84 (1985-90), did your company cease to recognize trade unions for the purposes of bargaining over wages and conditions in all,

some or none of your establishments?

x) **Changes in closed shop**: Over the year of 1980-84 (1985-90), was there any net change in the proportion of the work-force covered by agreements with unions such that employees have to be members of a union to get or keep their jobs?

xi) **Product and foreign market competition**: Over the years of 1980-84 (1985-90), has your company faced increased or decreased competition in its product market or markets?

1) From UK based competitors.

2) From competitors based outside the UK.

xii) **Changes in bargaining organization**: If your company has had more than one union recognized for your manual employees over the years 1980-84 (1985-90) has there been any change in whether these unions bargain jointly or separately?

xiii) **Changes in the level of bargaining**: Over the years of 1980-84 (1985-90) was there any change in the importance of the level at which negotiation of wages took place?

xiv) **Percentage of female workers**: What percentage of your company workforce are female?

xv)**Percentage of part-time workers**: What percentage of your company workforce are part-time employees (work less than 30 hours a week)?

Chapter 4

Unions and R&D : Evidence from British Companies and Plants

4.1 Introduction

This chapter aims at contributing to two debates. The first debate is over the weak technological performance of the UK economy. This has frequently been attributed to the poor state of industrial relations in Britain and, in particular, to the power of the trade unions. In order to shed some light on what drives the process of R&D investment, some models specified at the *firm and establishment level* will be examined here. In Britain, micro-econometric models of R&D are rare because of the difficulty of obtaining appropriate data [1].

The second debate is over the long-run impact of unionisation. Addison and Hirsch (1989) argue that the truly damaging effects of unions are not so much on static efficiency (productivity *levels)* but on dynamic efficiency (productivity *growth*). By retarding the investment that companies make in innovation, unions would reduce corporate growth rates. This reasoning follows from a rent-sharing view of how unions operate. If unions raise wages by extracting economic rents away from the firm and if some of these quasi-rents flow from past sunk investments in different forms of capital, this will reduce corporate incentives to invest [2].

As we saw in chapter 2, Grout (1984) details a model where unions bargain over employment

[1] Athough see Seaton and Walker (1994), for an exception.

[2] Another possible source of rents is collusion in the product market (Dowrick, 1989).

and wages conditional on investment. The perfect equilibrium of this two stage game results in lower investment than it would occur in the case of binding contracts. Later writers have amplified this point and argued that it is types of investment which are very long term and uncertain that are likely to be worst affected by union rent-extraction. R&D investment is seen as a prime target, since the fruits of R&D are highly uncertain and generally have long gestation lags. Since R&D is commonly viewed as an important determinant of firm productivity growth (see Mairesse and Sassanou, 1991, for a survey) the strength of unions could have dire consequences for their firms, and in the long-run, the very survival of the union movement.

There are some critical points to make about this literature. An important feature of R&D is its strong strategic component, that is, large R&D spending firms are always involved in innovation races with their rivals. Many physical capital investments also have some strategic components (e.g. to deter entry), but this is clearly an important feature of any model of the R&D process. The theoretical appendix draws upon models first articulated by Ulph and Ulph (1994) to show that, when R&D competition is modelled explicitly, the prediction arising from standard models (focusing on one-firm one-union bargaining), that increases in union strength tend to reduce R&D, may not always be sustained. In particular, in a model where R&D is determined by a stochastic patent race, increases in union power can increase the probability of a firm winning the race, but, after a certain level of union power, the effect always becomes negative.

In a more empirical vein, one must note that unions may influence the production process independently of their impact on wages or employment. Unions may alter the ability of the firm to adopt new technologies. The industrial relations literature is replete with examples of union resistance to the march of the machine despite Samuel Gompers' warnings[3]. On the other hand, unions may positively help the spread of new techniques by encouraging greater training, lower turnover and better morale through giving workers a collective voice (Freeman and Medoff, 1984).

What is the empirical evidence on these matters? As we saw in the second chapter, some U.S. studies conclude that unionised environments have a damaging effect on R&D spending. The absence of any European micro-econometric work relating labour market institutions to

[3] *It is absolutely futile for workmen to go on strike against the introduction of a new machine, a new device or tool because they may thereby push their employer out of business* (quoted in Bok and Dunlop, 1970, p.262)

R&D is an important lacuna which this chapter seeks to rectify. Furthermore, it seeks to go beyond the U.S. work, by attempting to control for selectivity bias in the sample of firms who declare R&D, to control explicitly for human capital and technological opportunity and to look at establishment, as well as company, R&D. The lay-out of the rest of the chapter is as follows. Section 4.2 deals with the company data and results, 4.3 with the plant level data and results and finally, section 4.4 offers some concluding comments.

4.2 Company R&D and Union Presence

4.2.1 Data and econometric specification

The company dataset is drawn from the accounts of firms between 1982-1990 taken from the EXSTAT database. This has an item for the total R&D expenditure during the accounting year, which is normalised on sales. Company accounts have no information on union presence or human capital characteristics, so a survey carried out amongst managers of the entire population of EXSTAT firms was used (the same survey was used in the last chapter). This provided information on the proportion of non-manual workers, skilled manual workers and many indices of union activity. The human capital information is usually absent from firm level studies of R&D. After cleaning and deleting firms with less than four continuous years of data of all the control variables, there are 446 companies. These tend to be large (they employed a total of 2.6m workers in 1990). Unlike many of the other studies, both manufacturing and non-manufacturing firms are included in the sample.

Figure 4.1 plots out the total R&D in the sample and compares it to total R&D in the UK economy. Although not entirely comparable in definition[4], both aggregates display a similar trend, but firm R&D in our sample is about one third as large as the aggregate figure (for example in 1990 total R&D was £1.2bn in our sample and £3.5bn in the economy as a whole).

The mean R&D/Sales ratios for union and non-union firms are plotted over time in Figure 4.2. As with U.S. work, unionised firms appear to have much lower R&D intensities than their non-unionised counterparts. An immediate problem arises with company R&D data however,

[4] The economy-wide figure is business enterprise R&D. This excludes the part of firm's R&D budgets that are spent overseas which is included in the firm level figures.

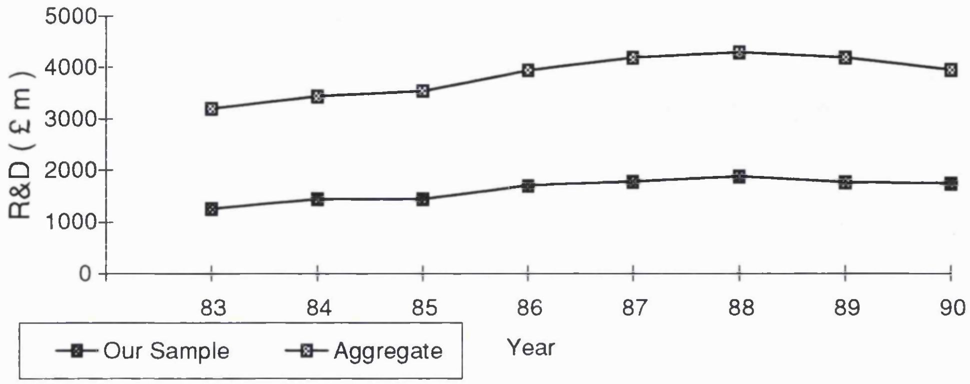

Figure 4-1: R&D Expenditures Over Time

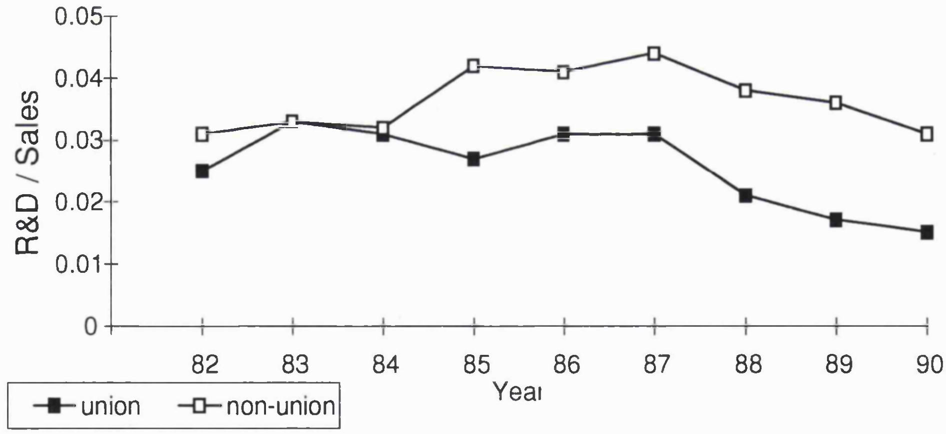

Figure 4-2: R&D Intensity and Union Presence

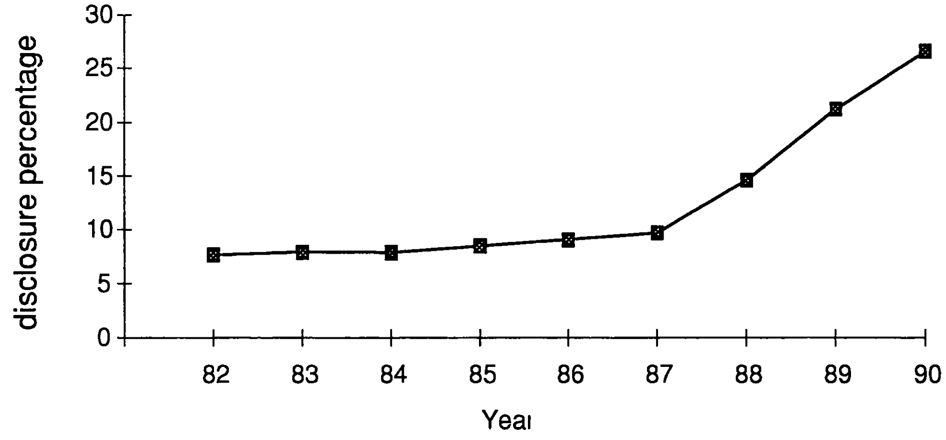

Figure 4-3: R&D Disclosure Over Time

since most firms do not disclose the amount of R&D performed[5]. This is because the relevant Standard Statement of Accounting Practice (SSAP13) contained no obligation on companies to provide details. Many companies did so anyway, but this was not mandatory. During the 1980s, political pressure built up to tighten the R&D disclosure requirements and in 1987 Exposure Draft 41 (ED41) proposed a change to make reporting compulsory. In 1989, SSAP13 (Revised) was passed, which made disclosure compulsory for firms who fulfilled two out of the following three criteria: turnover exceeds £80m, total balance sheet over £39m, and employment greater than 8000. This may explain the jump in the numbers of companies disclosing R&D illustrated in Figure 4.3, which plots disclosure rates over time.

To deal with the fact that the R&D equation may be on a non-random sample the well known two-stage estimator of Heckman (1979) will be used. First, the selectivity (disclosure) equation is estimated by probit maximum likelihood, to predict which firms will be in the selected sample. Then, the Mills ratio is calculated and added as an additional regressor to the R&D equation to correct for selectivity bias. An important difficulty with this method is that identification is achieved purely off the functional form of the model, unless there are variables which affect the decision to disclose but not the amount spent on R&D. A classic study of

[5]By disclosure we mean all firms who reported non-zero R&D. Amongst the 446 firms there were only two who reported zero R&D and these were classified as non-disclosers.

firm level R&D in the U.S., by Bound et al (1984), explicitly recognised the sample selectivity problem, but had no convincing exclusion restrictions to deal with the problem [6].

The variables we use to identify the model are the changes in accounting rules in 1987 (ED41) and 1989 (SSAP13). These are dummy variables equal to 1 if a firm was covered by the rule and zero otherwise. As seen above, these affected large firms differentially from the smaller firms, so there is variation in the instrument across firms, in addition to the variation across time periods. It seems highly unlikely that these accounting changes affected the amount of R&D performed. Since the accounting rules are conventions, not all firms covered by them reveal their R&D, although the overwhelming majority do. In other words, the accounting rule shifts act as a natural experiment to identify the R&D disclosure equation from the R&D intensity equation.

More formally, the model to be estimated is

$$DISC^{*}_{it} = Z'_{it-1}\delta + u_{it} \tag{4.1}$$

If the latent variable exceeds zero, (i.e. $DISC^{*} > 0$) the firm discloses R&D. If $DISC^{*} \leq 0$, the firm does not disclose R&D in that time period. Z will include the dummy variables for whether a particular firm was covered by the two changes in accounting rules (the identifying variables) as well as other controls affecting disclosure (see Machin and Van Reenen, 1995, for an application of this technique to an international panel dataset). Firms were deemed to have disclosed if we observe them reporting positive R&D in their company accounts. There were two firms who reported zero R&D and were treated as non-disclosers. There were no firms who switched from a disclosing to non-disclosing state [7].

The main equation of interest is:

$$R\&D_{it} = \alpha UNION_{i} + X'_{1i}\beta + X'_{2it-1}\gamma + v_{it} \tag{4.2}$$

Under the assumption that $u_{it,}v_{it}$ have a bivariate normal with means 0, variance σ_u and

[6] *'In the absence of a reporting predictor that is exluded from the quantity equation, it is impossible to distinguish selectivity bias and true 'nonlinearity' in the R&D-size relationship' (p.38)*

[7] One would like to treat the (disclosing) zero R&D performers differently from the nonzeros. This is because there may be fixed costs of conducting R&D. In the plant level analysis, some experiments along these lines are conducted.

σ_v, and correlation ρ, the conditional expectation of the incidentally truncated variable can be written:

$$E(R\&D_{it}|X_{it-1}, DISC_{it}=1) = \alpha UNION_i + X'_{1i}\beta + X'_{2it-1}\gamma + \rho\sigma_v \frac{\phi(Z'_{it-1}\delta)}{\Phi(Z'_{it-1}\delta)} \qquad (4.3)$$

Consistent estimation of the β and γ are achieved by substitution of the Mills ratio evaluated at the estimated values of δ from (4.1). The variance -covariance matrix must be adjusted for the fact that the Mills ratio is a generated regressor.

R&D is the log of the ratio of the firm's R&D expenditure over its sales. The amount of nominal R&D is deflated by an industry specific R&D price deflator and total sales by an industry-specific output price deflator. UNION is a measure of firm specific union power (recognition or density). In (4.2) X_{1i} is a vector of other time invariant characteristics drawn from the survey (such as human capital variables), and X_{2it} is a vector of time varying control variables. These include the firm size (number of employees), capital intensity (physical capital over sales ratio), market share, cash flow [8] and some cohort dummies. Technological opportunity and appropriability conditions are captured by the two digit R&D/sales ratio and industry patents to employment ratio. Many of the firms in the sample operate over many different industries [9], so the industry measures we weighted by the distribution of sales across these industries. The variables were transformed to be natural logarithms [10]. In (4.1) all the X' s were included in addition to the accounting rule variables. Further details are contained in the Data Appendix.

One econometric problem with panels lies in the possible presence of individual effects. Random effects models are presented for comparison with the baseline pooled least squares estimates. Allowing for fixed effects is specially problematic when union status varies very little over time. It also complicates the estimation procedure considerably[11].

[8] The usual liquidity constraints argument bites with particular force for R&D investments. Justifying to external funders why a firm needs finance for a project would reveal sensitive information to its rivals. See Himmelberg and Petersen (1994) for some recent empirical evidence.

[9] In our sample, 25 % of firms had sales in two or more 2 digit industries.

[10] For those variables were there are zeros or negative values the method of Pakes and Griliches (1984) was used, that is, to set the logarithm to zero but add an extra dummy variable equal to one if there was a zero.

[11] See Verbeek and Nijman (1992) for a parametric account of dealing with selectivity and fixed effects and Kyriazidou (1994) for a recent semi-parametric approach.

4.2.2 Company level results

Table 4.1 presents the results from the R&D disclosure equation. Column (1) regresses disclosure against our two identifying instruments (the accounting rule change dummies). Both enter positively and significantly as expected. Column (2) then includes the vector of firm and industry controls and (one-digit) industry dummies. Larger and more capital intensive companies are more likely to disclose as are more profitable firms and those who are in industries with higher R&D and/or patent intensities. Union Recognition and human capital have no significant influence on disclosure probabilities. Column (3) repeats this specification, but using *density* instead of recognition as a measure of unionization. The results are qualitatively the same [12].

Table 4.2 holds the results for the R&D intensity equation. Column (1) includes only the union recognition variable. As the raw statistics suggested, union firms appear to invest significantly less in R&D than non-union firms. Column (2) then includes the human capital variables and time-varying industry R&D, as a proxy for technological opportunity. The non-manual proportion and industry R&D are positively correlated with R&D, but negatively correlated with union presence. Their inclusion reverses the sign of the union effect, driving it into insignificance. These are important controls that are generally absent from the existing studies. Column (3) then includes the other control variables, which do not fundamentally change this result. Firms in industries with higher wages or greater patent intensities have higher R&D. Higher past profits are associated with higher current R&D expenditure, which may be due to the lower cost of financing R&D for cash-rich firms. There is also evidence that both very new firms (1980s cohort) and very old firms (start-up before 1940) also had higher R&D intensities than the middle-aged 1940-1979 cohort [13].

Column (4) includes the Mills ratio to correct for the suspected selectivity bias in our sample. Although it is strongly significant, the effect of union recognition is still positive and insignificant . The selectivity correction does have an important effect on the other covariates,

[12] Note though that because of the smaller sample size (due to missing values on union density), only one of our identifying instruments was significant in column (3). If we allow both variables to enter the equation then neither are individually significant. A LR test of the restriction is $\chi^2(1) = 0.71$.

[13] Freeman (1994) criticises many empirical studies of union effects because of the failure to adequately control for the age of the firm (p.292). The problem with this is that defining the appropriate 'age' of a company is conceptually very difficult. Firms operate on different sites, are involved in merger and takeover activities and re-tool their capital stocks. Nevertheless an age proxy was constructed and included in the specification.

Table 4.1: **R&D Disclosure Probits**

R&D Disclosure	(1)	(2)	(3)
ED 41	0.562	0.224	0.168
	(0.082)	(0.102)	(0.096)
SSAP 13	0.276	0.235	-
	(0.116)	(0.131)	
Union density	-	-	-0.111
			(0.146)
Union recognition	-	-0.121	-
		(0.093)	
Proportion non-manual wokers	-	-0.056	0.132
		(0.137)	(0.158)
Proportion skilled workers	-	0.103	0.352
		(0.202)	(0.231)
Ln(market share)	-	0.011	-0.033
		(0.032)	(0.036)
Ln(capital/sales)	-	0.143	0.137
		(0.051)	(0.055)
Ln(rate of return)	-	0.134	0.162
		(0.047)	(0.051)
Rate of return zero or less	-	-0.375	-0.389
		(0.176)	(0.188)
Ln (employment)	-	0.255	0.311
		(0.039)	(0.044)
Birth $\prec$ 1940	-	-0.113	-0.123
		(0.086)	(0.097)
Birth $\succ$1979	-	0.549	0.626
		(0.097)	(0.107)
Ln (industry R&D)	-	0.121	0.172
		(0.041)	(0.043)
Ln (ind.patents/empl)	-	0.088	0.179
		(0.028)	(0.032)
Industry patents =0 dummy	-	-0.138	0.050
		(0.122)	(0.130)
Ln (industry wage)	-	0.709	0.455
		(0.338)	(0.367)
Constant	-1.255	-1.915	-2.343
	(0.034)	(0.233)	(0.543)
Industry dummies	no	yes	yes
Sample size	2940	2940	2506
Log-likehood	-1125.73	-850.94	-704.78

Notes to Table

Dependent variable is R&D Disclosure. Column (3) uses union density instead of union recognition. Standard errors in brackets.

Table 4.2: **R&D Intensity Equation**

Ln(R&D/sales)	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Union recognition	-0.435	0.015	0.101	0.023	-	-	-	-
	(0.147)	(0.143)	(0.169)	(0.171)				
Union density	-	-	-	-	-0.583	0.000	0.189	0.093
					(0.225)	(0.230)	(0.292)	(0.268)
Proportion non-manual workers	-	1.208	1.097	1.105	-	1.400	1.278	1.613
		(0.246)	(0.242)	(0.262)		(0.285)	(0.293)	(0.342)
Proportion skilled workers	-	-0.325	-0.460	-0.570	-	-0.332	-0.318	-0.410
		(0.295)	(0.327)	(0.383)		(0.364)	(0.460)	(0.475)
Ln (market share)	-	-	0.046	0.036	-	-	0.066	0.100
			(0.047)	(0.060)			(0.048)	(0.073)
Ln (capital/sales)	-	-	0.098	0.290	-	-	0.174	0.424
			(0.095)	(0.110)			(0.109)	(0.130)
Ln (rate of return)	-	-	0.168	0.290	-	-	0.195	0.384
			(0.078)	(0.110)			(0.093)	(0.121)
Rate of return zero or less	-	-	-0.569	-0.905	-	-	-0.553	-0.974
			(0.258)	(0.339)			(0.278)	(0.394)
Ln (employment)	-	-	-0.045	0.192	-	-	-0.107	0.223
			(0.051)	(0.099)			(0.053)	(0.134)
Birth $\prec$1940	-	-	0.357	0.298	-	-	0.380	0.313
			(0.143)	(0.161)			(0.187)	(0.199)
Birth $\succ$1979	-	-	0.535	0.905	-	-	0.469	1.028
			(0.146)	(0.216)			(0.157)	(0.278)
Ln (industry R&D)	-	0.406	0.214	0.363	-	0.384	0.230	0.458
		(0.050)	(0.076)	(0.082)		(0.052)	(0.083)	(0.107)
Ln (ind patents/empl)	-	-	0.046	0.192	-	-	0.132	0.328
			(0.034)	(0.099)			(0.046)	(0.088)
Industry patents=0 dummy	-	-	-0.306	-0.452	-	-	-0.176	-0.133
			(0.261)	(0.267)			(0.278)	(0.295)
Ln (industry wage)	-	-	0.916	1.688	-	-	1.322	2.040
			(0.572)	(0.695)			(0.597)	(0.790)
Inverse Mills ratio	-	-	-	1.252	-	-	-	1.580
				(0.395)				(0.516)
Constant	-3.551	-2.690	-2.823	-3.189	-3.733	-3.040	-2.283	-6.509
	(0.249)	(0.325)	(0.803)	(0.563)	(0.347)	(0.361)	(0.861)	(1.765)
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes
Industry dummies	no	no	yes	yes	no	no	yes	yes
Sample size	405	405	405	405	339	339	339	339
Log-likelihood	-691.0	-641.6	-606.0	-586.6	-584.0	-542.7	-515.0	-495.4
Adjusted R-squared	0.05	0.25	0.35	0.37	0.03	0.23	0.32	0.34

Notes to Table

Dependent variable is R&D/Sales. Columns (4)-(8) uses union density instead of union recognition. Standard errors in brackets.

however. Employment and capital intensity, for example, were both heavily biased downwards because of selectivity, suggesting that small firms both do less R&D and are less likely to disclose it. The corrected regression implies that a doubling of employment results in an increase in R&D intensities of about 20%. Capital intensity turns out to be significant after the selectivity correction was made with an elasticity three times as large. Columns (5) to (8) replicate specifications (1) to (4) but using union density as an alternative measure of union power. Interestingly, the results are qualitatively very similar, with the human capital and technological controls decreasing a significantly negative union density effect on R&D. Insertion of our other controls reverse the negative effect.

The conclusion to be drawn from Table 4.2 is straightforward. The simple negative correlation of unionization with R&D intensity seems to be spurious. It appears to be primarily due to the fact that unions are less prevalent in the companies that operate in high-tech industries and where the workforce is more qualified, and these companies tend to have higher R&D intensities. This finding is robust to controlling to selectivity which mainly affects other variables in the model (such as employment). [14]

A variety of other experiments were attempted to check the robustness of Table 4.2. Table 4.3 summarises the results of these experiments, giving the coefficients and standard errors on the relevant variables in the first column, the coefficient and standard error on the union recognition variable in the second and the ones on the union density variable (from separate regressions) in the last one. The first row simple gives the union effects from our preferred specifications for comparison (from Table 4.2 columns (4) and (8)). The first group of experiments simply includes different variables which could bias the results if correlated with unionisation. The next two rows add measures of diversification based on the firm's distribution of sales across different industries. The negative value of a Herfindahl index of the firm's sales distribution across two digit industries (Row 1) and a simple dummy equal to one if a firm operates in more than one two digit industries (Row 2). Both tend to indicate that diversified firms invest more on R&D but the variables were never precisely estimated. Row 3 adds firm sales growth. As a simple test of the departure from the normality assumption we included a higher order power

[14] One might expect that the absence of a union effect was due to the fact that amongst the sampled firms labour is only a small share of total costs. However, there was no significant difference between the union effect in firms with higher labour share of total costs than those with a lower share ($\chi^2(1)$=2.92).

Table 4.3: **Robustness Tests**

Experiment	**coefficient (s.e.)** in recognition equation	**coefficient (s.e.) of union recognition**	**coefficient (s.e.) of union density**
Basic Specification [a]	-	0.023 (0.171)	0.093 (0.268)
1 Log of diversification index	0.111 (0.220)	0.015 (0.172)	0.094 (0.269)
2 Diversification dummy	0.085 (0.159)	0.028 (0.171)	0.116 (0.267)
3 Sales growth	-0.065 (0.167)	0.070 (0.184)	0.188 (0.296)
4 Mill's ratio squared	0.081 (0.210)	0.022 (0.169)	0.098 (0.283)
5 Drop profits	-	-0.035 (0.168)	0.053 (0.263)
6 Drop profits and capital	-	0.050 (0.160)	0.178 (0.239)
7 First - differences	-	-0.046 (0.083)	0.027 (0.054)
8 Recognition endogenous	-	0.171 [b] (1.006)	1.997 [c] (1.405)

Notes to Table

[a] *As in Table 3.2 column (4)*

Standard errors in brackets. [b] *Coefficient of the predicted probability of union recognition (from a probit model using all the controls of our preferred specification plus industry union density at time of start-up and proportion of female workers as identifying restrictions (see additional details in the text)*

[c] *Coefficient of the predicted union density (see note above)*

of the Mills ratio in Row 4. None of these experiments raised any doubts of the absence of a detrimental effect of unions on R&D.

Row 5 drops the profit/sales variable from the regression. It is possible that the inclusion of this variable disguises the union effect since unions reduce profits[15] and profits are positively associated with R&D investment. Indeed, the estimated union recognition coefficient is negative in this experiment and the coefficient on union density decreases, but both remain insignificant. In Row 6 we also drop capital/sales. If unions are associated with lower capitalisation because of their rent-sharing activities, then including capital intensity may disguise the union effect. This did not have the expected effect, as union effect in both specifications actually increases. Row 7 uses a first differenced specification. The union recognition term is negative but insignificant while the union density one remained positive [16]. Unfortunately, this is not an entirely convincing way of controlling for individual fixed effects as only six firms derecognised unions

[15] As shown in the last chapter.

[16] Dropping profitability and first-differencing the data at the same time resulted in recognition coefficient of -0.041 (0.080).

in our sample, while around 20% of the surveyed managers reported a decrease in firm level union density.

Union recognition may be endogenous because unions choose to locate in high R&D firms, where there are rents to grab (causing an upwards bias in the union coefficient) or because unions have found it more difficult to organise in new firms, which happen to be more R&D intensive (causing a downwards bias). Endogeneity is very difficult to deal with because of the need to find convincing instruments to identify the 'union recognition' equation from the R&D equation. However, the model of British union presence in Disney, Gosling and Machin (1995) suggests that conditions at the time of the firm start-up partially locks a company into a human resource strategy. Thus, conditions at the company's year of birth (such as industry union density) can predict current union power and may be a good identifying instrument, as there are no convincing reasons why they should affect current R&D decisions. The proportion of females in 1990 was also included in a probit model of union recognition and both were highly significant. Replacing the union variables by their predicted values (Row 8) suggested that we may be underestimating a positive union effect, but they remained insignificant. In the appendix (Table 4.11) the unionization equations are reported, which have remarkably well-determined coefficients and are interesting in their own right.

Also in the appendix (Table 4.9), it can be seen that the major part of the results described above were replicated when a linear specification was used, as opposed to a logarithmic one, particularly with respect to the union recognition effect. The results are robust to the inclusion of firms specific effects in a 'random-effect' model in column 3 [17]. Table 4.10 presents results for the manufacturing sector only. A very interesting feature here is that competitive sectors (low concentration and/or high import penetration ratios) are the most R&D intensive.

The theoretical model outlined in the appendix contains several predictions. Perhaps the most important one is that changes in union power could have a highly non-linear effect on R&D. However, these predictions referred to the *relative* level of R&D spending. In order to link the empirical part more tightly with this theory, one now uses the firm level of R&D expenditures *relative to the total industry R&D expenditures* as our dependent variable. Furthermore, to examine the predictions, the continuous measures of firm-level union power (union density) and

[17] An attempt was made to estimate this model using a logarithmic specification, but the estimated variances were negative (see Greene (1992) p.310)

Table 4.4: **Relative Company R&D**

Firm/industry R&D	**(1)**	**(2)**	**(3)**	**(4)**
Union density	1.800	0.767	11.368	4.465
	(0.647)	(0.369)	(1.762)	(1.502)
Union density	-	-	-10.852	-4.265
(squared)			(1.920)	(1.696)
Industry manual	3.005	0.664	-24.100	-11.903
union coverage	(0.923)	(0.546)	(3.916)	(2.267)
Ind manual union	-		18.315	10.761
coverage(squared)			(3.402)	(2.267)
Sample size	317	317	317	317
Log-likelihood	-716.3	-556.1	-678.4	-537.8
Adjusted R-squared	0.20	0.69	0.36	0.72

Notes to Table

Controls of Table 4.2, column (8) (except for industry level variables) are included in columns 2 and 4
Standard errors in brackets.

rival union power (union coverage at the industry level) were used. Table 4.4 shows the results of the estimations, always after controlling for the selectivity problem. These may also be seen as within-industry specifications, that is after controlling for unobserved industry specific effects (see Bronars, Deere and Tracey (1994)). Column (1) includes the two union density terms in a linear way. They are both positive and significant. In column (2), all the firm-level controls present in Table 4.2 are included, and the density terms remain positive but are now insignificant. However, column (3) provides evidence that the quadratic terms are preferred, with all the four terms entering highly significantly without any additional controls. The results seem to support the existence of a concave relationship between union density and relative R&D, and a convex one between rival's union power and firms' relative R&D expenditures. This is still true even after including the other firm-level controls in column (4). Both the log-likelihood and the adjusted R-squared values support column (4) as the preferred specification.

Have the correct functional forms really been tied down? Experiments were performed with higher order polynomials, splines and dummy variables. Throughout these test, there was always an area of moderate union density which was associated with higher R&D intensities than zero density. Nevertheless, at very high levels of density the association was always negative.

4.3 Establishment R&D and Union Presence

4.3.1 Data and econometric specification

Firm data has several disadvantages relative to establishment survey data. First, many companies operate across different plants with very different patterns of union organisation. Second, the disclosure problems discussed above are unlikely to be a major issue in an anonymous survey compared to an announcement in company accounts. Consequently, two plant level sources of R&D information are now examined.

The Workplace Industrial Relations Survey (WIRS) is based on stratified samples of over 2000 plants in Britain in 1980, 1984 and 1990. It is a major source for empirical research in labour economics and industrial relations (see the bibliography in Millward et al, 1992). The great advantage of WIRS is that is also has detailed information on union presence and activity, holding questions on recognition, union coverage and types of bargaining issues and structures. There are two sorts of information on plant R&D. The first comes from a special section of the WIRS questionnaire administered to the organisation's financial manager where the plant was an individual cost or profit centre. Financial managers were asked what proportion of total current expenditure was spent on R&D. The second source of R&D information comes from a follow-up survey, EMSPS (Employer Manpower and Skills Practices Survey) which re-sampled 82% of the WIRS establishments in 1991. Unlike the original WIRS, *all* respondents were asked how many R&D *workers* were based at the establishment. This should be a good proxy for R&D effort as the majority of the costs associated with R&D are staff costs. Thus there are two dependent variables: R&D as a proportion of total expenditure and the number of R&D workers as a proportion of total workers. The first definition is closest to that used in the firm-level analysis, but the second has the advantage that it is regressed on lagged explanatory variables and is available for a larger sample. The Data Appendix gives a full description of these variables and databases.

There was a high response rate to both of the R&D questions, which constitutes one of the only available sources of information on plant level R&D activity. The disadvantage of WIRS is that it has only limited economic information on other aspects of the firm's economic environment (e.g. turnover or capital), as compared to company accounts data. In the R&D equation, a quadratic in employment, the proportion of non-manual workers, the proportion of technical workers, industry R&D intensity, industry patents intensity and a set of 1 digit industry dummies are included. In addition, the proportion of R&D workers in the plant's industry is also included in the R&D worker equation and a dummy for whether or not the establishment belonged to a multi-plant firm.

Since the plant surveys are anonymous, it is assumed that those firms claiming to do no R&D were being truthful and the zeros in the data are genuine rather than a refusal to disclose. Consequently tobit analysis was used as there is a censoring problem at zero (see below for experiments with alternative econometric methods). The model is of the form

$$R\&D_i^* = \alpha UNION_i + X_{1i}^{'}\beta + v_i \tag{4.4}$$

where $R\&D_i^*$ is a latent variable. Observed R&D = $R\&D^*$ if $R\&D^* > 0$; otherwise $R\&D = 0$. The v_i are assumed to be normally distributed with variance σ^2.

4.3.2 Establishment level results

The results of the tobit model of R&D intensity are contained in Table 4.5. Columns (1)-(4) hold the results for (normalised) R&D expenditure and columns (5)-(8) for normalised R&D employees. Column (1) contains the full set of controls and uses union recognition as the measure of union power. Recognition is positive and insignificant. In the second column union density is negative, but also completely insignificant. Columns (3) and (4) reproduce the experiment of the firm level work and drop the human capital variables and industry R&D. As expected, the size of the coefficient falls and, in the case of density becomes weakly significant. The final columns are based on the larger sample where the number of R&D workers is known. Comparing columns (6) and (8), it is clear that the exclusion of the human capital and industry R&D cause the coefficient on union density to increase by about half and gain significance. The occupational variables also appear highly significant.

Overall, this table appears broadly consistent with the finding of the company level results. The negative relation between simple measures of union power and R&D are driven by a failure to control for key variables. But is the relationship simply linear? Table 4.6 goes on to include industry union density and higher order terms in union density to the plant R&D equations. Whether using expenditure or workers, the relationship between plant union power and R&D

Table 4.5: **Plant R&D - Tobits**

Ln(R&D intensity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Proportion R&D Expenditure				**Proportion R&D workers**			
Union density	-	-0.009	-	-0.032	-	-0.017	-	-0.034
		(0.019)		(0.018)		(0.013)		0.014
Union recognition	2.081	-	0.763	-	-0.643	-	-0.959	-
	(1.586)		(1.586)		(0.977)		(1.028)	
Proportion non-manual workers	2.534	1.513	-	-	9.328	9.095	-	-
	(2.966)	(3.024)			(1.994)	(1.987)		
Proportion technical workers	0.177	0.166	-	-	0.093	0.087	-	-
	(0.073)	(0.074)			(0.047)	(0.047)		
size[a]	0.252	0.320	0.356	0.428	0.643	0.665	0.765	0.810
	(0.173)	(0.017)	(0.174)	(0.174)	(0.125)	(0.124)	(0.129)	(0.129)
size squared[b]	-0.053	-0.065	-0.066	0.078	-0.130	-0.134	-0.148	-0.156
	(0.038)	(0.039)	(0.038)	(0.039)	(0.031)	(0.031)	(0.032)	(0.023)
ln(industry R&D intensity)	1.426	1.297	-	-	0.612	0.609	-	-
	(0.774)	(0.777)			(0.564)	(0.700)		
ln(ind patents/empl)	0.470	0.492	0.805	0.681	-0.170	-0.207	0.296	0.200
	(0.566)	(0.568)	(0.575)	(0.575)	(0.445)	(0.445)	(0.453)	(0.045)
ln(industry R&D employees)	-	-	-	-	0.641	0.619	-	-
					(0.703)	(0.563)		
ln(industry wage)	-0.134	-0.124	-0.081	-0.075	-0.076	-0.072	-0.019	-0.013
	(0.067)	(0.068)	(0.067)	(0.066)	(0.052)	(0.052)	(0.052)	(0.051)
single site	5.327	4.797	5.251	4.700	3.222	3.059	2.794	2.400
	(2.159)	(2.153)	(2.216)	(2.186)	(1.065)	(1.066)	(1.127)	(1.118)
Constant	67.401	63.092	36.065	35.080	29.542	27.836	-2.802	-4.690
	(38.655)	(39.000)	(37.710)	(37.450)	(29.954)	(29.948)	(29.387)	(29.268)
Industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Sample size	340	340	340	340	782	782	782	782
Censored observations	158	158	158	158	545	545	545	545
Log-likelihood	-661.6	-662.3	-669.3	-667.8	-1015.5	-1014.9	-1040.1	-1037.4
Pseudo R-squared	0.051	0.050	0.040	0.042	0.11	0.11	0.09	0.09

Notes to Table

Standard errors in brackets. [a] denotes coeffients and standard error multiplied by 1000
[b] denotes coeffients and standard error multiplied by 1000000

intensity appears to be concave. Again there appears to be some convexity in the industry density -R&D relationship, but only for the R&D worker equation.

Table 4.6: **Plant R&D - Nonlinearities**

	Proportion R&D Expenditure		**Proportion R&D workers**	
	(1)	**(2)**	**(3)**	**(4)**
Union density	-0.002 (0.020)	0.167 (0.070)	-0.007 (0.014)	0.106 (0.045)
Union density (squared)	-	-0.002 (0.001)	-	-0.0012 (0.0005)
Industry density	-0.030 (0.009)	0.077 (0.140)	-0.084 (0.033)	-0.301 (0.090)
Industry density (squared)	-	-0.001 (0.001)	-	-0.002 (0.001)
Sample size	340	340	782	782
Log-likelihood	-661.4	-656.8	-1011.7	-1005.9
Pseudo R-squared	0.05	0.06	0.11	0.12

Notes to Table
All regressions include all the controls of Table 4.1
Standard errors in brackets.

Various robustness tests were implemented on the plant level equations. First, an exact replication of the firm-level specification would need to estimate relative R&D equations (plant R&D as a proportion of industry R&D). Unfortunately, this is difficult in the case of R&D expenditures, by the absence of total costs or sales data in WIRS. In fact, using proxies[18] for the relative R&D proportions as dependent variables produces similar results to simply using the R&D intensity measures. Secondly, the restrictive nature of the tobit specification is relaxed by estimating first a probit on whether the plant does any R&D, and then an OLS regression on the log R&D intensity. This allows the coefficients to be different between the decision to 'participate' in R&D and then the choice of how much R&D to perform. The processes could be different if there are fixed costs of performing R&D. Although the smaller samples meant that the parameter estimates were less precisely determined, most of the qualitative conclusions

[18]For the relative R&D employees equation the total number of plant R&D workers was divided by the number of industry R&D employees. For the relative R&D expenditure variable the R&D intensity measure was divided by the R&D sales ratio in the firm's industry.

carried over in the OLS regressions. For example, in the log R&D expenditure equation, the linear union density entered with a coefficient (*standard error*) of 0.0190(*0.0102*) and squared density -0.0002(*0.0001*). Moreover, there was no evidence of a union impact on the decision to participate in the R&D process. Additionally, the most important effect of controlling for human capital and industry R&D came through the OLS regressions rather than the probits.

Thirdly, other potential covariates were entered into the equation to check the robustness of the results, including a dummy for whether the plant was set-up in the 1980s, financial performance, market power, whether the plant was UK owned and a dummy variable for whether there was a closed shop present. None of these were significant in any of the specifications at conventional levels of significance[19].

Finally, a criticism of all the empirical analysis is that the concave relationship observed in all datasets between union power and R&D should only hold, according to theory set out in the appendix, when unions have some say in the employment determination process. When unions bargain only over wages (right-to manage model), the relationship should be uniformly negative. It is notoriously difficult to find empirical proxies for whether unions are engaged in job bargaining but WIRS does have a series of questions relating to whether there is any bargaining over various non-pay issues including: staffing levels, redeployment, recruitment, working hours, working conditions or redundancy pay. The sample was divided into two sub-samples, based upon whether there was any bargaining over these issues and the specifications re-estimated. Table 4.7 holds a representative example for unionised plants. Where there is some bargaining over non-pay issues (columns (3) and (4)), the standard result of a quadratic in union density provides the best fit. For the larger sample where there is no bargaining over non-pay issues the relationship between union power and R&D is simply negative (F-test of joint significance of the squared terms = 1.11, compared to 4.94 for the other sample). These findings are supportive of the strategic interpretation, but one must be very wary about concluding too much from the very crude proxies for the 'scope of the bargain'.

[19] One important additional control which was strongly correlated with R&D intensity was whether the establishment gave information on its investment plans to the workforce. In the preferred model this entered with a coefficient of 3.249 and a standard error of 1.175, which suggests that information-sharing establishments tend to be more R&D intensive.

Table 4.7: **Relative Plant R&D -Union plants**

Plant/industry R&D workers	(1)	(2)	(3) NonPay=1	(4) NonPay=1	(5) Nonpay=0	(6) Nonpay=0
Union density	-0.0302	0.0338	-0.0122	0.2345	-0.0441	-0.0895
	(0.0128)	(0.0550)	(0.0165)	(0.0963)	(0.0221)	(0.0870)
Union density (squared)	-	-0.0000	-	-0.0019	-	0.0004
		(0.0005)		(0.0007)		(0.0008)
Industry density	0.0217	0.2470	-0.0117	0.0867	0.0695	0.2875
	(0.0209)	(0.0960)	(0.0208)	(0.0941)	(0.0390)	(0.1834)
Industry density (squared)	-	0.0019	-	-0.0008	-	-0.0018
		(0.0007)		(0.0008)		(0.0015)
Sample size	438	438	195	195	243	243
Log-likelihood	-585.9	-582.7	-303.6	-298.2	-261.2	-260.3
Adjusted R-squared	0.086	0.090	0.07	0.083	0.11	0.11

Notes to Table

Dependent variable (Plant R&D workers/industry R&D workers)

Standard errors in brackets. Controls of Table 3.4 are included in all specifications

NonPay=1 if the manual and non-manual unions bargain about at least one non-pay issue (see text)

4.4 Conclusions

Even those who are sympathetic to unions usually admit that unions can have detrimental effects on firm's incentives to invest in investments whose returns are uncertain and long-term. For example, in a recent survey Freeman (1992) writes

> *The strongest body of evidence that unionism may harm economic growth lies in the analysis of the relation between unionism and spending on R&D (p.160)*

In this chapter, micro-economic evidence was used on plants and companies to examine the process of R&D investment. Several different measures of R&D were used including both expenditure and headcounts of R&D employees. The negative association between union power and R&D intensity revealed in many U.S. studies is also present in our data. This correlation appears mainly spurious, however, and arises primarily because unions are more prevalent in enterprises with lower human capital and in low tech industries. In Britain there is no compelling evidence that union bargaining has, on average, a detrimental effect on R&D.

However, some evidence was uncovered of a more complex link between union power and R&D expenditures. In both enterprise datasets, union density had a non-linear relationship with R&D intensity. Although highly unionised enterprises generally invested less in R&D, increases in unionisation from a low base were positively associated with R&D. The hump-shaped relationship is broadly consistent with the ex-post model of union bargaining set out in the appendix, where the union bargains over both wages and employment, but not over R&D.

Another finding was that dealing with selectivity is important in R&D models. The effects of many variables is disguised by a systematic tendency of British firms not to disclose the amount of R&D they were doing. Using changes in accounting rules as a 'natural experiment' to identify the disclosure equations revealed the familiar pattern that larger and more capital intensive firms were also more R&D intensive.

Why do the results here differ from much of the North American empirical studies revealing a negative association with unions and R&D? One possibility is that the extra controls introduced in this study are important, and similar findings would also emerge in the U.S. Another possibility, however, is that there are systematic differences between British and American unionism. U.S. unions have traditionally placed a greater emphasis on the goal of wage increases and cross-country studies tend to reveal that the union wage mark-up is greater in the United States than in most other OECD countries (see Freeman, 1992). Only detailed cross-country comparisons will be able to unravel whether the differences uncovered in this study are fundamentally methodological or institutional.

4.5 Appendix

4.5.1 Theoretical Appendix

This appendix considers a simple model of R&D rivalry under oligopolistic competition and union bargaining. The purpose is simply to make the point that the prediction that increases in union power reduce R&D is not always sustained when the strategic aspects of R&D rivalry are explicitly modelled. In order to focus on the pure case, it is assumed that the only direct effect of unions is over wages and employment and their other possible effects on training and productivity mentioned in the introduction will be ignored.

The basic set up is as follows. There is a homogeneous product Cournot duopoly in the product market with linear demand. Each firm faces a single but independent union. The scope of the bargain could include wages only, wages and employment or wages, employment and R&D. The case where there is a fully efficient bargain over all three issues is known as *ex ante* bargaining (see Ulph and Ulph, 1995, for a detailed analysis). Since there is no evidence that unions in Britain bargain over R&D, the focus here will be on the cases where both firms bargain over only wages and possibly employment, conditional on the R&D decision (*ex post bargaining*). Formally, this can be modelled as a two stage game where wages and employment are determined in the second stage, conditional on the level of R&D expenditures, which is set in the first stage. The aim is to find a sub-game perfect equilibrium relating R&D to union power. To do this, it is necessary first to consider the second stage of the game and then solve backwards. It is assumed that the scope of the bargain is the same in each firm.

To fix ideas, assume that demand is linear and defined as:

$$P = a - q_i - q_j \tag{4.5}$$

where q is output and P is industry price. Assume that q_i units of output need q_i^2/u units of labour (n) where u is a parameter representing technical efficiency. Firm j has a technical efficiency parameter v.

The union of each firm maximises the utility of the median union member. This median member's utility is parameterised as:

$$u = n\frac{1}{1-m}(w - w_b)^{1-m} \tag{4.6}$$

where w_b is the alternative wage, w the own wage, n is employment and m a risk aversion parameter. If $m = 0$, the median worker in the union is risk-neutral.

This appendix will describe the results of the "efficient bargaining case", where firms and unions bargain over wages and employment.[20] The reason for this is that the "right to manage" model will eventually reach the same conclusions as Grout (1984), whereas the empirical results above are more in line with predictions of the "efficient bargaining" case. If there is *ex post* bargaining over wages and employment, then the game is solved by using the generalised Nash

[20] The readers interested in the calculations of the "right to manage" model are referred to Ulph and Ulph (1990).

bargaining solution:

$$\arg\max_{w_i, n_i} N = (1-s)Ln[\pi_i - \underline{\pi_i}] + (s)Ln[U_i - \underline{U_i}] \tag{4.7}$$

Firm j does the same but instead of a relative bargaining power parameter s, it faces a union with power t. In the case where there is only bargaining over the wage, then (4.3) is maximised with respect to wages with the constraint that the outcome must be on the labour demand curve.

Assume that q_j has been determined, so that firm i faces a residual demand curve:

$$P = A - q_i \tag{4.8}$$

where $A = a - q_j$. The values of wages, output, employment and profits for firm i under efficient bargaining will be (see Ulph and Ulph, 1990 for the proofs) :

$$w = \frac{w_b(1+s) + (1-m)su}{(1+ms)} \tag{4.9}$$

$$q_i = \frac{uA(1+ms)}{2(w_b+u)} \tag{4.10}$$

$$n = \frac{q_i^2}{u} \tag{4.11}$$

$$\pi = \frac{uA^2(1+ms)(1-s)}{4(r+u)} \tag{4.12}$$

The equivalent results for firm j are symmetrically determined. It is possible to show that an increase in other firm's output (decrease in A) will leave the wage unaffected, but will lower output, employment and profits. An increase in union bargaining strength raises the wages, output and employment, but lower profits. An increase in productivity (u) will increase wages, output and profits but will have ambiguous effect on employment.

Equation (4.10) and its counterpart for firm j define reaction functions for both firms. Solving the Nash equilibrium output choices of the two firms:

$$w = \frac{w_b(1-s) + (1-m)su}{(1+ms)} \tag{4.13}$$

$$q_i = \frac{a(l-1)}{(kl-1)} \tag{4.14}$$

$$n = \frac{q_i^2}{u} \tag{4.15}$$

$$\pi = n\frac{uk(1-s)}{2} \tag{4.16}$$

where

$$k = \frac{2(w_b+u)}{u(1+ms)} \tag{4.17}$$

and

$$l = \frac{2(w_b+v)}{v(1+mt)} \tag{4.18}$$

One of the essential points in this model is the characterization of the comparative statics related to a increase in the technology parameters (u and v). What happens in terms of profits, for example, if one firm gets a new technology as compared to the existing position, where both firms have their initial technologies? It can be shown that $\partial\pi_i/\partial u > 0$ and $\partial w/\partial u > 0$. This simply means that, when a firm innovates, it enjoys a larger surplus, some of which goes towards profits and, since there is bargaining, some of the rents goes to workers in the form of higher wages. These propositions have received support from several pieces of empirical work [21]. Furthermore, it can be shown that $\partial\pi_i/\partial t < 0$, as increases in rival union power will increase their market share and reduce own firm profits.

Surprisingly, *when unions have a large* m *and low* s , $\partial\pi_i/\partial s > 0$. Under these circumstances, the bargained wage is quite near the alternative wage. An increase in union power will translate almost entirely into employment and raise the firm's market share. The benefits of a larger market share can outweigh the offsetting effects of higher wage costs. Note that this effect can only arise because of the interaction between firms in the product market. Otherwise, an increase in union power will always shift the equilibrium solution to a point in a lower isoprofit curve.

Having determined the profit functions, it is time now to turn to the patent race. Assume that there is a new technology z which is greater than both u and v, the existing technologies of the firms. Parameter z is known with certainty, as is the fact that there is a unique set

[21] For the former see Geroski, Machin and Van Reenen (1993) and the latter see Van Reenen (1994).

of techniques which will produce z. What these techniques are is currently unknown, but whichever firm discovers them first will get an infinitely long-lived patent giving it the sole right to use the technology. The firms are therefore involved in a *tournament.* The tournament model we use is well known (see Lee and Wilde, 1980 or Beath et al, 1989).

Firms spend money on R&D and at each moment in time they have only a random chance of making the discovery. The stochastic process is assumed to be a Poisson process, in which each firm's hazard rate - its probability of discovery at any one time conditional on not having discovered it by that time - depends solely on its flow level of expenditure on R&D at that time. We will assume both firms face the same R&D technology whereby the flow level of R&D expenditure required to generate a hazard rate h is h^2.

Let g denote the (constant) hazard rate chosen by firm i; h is that chosen by firm j . Let us define π_i^a as the flow of profits earned by firm i in outcome a, where $a = 1$ if firm i wins the race and $a = 2$ if firm j wins it. Let V_i be the expected present value of profits of firm i and $\overline{V}_i$ the permanent flow of profit income that has present value V_i. It can be shown that, when interest rates are sufficiently small, the two permanent profit flows can be written as :

$$\overline{V}_i = \frac{g}{g+h}\pi_i^1 + \frac{h}{g+h}\pi_i^2 - \frac{g^2}{g+h} \tag{4.19}$$

$$\overline{V}_2 = \frac{g}{g+h}\pi_j^1 + \frac{h}{g+h}\pi_j^2 - \frac{h^2}{g+h} \tag{4.20}$$

The interpretation is straightforward: $\frac{g}{g+h}$ is the probability that firm i wins, $\frac{h}{g+h}$ is the probability that j wins. The first two terms give the expected profits at the date of innovation. Since these accrue forever, at a low interest rate they dominate any profits earned prior to innovation. Therefore, in a present value context, we might as well think of these profits arising now. The expected date at which the race will end is $\frac{1}{g+h}$ so $\frac{g^2}{g+h}$ is the expected cummulative spending on R&D by firm 1.

Firm i will choose g to maximise (V_i) and firm j will choose h to maximise (V_j). The value functions can be used to define R&D reaction functions and consequently, find the Nash equilibrium in hazard rates. The equilibrium hazard rates will be given by the equations[22]:

$$g^e = \frac{2\overline{g}\overline{h}}{(\overline{g} + 2\overline{h})} \tag{4.21}$$

and

$$h^e = \frac{2\overline{g}\overline{h}}{(\overline{h} + 2\overline{g})} \tag{4.22}$$

where $\overline{g}$ and $\overline{h}$ are the "competitive threats", that is, the difference between the profits firm i would get if it won the race and the profits it would get if its rival won it:

$$\overline{g} = \frac{\pi_i^1 - \pi_i^2}{2} \tag{4.23}$$

and:

$$\overline{h} = \frac{\pi_j^2 - \pi_j^1}{2} \tag{4.24}$$

By using the comparative statics with relation to an increase in the technology parameters, it is possible to analyse the effect that an increase in union power would have on π_i^1, π_i^2, $\pi_j^1$and π_j^2 . To focus attention on the variables of interest, assume that the technologies are initially the same: $u = v$. It can be shown that, when the union is risk averse ($m \approx 1$) and not strong (s is low), then increases in union power will improve the chances of a firm winning the patent race:

$$g_s^e > 0, \frac{\partial(g^e/h^e)}{\partial s} > 0 \tag{4.25}$$

Hence, movements from very low degrees of union power (perhaps non-unionisation) to moderate degrees of power can actually enhance a firm's R&D prospects. Notice however, that, as the union becomes increasingly powerful, firm j will eventually spend relatively more R&D. Finally, note that an increase in rival's union power may lead initially to a decrease in firm's relative R&D spending but will eventually provoke an increase in it.

4.5.2 Data Appendix

[22]See Beath, Katsoulacos and Ulph (1993)

Table 4.8: **Descriptive Statistics**

Variables	**Firm Level Mean**	**Firm Level Standard deviation**	**Plant Level Mean**	**Plant Level Standard Deviation**
R&D intensity [a]	0.029	0.041	0.013	0.046
Proportion of R&D employees	-	-	0.0148	0.045
Union Recognition	0.564	0.496	0.558	0.497
Union Density	0.30769	0.33218	0.417	0.407
Industry unionization [b]	0.56682	0.20387	0.431	0.250
Capital/sales	0.312	0.553	-	-
Market share	0.0124	0.043	-	-
Sales(čm)	318.639	1012.742	-	-
Size (employment)	5954.434	19235.53	177.050	292.842
Birth $\prec$ 1940	0.281	0.450	-	-
Birth $\succ$ 1979	0.247	0.431	-	-
Profits/sales	0.104	0.117		
Profits zero or less	0.083	0.275		
Prop of manual skilled	0.14978	0.18625	12.237	18.206
Prop of non-manual	0.47969	0.30425	48.567	35.533
Prop of technical	-	-	5.741	9.093
Prop of R&D disclosures	0.138	0.345	-	-
ED41	0.188	0.391	-	-
SSAP13	0.072	0.259	-	-
Industry R&D/sales	0.01178	0.02656	0.007	0.002
Patents/employment	5.432	11.785	6.935	4.864
Industry patents=0 dummy	0.205	0.404	-	-
Industry concentration	0.36366	0.18305	-	-
Industry imports/sales	0.29847	0.19362	-	-
ln(Industry wage)	5.202	0.182	5.407	0.157

Notes to Table

R&D /sales in firm level and R&D/expenditures in establishment level

Industry coverage in firm level and Industry density in establishment level

Table 4.9: **Linear Specification**

rdsales	**(1)**	**(2)**	**(3)**
Union recognition	0.003	0.006	-0.004
	0.004	0.004	0.008
Proportion non-manual workers	0.038	0.039	0.020
	0.008	0.007	0.013
Proportion skilled workers	-0.039	-0.043	-0.022
	0.010	0.011	0.017
Market share	-0.097	-0.089	-0.019
	0.024	0.028	0.010
Capital/sales	0.017	0.021	0.063
	0.014	0.004	0.002
Rate of Return	0.002	-0.002	0.036[a]
	0.011	0.014	0.338
Employment	0.015[b]	0.035[b]	0.048[b]
	0.005	0.008	0.006
Birth $\prec$1940	0.013	0.014	0.006
	0.004	0.004	0.008
Birth $\succ$1979	0.021	0.024	0.021
	0.004	0.005	0.008
Industry R&D	0.158	0.224	0.206
	0.087	0.063	0.059
Industry (patents/empl)	-0.003[a]	-0.005[a]	-0.004[a]
	0.007	0.011	0.010
Industry Wage	0.081[a]	0.015[a]	0.053[a]
	0.067	0.008	0.064
Inverse Mill's ratio	-	0.021	0.015
		0.006	0.003
Constant	-0.008	-0.058	-
	0.012	0.018	
Time dummies	yes	yes	yes
Industry dummies	yes	yes	yes
Sample size	405	405	405

Notes to Table

[a] *means coefficient (standard error) multiplied by 100*

[a] *means coefficient (standard error) multiplied by 10000*

Column (3) is a random effects specification

Table 4.10: **Manufacturing sector**

Ln (rdsales)	**(1)**	**(2)**	**(3)**
Union recognition	0.232	0.235	0.117
	0.161	0.162	0.172
Proportion non-manual workers	0.598	0.673	0.384
	0.210	0.228	0.300
Proportion skilled workers	-0.121	-0.253	-0.539
	0.342	0.352	0.398
Ln (market share)	-0.156	-0.149	-0.125
	0.052	0.055	0.065
Ln (capital/sales)	0.186	0.219	0.270
	0.052	0.112	0.111
Ln (rate of return)	0.199	0.198	0.335
	0.084	0.033	0.106
Rate of return zero o less	-0.508	-0.556	-0.888
	0.274	0.274	0.353
Ln (employment)	0.178	0.164	0.390
	0.052	0.056	0.126
Birth $\prec$1940	0.209	0.244	0.140
	0.137	0.136	0.153
Birth $\succ$1979	0.407	0.404	0.650
	0.151	0.157	0.217
Ln (industry R&D)	0.290	0.297	0.404
	0.068	0.074	0.090
Ln (ind patents/empl)	-0.045	-0.050	-0.022
	0.033	0.033	0.048
Industry patents =0 dummy	-0.138	-0.100	-0.312
	0.231	0.226	0.274
Ln (ind concentration)	-0.679	-0.594	-0.636
	0.087	0.098	0.141
Ln (ind imports/sales)	0.975	0.835	0.968
	0.111	0.137	0.185
Ln (industry wage)	1.028	0.955	1.493
	0.546	0.578	0.683
Inverse Mill's ratio	-	-	1.085
			0.450
Constant	-5.334	-5.094	-8.101
	0.869	0.855	0.634
Time dummies	yes	yes	yes
Industry dummies	no	yes	yes
Sample size	362	362	362

Company R&D Dataset

Data Description The data used in this work come from several different sources. The economic firm-level variables (assets, sales and R&D) were drawn from the Exstat database of company accounts, while the industry level ones (R&D intensity, concentration ratios, imports ratio) were reported in the Census of Production. The patents data was kindly supplied by Chi Research Associates. The industrial relations variables (union recognition and closed shop) are the result of a survey related to a broad range of union arrangements over the 1980s and carried out amongst managers of UK firms operating in various sectors of the economy[23] After removing all firms that did not have at least 4 continuous years of data with non-missing observations between 1983-90 (responsible for the employment of around 2.6 million workers in 1990) 446 firms were left in the sample, around 25% of them disclosed information on R&D at some point during the sample period. The age of the firm was taken as the date of first listing on the London Stock Exchange (London Business School Share Price Database) or, if this information was not available, the date of first incorporation as stated in Key British Enterprise, various years.

EXSTAT Data *R&D:* Research and Development expenditure (C65)

Sales: Total sales (C31)

Capital : Total net tangible assets (C91)

Rate of Return: Pre tax profits (C34) divided by total sales (C31)

Employment: Total employees (C19)

Diversification: Negative of the Herfindahl index = -H = $-\sum_i \left(\frac{s_i}{S}\right)^2$ where i = industries across which the firm operates, S = total sales of the firm, s_i =sales of firm in industry i.

Market Share. Weighted average of sales/industry sales across up to six different two digit SIC codes. See Menezes-Filho (1994) for full details.

Survey Questions The survey (carried out by Paul Gregg from the National Institute for Economic and Social Research) was structured to ask respondents details of union presence in 1990 and changes in union presence for two time periods (1980-84 and 1985-90).

[23] See Gregg and Yates (1991) for a description and an analysis of the survey.

Table 4.11: **Unionization Equations**

	Union Recognition	**Union Density** [a]
Union Density at	1.271	0.318
Time of Birth	0.200	0.011
Female Proportion	-1.005	-0.163
	0.194	0.037
Proportion non-manual	-0.909	-0.242
workers	0.143	0.027
Proportion skilled	0.935	0.195
workers	0.202	0.041
Ln (market share)	-0.152	0.011
	0.028	0.461
Ln (capital/sales)	0.049	1.973
	0.041	0.703
Ln (rate of return)	-0.043	-0.221
	0.037	0.729
Rate of return zero	-0.045	4.271
or less	0.163	2.911
Ln (employment)	0.519	5.179
	0.034	0.620
Birth $\prec$1940	0.479	15.868
	0.102	1.813
Birth $\succ$1979	-0.414	-11.496
	0.100	1.739
Ln (industry R&D)	-0.286	-4.014
	0.045	0.636
Ln (ind patents/empl)	0.055	0.360
	0.034	0.540
Industry patents=0	-0.167	-0.726
dummy	0.104	2.079
Ln (industry wage)	1.455	17.742
	0.306	4.761
Constant	-6.174	-31.413
	0.540	8.848
Time dummies	yes	yes
Industry dummies	yes	yes
Sample size	2027	1767

Notes to Table

Dependent variable Recognition in Column (1) and Union Density in (2)

Estimation by Probit in Column (1)

[a] *All coefficients were multiplied by 100*

Union Recognition: Does your company recognise trade unions for the purposes of bargaining over wages and conditions in any of your establishments?

Union density: proportion of firm's employees who are members of a trade union

Industry Variables *Industry R&D over sales:* Business Monitor M014, various years

Industry Patents over employment: Patents from Chi Research Group, employment from aggregating the Labour Force Survey, various years

Industry Concentration: Table P1002a Census of Production, various years

Industry Imports : Table MQ12 Business Monitor, various years

Industry union coverage: Derived from the New Earnings Survey 1987

Industry Wage: New Earnings Survey various years: Full time male manual workers

Disclosure of R&D Information in Company Accounts As described in the main text, a reason underpinning this process of increasing disclosure over time is the accounting rule changes affecting R&D. The political pressure was first concretely felt in 1986 when the House of Lords Selected Committee on Science and Technology started investigating the issue and eventually published a report indicating the need for more compulsory R&D disclosure As a result of this, the Accounting Standards Committee (ASC) published an Exposure Draft (ED 41) in June 1987 requiring total disclosure of R&D expenditures of large firms, which legally came into effect in 1989, with the revised version of the SSAP 13.

In order to try to capture the impact of these facts in our experiments, construct two dummy variables were constructed: ED41 (equal to one for observations in which the firm meets the "big firm" criteria and with accounting periods lying after June 1987) and SSAP13 (equal to one for "big firms" whose accounting periods began at or before June 1989). As we do not have reasons to expect these variables to be related to the level of R&D expenditures (conditionally on other determinants), these can be used in our selectivity equation to identify it from the R&D equations.

Establishment R&D Dataset

The Workplace Industrial Relations Survey is a stratified random sample containing information on 2061 plants in the United Kingdom. In the 1990 Survey a special section of the survey was asked to the Financial Managers of 489 establishments who were independent cost or profit centres. These questions were more of a direct economic nature than the rest of the survey. In November 1990 to October 1991 a follow up survey of 96% of plants (the remainder refused to be interviewed) was used for the Employers Manpower and Skills Practices Survey (EMSPS)

R&D Expenditure. Managers were asked : 'Is any research and development carried out at this establishment? (B10). If yes they were asked 'And roughly what proportion of total current expenditure is on R&D? (B11).

R&D Workers. Approximately how many staff take part in R&D activities?

Plants where these R&D intensities exceeded 60% were removed from the sample (essentially R&D labs)

Union density: The proportion of an establishment's workplace who are members of a trade union

Industry union density: Aggregated up at the two digit level from the full WIRS sample of plants using the plant and size weights.

Union recognition: Whether there was a union recognised for purposes of wage bargaining in the plant

% Technical workers: proportion of the total employees who are senior professional or technical workers

Size: Employment

Industry R&D workers. Business Monitor M014, various years

Chapter 5

Consumer Demand and Economic Performance: a Survey

5.1 Introduction

The aim of this chapter is to survey studies that examined the relationship between consumer demand, market power and profitability. In recent years, the industrial organization literature has split along two lines. On the one side is the traditional structure-conduct-performance (SCP) paradigm. Researchers in this area search for empirical regularities that hold across a broad range of industries, by estimating econometric models using cross-sectional or (more recently) panel data. The other line of research is the New Empirical Industrial Organization (NEIO). Studies in this area aim at formulating tightly specified theoretical models to estimate behavioral parameters (e.g. a "conduct parameter" that summarises the degree of collusion in an industry), using detailed data on particular industries.

As most of this literature is well-known, the survey will concentrate on the role that consumer demand plays in the research developed in both areas. Although obviously very important from a theoretical point of view, the role of demand has, in general, been overlooked in the SCP work. Some of the NEIO studies, on the other hand, do use demand information to identify the conduct parameters, as seen below.

5.2 New Empirical Industrial Organization (NEIO)

The SCP paradigm has suffered many criticisms from the NEIO researchers. They argue that accounting profitability is, at the very best, a poor measure of economic profitability and that inter-industry cross-section studies ignore fundamental institutional details that shape the pattern of behaviour of firms. Hence, according to this view, SCP studies are incapable of generating accurate information on this behaviour and its effect on profitability. The literature (surveyed in Bresnahan, 1987) advocates, as an alternative, focusing on specific industries (case studies) and using economic theory to specify equations that, when estimated, will yield a conjectural variations parameter(s), together with the one of the cost and demand functions.

A typical starting point is an equation like (see Bresnahan, 1987);

$$P_t = C_1(Q_t, W_t, Z_t, \Gamma) - D_1(Y_t, \delta)Q_t\theta + \varepsilon_t \tag{5.1}$$

where P_t is market price, C_1 is marginal cost, Q_t is total industry production, W_t is factor prices, Z_t are other cost-shifters, δ and Γ are unknown parameters, D_1 is the slope of the demand curve, Y_t are demand-shifters and θ is a conjectural variation term:

$$\theta = \frac{dQ}{dq_i}\frac{q_i}{Q} \tag{5.2}$$

It would be possible for a researcher to estimate δ using instruments from the cost equation. With this estimate, $D_1^*(Y_t, \widehat{\delta})$ can be computed and (5.1) estimated, provided that Y_t has more than one component, one entering $D_1^*(Y_t, \widehat{\delta})$ and the other not. This would mean that changes in the slope of the demand curve could identify the conjectural variations parameter θ.

In practice, most studies try either to estimate the marginal cost directly or impose a value to θ a priori. This survey will focus on only two studies, which are, nevertheless, in a similar vein to what is done in chapters 6 and 7 below. Iwata (1974) is an early example of the first case. In his study of the Japanese flat glass industry, the author starts from a model identical to Cowling and Waterson (1976, see below), which is reproduced here:

$$p + \frac{1}{\eta}\frac{p}{Q}(1 + \lambda_i)q_i - c_i = 0 \tag{5.3}$$

where p is industry price, Q is industry quantity, q_i is firm-level quantity η is the demand elasticity, c_i is the marginal cost and λ_i is a conjectural variations parameter: $\lambda_i = \frac{\partial \sum_{i \neq j} q_j}{\partial q_i}$. The aim is to estimate the conjectural variations parameter using the expression:

$$\lambda_i = \eta \frac{c_i - p}{p} \frac{Q}{q_i} - 1 \tag{5.4}$$

and based on three basic assumptions: i) price elasticity of market demand is constant regardless of the level of demand; ii) the marginal cost of each firm is constant with respect to short-run variations in output and iii) the conjectural variations parameter is constant for each firm for each period.

In order to achieve his objective, Iwata (1974) firstly estimates the cost function:

$$C_i = \sum_j s_j m_j + Po_i \frac{Co_i}{Po_i} + w_i L_i + r_i K_i \tag{5.5}$$

where C is total cost, s are raw-materials prices, m are raw-materials, Co is other costs, Po is an other cost deflator, w is the wage level, L is employment level, r is unit price of capital and K is capital. The author treats the last two terms in (5.5) as constants with relation to short-run output variation, and therefore not entering the estimation of the marginal cost c_i (so that they do need to be properly measured either). The cost function was estimated in two steps, using detailed accounting data on three companies whose products had little differentiation from 1956 to 1965 and whose shares were approximately (50%, 30% and 20%) of the market. In the first step, the raw-material levels were regressed on the output levels for each firm. In the second one, equation (5.5) was estimated with the predicted values of the first step regression included in the place of m_j. It should be noted that the use of accounting data to estimate (5.5) incurs in the same problems of the SCP literature.

Once the marginal cost of each firm are obtained, a demand equation was estimated of the form:

$$\log D = \alpha_0 + \alpha_1 \log(\frac{P}{P_I}) + \alpha_2 \ln \omega + \alpha_3 \ln Y_G + \varepsilon \tag{5.6}$$

where D is total demand for window glass, P is a price-index for the window glass, P_I is price index of investment goods, ω is the ratio of wooden building construction to the floor area of total building construction and Y_G is real gross national product.

Although Iwata (1974) recognized that price and quantity are simultaneous determined in (5.6), he argues that, by aggregating (5.2) to the industry level:

$$p = \frac{\eta \sum_i \frac{c_i}{1+\lambda_i}}{(\eta \sum_i \frac{1}{1+\lambda_i} + 1)} \tag{5.7}$$

so that, as a result of assumptions (i) to (iii) above (that is : η, λ_i and c_i are constants or exogenously determined, independently of quantity), price can be taken as pre-determined. Assumptions (i) to (iii) seem very strong indeed and one would also have to rule out shocks that affect industry prices and quantities simultaneously for equation (5.6) to be identified.

After estimating η ($= \alpha_1$) and c_i, the author goes on and computes λ_i using (5.4). Its value varies from -0.3 to 0.6 and show a great deal of variation over the time period considered. However, the conjectural variations parameters were very imprecisely estimated, which meant that no statistical tests about different types of collusion were meaningful.

A recent study in the NEIO line of research is that of Goldberg (1995). In this study of the US. automobile industry, the author uses a slightly different framework from the one examined so far, as the emphasis is on price competition with product differentiation, and not on quantity competition with oligopolistic interaction. In this model, market power arises because consumers have preferences (observed and unobserved) over the various product characteristics. The first order condition in this case is:

$$E_t D_{it} + \sum_j (p_{jt} - c_{jt}) \frac{\partial E_t D_{jt}}{\partial p_{it}} = 0 \tag{5.8}$$

where $E_t D_{it}$ is the expectation about aggregate demand, p_{jt} are the prices of the firm's products and c_{jt} are marginal costs.

The household decision is modelled using a nested multinomial logit framework whereby the household utility is:

$$U^h = \alpha' B_b^h + \beta' N_{b,n}^h + \gamma' C_{b,n,c}^h + \delta' O_{b,n,c,o}^h + \zeta' M_{b,n,c,o,m}^h + \varepsilon_{b,n,c,o,m}^h \tag{5.9}$$

where U is household utility, B is a vector of explanatory variables describing the buying decision, N is a vector specific to the buying a *new* versus an *old* car decision, C is a vector specific to the decision about the *market segment* of the car, O is a vector specific to the decision about the *origin* of the car, M is a vector specific to the decision about the *model* of the car and the error ε^h is assumed to follow a generalized extreme value distribution (see McFadden , 1978). The subscripts refer to the stages of the decision process that are being jointly modelled.

Expected aggregate demand is equal to:

$$E_t D_{it} = E_t\{\sum_h P_{it}^h w^h + \sum_h \eta_{it}^h w^h\} = \sum_h P_{it}^h w^h \tag{5.10}$$

where P_{it}^h is the estimated joint probability of choosing a vehicle type i :

$$P_{it}^h = P_{b,n,c,o,m}^h = P_b^h * P_{n/b}^h * P_{c/n,b}^h * P_{o/c,n,b}^h * P_{m/o,c,n,b}^h \tag{5.11}$$

with w^h being the individual household weight (supplied by the survey) and η_{it}^h a random error.

The price variable in this model is treated just as another characteristic, although it also is the strategic variable by the firms. In order to deal with identification in equation (5.9), Goldberg (1995) argues that with the use of micro data, the simultaneity problem will only arise if the consumer specific error term is correlated with the products' prices through aggregate components. Aggregate components could be present in the error term for two reasons: macroeconomic shocks or unobserved product characteristics that are perceived in the same way by all consumers. The first one is controlled for by including variables like income, employment status, assets and time dummies in the right hand side of (5.9). The second is dealt with by including unobserved product effects that are constant over the sample period. This effect, however, is not model specific, as some models are only bought once, but is decomposed into components associated with the origin, the segment and brand of the cars.

After the estimation, Goldberg (1995) computes price elasticities of demand for each product by aggregating the effect of a price change on the purchase probability for each household, as in (5.10) above. The results seem to follow fairly intuitive patterns. The price derivatives are then used in (5.8) to compute the marginal costs. These are, in turn, used to measure the markup [(wholesale price - marginal cost)/wholesale price] and are also regressed on the vehicle characteristics and year dummies in order to estimate the parameters of the cost function. Finally, the cost and demand parameters are used in economic applications.

It seems that this procedure strongly relies on the functional form assumptions to derive the markups, which is the performance measure. Moreover, the oligopolistic component of the market is assumed away by the hypothesis that the only source of market power is product differentiation. Finally, generalizing the methodology used here to study firms' behaviour in other industries would be very problematic.

5.3 Traditional Approach (SCP)

The traditional approach has its roots in the works of Bain (1951, 1956), who observed a positive relationship between industry structural measures (concentration, entry barriers) and performance indicators (profitability). The implied reasoning underlying these studies is that concentration would facilitate oligopolistic coordination, so that existing firms (shielded from entry by the barriers) could enjoy supra-normal profits. Collusion need not to be the result of an open agreement. Indeed, Chamberlain (1929) argued that if firms recognize their interdependence, they will realize that a price cut will probably result in some kind of retaliation and could, acting non-cooperatively, keep prices high. Stigler (1964) argued that the successful maintenance of high prices depends on the speed and completeness with which information on secret price cutting reaches the other firms in the industry. If the information process is efficient, it will result in quick retaliation, diminishing the profitability of price cutting. The lower the number of sellers concentrating the bulk of industry sales, the easier it is to monitor sizable deviations from monopoly behaviour. More recently, many models appeared in the literature trying to formalize these ideas in a game-theoretical framework [1].

One of the first studies in the SCP paradigm to incorporate the demand side in a central manner was Comanor and Wilson (1974). In this study, the authors estimate the following dynamic consumer demand model (augmented to include advertising) developed by Houthakker and Taylor (1970):

$$C_t = a_o + a_1 \Delta A_t + a_1 \lambda A_{t-1} + a_2 \Delta Y_t + a_2 \lambda Y_{t-1} + a_3 \Delta P_t + a_3 \lambda P_{t-1} + a_4 C_{t-1} \tag{5.12}$$

[1] See Green and Porter (1984), Rotemberg and Saloner (1986) and Haltiwanger and Harrington (1991), for example.

with: C_t - real per-capita sales, A_t - advertising intensity, Y_t - per-capita constant-dollar consumer expenditure and P_t - price of good relative to price of all consumer goods.

Equation (5.12) can be interpreted as a generalization of the distributed-lag model developed by Koyck (1954) and was estimated by Comanor and Wilson (1974) for each of 41 consumer goods industries in the US. from 1947 to 1964. The estimator used was a non-linear least squares, as the equation yields 8 coefficients from which to estimate 6 parameters. The main results were: i) the R-squared were generally high (as typical in time-series regression); ii) the coefficients typically had the expected sign, although the price and expenditure ones were frequently insignificant; iii) the dynamic process of sales adjustment was generally important and iv) the regressions did not show a great deal of serial-correlation [2].

Despite being a pioneering attempt, there are some problems with the analysis. First, the endogeneity problem is clear in this case, as industry sales and industry prices are jointly determined. The authors do use a two-stage least squares procedure, but to control for endogeneity of advertising and not of industry prices. Secondly, the authors used industry sales rather than consumer expenditures as the dependent variable. This is problematic since, as the authors acknowledge, part of the industries' sales are bought by other industries and the model is one of consumer behaviour. Furthermore, the sales generally pass through retailers before reaching the consumers and their behaviour may also interfere with the interpretation of the results. Third, the use of aggregate data to estimate consumer demand systems is only justified under certain aggregation conditions (see Blundell, Pashardes and Weber, 1993) and these conditions are not discussed by Comanor and Wilson (1974).

These problems may explain the poor performance of the estimated price and expenditure coefficients. Approximately 60 % of the estimated price coefficients were not significant using the 5% significance level. However, even when these relatively poor estimates were treated as independent variables in profitability regressions, the results were surprising. The coefficients of both the long-run and short-run elasticities[3] were precisely estimated and the R-squared increased by about 10%. The authors recognize that there is a spurious correlation between industry profitability and the average prices used to compute the demand elasticities (see foot-

[2] The authors devise a serial correlation test specific to this model, that takes into account the presence of a lagged dependent variable.

[3] Long run elasticity was computed as $\frac{\lambda a_3}{1-a_4}\frac{\overline{P}}{C}$ and the short run elasticity as $a_3\frac{\overline{P}}{C}$.

note above). They argue, however, that the inter-industry variation in the other elements of the price-elasticity formula (a_3, a_4, λ and $\overline{C}$) is greater than the inter-industry variation in prices and so any biases are likely to be small.

Another study that estimated demand elasticities, although in a less sophisticated fashion is Pagoulatos and Sorensen (1976), who estimate equations of the form:

$$Q_t = a_o + a_1 P_t + a_2 Y_t + \varepsilon_i \tag{5.13}$$

where: Q_t is the index of per-capita output P_t is a price index for the goods in the industry, deflated by the retail food price index and Y_t is an index of disposable personal income per capita deflated by the by the implicit GNP deflator.

This equation was estimated for each one of 47 US. food processing industries from 1952-1975. Unfortunately, the procedure is characterised by the same problems of Comanor and Wilson (1974), detailed above. Nevertheless, the authors use these elasticities estimates as independent variables in a system of equations in which advertising, concentration and profitability are treated as endogenous. They attract a negative significant coefficient, whose magnitude would mean that a 10% increase in the absolute value of the elasticity would provoke a decrease of 1% in the price-cost margin.

A theoretical advance in the SCP paradigm came with the Cowling and Waterson (1976) model. As seen in chapter 3, this study provided a formal theoretical framework explaining the relationship between profit margin and concentration or market share. The main equations are, at the firm level:

$$\frac{p - c_i}{p} = \frac{MS_i(1 + \lambda_i)}{\eta} \tag{5.14}$$

where i indexes the firm variables and no index is used for the industry ones, p is price, c_i is the marginal cost, MS_i is the market share and λ_i , as seen above, is the firm's conjecture about rivals' response to a change in its output q_i:

$$\lambda_i = \frac{\partial \sum_{j \neq i} q_j}{\partial q_i} \tag{5.15}$$

At the industry level:

$$\frac{\pi}{R} = \frac{\sum_i (pq_i - c_i q_i)}{pq} = \frac{H(1 + \mu)}{\eta} \tag{5.16}$$

with π/R being the profit/revenues ratio, H is the Herfindahl index of concentration and μ is the industry average conjectural variations' term:

$$H = \frac{\sum_i q_i^2}{q}, \mu = \frac{\sum_i \lambda_i q_i^2}{\sum_i q_i^2} \tag{5.17}$$

The theoretical and empirical objections to the estimation of a model relating concentration (or market share) to profit margins on the basis of the Cowling and Waterson (1976) model are well known. Clarke and Davies (1982) point out that concentration (or market share) is jointly determined with profitability by the "truly" exogenous variables in the model, that is, the cost and demand parameters:

$$H = \frac{1}{N} + \{1 - N\frac{(\eta - \alpha)}{(1-\alpha)}\}^2 \frac{v_c^2}{N} \tag{5.18}$$

where N is the number of firms in the industry, v_c is the coefficient of variation in marginal costs and α is the conjectural variations term in elasticity form (assumed equal for all firms):

$$v_c = \frac{\sum_i c_i^2}{(\sum_i c_i)^2}, \alpha = \frac{d\sum_{j\neq i} q_j}{dq_i} \frac{q_i}{\sum_{j \neq i} q_j} \tag{5.19}$$

Therefore, increases in efficiency differences among firms (reflected in differences in their marginal costs) will increase market shares, concentration and average profitability.

The advent of firm level data made it possible to include both market share and concentration in a profitability regression. This studies[4] generally found that market share entered positively and significantly, whereas concentration was insignificant and sometimes had the wrong sign. These findings are subject to criticisms, as most of them used cross-sectional data and not only the relationship between market power and profitability may exhibit cyclical behaviour [5], but also firm specific effects were not controlled for. Moreover, market share is likely to be endogenous, following the discussion above [6]. The question of interpreting the results remains, nevertheless, interesting. Demsetz's (1974) interpretation was that higher market shares are a reflection of superior efficiency. Shepherd (1972, 1986) argued that market dominance is

[4]See Shepherd (1972), Smirlock, Gilligan and Marshall (1984), Ravenscraft (1983), Kwoka and Ravenscraft (1986) .

[5]See Domowitz, Hubbard and Petersen (1986)

[6]For example, Machin and Van Reenen (1992) use panel data and control for endogeneity to find that both market share and concentration are significant determinants of profitability in the U.K.

the most direct source of market power.

Stevens (1990) argues that including an interaction between market share and concentration would be a way of shedding some light into this question. A positive interaction would mean that market concentration offers price collusion and inefficient firms survive under the pricing umbrella, thus offering support for the collusion hypothesis. On the other hand, the efficiency hypothesis would mean that interaction term would be negative as a firm with high market share attracts a premium due to efficiency, which would be lower if there is oligopolistic competition. According to this argument, Stevens (1990)'s finding of a positive estimated coefficient on the interaction between market share and concentration lends support to the "collusion hypothesis" (see also chapter 3).

Cowling and Waterson (1976) assumed that demand elasticities for each industry were constant over time and estimated their model in first-differences so that the elasticity effect would be implicitly controlled for. This method is equivalent to using firm level data and controlling for industry specific effect and hinges on the assumption of time constancy of the elasticities which, as it will be shown in chapter 7, does not seem very compelling. Moreover, this method does not estimate the effect the demand elasticities might have on profitability, which maybe very important from an economic policy point of view.

Some studies have tried to estimate the demand elasticities using Cowling and Waterson (1976)'s model. Long and Ravenscraft (1982) use Clarke and Davies (1982)'s extension of it to derive:

$$\frac{p - c_i}{p} = \frac{\alpha + (1 - \alpha)MS_i}{\eta} \tag{5.20}$$

The authors then estimate

$$\frac{p - c_i}{p} = \gamma_0 + \gamma_1 MS_i + \varepsilon_i \tag{5.21}$$

where $\gamma_0 = \alpha/\eta$ and $\gamma_1 = (1 - \alpha)/\eta$ and the estimated inverse elasticity is $1/\eta = \gamma_0 + \gamma_1$. Equation (5.21) was estimated for each one of 201 FTC manufacturing industries, using market share and profitability variation across the firms in a industry. The authors reported an average value of $1/\eta$ equal to 0.76. A second stage regression was then performed, in which the estimated elasticities were included in profitability regressions, estimated on a sample of 3185 line of business observation for 1976. The reported results showed a threefold increase in both the market share and in the (negative) estimated concentration coefficient and an increase of 5 percentage point in the R-squared. The main problems with this approach is that: i) endogeneity of market share is not controlled for; ii) the sample size is small, given it only uses within industry information (the minimum number of observations is 6); iii) one must believe the strong functional form assumption, whereas the market share coefficient was not found to be close to one as it should be; iv) firm specific effects were not controlled for; v) the elasticity of demand may vary over time; and vi) 25% of the estimated elasticities had the wrong sign.

Mueller (1986) uses a similar procedure. He derives:

$$\frac{\pi}{R} = \frac{\alpha + (1-\alpha)Conc}{\eta} \tag{5.22}$$

and, assuming

$$\alpha = a + bConc \tag{5.23}$$

then

$$\frac{\pi}{R} = \frac{a + (1-a+b)Conc - bConc^2}{\eta} \tag{5.24}$$

which he estimates by applying OLS to

$$\frac{\pi}{R} = \frac{\gamma_0 + \gamma_1 Conc + \gamma_2 Conc^2}{\eta} + \varepsilon_i \tag{5.25}$$

using separate intercepts and slopes for each industry. The data come from a sample of 551 US. firms for the years of 1950 and 1972. According to the author, the results were disappointing, as approximately 50% of the estimates of the intercept were of the wrong sign. Therefore, Mueller (1986) concludes that it is impossible to separate the influences of concentration and demand elasticities on firms' profitability using internally generated elasticities. As an additional procedure, Mueller (1986) uses externally generated demand elasticities and re-estimates (5.25). The author uses elasticities estimated by Intriligator and DeAngelo at the four-digit level and, whenever they were of the wrong sign, estimates were obtained at a higher level of aggregation. Unfortunately, the reported results showed no improvement in the fit of this model as compared to one where all elasticities were assumed to be equal to 1.

Finally, Connor and Peterson (1992) use the demand elasticities estimated by Pagoulatos and Sorensen (1976) to estimate a linear version of equation (5.25) above (plus additional controls) on a sample of 45 US. food industries for the years of 1979 and 1980. The dependent variable is a Lerner index of monopoly computed as the percentage difference between observed retail price of "national brands" of processed foods and beverages and the price of equivalent "private label" products (assumed to approximate the competitive prices). The results show a positive and significant estimated coefficient on the concentration variable adjusted for the own-price elasticity of demand. The authors also report experiments showing that elasticity of demand plays a larger role than market concentration in determining the price difference between national brands and private label products. Apart from the problems with the elasticities estimated by Pagoulatos and Sorensen (1976) discussed above, the definition of mark-up used by the authors is very peculiar.

In conclusion, it seems that, while some studies in the NEIO line of research have estimated consumer behaviour parameters in order to examine companies' performance, the SCP efforts in this direction were clearly not satisfactory. In the next two chapters, an attempt will be made to jointly analyse the demand and the supply for several products in the UK. Two independent micro data sets will be used in conjunction for the first time to examine the relationship between consumer behaviour and profitability, and how this relationship can be used to explain the impact of market structure on the firms' mark-ups.

5.4 Profitability Regressions with Panel Data

This section presents a brief digression on the thesis, examining some problems associated with the use of panel data to estimate profitability regressions.

5.4.1 Data

The data for this exercise come from company accounts available from the Datastream on-line service. The industry level information comes from the Census of Production. The criteria for selecting firms was that they operated in the consumer non-durables sector of the economy and that information was available both on the distribution of sales across different industries and on the percentage of sales sold abroad. We were left with an unbalanced sample of 161 firms operating from 1974 to 1992. Table 5.3 in the appendix presents some descriptive statistics on the firm and industry level variables used in this chapter.

5.4.2 Measurement of Market Share

As seen in chapter 5, the use of market share as a measure of competitiveness, alongside measures of industrial concentration, became common with the availability of firm-level data and with the appearance of theoretical models explaining the relationship between market share and profitability (Cowling and Waterson, 1976)[7]. Nevertheless, little attention has been paid to the measurement of the market share variable. As seen in the first chapter, attention has generally focused on the measure of profitability. An exception is Nickell (1996), who points out several deficiencies with the measurement of market share[8]. This section tries to use different proxies for market share to investigate to what extent measurement error is present in the variable traditionally used and, if so, how it behaves at various differencing lags.

Assume that the true relationship between profitability and market share (ignoring other controls for the moment) is:

$$PROF = \beta MS^{*} + u \tag{5.26}$$

The market share variable traditionally used in SCP studies is the ratio of firm's total sales to its main industry sales (MS_1). However, many firms are diversified and operate across different industries. Therefore, the first step towards improving the market share variable would be to take this into account, by using the sales distribution information to compute a market share for each industry in which the firm operates. Then, MS_2 is the weighted average of these market shares, with the weights being the percentage of the firm's sales in each industry.[9]

If the main interest of the analysis is the relationship between *domestic* market share and profitability, then sales abroad must be excluded. MS_3 incorporates the sales correction above, uses only domestic sales in the numerator and exclude industry exports from the industry sales in the denominator.[10]

[7] One very early such study was Shepherd (1972).

[8] Among the deficiencies of the traditional market share variable is, according to Nickell (1996), the fact that it does not measure other factors that influence collusion like asymmetries in cost, secrecy of price cuts, potential competition and foreign competition and that the definition of "market" is not correct.

[9] Unfortunately, with the data I use the information on sales' distribution begins only in 1979 for some firms and in 1980 for the others. Therefore, we used the 1979/80 weights from 1975-79.

[10] Unfortunately, for some of the firms in our sample the information on exports does not cover the entire sample period. Therefore, we used information on the percentage of domestic employes to predict the percentage of domestic sales when the information required was missing. In the cases where that was not enough, we used an interpolation method by regressing the observed values for each firm on a constant, trend and trend squared and then predicting the missing values.

Finally, it is well-known that for some firms the accounting year does not coincide with the calendar year. This means, for example, that the sales figure of a firm may cover a period ending in June, while industry sales figures always cover a whole calendar year. Therefore, an arbitrary decision is needed to allocate these firms to a calendar year. In order to try to avoid this, weighted average monthly sales for each industry were computed, with weights derived from a 2-digit production index. MS_4 departs from MS_3 by using industry sales in the last 12 months in the denominator so as to match the firm's sales figure used in the numerator.

Assume (this is a testable assumption) that MS_4 is the one closest to the true market share. Then:

$$MS_4 = MS^* + u_4 \tag{5.27}$$

$$MS_3 = MS_4 + u_3 = MS^* + u_4 + u_3 \tag{5.28}$$

$$MS_2 = MS_3 + u_2 = MS^* + u_4 + u_3 + u_2 \tag{5.29}$$

$$MS_1 = MS_2 + u_1 = MS^* + u_4 + u_3 + u_2 + u_1 \tag{5.30}$$

so that:

$$MS_{k-1} = MS_k + u_{k-1} \tag{5.31}$$

where the subscript means that MS_k is theoretically a better measure of the "true" market share (by one-step) than MS_{k-1}. This is the traditional formula for the error in variables case.

If u_{k-1} is *uncorrelated* with MS_k then:

$$Var(MS_{k-1}) = Var(MS_k) + Var(u_{k-1}) \tag{5.32}$$

By comparing the different market share measures (table 5.3), it is clear that as one moves from MS_1 to MS_4 the standard deviation decreases, although the difference between MS_3 and MS_4 is very small. The classical measurement error bias in this case is equal to :

$$Bias1_{k-1} = \frac{p\lim b_{k-1} - \beta_k}{\beta_k} = -\frac{Var(u_{k-1})}{Var(u_{k-1}) + Var(MS_k)} \tag{5.33}$$

where b_{k-1} is the O.L.S. coefficient from regressing $PROF$ on the proxy MS_{k-1} and β_k is the one obtained from regressing $PROF$ on the proxy MS_k.

If, on the other hand, u_{k-1} is *correlated* with MS_k (see Bound, Brown, Duncan and Rodgers, 1994):

$$\beta ias2_{k-1} = \frac{p\lim b_{k-1} - \beta_k}{\beta_k} = -(MS_k' MS_k)^{-1} MS_k' u_{k-1} = -b_{u_{k-1}MS_k} \qquad (5.34)$$

that is, the measurement error bias will be equal to the estimated coefficient of a hypothetical regression of u_{k-1} on MS_k . When u_{k-1} and MS_k are in fact uncorrelated, $\beta ias2_{k-1} = \beta ias1_{k-1}$.

As pointed out by Griliches and Hausman (1986), $Bias1_{k-1}$ (and $\beta ias2_{k-1}$) may behave differently with different transformations of the data. Its behaviour will depend primarily on the l_{th} serial correlation coefficient in MS_k (denoted $corr_{kl}$) and on the l_{th} serial correlation coefficient in u_{k-1} (denoted $corru_{k-1l}$). For example, if the variance of MS_k (denoted $\tau^2_{MS_k}$) is the same in two years, the variance of ΔMS_k will be equal to $2\tau^2_{MS_k}(1 - corr_{k1})$, which is greater (less) than $\tau^2_{MS_k}$ as $corr_{k1}$ is less (greater) than 1/2. If the values of market share (MS_k) are highly correlated over time and the measurement errors (u_{k-1}) are not, then $\tau^2_{\Delta MS_k} < \tau^2_{MS_k}$ and $\tau^2_{\Delta u_{k-1}} > \tau^2_{u_{k-1}}$, so that $Bias1_{k-1}$ in first differences will be higher than $Bias1_{k-1}$ in levels. The lag length (l) that minimizes the inconsistency is the one that maximizes:

$$ratio_{k-1} = \frac{(1 - corr_{kl})}{(1 - corru_{k-1l})} \qquad (5.35)$$

Figure 5.1 graphs $Bias1_{k-1}$ and $Bias2_{k-1}$ at various differencing lags. It is clear that the biases can be substantial. Using only the levels of the variables (lag = 0), $Bias1_1 \simeq Bias1_2 \simeq 0.5$. Furthermore, $Bias1_3 \simeq 0$, suggesting that the measurement error due to the mismatch between the accounting and calendar year is not very serious. However, first-differencing the data (lag = 1) increases $Bias1_1$ by a significant extent, which accords to the view that differencing may increase the error/signal ratio. Moreover, $Bias1_1$ remains very high ($\simeq 1$) as the differencing lag increases, while $Bias1_2$ and $Bias1_3$ show some tendency to decline. This seems to indicate that the bias due to the use of main industry sales in the denominator of the market share variable is especially high in first-differences and that the use of longer differences will not attenuate the problem. The straight lines in the graph refer to the $Bias2_k$'s (equation (5.34)) [11]. They behave in a similar way to the $Bias1_k$'s except that

[11] Additional controls included in the regressions are Concentration, Capital/Sales, Import Protection and

$Bias2_2$ declines much faster than $Bias1_2$, suggesting that $\Delta_l u_2$ tends to be more correlated with $\Delta_l MS_3$ as l increases.

To check for the reasons behind this behaviour, Figures 5.2 to 5.4 plots the serial-correlations of the "true" market share proxies (fig. 5.2), of the different measurement errors (fig. 5.3) and the ratios in equation 5.35 (fig. 5.4), respectively. Figure 5.2 shows that the first-order serial correlation is very high in all proxies. But it also shows that while MS_2 is highly serially-correlated for lags higher than 1, the auto-correlations in MS_3 and MS_4 decline with increases in the lag length. Figure 5.3, on the other hand, shows that while u_2 is highly and persistently serially correlated (which means that the bias due to exports should decrease with differencing), both u_1 and u_3's serial correlation tends to decline with the lag length [12]. Figure 5.4 summarizes these results by showing the behaviour of the $ratio_{i-1}$'s (graphed as rt_{i-1}). It shows that while increasing the differencing lag can decrease the measurement error bias due to exports, this does not seem to have any effect on the bias due to the use of main industry sales.

These results are generally confirmed by the actual results of the profitability regressions showed in Fig 5.5 (the horizontal lines are the results of the within-groups estimator). These graphs represent the behaviour of the estimated coefficient on the market share variable in a regression that includes the other firm and industry level controls. The coefficient on the basic market share variable (MS_1) is very low in the levels specification and remains so in the differences ones. It does not decrease as much as it would have been expected from Fig 5.1, but when one moves from the levels to the differences specifications one is, of course, also controlling for firm specific effects and this may also have an important effect here.

The coefficient on the second proxy (taking into account the sales distribution) is also low in levels (although it is two times higher than the one on MS_1), but increases continually with the lag length. Finally, the coefficients on MS_3 and MS_4 behave very similarly. Both are around ten times higher than the basic market share variable in levels and increase until the fourth differencing lag, stabilizing after this. This indicates that there might still be a substantial amount of measurement error in the preferred market share variables.[13]

Time Dummies.

[12]Note that the persistence of serial correlation in the errors at lags longer than one puts into question the use of longer lags of the independent variable as instruments to deal with the measurement error.

[13]The use of MS_4 implies a reduction in the sample size because industry sales figures are not available in the SIC aggregation level for 1993. Therefore we use MS_3 in the regressions below.

All the results above are conditional on the assumption of exogeneity of market share. However, there are reasons to believe that this may not be true and it is possible that the increase in differencing lag may weaken even more the plausibility of this assumption. This would mean that the observed increase in the coefficient of the preferred market share variable with the lag length may reflect a corresponding increase in the endogeneity bias. This possibility will be discussed below.

5.4.3 Model Specification and Estimation

The substantial amount of first-order serial correlation in all market share proxies showed in Figure 5.2 means that first-differences of market share can be very close to a random walk and, therefore, only weakly correlated with lagged values of this variable. This would cast doubts over a GMM estimator that uses lagged values of market share as instruments in a first-differences specification.

Moreover, by estimating the model in first-differences, researchers impose testable restrictions on the model. As show by Holtz-Eakin, Newey and Rosen (1988), the use of panel data allows each of the coefficient of the firm specific effect to be time-varying. It also permits the researcher to control for the firm specific effect without differencing the data, thereby attenuating the measurement error and instrument power problems referred to above.

Define the statistical relationship between the dependent variable Y and the independent variable X_i (ignoring the other controls for a while) as follows:

$$Y_{it} = \alpha_0 + \gamma_t \alpha_i + \beta X_{it} + \varepsilon_{it} \tag{5.36}$$

where α_0 is a constant, α_i is the firm specific effect, γ_t and β are parameters to be estimated and ε_{it} is a random error term. By lagging (5.36) one period , solving for α_i and substituting back in (5.37) one gets a quasi-differences specification:

$$Y_{it} = (1 - \gamma_t/\gamma_{t-1})\alpha_0 + \beta X_{it} - (\beta\gamma_t/\gamma_{t-1})X_{it-1} + (\gamma_t/\gamma_{t-1})Y_{it-1} + \varepsilon_{it} - (\gamma_t/\gamma_{t-1})\varepsilon_{it-1} \tag{5.37}$$

This expression can be estimated by applying a GMM approach to:

$$Y_{it} = a + b_1 X_{it} + b_2 X_{it-1} + cY_{it-1} + v_t \tag{5.38}$$

Where $a = (1 - \gamma_t/\gamma_{t-1})\alpha_0$, $b_1 = \beta$, $b_2 = -(\beta\gamma_t/\gamma_{t-1})$, $c_t = (\gamma_t/\gamma_{t-1})$ and $v_t = \varepsilon_{it} - (\gamma_t/\gamma_{t-1})\varepsilon_{it-1}$. One can then test for the first-differences specification, in which $c = 1$ and $b_1 = -b_2$ [14].

Table (5.1) reports the tests on the equation:

$$\begin{aligned} PROF_{it} &= a + b_1 MS_{it} + b_2 MS_{it-1} + b_3 Conc_{it} + b_4 Conc_{it-1} + b_5 K/S_{it} \\ &\quad + b_6 K/S_{it-1} + b_7 IMPP_{it} + b_8 IMPP_{it-1} + cPROF_{it-1} + v_t \end{aligned} \tag{5.39}$$

The results of the specification tests strongly rejects the first-differences specification, which is a joint test of: $b_1 = -b_2$, $b_3 = -b_4$, $b_5 = -b_6$, $b_7 = -b_8$ and $c = 1$ ($\chi^2(5) = 18.05$, p-value = 0.003). This means that the fixed effect coefficient is allowed to change over time.

Column (1) reports the results of the first-differences specification, as a benchmark. The market share coefficient is very poorly estimated, perhaps reflecting the measurement error problem, the lack of power in the instruments and/or the constancy of the fixed effect coefficient. The second column shows the results of the quasi-differences specification, with only the market share variables included. A Wald test rejects the null that they are jointly insignificant. Column (3) then adds the additional controls present in column (1). Comparing the market share results with those in the first column, shows a great improvement (by almost three times) in the market share coefficients. It is also the case that $b_2 \simeq -b_1 c$ as the model would predict . However, the other variables in the regression remain insignificant.

In column (4), an interaction of concentration and import protection enters strongly and significantly and brings the linear variables into significance. The result of a negative concentration-import protection interaction is common in consumer goods industries [15]. If seen in a market power context it may reflect the fact that intensive collusion may in fact be prejudicial to the majority of firms in the industry[16]. In column (4), an additional lag of the dependent variable

[14] Jakubson (1991) performs a similar first-differences test using union wage models.
[15] See Domowitz, Hubbard and Petersen (1986).
[16] See Kwoka & Ravenscraft (1986) and the results in chapter 2.

Table 5.1: **Profitability Models: 1979-1992**

Profits/Sales	(1)	(2)	(3)	(4)	(5)
Constant	-0.003 (0.003)	-0.008 (0.004)	-0.007 (0.007)	0.011 (0.017)	0.010 (0.015)
D(Market share)	0.312 (0.353)	-	-	-	-
Market Share	-	0.700 (0.412)	0.970 (0.518)	1.148 (0.588)	0.949 (0.505)
Market Share (-1)	-	-0.605 (0.401)	-0.881 (0.503)	-1.047 (0.570)	-0.865 (0.488)
D(Capital/Sales	-0.007 (0.024)	-	-	-	-
Capital Sales	-	-	-0.015 (0.028)	-0.023 (0.027)	-0.019 (0.026)
Capital Sales (-1)	-	-	0.021 (0.029)	0.031 (0.028)	0.025 (0.027)
D(Concentration)	0.026 (0.052)	-	-	-	-
Concentration	-	-	0.084 (0.052)	0.880 (0.252)	0.705 (0.228)
Concentration (-1)	-	-	-0.078 (0.051)	-0.886 (0.262)	-0.716 (0.235)
D(Import Protection)	0.570 (0.132)	-	-	-	-
Import Protection	-	-	0.152 (0.152)	0.876 (0.291)	0.739 (0.259)
Import Protection (-1)	-	-	-0.147 (0.153)	-0.886 (0.305)	-0.752 (0.270)
Concentration * Import Protection	-	-	-	-1.011 (0.293)	-0.826 (0.275)
Concentration * Import Protection (-1)	-	-	-	1.014 (0.306)	0.835 (0.283)
Profitability (-1)	-	1.015 (0.028)	0.935 (0.035)	0.936 (0.035)	1.225 (0.138)
Profitability (-2)	-	-	-	-	-0.256 (0.122)
Wald (p-value)	0.781 (0.540)	13.15 (0.001)	7.47 (0.024)	7.67 (0.022)	6.95 (0.031)
Sargan (p-value)	51.16 (0.507)	24.56 (0.267)	56.61 (0.636)	65.89 (0.710)	61.15 (0.798)
SC1 (p-value)	0.657 (0.511)	0.957 (0.338)	1.466 (0.143)	0.951 (0.342)	-1.362 (0.173)
SC2 (p-value)	-2.100 (0.036)	-1.975 (0.048)	-1.761 (0.078)	-1.750 (0.080)	-1.616 (0.106)
Time Dummies	Yes	Yes	Yes	Yes	Yes
Number of Firms	151	151	151	151	151
Sample Size	1592	1592	1592	1592	1592

Notes to Table

Standard Errors in Parentheses. Instruments used: Lagged values (t-3) of all included variables. Wald is a test of joint significance of the market share variables.

is included to incorporate additional dynamics and help whitten the residuals. The results remain basically the same. The use of longer lags (up to 5) left the market share results basically unaltered.

5.4.4 Granger Causality Tests

The assumption that the causality of the relationship examined above runs from market share to profitability may, of course, be questioned. Firstly, seen above, Clarke and Davies (1982)'s extension of Cowling and Waterson (1976)'s model demonstrated that both market share and profitability may be jointly determined by the "true" exogenous variables in the model, that is, cost and demand parameters. More generally, Schmaleense (1987) pointed out that all market structure variables are very likely to be affected by firms's conduct in the long run, so that, for example, high profitability may attract entry which, in turn, would decrease market share and concentration.

Another point that could be raised against the exogeneity of market share is derived from the examination of recent customer pricing models. Chevalier and Scharfstein (1996) [17], for example, present a model in which a firm may price low in the first period in order to increase its market share and explore the existence of switching costs to recover the profitability in the second period. In this model, prices (and profits) determine market share in the first period, although market share will eventually determine second period profits.

The quasi-differences framework adopted above offers the additional possibility of performing Granger causality tests on the relationship between market share and profitability. The equation to be estimated is a variant of (5.39) above, where current values of the right-hand-side variables are dropped to test whether lagged values of market share can predict current profitability and vice-versa, conditional on the lagged values of all the other independent variables and on the firm specific effect:

$$Y_{it} = a + \sum_{l=1}^{m+1} b_{1l} X_{it-l} + \sum_{l=1}^{m+1} c_l Y_{it-l} + v_t \tag{5.40}$$

As in Holtz-Eakin, Newey and Rosen (1988), the test for non-causality will be conditional

[17] See also Bils (1989).

Table 5.2: **Granger Causality Tests**

Dependent Variable	**M**	**Wald 1** D.F (p)	**Sargan** D.F. (p)	**SC1** D.F (p)	**SC2** D.F (p)	**Wald 2** D.F (p)
Profitability	4	1.98 5 (0.852)	43.36 35 (0.157)	-2.760 144 (0.006)	-0.273 137 (0.785)	4.56 5 (0.471)
Market Share	4	6.06 5 (0.300)	19.78 35 (0.982)	-0.803 144 (0.222)	0.222 137 (0.824)	4.30 5 (0.507)
Profitability	3	1.61 5 (0.900)	34.61 40 (0.711)	-1.945 148 (0.052)	0.908 144 (0.364)	3.41 4 (0.492)
Market Share	3	4.59 5 (0.468)	24.58 40 (0.974)	-0.844 148 (0.399)	-1.151 144 (0.250)	5.09 4 (0.278)
Profitability	2	11.12 5 (0.049)	48.46 50 (0.535)	-2.445 148 (0.014)	1.858 144 (0.063)	4.52 3 (0.210)
Market Share	2	4.41 5 (0.492)	48.12 50 (0.549)	-1.715 148 (0.308)	-0.308 144 (0.758)	4.11 3 (0.250)
Profitability	1	13.53 5 (0.019)	71.60 60 (0.145)	-1.705 148 (0.088)	-1.632 144 (0.103)	7.24 2 (0.027)
Market Share	1	246.60 5 (0.000)	69.43 60 (0.189)	-1.080 148 (0.280)	-0.085 144 (0.932)	1.09 2 (0.579)

Notes to Table

Standard Errors in Parentheses. Wald 1: Test of Joint Significance of longest included lags. Wald 2: Test of Joint Significance of Market Share vars. in Profit. eqs and of Profit. vars in Market Share eqs. Instruments used: Lagged values (t-3) of all included variables.

on a test of lag length. Table (5.2) reports the results of the lag length tests together with over-identifying restrictions and serial-correlation tests .The last column of the table reports Wald tests of joint significance of the market share variables in profitability regressions and vice-versa.

For the profitability regressions, the tests on the lag length seem a bit mixed. While one cannot reject the hypothesis that M=2 (lag length=3) at a 5% significance level, evidence on M=1(lag length=2) is more convincing (p =0.019). The specification tests also perform much better when M is set to 1. The results of the non-causality tests also depend on the value of M. For M=2 the lagged market share variables are jointly insignificant at 5% significance level, while the reverse occurs if M is set to 1. When market share is used as the dependent variable, the results are clearer. The evidence clearly supports M=1 (lag length=2). More importantly, profitability does not seem to Granger-cause market share for any of the lag lengths experimented with here.

5.4.5 Appendix

Table 5.3: **Descriptive Statistics: Supply 1974-1992**

Variables	Mean	S.D.	Min.	Max.
Profitability	0.076	0.069	-0.517	0.424
Capital/Sales	0.377	0.419	0.013	3.133
Market Share 1	0.016	0.062	2E-07	0.804
Market Share 2	0.011	0.034	6E-06	0.307
Market Share 3	0.008	0.023	3E-06	0.248
Market Share 4	0.008	0.022	3E-07	0.245
Concentration	0.405	0.224	0.060	1
Import Protection	0.818	0.139	0.369	0.994

Figures

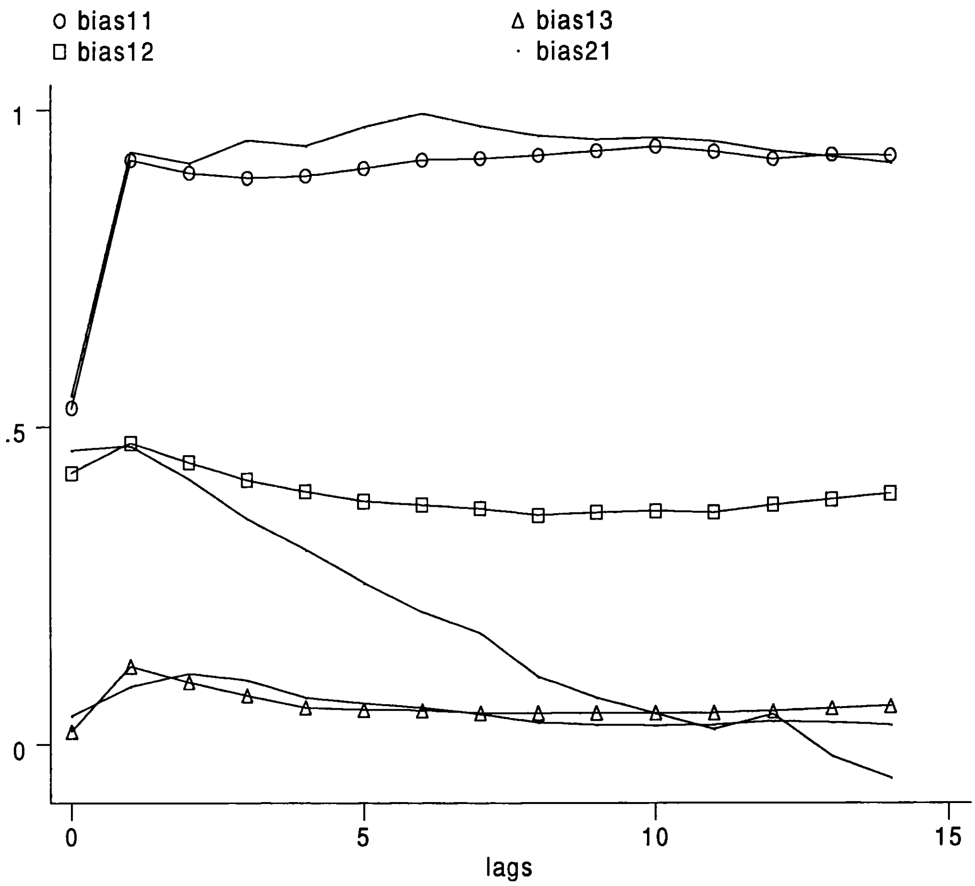

Figure 5-1: Measurement Error Biases at various Differencing lags.

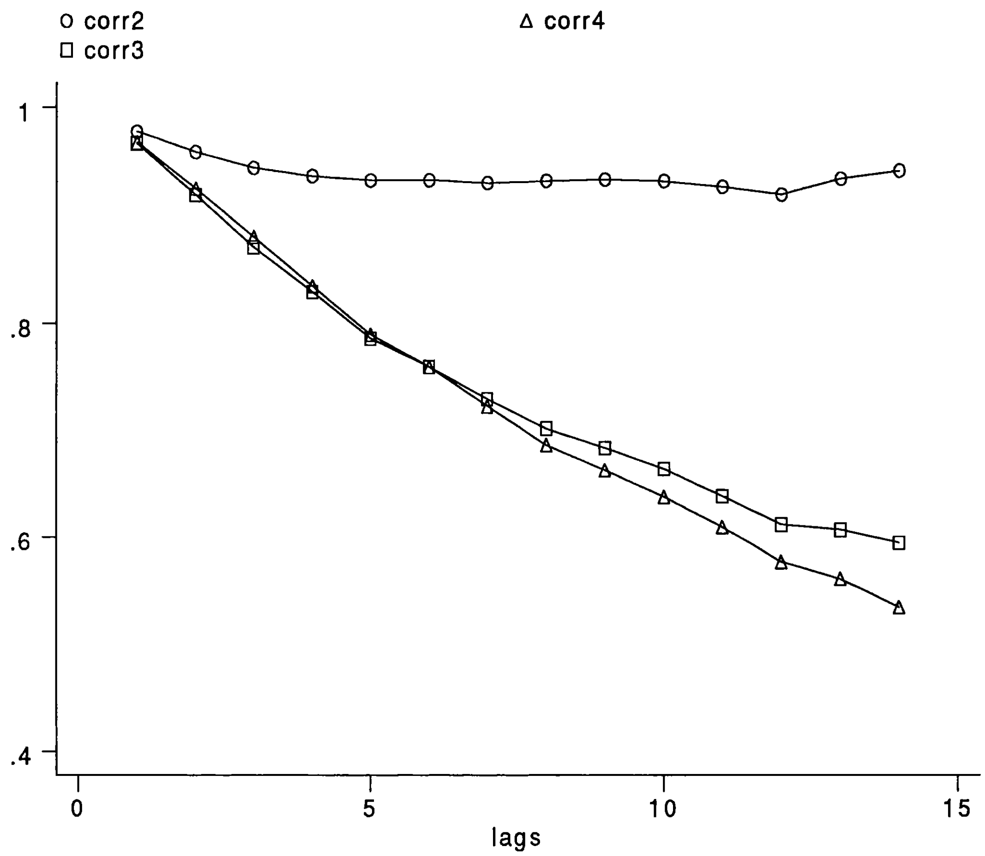

Figure 5-2: Auto-Correlations of Different Market Share Proxies

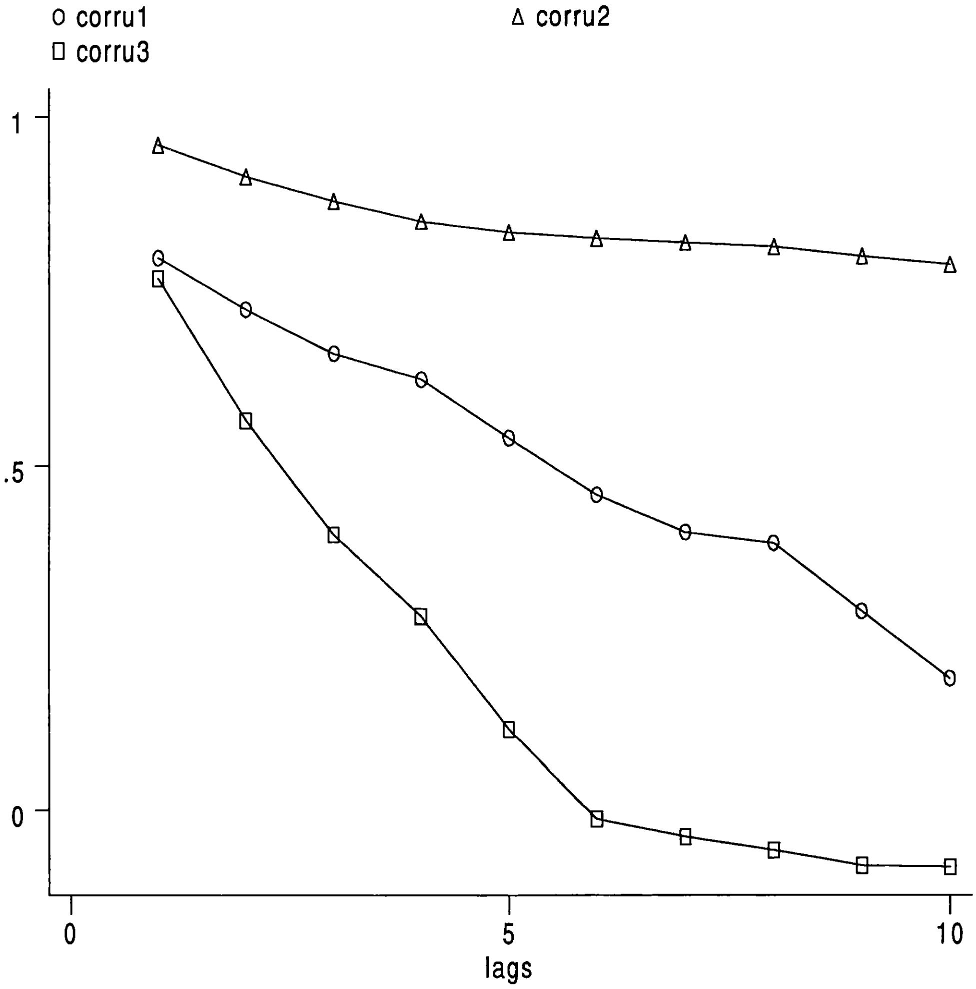

Figure 5-3: Auto-Correlations of Market Share Measurement Errors

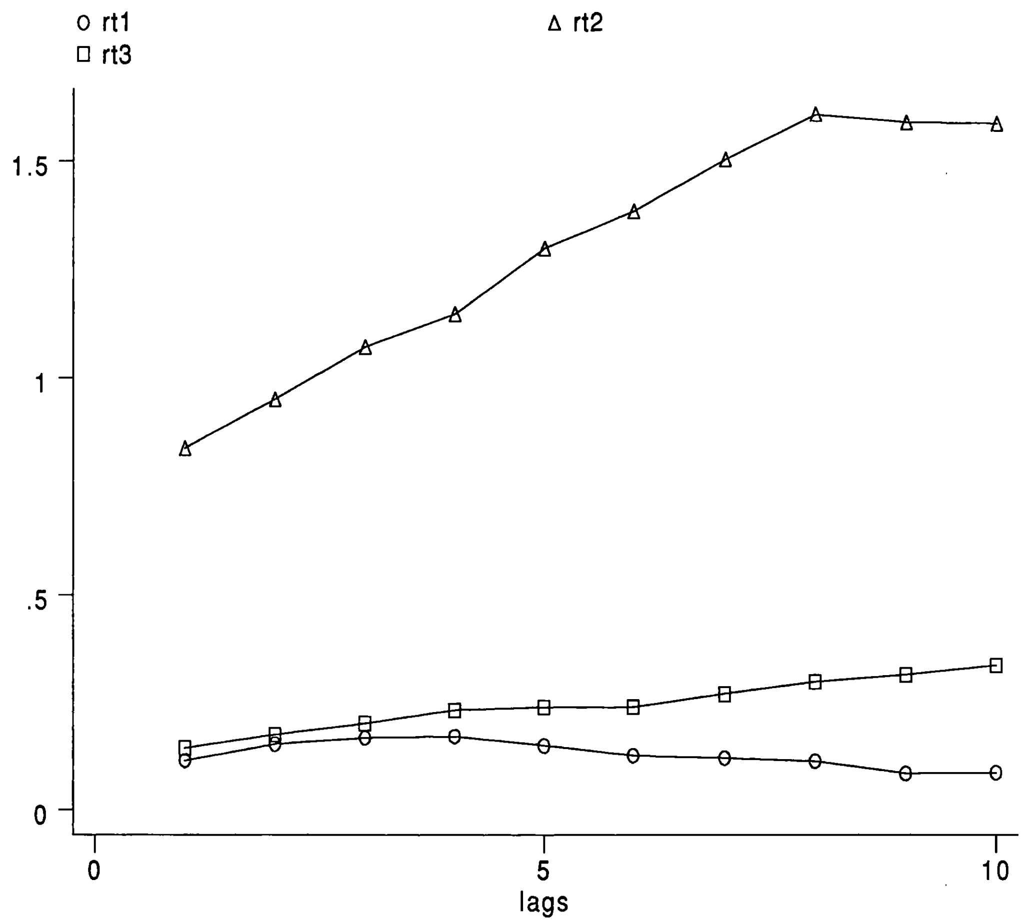

Figure 5-4: Ratio of Correlations

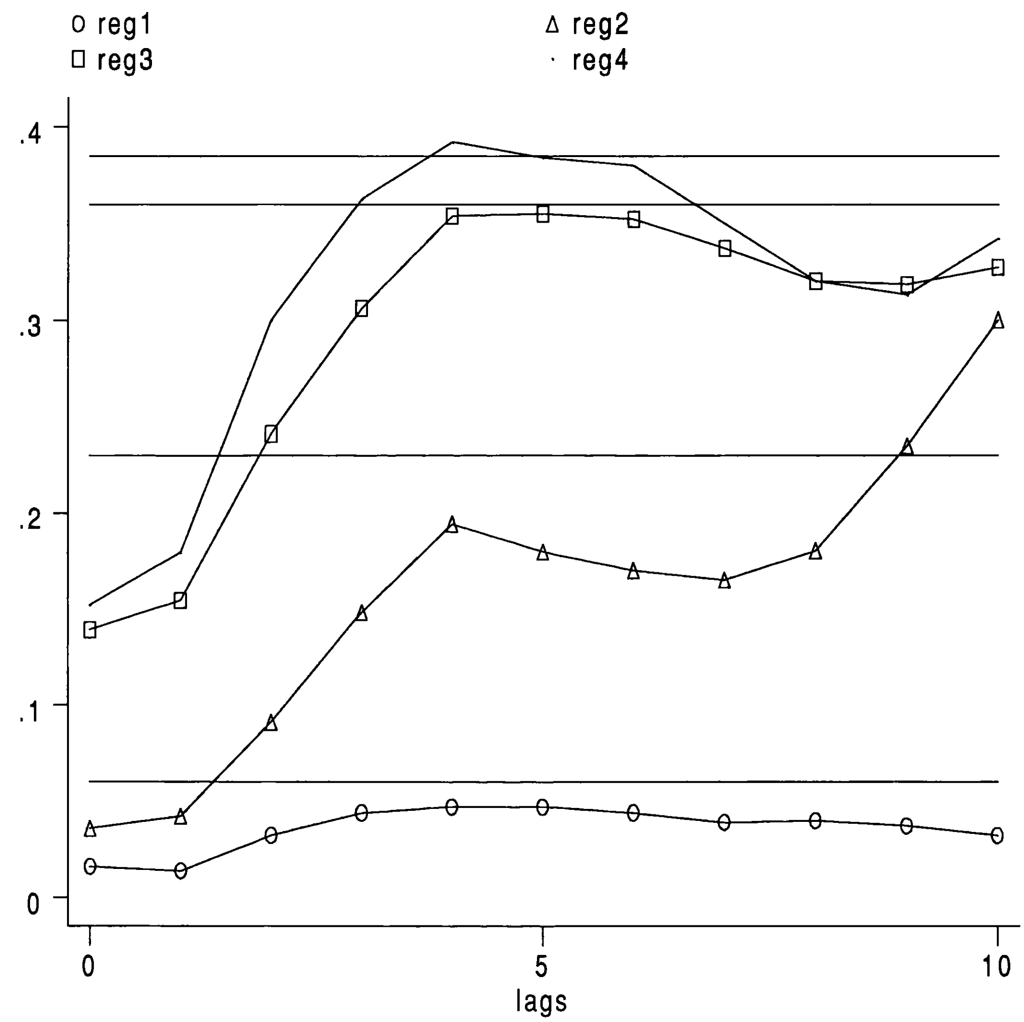

Figure 5-5: Regressions with Different Market Share Proxies at Various Lags

Chapter 6

Demand Estimation

6.1 Introduction

The aim of this chapter is to estimate models of consumer behaviour for four groups of disaggregated commodities in the UK. The main objective is to obtain price elasticities that will be used in the next chapter to examine the impact of consumer behaviour on the profitability of UK firms. As such, the exercise will be carried out in a more disaggregated level than usual and the assumption that the elasticities are constant over time will be dropped. Before examining the model to be estimated and carrying out the estimation procedure, a brief review of some important demand studies seems worthwhile.

6.2 Modelling Demand

Estimation of consumer demand systems has always played an important role in the economics agenda (see the surveys by Deaton and Muellbauer, 1980b and Blundell, 1988)[1]. Most studies used time-series data on broadly defined commodities groups. An early study that did estimate price elasticities for products defined at a very disaggregated level, using time series information, was Stone (1954a). His starting point was an empirically inspired equation of the form:

$$\log(q_i) = \alpha_i + e_i \log(x) + \sum_j e_{ij} \log(p_j) \tag{6.1}$$

[1]We draw primarily on Deaton and Muellbauer (1980b) in what follows.

where q_i is quantity, x is total expenditure, p_j is the price, e_i is the expenditure elasticity and e_{ij} is the uncompensated price elasticity.

Stone's (1954a) aim was to estimate elasticities for 49 goods using data on prices and quantities for 19 years (1920-38) in the UK. Therefore, some simplifications were necessary to generate degrees of freedom. The first obvious way of doing so is to drop the number of "other prices" to be included in (6.1). However, in order to do this, a transformation has to be made, since the uncompensated elasticities in (6.1) contain income effects that cannot be arbitrarily set to zero, even for unrelated goods. From the duality between the utility maximization and the cost minimization problem:

$$q_i = g_i(x,p) = g_i[c(u,p),p] = h_i(u,p) \tag{6.2}$$

where $g_i(x,p)$ is the Marshalian demand, u is utility, $c(u,p)$ is the cost function and $h_i(u,p)$ is the Hicksian demand. Differentiating (6.2) with respect to the price, gives the "Slutsky equation":

$$\frac{\partial g_i}{\partial p_j} = \frac{\partial h_i}{\partial p_j} - q_j \frac{\partial g_i}{\partial p_j} \tag{6.3}$$

which can also be expressed in elasticity form:

$$e_{ij} = e_{ij}^* - e_i w_j \tag{6.4}$$

where e_{ij}^* is the compensated price elasticity and w_j is the expenditure share in good j :

$$w_j = \frac{p_j q_j}{x} \tag{6.5}$$

Substituting (6.4) in (6.1) gives:

$$\log(q_i) = \alpha_i + e_i \log(\frac{x}{P}) + \sum_j e_{ij}^* \log(p_j) \tag{6.6}$$

where the effects of unrelated goods can now be excluded, as the income effect in not present in the last term of (6.6).

Stone (1954a) estimated the expenditure elasticities separately, using cross sectional data from two budget studies, carried out in 1937-39. Homogeneity was imposed (see below) and each equation was estimated in first-differences to minimize serial correlation problems, that is:

$$\Delta[\log q_i - \widehat{e}_i \log(\frac{x}{P})] = \alpha_i + \sum_{k<j} e_{ik} \Delta \log(\frac{p_k}{P}) \tag{6.7}$$

Three groups were defined : food, alcohol/tobacco and fuel. Each equation within a group was estimated separately and a number of different combinations of prices of close substitutes and complements was tried in each case.

As there are many estimated equations, it is somewhat difficult to summarize the results. Nevertheless, the products with the highest expenditure elasticity were found to be poultry, fruits, coffee and wine. The inferior goods were flour, margarine, sugar, cocoa and beer. Goods very price elastic were lamb, legumes, vegetables and beer, while the ones with positive compensated price elasticities (at odds with the theory) were cheese, margarine, coffee and cocoa.

If the quantities chosen by a household are the result of a utility maximization process, the following well-known properties will hold:

i) adding-up: $\sum_i p_i g_i(x,p) = \sum_i p_i h_i(u,p) = x$;

ii) homogeneity: $h_i(u, \theta p) = h_i(u,p) = g_i(\theta x, \theta p) = g_i(x,p)$;

iii) symmetry: $s_{ij} = \frac{\partial h_i}{\partial p_j} = \frac{\partial h_j}{\partial p_i} = s_{ji}$ and

iv) negativity: $s_{ii} = \frac{\partial h_i}{\partial p_i} < 0$.

The main problem with Stone (1954a)'s methodology is the constant elasticity form of (6.1), which means that it only satisfies adding-up if all expenditure elasticities were equal to one, that is, if the proportion spent on each good was independent of total expenditure. This is clearly at odds with the observed consumer behaviour. Moreover, by estimating each equation separately, the author cannot test the symmetry condition implied by the theory.

One of the first studies to incorporate a close relationship between theory and estimation was also carried out by Stone (1954b). Starting from the Stone-Geary utility function:

$$u = \sum_i \beta_i \log(q_i - \gamma_i) \tag{6.8}$$

the following linear expenditure equations can be derived:

$$p_i q_i = p_i \gamma_i + \beta_i (x - \sum_j p_j \gamma_j) \tag{6.9}$$

where the amount $p_i\gamma_i$ is spent on subsistence and $(x - \sum_j p_j\gamma_j)$ is spent according to the fixed proportions β_i. This system of equations satisfy adding-up, homogeneity and symmetry. The main problem with this specification is that, because the utility function is additive in q, it can be shown that[2]:

$$e_{ii} = \phi e_i - e_i w_i (1 + \phi e_i) \tag{6.10}$$

where ϕ is independent of i so that, for a reasonably large system, $e_{ii} \simeq \phi e_i$. Therefore:

i) knowledge of one price elasticity is sufficient to derive all the other ones from the expenditure elasticities alone and

ii) the price elasticities are approximately proportional to the expenditures ones.

Another class of (indirect) utility functions is based on "flexible functional forms", that is, specifications that are flexible enough to approximate any arbitrary utility function one may wish to consider. The classic example is that of Christensen, Jorgenson and Lau (1975):

$$V = \alpha_0 + \sum_i \alpha_i \log(\frac{p_i}{x}) + \frac{1}{2}\sum_i \sum_j \beta_{ij} \log(\frac{p_i}{x}) \log(\frac{p_j}{x}) \tag{6.11}$$

where V is the indirect utility function and (6.11) can be regarded as a second-order Taylor approximation to any utility function. Closely related to this, is the Almost Ideal Model developed by Deaton and Muellbauer (1980a), which derives from a cost function:

$$\log c(u,p) = a(p) + ub(p) \tag{6.12}$$

where $a(p)$ can be regarded as the cost of subsistence and $b(p)$ as the cost of bliss. From Shephard's lemma, the share equations can be shown to be:

$$w_i = (\frac{\partial a}{\partial p} + u\frac{\partial b}{\partial p})p \tag{6.13}$$

[2] See Deaton and Muellbauer (1980b).

By inverting the cost function, one obtains the indirect utility function which, if substituted in (6.13), gives:

$$w_i = \frac{\partial a}{\partial p} p + (\log x - a) \frac{\partial \log b}{\partial \log p} \tag{6.14}$$

Deaton and Muellbauer (1980a) take the $a(p)$ and b(p) to be the following linearly homogenous, concave functions of prices:

$$a(p) = \alpha_0 + \sum_i \alpha_i \log(p_i) + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \log(p_i) \log(p_j) \tag{6.15}$$

$$b(p) = \beta_0 \prod p_i^{\beta_i} \tag{6.16}$$

hence:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log(p_j) + \beta_i \log(\frac{x}{P}) \tag{6.17}$$

with P being the price index:

$$\log(P) = \alpha_0 + \sum_i \alpha_i \log(p_i) + \frac{1}{2} \sum_i \sum_j \gamma_{ij}^* \log(p_i) \log(p_j) \tag{6.18}$$

and

$$\gamma_{ij}^* = \frac{1}{2}(\gamma_{ij} + \gamma_{ji}) \tag{6.19}$$

In this model, adding up requires: $\sum_i \alpha_i = 1, \sum_i \beta_i = 0$ and $\sum_i \gamma_{ij} = 0$; homogeneity is satisfied if $\sum_j \gamma_{ij} = 0$, while symmetry requires: $\gamma_{ij} = \gamma_{ji}$.

Blundell, Pashardes and Weber (1993) estimate the Almost Ideal System on a sample covering 61,000 UK households from the Family Expenditure Surveys between 1970-1984. In their study, the authors approximate the expenditure deflator P (as suggested by Deaton and Muellbauer, 1980a) by the Stone price-index:

$$\log(P) = \sum_i w_i \log(p_i) \tag{6.20}$$

In this model, the budget elasticity is equal to:

$$e_i = \frac{\beta_i}{w_i} + 1 \tag{6.21}$$

whereas the uncompensated and compensated price elasticities are:

$$e_{ij}^{u} = \frac{\gamma_{ij}}{w_i} - \beta_i \frac{w_j}{w_i} - \delta_{ij} \ , \tag{6.22}$$

$$e_{ij}^{c} = \frac{\gamma_{ij}}{w_i} + w_j - \delta_{ij} \tag{6.23}$$

where δ^{ij} is the Kronecker delta.

Finally, the authors allow α_i in (6.17) to include a series of time-varying household characteristics (z_{k_t}), seasonals (S_k) and a time trend (T):

$$\alpha_i = \alpha_0 + \sum_k \alpha_{ik} z_{kt} + \delta T + \vartheta_k S_k \tag{6.24}$$

The demand system in Blundell, Pashardes and Weber (1993) has 7 broad commodities groups: food, alcohol, fuel, clothing, transport, services and other. The question of dealing with "zero" expenditures in household surveys, like the one used here, is very important, as the short interview period means that most households do not buy all the goods under consideration. In this study, the authors assume that all the zeros recorded are the result of purchase infrequency, that is, that the theoretical concept of "consumption" differs from its measured counterpart, "expenditure". As this affects both the shares and the expenditure variables, OLS estimation would result in biased estimates. Therefore, the authors use an IV approach, whereby total expenditure is instrumented by income, lagged interest rates and unemployment rates (following the 2-stage budgeting assumption, see below), plus a series of occupational and seasonal variables.

The main results seem to indicate that food and fuel are relative necessities, while alcohol and services are luxuries in this system. All the own-price compensated and uncompensated elasticities are negative, with alcohol being the only price-elastic good in the system. While homogeneity restriction in not rejected, evidence on the symmetry one is more mixed. Finally, exogeneity of total expenditure is rejected by the data.

6.3 Estimation

The estimation framework developed here is based on Blundell, Pashardes and Weber (1993), but it departs from their study in that the products here are defined at a more disaggregated level, so as to match to the 3-digit SIC definition on the supply side, and that the focus will be on time-varying elasticities, which will be used in first-differenced form when combining demand and supply information in the next chapter.

The main assumption required at this stage is weak separability of preferences. Preferences are separable if they can be represented by a utility function of the form:

$$u = f[u_1(q_1), ..., u_G(q_G), ..., u_N(q_N)] \tag{6.25}$$

where, for example, q_g is a vector of commodities inside group G. However, this assumption implies strong restrictions on the substitution effects between goods belonging to different groups. It can be shown (see Gorman, 1959) that whole groups will be either complements or substitutes to each other and that every good inside a group will bear the same relationship with an outside good, determined by the between-groups one.

The main advantage of the separability assumption, on the other hand, is that the decision on the ranking of commodities in anyone of the groups is independent of the products outside it. Therefore, expenditure on any good inside the group will only depend on expenditures and prices inside this group. The expenditure decision here is modelled as a three-stage budgeting decision. First, the household decides between the spending on non-durables goods on the one hand, and saving, buying durable and other goods on the other. Modelling this stage is the aim of several papers in the life-cycle literature (see Blundell, Browning and Meghir, 1994). The household then decides the amount to spend on each of the four non-durable groups considered here: food, alcohol, clothing and other non-durables (see Blundell, Pashardes and Weber, 1993). Given that preferences are weakly separable over time, once the optimal saving decision is made, prices and incomes outside the period have no independent effect on within-period allocations. Finally, the decision on how much to spend on each of the goods within the broad sup-groups is made. This chapter will estimate the parameters of this third stage decision. One can think of the studies in the NEIO literature (see chapter 5) as going one step further and examining the consumer decision with respect to just one (differentiated) product.

Let m^t be the expenditure allocated by a household to non-durable goods in period t. Given m^t, the household decides (based also on her preferences and within-period group prices) how to spend it on food (x^t_f) , alcohol (x^t_a) , clothing (x^t_c) and other non-durables (x^t_o) Given each group expenditure x^t_g, the consumer then decides how much to spend on each individual good $(p^t_i q^t_i)$ according to the following share equation (Almost Ideal model discussed above, with time subscripts omitted):

$$w_i = \alpha_i + \sum_{j=1}^{n_g} \gamma_{ij} p_j + \beta_i \log(\frac{x_g}{P_g}) \tag{6.26}$$

where $w_i = (p_i q_i)/x_g$, P_g is the relevant group Stone price index, α_i and γ_{ij} and β_i are parameters to be estimated and p_j 's are the intra-group prices.

The estimation of the four demand systems will be carried out using the two-stage procedure outlined by Blundell (1988) and Browning and Meghir (1991). In the first stage, each equation in each system is estimated by an I.V. technique, with total group expenditures being treated as endogenous and total income, real interest rates and lagged unemployment rate used as instruments (following our three-stage budgeting approach). As seen above, this procedure allows for measurement errors in expenditures and shares which, by assumption, are the reason for the zeros recorded in the third stage. Homogeneity is imposed at this stage.

However, the estimation must also take account of the fact that some households may not consume any of the goods within a group, thereby making the expenditure shares of all the goods inside the group undefined for this household. To deal with this issue the selectivity approach proposed by Heckman (1979) will be used. In the first step, a probit equation is estimated for each group (except food, for which there were no zeros recorded in the 2-weeks interview period), determining whether or not the household spends anything on the goods of the group:

$$e^g = \gamma' c_i + u_i \tag{6.27}$$

Where e^g is a discrete variable which can take the values 0 or 1 depending on whether the household spends anything on the goods inside the group and c_i include all the controls present in (6.26), with the exception of the total expenditure term, plus total income, real interest rates and the lagged unemployment rate.

The inverse Mill's ratio is then computed:

$$\lambda_g = \frac{\phi(\gamma' c_i)}{\Phi(\gamma' c_i)} \tag{6.28}$$

And estimate the share equations with the inverse Mill's ratio included:

$$w_i = \alpha_i + \sum_{j=1}^{n_g} \gamma_{ij} p_j + \beta_i \log(\frac{x_g}{P}) + \theta_i \lambda_g + \varepsilon_i \tag{6.29}$$

It is assumed (again invoking our three-stage budgeting approach) that total income, real interest rates and the lagged unemployment rate are determining the second but not the third-stage expenditures decisions.

Given the first-step estimates, symmetry cross-equation restrictions are imposed by means of a minimum distance estimator . Denote s the unrestricted parameters and s^* their restricted counterparts. Then, the restrictions can then be expressed as:

$$s = Rs^* \tag{6.30}$$

To impose these restrictions, s^* is chosen so as to minimize :

$$m = (\hat{s} - Rs^*)\hat{w}^{-1}(\hat{s} - Rs^*) \tag{6.31}$$

where $\hat{s}$ is the consistent estimator of s obtained in the first step and $\hat{w}$ is the estimate of its variance-covariance matrix. This procedure was first introduced in the econometrics literature by Ferguson (1958). The second stage estimator is given by:

$$\widehat{s}^* = (R\hat{w}^{-1}R)^{-1}(R\hat{w}^{-1}\widehat{s}) \tag{6.32}$$

and involves only matrices in the dimension of s, which is much lower than the number of observations.

6.4 Data

The data used on the demand side come from the UK Family Expenditure Surveys (FES) from 1974 to 1992. This survey has been widely used by studies investigating the properties of household consumption, savings and earnings [3]. It contains information on household expenditures on a detailed set of goods (recorded in a two-week diary) and also on household composition. From the original dataset, households whose head is higher than 60, self-employed or living in Northern-Ireland were excluded to keep a more homogenous sample. A list of the variables used and some descriptive statistics are presented in Tables 6.7 and 6.8 in the appendix.

The goods modelled here are cereal, bread/biscuits, meat, fish, oils/fats, milk, soft drinks, sugar, sweets/chocolates and fruits/vegetables in the food group. In the alcohol group the focus is on beer, wine and spirits. The goods modelled in the clothing group are general clothing and footwear. Finally, the other non-durables group comprises household consumables, books/newspapers and toys/sport goods. The goods were defined so as to match the industry definition given by the UK Standard Industry Classification (1980) [4]. When a higher level of aggregation in the product definition was needed than one provided in the F.E.S., expenditures on the disaggregated goods were added and the price computed as a weighted average of each good's price, with weights given by the F.E.S. (reflecting the importance of the good for a representative UK consumer). The principal excluded goods were durables, vehicles and housing, to avoid the difficulties involved in modelling the dynamics involved in the household decision to buy these goods.

Figure 6.1 shows the behaviour of real group expenditures over time. It appears that expenditures in alcohol and clothing have increased in real terms over the last 20 years, after a drop in the 74-77 period. Indeed, all group expenditures experienced such a drop in the beginning of our sample period. It also seems that food expenditure has decreased markedly over the period and that other non-durables expenditure is very sensible to cyclical fluctuations.

Figure 6.2 plots expenditure in each group as a share of total non-durables. The graphs show that, as expected, food share has decreased continually over the period, apart from a upward blip in the 70s. This reflects the fact that food is a necessity and non-durable expenditures

[3] See Attanasio and Browning (1995) and Blundell, Duncan and Meghir (1995), for example.

[4] Table (2.1) below shows the match between goods and industries.

were rising over the sample period. Alcohol and other-goods shares steadily increased over the 80s, while clothing's share showed a great deal of fluctuation.

6.5 Results

Table 6.1 reports estimated own-price coefficients in the individual share equations. Each row shows the results of a particular share regression. The within-group Stone price index is used as a deflator throughout. In column (1) only own-price and total group expenditure are included. All the own-price coefficients are significant and substantially different from each other both within and between groups.

In column (2) the seasonal, demographic and compositional controls are also included. The price coefficients change significantly in most cases, confirming the importance of including these controls in disaggregated regressions. These results would be the ones used to compute demand elasticities, had the exercise restricted itself to analyzing only a particular good with these data. The results in column (3), where all the other group prices are included, show that for some goods (like bread/biscuits, milk, sugar, spirits, footwear) the inclusion of other prices does not dramatically change the own-price coefficient. However, for other goods (meat, fish, soft drinks, fruit/vegetables,beer, clothing, books) significant changes can be observed. This emphasizes the risks associated with working with individual goods.

Tables 6.2 to 6.5 report the results of estimating the symmetric constrained Almost Ideal Demand System for each group of non-durable goods. In the food system, the parameters are generally well-determined. Most own-price coefficients are precisely estimated, the exceptions being meat and fish.

With the estimated parameters it is possible to compute predicted shares for each good for each sample year, at the yearly average expenditures, prices and household characteristics. Figures 6.3 to 6.5 plots actual and predicted average shares for each good in the food group over the sample period. These shares will be used to compute the time-varying demand elasticities. The first thing to note is that both lines behave in a very similar fashion for all goods. This means that the time-series variation in the average values of the independent variables is able to predict quite well the actual variation in average shares in the food sector. There is also substantial variation in the behaviour of the different shares over time. It seems that, while

Table 6.1: **Own-Price Single-Equation Coefficient Estimates 1974-1992**

Dependent Variable	**1**	**2**	**3**
WCEREAL	0.059 (0.002)	0.050 (0.005)	0.024 (0.010)
WBBC	0.052 (0.006)	0.121 (0.008)	0.142 (0.028)
WMEAT	0.240 (0.008)	0.077 (0.018)	-0.187 (0.044)
WFISH	0.021 (0.002)	0.007 (0.002)	0.001 (0.005)
WOILSF	0.008 (0.000)	0.007 (0.001)	0.014 (0.002)
WMILK	0.032 (0.003)	0.145 (0.005)	0.143 (0.022)
WSDRINK	0.086 (0.003)	0.054 (0.003)	0.015 (0.005)
WSUGAR	0.033 (0.001)	0.024 (0.001)	0.020 (0.002)
WSWEETS	-0.007 (0.003)	-0.013 (0.004)	0.000 (0.009)
WFVEG	0.120 (0.004)	0.170 (0.005)	0.120 (0.008)
Sample Size	79212	79212	79212
WBEER	-0.061 (0.010)	0.223 (0.037)	0.148 (0.039)
WWINE	0.287 (0.010)	-0.102 (0.020)	-0.050 (0.026)
WSPIRITS	-0.348 (0.022)	-0.214 (0.032)	-0.225 (0.042)
Sample Size	63842	63842	63842
WCLOTHING	-0.286 (0.051)	-0.207 (0.116)	-0.110 (0.125)
WFWEAR	0.111 (0.018)	0.092 (0.036)	0.078 (0.034)
Sample Size	66267	66267	66267
WCONSUMABLES	-0.529 (0.026)	0.140 (0.038)	0.115 (0.053)
WBOOKS	-0.251 (0.009)	0.222 (0.030)	0.344 (0.035)
WTOYS	-0.008 (0.004)	-0.114 (0.022)	-0.141 (0.032)
Sample Size	78811	78811	78811

Notes to Table

Standard Errors in Parentheses. I.V. Estimates: instruments for ln(expenditure) are ln(tot. income), interest rates and unemployment rates. Controls of column 1 are ln(expenditure) and a constant term. Controls of column 2 are ln(expenditure), 3 seasonal, 10 regions, 15 demographic, 4 occupational variables and a trend. Controls of column 3 are those in column (2) plus all the other group prices. Stone price index for each group is used as deflator for the group prices.

Table 6.2: **The Almost Ideal Demand System - Food**

				Share	**Equations**					
Variables	**Cereal**	**BBC**	**Meat**	**Fish**	**Oilsf**	**Milk**	**Sdrink**	**Sugar**	**Sweets**	**FVeg**
Ln(Exp)	-0.018	-0.044	0.052	0.014	-0.025	-0.063	0.020	-0.034	0.037	0.062
	(0.002)	(0.003)	(0.005)	(0.002)	(0.001)	(0.004)	(0.002)	(0.001)	(0.003)	(0.004)
LPCereal	0.020	-0.008	0.015	0.013	-0.001	-0.031	0.008	-0.003	-0.003	-0.010
	(0.009)	(0.009)	(0.006)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)	(0.004)	(0.002)
LPBBC	-0.008	0.041	0.024	0.010	-0.014	-0.066	-0.013	-0.005	0.055	-0.024
	(0.009)	(0.017)	(0.012)	(0.005)	(0.003)	(0.005)	(0.006)	(0.003)	(0.007)	(0.004)
LPMeat	0.015	0.024	-0.015	-0.012	0.008	0.054	-0.010	-0.009	-0.019	-0.035
	(0.006)	(0.012)	(0.016)	(0.005)	(0.003)	(0.007)	(0.005)	(0.003)	(0.007)	(0.005)
LPFish	0.013	0.010	-0.012	0.002	-0.002	-0.004	0.001	-0.002	-0.004	-0.003
	(0.003)	(0.005)	(0.005)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
LPOilsf	-0.001	-0.014	0.008	-0.002	0.011	-0.001	-0.004	0.000	0.011	0.008
	(0.002)	(0.003)	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
LPMilk	-0.031	-0.066	0.054	-0.004	-0.001	0.113	-0.000	-0.008	-0.006	-0.050
	(0.003)	(0.005)	(0.007)	(0.003)	(0.002)	(0.006)	(0.003)	(0.002)	(0.005)	(0.003)
LPSdrink	0.008	-0.013	-0.010	0.001	-0.004	-0.000	0.044	0.005	-0.026	-0.004
	(0.003)	(0.006)	(0.005)	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)
LPSugar	-0.003	-0.005	-0.009	-0.002	0.000	-0.008	0.005	0.020	0.004	-0.003
	(0.002)	(0.003)	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
LPSweets	-0.003	0.055	-0.019	-0.004	0.011	-0.006	-0.026	0.004	-0.017	0.006
	(0.002)	(0.007)	(0.007)	(0.003)	(0.002)	(0.005)	(0.003)	(0.002)	(0.006)	(0.003)
LPFVeg	-0.010	-0.024	-0.035	-0.003	-0.008	-0.050	-0.004	-0.003	0.006	0.131
	(0.002)	(0.004)	(0.005)	(0.002)	(0.001)	(0.003)	(0.002)	(0.001)	(0.003)	(0.004)
Sample Size	79212	79212	79212	79212	79212	79212	79212	79212	79212	79212

Notes to Table

Standard Errors in Parentheses. I.V. Estimates: instruments for ln(expenditure) are ln(income), interest rates and unemployment rates. Symmetric Constrained Estimates.

goods like cereal, fish, soft drinks and fruits/vegetables have increase their share in the consumer food budget, others like meat and sugar have seen their shares decrease.

Table 6.3: **The Almost Ideal Demand System - Alcohol**

	Share Equations		
Variables	**Beer**	**Wine**	**Spirit**
Ln(Exp)	-0.256	0.146	0.110
	(0.011)	(0.009)	(0.008)
LPBeer	-0.053	0.032	0.021
	(0.033)	(0.022)	(0.025)
LPWine	0.032	-0.062	0.030
	(0.022)	(0.025)	(0.024)
LPSpirit	0.021	0.030	-0.051
	(0.025)	(0.024)	(0.034)
Mill's ratio	-0.248	0.194	0.054
	(0.027)	(0.020)	(0.019)
Sample Size	63842	63842	63842

Notes to Table

Standard Errors in Parentheses. I.V. Estimates: instruments for ln(expenditure) are ln(income), interest rates and unemployment rates. Symmetric Constrained Estimates.

Table 6.3 presents the parameter estimates of the Alcohol system. The expenditure coefficients are all precisely estimated and so are the Mill's ratios ones, which confirms the importance of controlling for selectivity. The own-price coefficient is precisely estimated in the wine equation and significant at 10% level in the beer and spirit equation. Figure 6.6 plots the actual and predicted shares for each good in the alcohol system. The behaviour of both shares is again quite similar for every graph. It seems that the wine share has been increasing over the years at the expense of the beer and spirit ones.

In table 6.4, the results of estimating the clothing system are set out. Again, all the coefficients in the table are precisely estimated, although the expenditure ones only marginally so. However, inspection of figure 6.7 reveals that the predicted shares do not seem to keep track very well of the actual ones. Therefore, the model cannot predict a significant part of the time-series variation in average shares.

Table 6.4: **The Almost Ideal Demand System - Clothing**

	Share	Equations
Variables	**Clothing**	**Fwear**
Ln(Exp)	0.009	-0.009
	(0.005)	(0.005)
LPClothing	0.085	-0.085
	(0.039)	(0.039)
LPFWear	-0.085	0.085
	(0.039)	(0.039)
Mill's ratio	-0.050	0.050
	(0.016)	(0.016)
Sample Size	66267	66267

Notes to Table

Standard Errors in Parentheses. I.V. Estimates: instruments for ln(expenditure) are ln(income), interest rates and unemployment rates. Symmetric Constrained Estimates.

Table 6.5: **The Almost Ideal Demand System - Other Non-Durables**

	Share	Equations	
Variables	**Toys**	**Books**	**Consumables**
Ln(Exp)	0.093	0.010	-0.103
	(0.004)	(0.005)	(0.005)
LPToys	-0.016	-0.032	0.048
	(0.027)	(0.015)	(0.030)
LPBooks	-0.032	0.082	-0.050
	(0.015)	(0.019)	(0.019)
LPConsumables	0.048	-0.050	0.002
	(0.030)	(0.019)	(0.039)
Mill's ratio	0.176	0.442	-0.618
	(0.057)	(0.071)	(0.066)
Sample Size	78811	78811	78811

Notes to Table

Standard Errors in Parentheses. I.V. Estimates: instruments for ln(expenditure) are ln(income), interest rates and unemployment rates.. Symmetric Constrained Estimates.

Finally, table 6.5 shows the parameter estimates of the other-non-durable goods. It reveals that, while the expenditure and mill's ratio coefficients are significant, the only significant own-price coefficient appears in the book equation. This may occur either because the coefficient is genuinely approximate zero both in the consumables and in the toys equations or because the estimate is not precise enough. Examination of figure 6.8 shows that predicted and actual average shares move quite close together and that the share of household consumables has increased in the period at the expense of the books/newspapers one.

In table 6.6 the price and budget elasticities are set out. The results in the first column generally reveal an intuitive pattern. According to them, within the food system: meat, fish, soft drinks, sweets/chocolates and fruits/vegetables are luxuries while cereal, bread, milk are necessities and oils/fats and sugar are inferior goods. In the alcohol system, beer is a necessity, while wine and spirits are luxuries. There is no clear pattern in the clothing system, while there is some suggestion that household consumables are necessities and toys/sport goods are luxuries, in the other non-durables one.

Looking at the second column, it can be seen that all compensated own-price elasticities are negative, as the theory predicts, with the exception of the soft drinks one, which is only marginally different from zero. The average uncompensated price elasticities are set out in column (3). They show that in the food system only meat and sweets are price elastic, though fish has an elasticity close to one. Most of the elasticities are negative and significantly different from zero, with the exception of the soft drink one, which is positive but insignificant and the cereal one, which is insignificant. The alcohol goods all have negative and significant elasticities, with beer having an inelastic demand. In the clothing system, general clothing seems to be more elastic than footwear and in the other-goods system, toys/sport goods are the more elastic of the group.

The last two columns of the table present the variation over time of the uncompensated price-elasticities, by showing the extreme elasticity values for each good. It can be seen that, while the elasticity of goods like cereal, oils/fats, milk, soft drink and sugar show a great deal of variation over time, others like beer, clothing, footwear and consumables show little variation. Figures 6.9 to 6.14 show graphically these patterns of variation, by plotting the values of the elasticities for each good over the sample period. It is important to highlight the fact that, to the best of our knowledge, this is the first study to examine the time series patterns of demand

Table 6.6: **Price and Budget Elasticities 1974-1992**

Product	Budget Elasticity	Compensated Own-Price Elasticity	Uncompensated Own-Price Elasticity	Highest Uncomp. Own-Price Elasticity	Lowest Uncomp. Own-Price Elasticity
CEREAL	0.456	-0.354	-0.369	-0.208	-0.498
	(0.05)	(0.28)	(0.28)	(0.35)	(0.22)
BBC	0.714	-0.581	-0.692	-0.675	-0.701
	(0.02)	(0.11)	(0.11)	(0.12)	(0.11)
MEAT	1.234	-0.849	-1.120	-1.113	-1.130
	(0.02)	(0.07)	(0.07)	(0.07)	(0.08)
FISH	1.383	-0.895	-0.945	-0.936	-0.952
	(0.05)	(0.09)	(0.09)	(0.10)	(0.08)
OILSF	-0.054	-0.532	-0.530	-0.476	-0.594
	(0.05)	(0.06)	(0.06)	(0.07)	(0.05)
MILK	0.674	-0.226	-0.356	-0.299	-0.398
	(0.01)	(0.03)	(0.03)	(0.03)	(0.03)
SDRINK	1.542	0.213	0.156	0.546	-0.185
	(0.05)	(0.10)	(0.10)	(0.14)	(0.07)
SUGAR	-0.391	-0.129	-0.112	0.321	-0.675
	(0.05)	(0.06)	(0.06)	(0.09)	(0.12)
SWEETS	1.817	-1.330	-1.413	-1.367	-1.447
	(0.06)	(0.13)	(0.13)	(0.12)	(0.14)
FVEG	1.270	-0.203	-0.495	-0.434	-0.554
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
BEER	0.583	-0.473	-0.831	-0.825	-0.838
	(0.02)	(0.05)	(0.06)	(0.05)	(0.06)
WINE	1.876	-1.206	-1.518	-1.427	-1.737
	(0.05)	(0.15)	(0.15)	(0.11)	(0.24)
SPIRITS	1.499	-1.012	-1.343	-1.319	-1.376
	(0.04)	(0.16)	(0.16)	(0.14)	(0.18)
CLOTHING	1.012	-0.084	-0.904	-0.903	-0.905
	(0.01)	(0.05)	(0.05)	(0.05)	(0.05)
FWEAR	0.951	-0.360	-0.540	-0.521	-0.560
	(0.03)	(0.20)	(0.20)	(0.21)	(0.19)
CONSUMABLES	0.762	-0.561	-0.892	-0.891	-0.892
	(0.01)	(0.09)	(0.09)	(0.10)	(0.08)
BOOKS	1.024	-0.383	-0.815	-0.789	-0.833
	(0.01)	(0.05)	(0.05)	(0.05)	(0.04)
TOYS	1.628	-0.958	-1.200	-1.191	-1.208
	(0.03)	(0.18)	(0.18)	(0.17)	(0.20)

Notes to Table
Standard Errors in Parentheses.

elasticities.

6.6 Conclusion

This chapter estimated complete demand systems for four non-durable groups: food, alcohol, clothing and other-non-durables. It briefly reviewed the literature on demand estimation, formulated the models to be estimated and carried out the estimation, using a 2-stage Minimum Chi-Square procedure. The main results produced elasticities very much in line both with the theory and with the prior intuition one might have. The elasticities showed a great deal of variation over time and will be used in the next chapter to examine the impact of consumer behaviour on the profitability of UK firms.

6.7 Appendix

Table 6.7: **Descriptive Statistics: Demand 1974-1992**

Variables	Mean	S.D.	Min.	Max.
Shares				
Cereal	0.033	0.038	0	1
Bread,Biscuits and Crispbreads (BBC)	0.155	0.077	0	1
Meat	0.220	0.130	0	1
Fish	0.036	0.046	0	1
Oils and Fats (Oilsf)	0.024	0.025	0	1
Milk	0.194	0.097	0	1
Soft Drinks (SDrink)	0.037	0.047	0	1
Sugar	0.024	0.027	0	1
Sweets and Chocolates	0.046	0.061	0	1
Fruits and Vegetables (FVeg)	0.156	0.095	0	1
Clothing	0.678	0.401	0	1
Footwear (Fwear)	0.159	0.276	0	1
Beer	0.494	0.409	0	1
Wine	0.134	0.256	0	1
Spirit	0.178	0.283	0	1
Household Consumables	0.430	0.256	0	1
Toys and Sport Goods	0.148	0.234	0	1
Books and Newspapers	0.419	0.260	0	1
LN(Prices)				
Cereal	-0.297	0.456	-1.444	0.312
Bread,Biscuits and Crispbreads (BBC)	-0.266	0.423	-1.293	0.320
Meat	-0.202	0.343	-1.011	0.221
Fish	-0.326	0.423	-1.234	0.259
Oils and Fats	-0.091	0.235	-0.849	0.254
Milk	-0.297	0.493	-1.558	0.323
Soft Drinks	-0.179	0.404	-1.270	0.446
Sugar	-0.187	0.388	-1.417	0.333
Sweets and Chocolates	-0.315	0.435	-1.584	0.214
Fruits and Vegetables	-0.264	0.373	-1.315	0.255
Clothing	-0.130	0.239	-0.804	0.192
Foowear	-0.154	0.288	-0.883	0.221
Beer	-0.399	0.580	-1.676	0.439
Wine	-0.161	0.323	-0.986	0.414
Spirits	-0.289	0.455	-1.277	0.449
Household Consumables	-0.306	0.489	-1.549	0.214
Toys and Sport Goods	-0.224	0.329	-1.094	0.160
Books and Newspapers	-0.403	0.601	-1.788	0.441
Stone Price Indexes				
Food	-0.250	0.396	-1.255	0.266
Alcohol	-0.277	0.415	-1.173	0.366
Clothing	-0.119	0.214	-0.703	0.165
Other Non-durables	-0.337	0.512	-1.621	0.364

Table 6.8: **Descriptive Statistics: Demand (Continued)**

Variables	Mean	S.D.	Min.	Max.
Nominal Expenditures				
Total Non-Durables	46.97	38.89	0.32	921.53
Food	19.82	13.35	0.04	228.28
Alcohol	7.92	12.43	0	871.15
Clothing	12.44	20.14	0	813.04
Other Non-Durables	6.79	10.37	0	797.14
Other Variables				
Total Income	156.16	118.45	0.19	954.76
First Quarter Dummy (S1)	0.251	0.433	0	1
Second Quarter Dummy (S2)	0.248	0.432	0	1
Third Quarter Dummy (S3)	0.251	0.433	0	1
North	0.065	0.246	0	1
Yorkshire (Yorks)	0.095	0.293	0	1
North-West (Nothwes)	0.116	0.320	0	1
East-Midlands (Eastmid)	0.073	0.260	0	1
West-Midlands (Westmid)	0.099	0.298	0	1
East-Anglia (Eanglia)	0.036	0.186	0	1
Great London (Grlondon)	0.114	0.318	0	1
Scotland	0.097	0.296	0	1
South-West (Southwes)	0.073	0.261	0	1
Wales	0.052	0.221	0	1
Head White Collar (WHC)	0.221	0.416	0	1
Head Professional (PROF)	0.100	0.299	0	1
Head Skilled (Skil)	0.275	0.447	0	1
Head Semi-Skilled (SSKIL)	0.140	0.347	0	1
Children aged 0-1 (NK01)	0.170	0.425	0	5
Children aged 2-5 (NK25)	0.115	0.336	0	3
Children aged 6-10 (NK610)	0.344	0.667	0	7
Children aged 11-16 (NK1116)	0.325	0.655	0	6
Children aged 17-18 (NK1718)	0.023	0.153	0	3
Age of head	40.35	11.27	18	60
Number of Pensioners (NNRET)	0.025	0.194	0	4
Number of Females (NNFEMS)	1.049	0.500	0	6
Number of Adults (ADULTNR)	2.059	0.770	1	9
Head Single-parent (SGLPAR)	0.055	0.229	0	1
Car Dummy (DCAR)	0.705	0.456	0	1
Tobacco Dummy (DTOB)	0.586	0.493	0	1
Trend	38.24	21.81	1	76

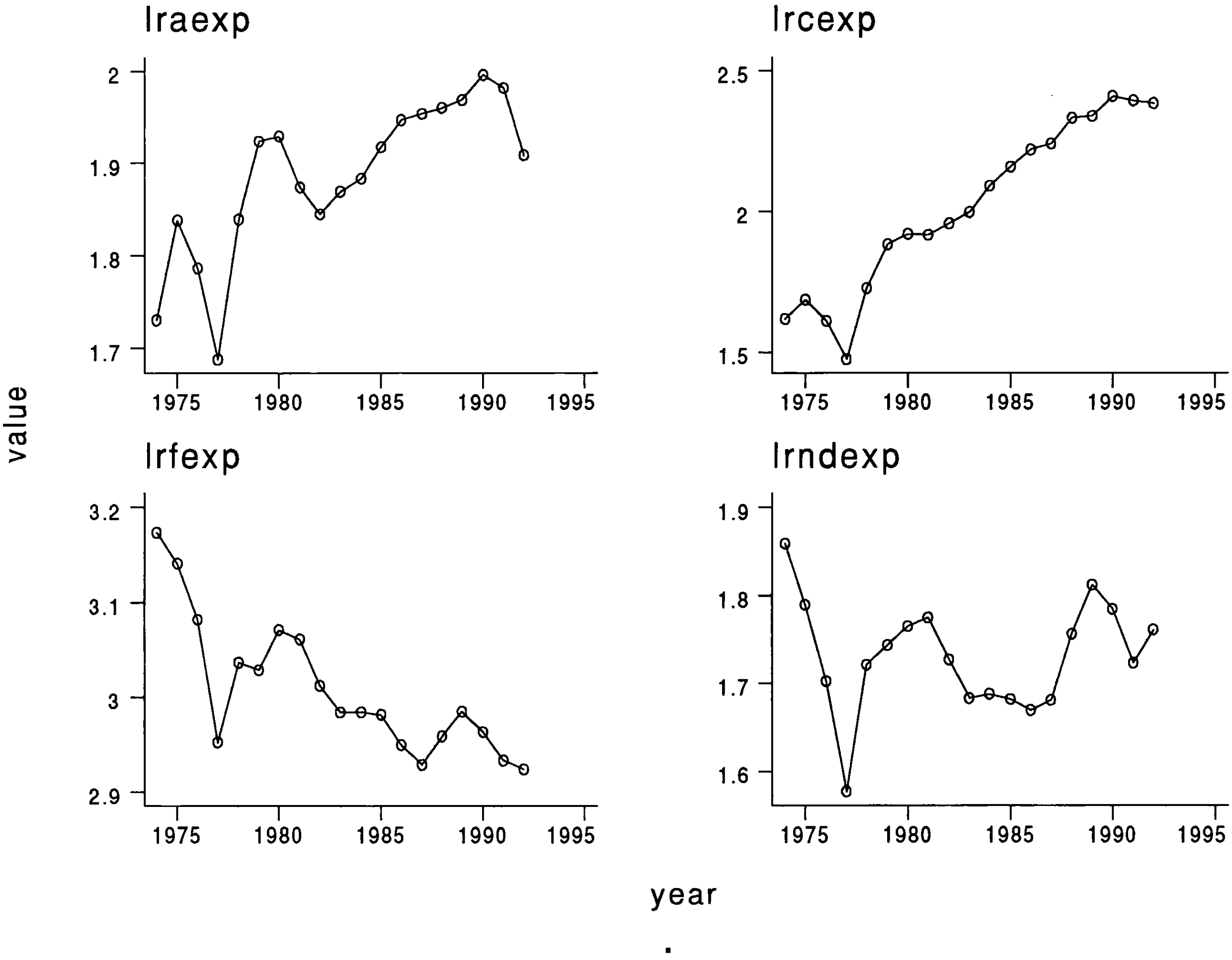

Figure 6-1: Aggregated Expenditures over Time

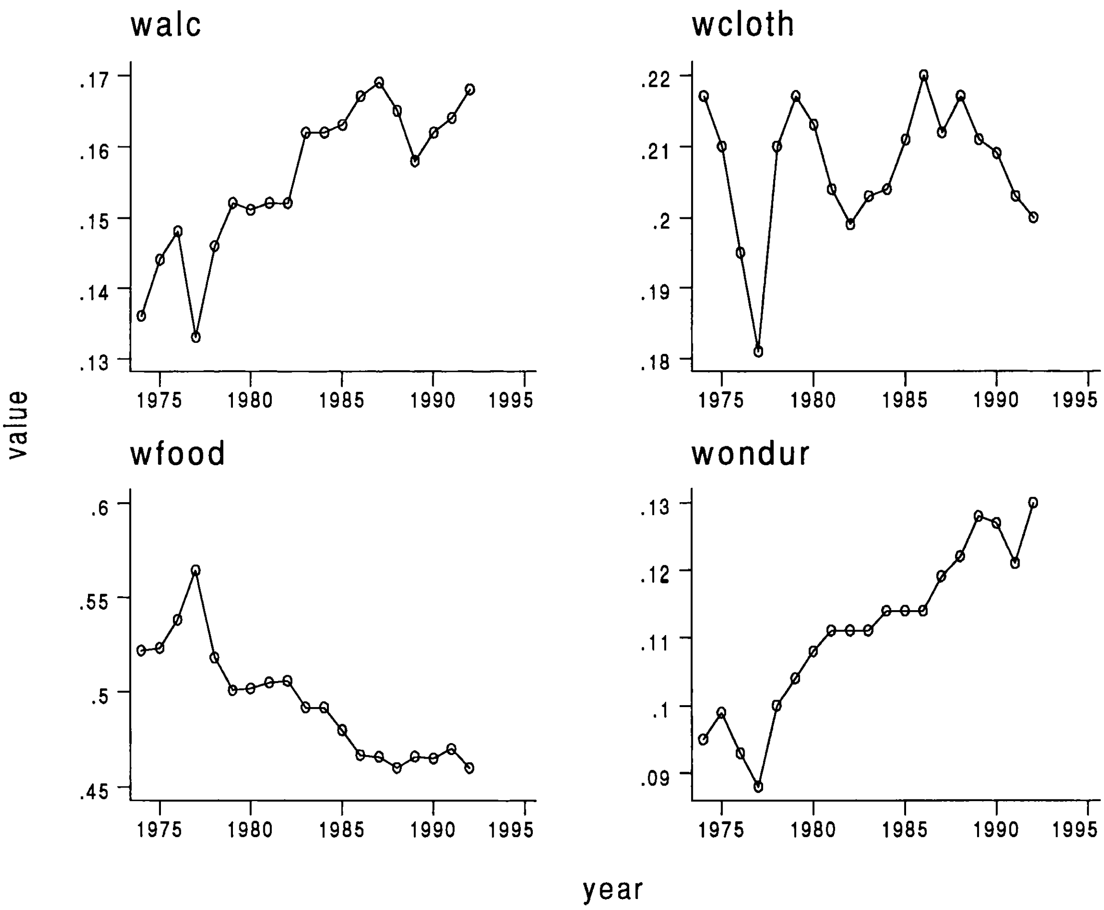

Figure 6-2: Aggregated Shares over Time

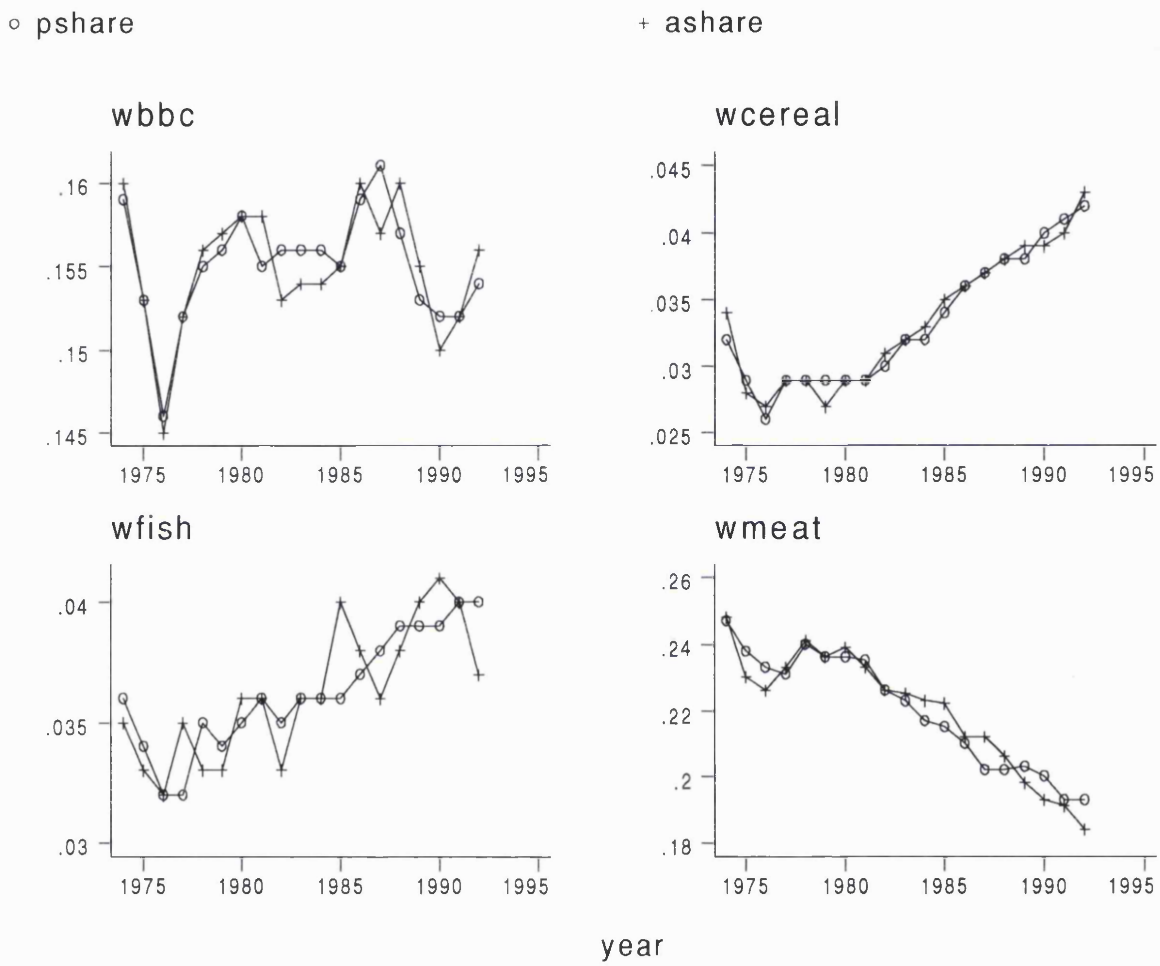

Figure 6-3: Actual and Predicted Shares over Time: Food 1

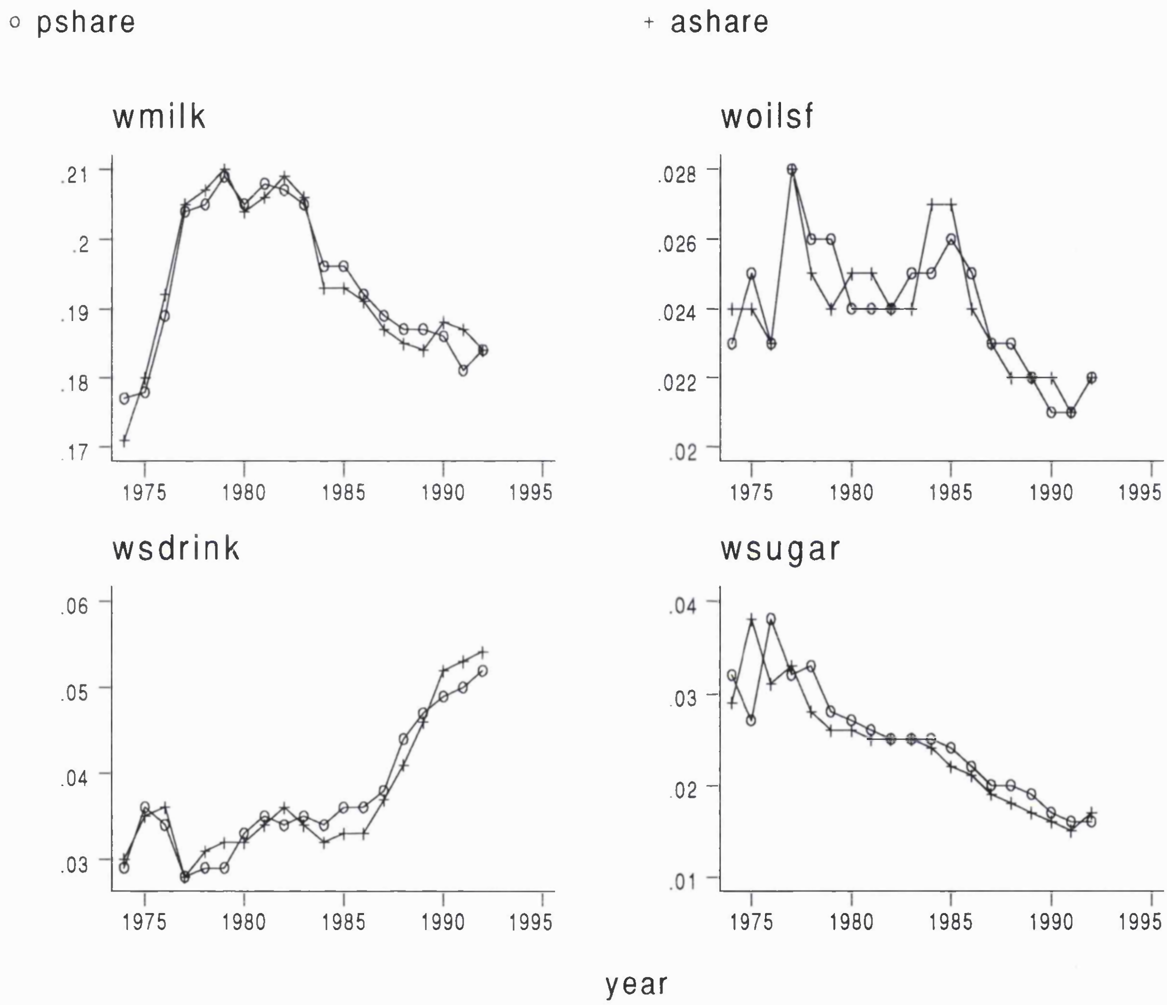

Figure 6-4: Actual and Predicted Shares over Time: Food 2

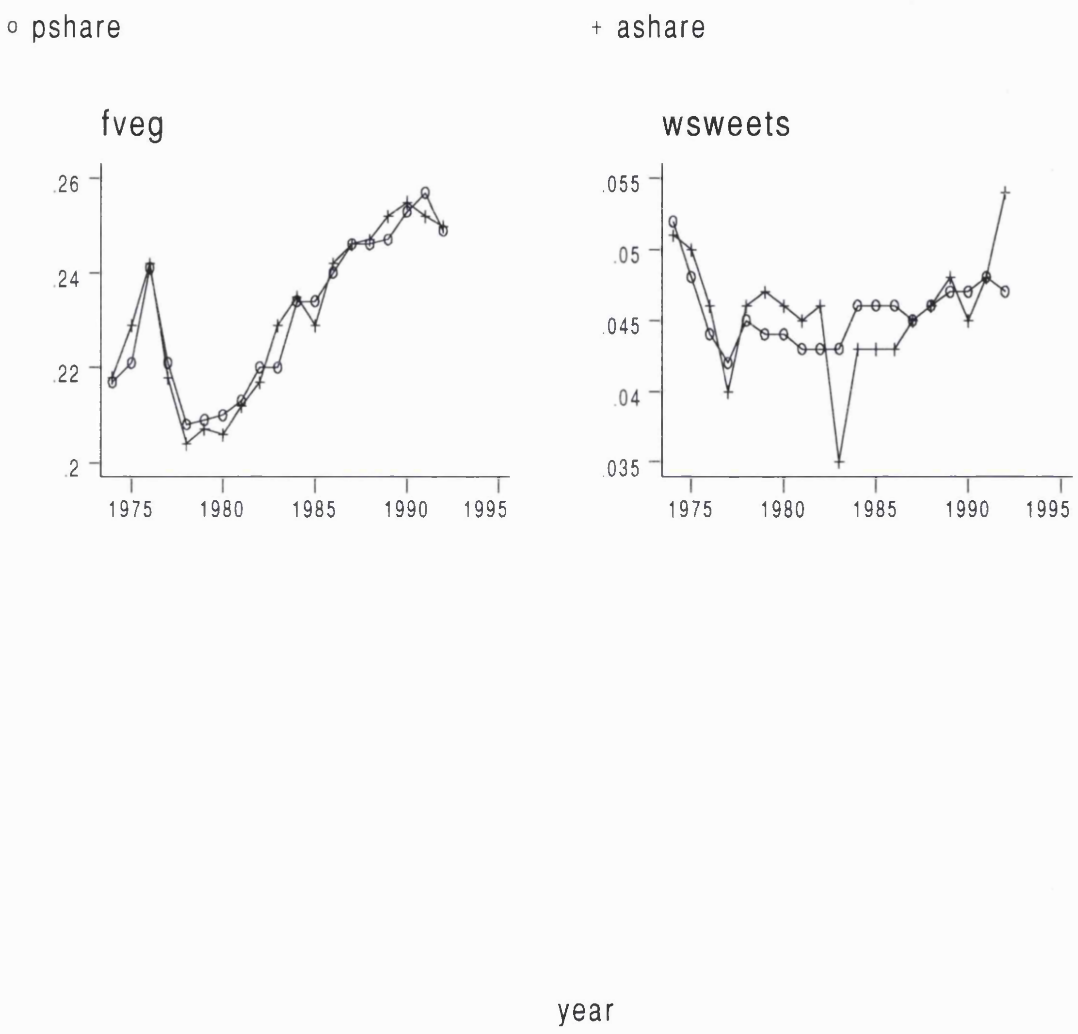

Figure 6-5: Actual and Predicted Shares over Time: Food 3

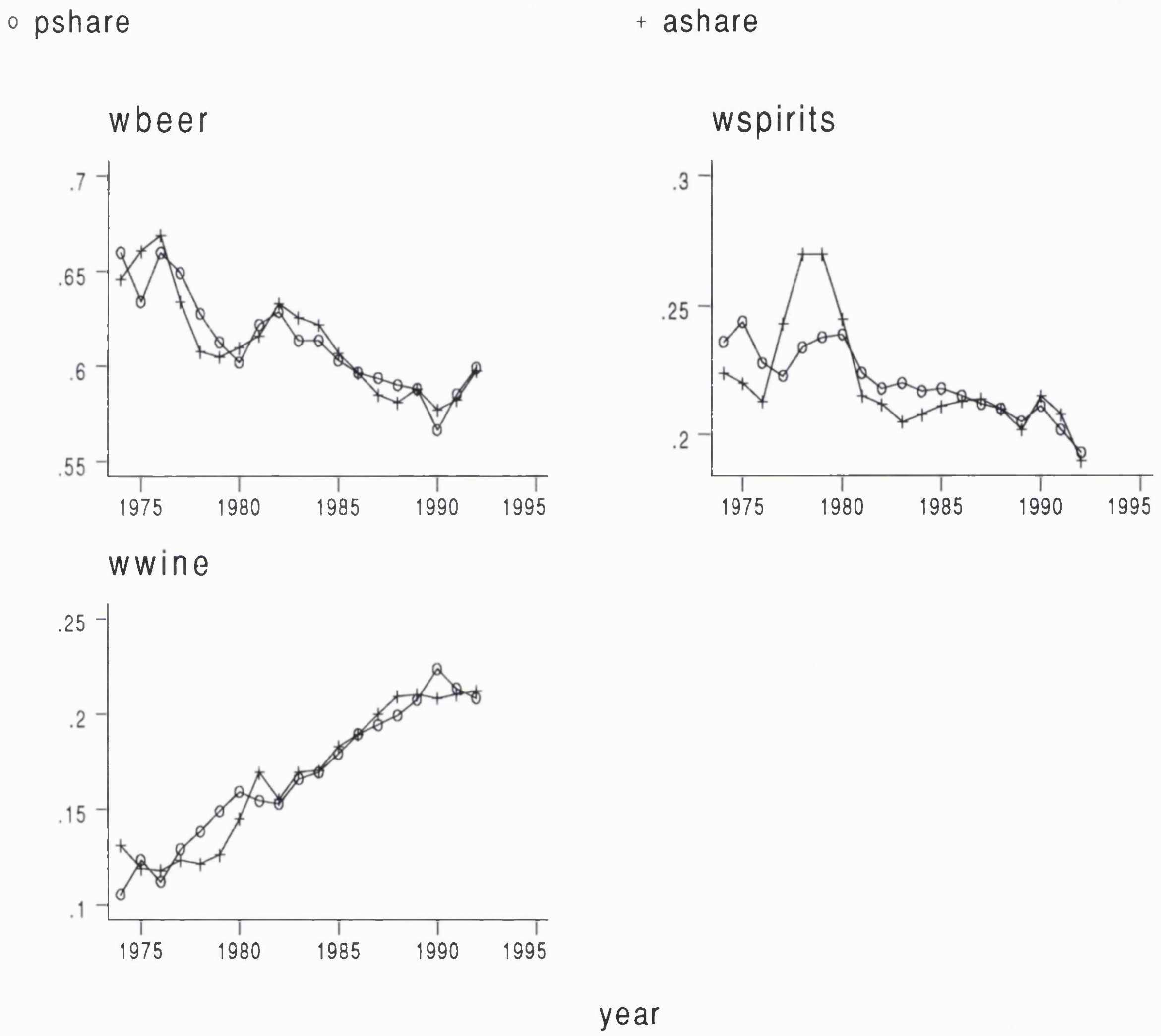

Figure 6-6: Actual and Predicted Shares over Time: Alcohol

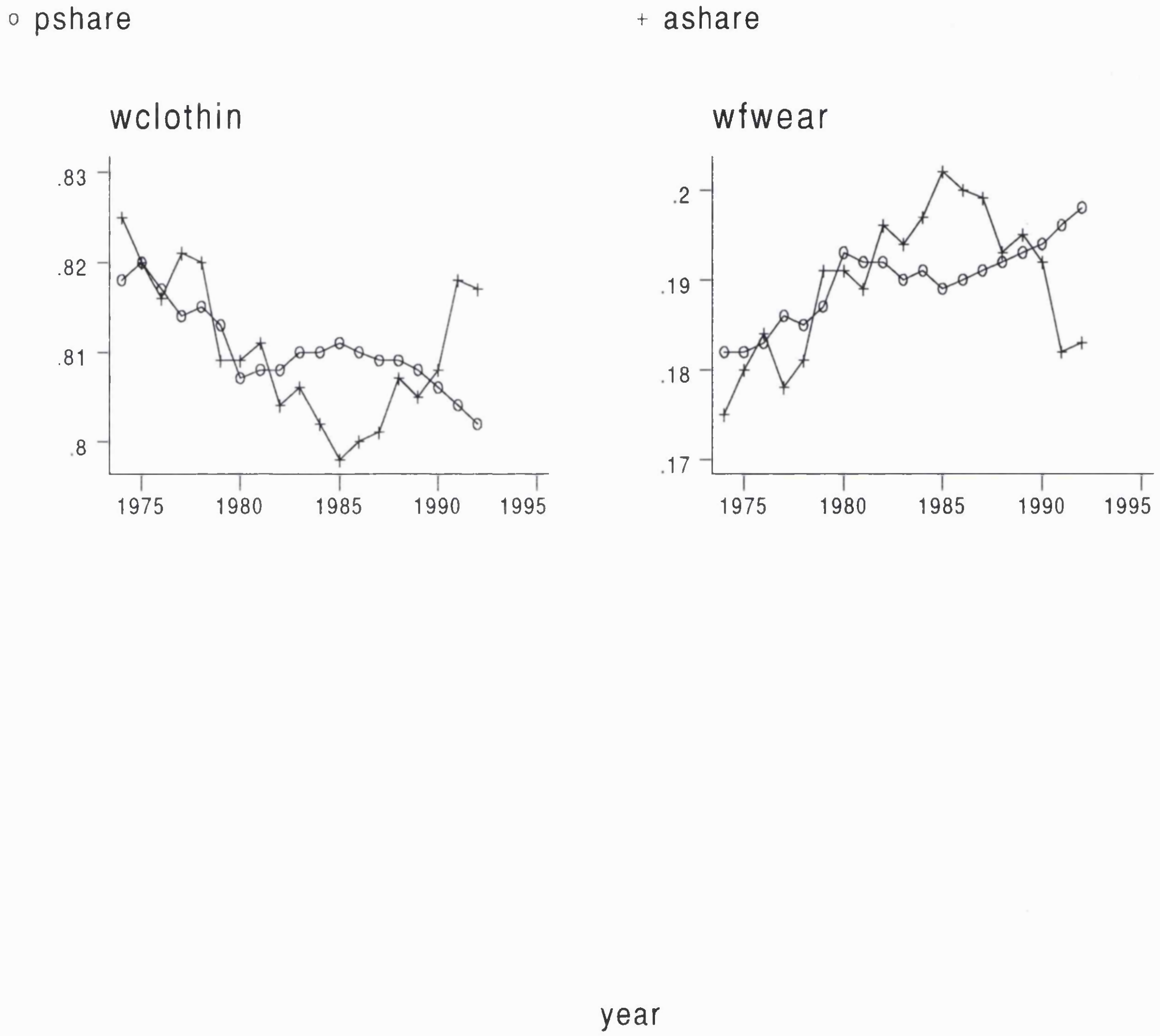

Figure 6-7: Actual and Predicted Shares over Time: Clothing

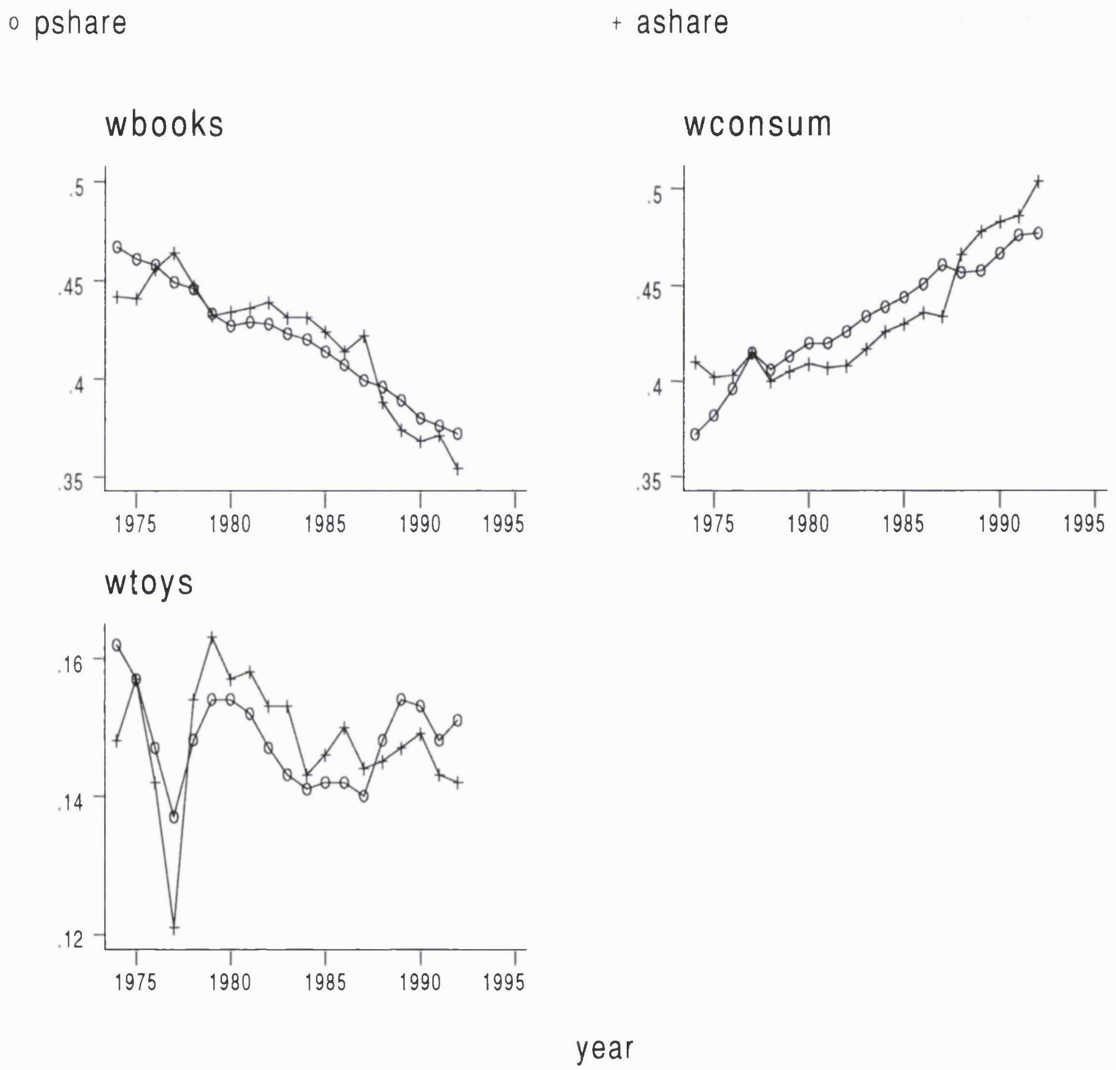

Figure 6-8: Actual and Predicted Shares over Time: Other

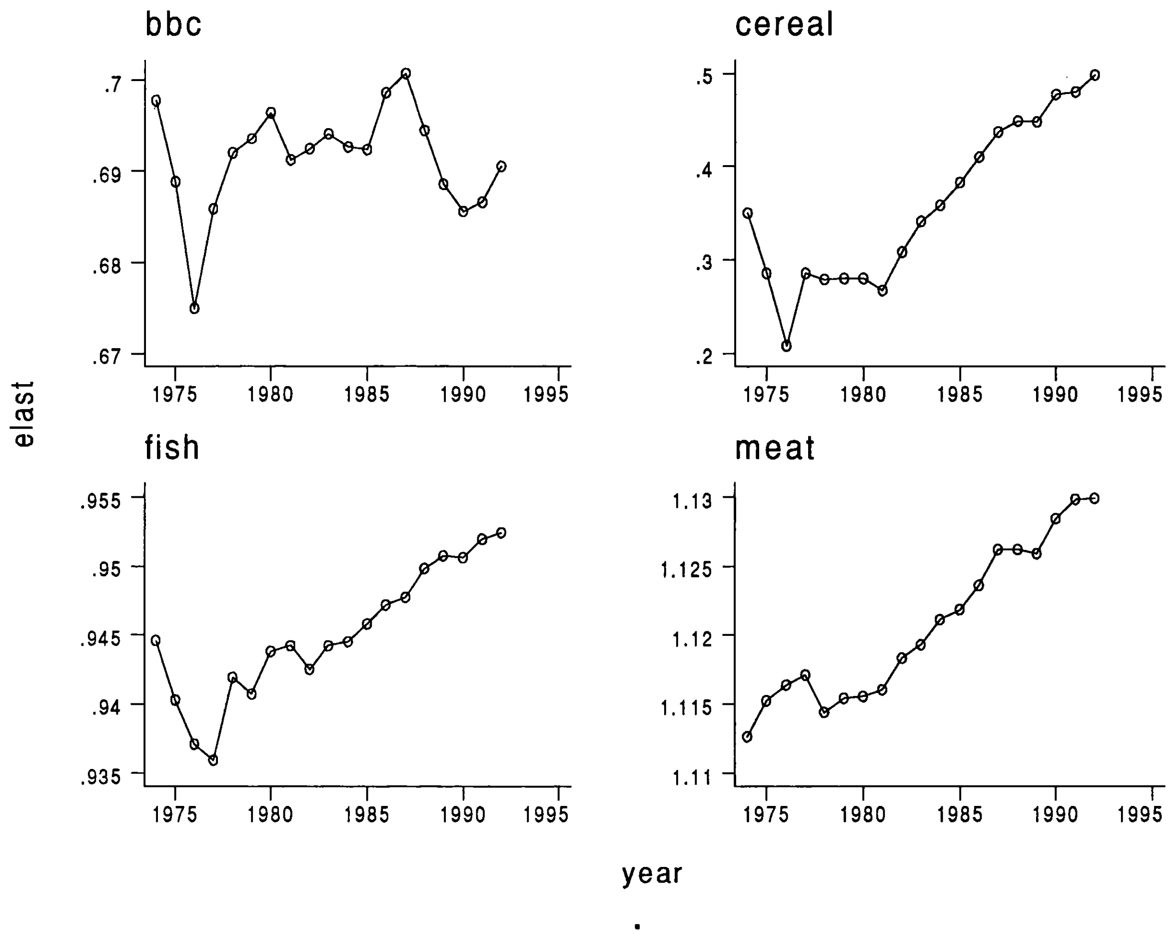

Figure 6-9: Elasticities over Time: Food 1

Figure 6-10: Elasticities over Time: Food 2

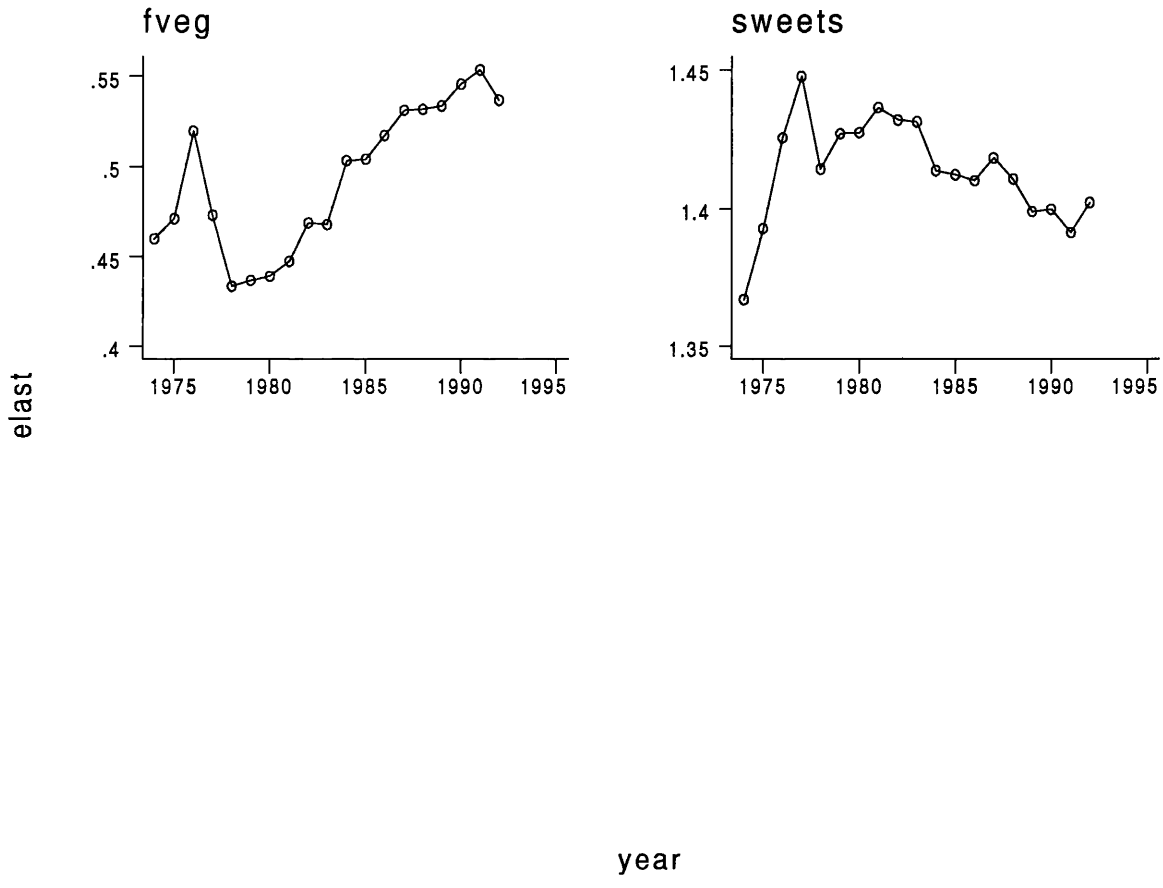

Figure 6-11: Elasticities over Time: Food 3

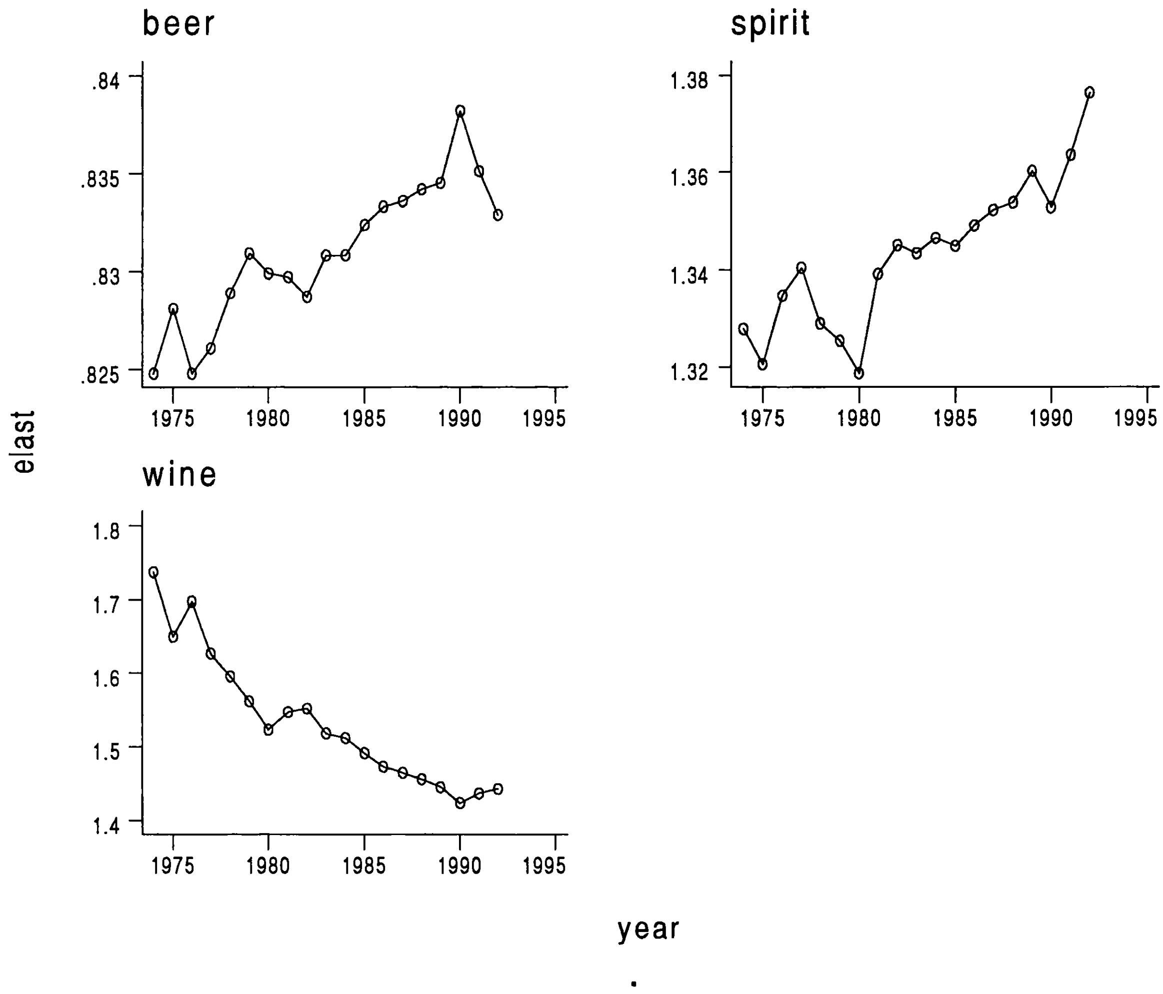

Figure 6-12: Elasticities over Time: Alcohol

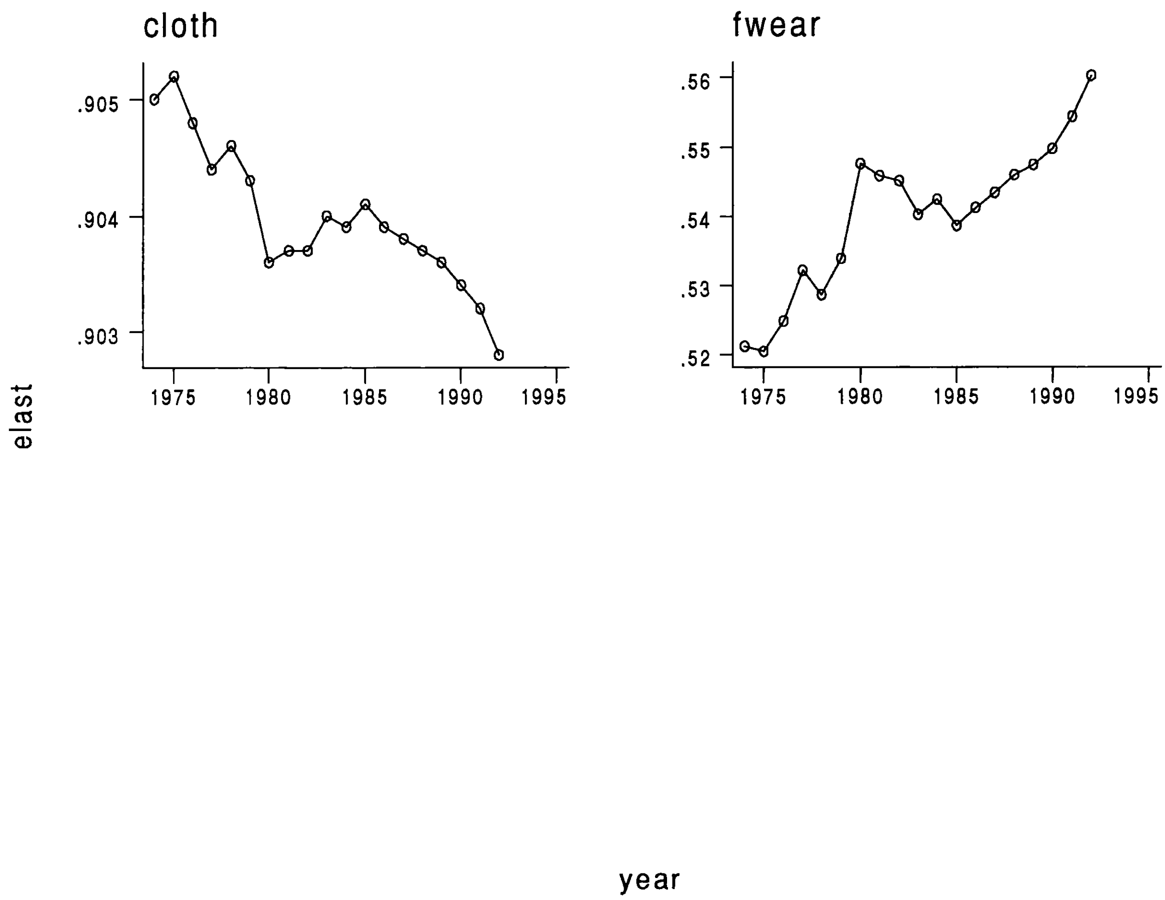

Figure 6-13: Elasticities over Time: Clothing

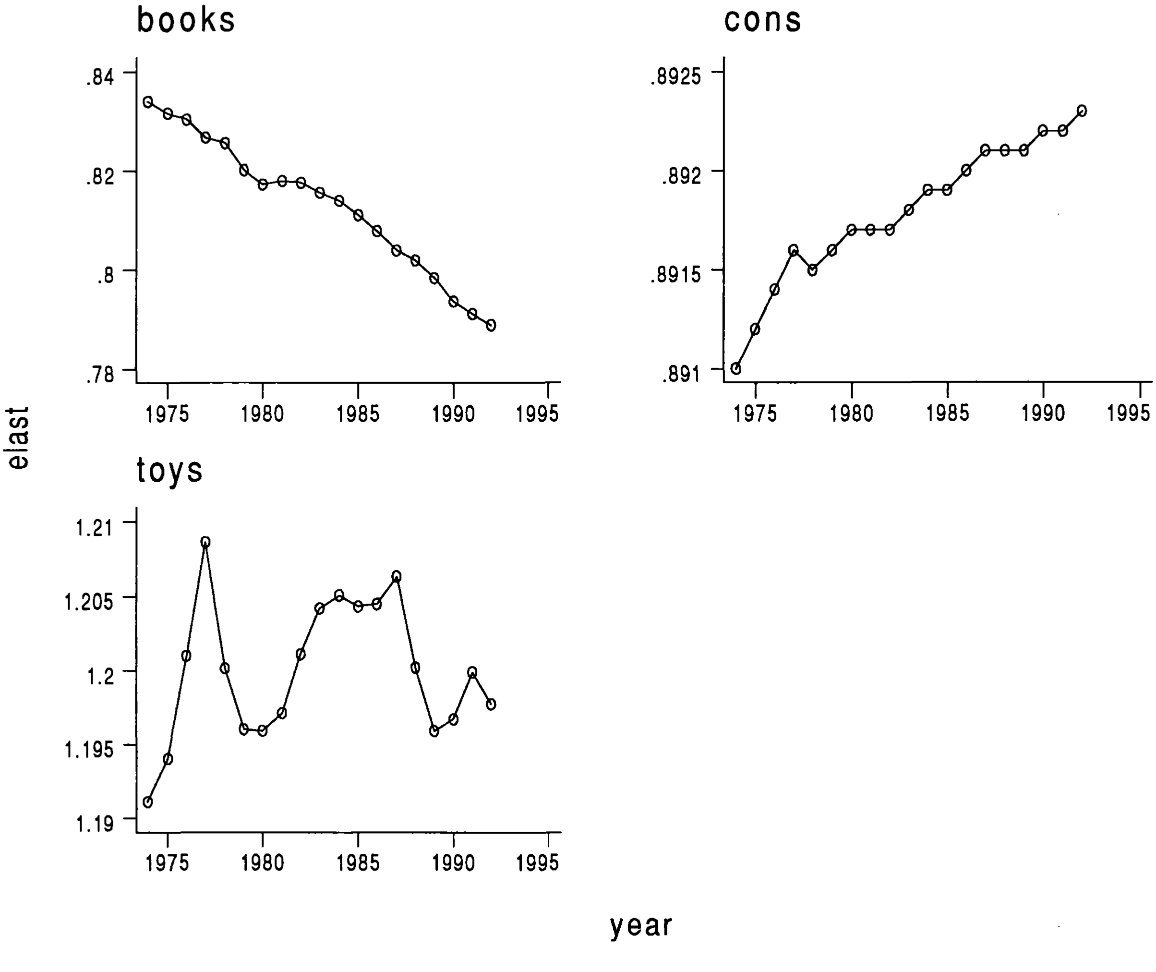

Figure 6-14: Elasticities over Time: Other

Chapter 7

Matching Supply and Demand

7.1 Introduction

The aim of this chapter is to examine the impact of the demand elasticities estimates obtained in the last chapter on the profitability of UK firms. In order to do that, the product definitions used in the last chapter will be matched to the 3-digit SIC industry definitions, traditionally used in empirical Industrial Organization literature. Then, the estimated elasticities will be included in profitability regressions to analyse the magnitude and significance of their effect on the firms' mark-ups. The time-varying household characteristics, available form the FES and used to compute the demand elasticities, will form the instrument set used to identify the supply equation.

7.2 The Matching Process

As seen above, the goods in the demand sector were defined in such a way as to facilitate the matching between industries and product definitions. In Table 7.1 the matching process is set out.

To examine the validity of the matching process, Figures 7.1 to 7.5 show the behaviour of the 12th differences of monthly prices in the producer sector vis-a-vis the retail sector for each sic/product match [1]. An analysis of these figures shows that in most cases the prices move

[1]The producer prices series is taken from British Business, various issues, until 1983 and subsequently from

Table 7.1: **Matching the S.I.C. with the Product Definitions**

S.I.C. Code	S.I.C. Name	Product Name.
411	Organic Oils and Fats	Oils and Fats
412	Slaughtering of Animals and Production of Meat and By-Products	Beef+ lamb+ Pork+ Bacon+ Poultry + Other meat
413	Preparation of Milk and Milk Products	Milk + Milk Products
414	Processing of Fruits and Vegetables	Fruit + Vegetables
415	Fish processing	Fish
416	Grain Milling	Cereals
419	Bread, Biscuits and Flour Confectionary	Bread+Biscuits and cakes
420	Sugar and Sugar By-products	Sugar
421	Ice Cream, Cocoa, Chocolate and Sugar Confectionary	Sweets and Chocolates
426	Soft Drinks	Soft drinks
424	Spirit Distilling and Compounding	Spirits
427	Brewing ans Malting	Beer
426	Wines, Cider and Perry	Wines
436	Hosiery and Other Knitted Goods	Men's outerwear+Women's Outerwear +Children's outerwear+Other Clothing
451	Footwear	Footwear
453	Clothing	Men's outerwear+Women's Outerwear + Children's outerwear+Other Clothing
258	Soap and Toilet Preparations	Household Consumables
475	Printing and Publishing	Books and Newspapers
494	Toys and Sport Goods	Toys, Photos and Sport Goods

quite close together, which indicates that the matching process is satisfactory, specially if one takes into account the fact that other possible determinants of the behaviour of retail prices (like the price imported products and retailers' markup, for example) are not being controlled for.

7.3 Identification

The usual problem with a procedure that tries to combine supply and demand data to investigate the interaction between consumers and firms in the market is that market prices are jointly determined by supply and demand behaviour. Describe the profitability formula by [2]:

$$\frac{(p_{it} - c_{it})}{p_{it}} = \beta' X_{it} + \gamma \eta_{jt} + \varepsilon_{it} \tag{7.1}$$

where

$$\eta_{jt} = -(\frac{\partial q}{\partial p})_j \frac{p_{jt}}{q_{jt}} \tag{7.2}$$

is the demand elasticity and X_{it} is a vector of variables reflecting market structure. Shocks affecting firms' prices tend to affect both firms' profitability (directly) and the product market elasticity (through the retail price index), although the direction of the bias is not clear *a priori*. Positive product price shocks tend to increase the mark-up (7.1), but will increase the absolute value of η_{it} only if the product demand is inelastic, decreasing it otherwise. Given that 13 out of the 18 products in Table (6.6) have inelastic demands on average (column 3), and that one would expect a negative relationship between profitability and the absolute value of the elasticity, one can tentatively predict that the OLS estimate of γ would be downwards biased (in absolute value) [3].

This bias can be reduced by examining the joint response of both the mark-ups and the elasticities to variables that affect demand and are orthogonal to the supply shocks. As shown in Shea (1993, 1996), the usefulness of the instrument set depends on its exogeneity (absence

the Business Monitor M22. The retail price series comes from the Central Statistical Office's "The Retail Price Index".

[2] The subscript i refers to the firm here, while j refers to the industry.

[3] One could ask why don't the producers increase prices in the face of an inelastic product demand. But the elasticity facing an individual producer also depends on the behaviour of its competitors.

of correlation between instrument set and supply shocks) and relevance (presence of correlation between instrument set and demand elasticities). Recent research has shown that low relevance can increase the inconsistency of IV estimates whenever the instruments are not perfectly exogenous and can even affect the consistency of perfectly exogenous instruments in small samples [4].

One of the advantages of the procedure used in this paper is that household characteristics, available from the survey data, provide a unique way of identifying the supply equation. The fitted values of the Almost Ideal Equation estimated in the last section are:

$$\widehat{w_{jt}} = \widehat{\alpha_j} + \sum_k \widehat{\gamma_{jk}} \log(p_{kt}) + \widehat{\beta}_j \log(\frac{x_{it}}{P_t}) \tag{7.3}$$

$$\widehat{\alpha_j} = \widehat{\alpha_0} + \sum_i \widehat{\alpha_j} z_{it} + \widehat{\delta} T + \widehat{\vartheta} S \tag{7.4}$$

so that the price elasticities were computed according to:

$$\eta_{jt} = \frac{\widehat{\gamma_{jj}}}{\widehat{w}_{jt}} - \widehat{\beta}_j - 1 \tag{7.5}$$

where $\widehat{w}_{jt}$ are the predicted shares. The household characteristics variables z_{it} enter the share equations in order to reflect differences in household preferences and composition, that affect shares and may be correlated with total expenditures and prices.

First-differencing (7.5) one gets:

$$\Delta \eta_{jt} = \widehat{\gamma_{jj}} (\frac{1}{\widehat{w_{jt}}} - \frac{1}{\widehat{w_{jt-1}}}) \tag{7.6}$$

so that, as $\widehat{\gamma_{jj}}$ does not vary over time, the time variation of the elasticities is determined by the variation in the predicted $\widehat{w_{jt}}$'s. The time-varying household characteristics z_{kt} will, by construction, affect the predict shares and hence the elasticities, thereby fulfilling (in theory) the relevance criteria. These are age, age squared, number of adults, number of adults squared, number of females, a single parent dummy, number of kids in various age groups and five occupational dummies [5]. Moreover, there is no reason to expect those variables to affect the

[4] See Stock and Staiger (1994), Nelson and Startz (1990) and Bound, Jaeger and Baker (1995).

[5] The household characteristics are summarized in Table 6.8.

firms' pricing behaviour conditional on their effect on the demand elasticities. In order to construct the instrument set, yearly weighted averages of the household characteristics were computed for each product, using each household's expenditure on the product as a percentage of total product expenditure in a given year as weights. All variables will be used in first-differences.

In order to check whether the relevance criterion is also fulfilled in practice [6], the tables below report partial R^2 and F statistics on the excluded instruments in a first-stage regression of the demand elasticities on the instrument set. Since the equations estimated below contain more than one endogenous variables, the partial R^2 statistics are computed according to Shea (1996), who describes a method to measure the relevance of the instrument set for each endogenous variable, even if the instruments are highly collinear. The essence of the procedure is to compute the squared correlation between the values of the endogenous variable of interest, orthogonalized with relation to the other endogenous variables, and the fitted values of it (from a regression on the instrument set), again orthogonalized with relation to the fitted values of the other endogenous variables.

As another check of the validity of instruments, the results of this procedure will be compared with a more traditional Generalized Method of Moments procedure, that uses lagged values of the endogenous variables as instruments [7]. This procedure has often been criticized on the basis of the relevance criteria, since the persistence of the majority of micro variables over time would mean that lagged values of them are only weakly correlated with their first-difference values[8]. The validity of this procedure also hinges on the absence of serial correlation in the levels specification.

In order to complete the identification procedure and examine the effect of consumer behaviour on firms' mark-ups, it is necessary to discuss the consistency of the estimates of the price parameter in the share equation $\widehat{\gamma_{jj}}$. In this case, as prices have only time series variation, the use of micro data alleviates the problem of simultaneity, as long as there are no common aggregate shocks in the error term (see Goldberg, 1995). The inclusion of seasonals, total expenditures and a time trend in the share equations helps removing these aggregate terms out

[6] In practice, the relevance depends on the importance of the household composition variables in each share equation.

[7] See Arellano and Bond (1991).

[8] See Grilliches and Mairesse (1995), for example.

of the errors.

7.4 Data

On the supply side, data on company accounts are used in this paper, available from the UK Datastream on-line service. The industry level information comes from the UK Census of Production. The criteria for selecting firms was that they operated in the consumer non-durables sector of the economy and that information was available both on the distribution of sales across different industries and on the percentage of sales sold abroad. We were left with an unbalanced sample of 161 firms operating from 1974 to 1992.

The dependent variable used throughout this study is accounting pre-tax profits (before depreciation allowances) divided by total sales [9]. The other firm level variables are market share and capital/sales. The market share variable takes into account the fact that the firms are diversified and that part of their sales are sold abroad (see chapter 5). The industry level variables are the five-firm concentration ratio and import penetration (imports/sales). Table 5.3 above presents some descriptive statistics of the firm and industry level variables used in this paper.

7.5 Results

In this section, the estimated time-varying uncompensated demand elasticities will be used as independent variables in profitability regressions, in order to examine the effect that consumer behaviour may have on the firms' mark-ups. Table 7.2 describes the variation in the demand elasticity variable across industries and its relationship with the average concentration ratio, import penetration and firm level profitability over the sample period. The industries are listed in decreasing order of concentration ratio within each group.

Just eyeballing the table shows that there is no obvious correlation between the concentration measure and the elasticity. Industries with the lowest elasticity in the food group, like sugar and soft drinks, have the highest average profitability, although with very different concentration and import penetration ratios from each other. The reverse occurs with products

[9] See the discussion about the performance of different profitability measures in chapter 2.

Table 7.2: **Data Description: 1974-1992**

Industry	**Sample Averages**				
	Industry Concentration	**Import Penetration**	**Demand Elasticity**	**Firm Level Profitability**	**Number of Obs.**
Food	**0.59**	**0.79**	**0.59**	**0.051**	**667**
Sugar	0.96	0.37	0.15	0.086	67
Oils and Fats	0.71	0.31	0.53	0.046	58
Grain Milling	0.70	0.12	0.41	0.023	23
Fish Processing	0.65	0.31	0.95	0.032	21
Sweets and chocolates	0.64	0.11	1.42	0.044	159
Bread and Biscuits	0.59	0.02	0.69	0.054	50
Milk and Milk Products	0.53	0.02	0.36	0.054	71
Soft Drinks	0.52	0.01	-0.18	0.079	54
Fruits and Vegetables	0.40	0.38	0.51	0.052	64
Meat	0.22	0.20	1.01	0.040	100
Alcohol	**0.69**	**0.78**	**1.22**	**0.117**	**524**
Wine	0.92	0.58	1.50	0.089	54
Spirits	0.62	0.07	1.34	0.139	99
Beer	0.52	0.02	0.83	0.123	371
Clothing	**0.28**	**0.71**	**0.71**	**0.062**	**717**
Footwear	0.37	0.35	0.54	0.061	88
Hosiery	0.31	0.28	0.89	0.070	106
Clothing	0.16	0.24	0.89	0.054	523
Other Non-Durables	**0.32**	**0.81**	**0.96**	**0.086**	**328**
Soap and Toilets Prod.	0.53	0.10	0.89	0.092	35
Toys and Sport Goods	0.23	0.33	1.17	0.067	93
Books and Newspapers	0.19	0.04	0.81	0.101	200

like Sweets/Chocolates and Meat, the only ones with elastic demands in the group, which have lower than average profitability despite having very different levels of concentration and import penetration. A similar story is to be found in the alcohol group, specially in a comparison between the wine and beer industries, although import penetration may have an important role in this case. In the clothing group, all industries tend to have low concentration, inelastic demands and low profitability. Finally, in the other non-durables group, books/newspapers have a much lower concentration ratio than the soaps/toilet prod. industry, but both have above average profitability, in line with their relatively inelastic demand.

Table 7.3 shows the results of estimating the demand elasticities' impact on profitability. All models in this table are estimated in differenced form, in order to capture the relationship between changes in profitability and changes in elasticity, which could not be captured through the inclusion of industry dummies.

The first column shows that profitability and demand elasticities are indeed negatively correlated, after allowing for time dummies and a constant term. The second column shows that this result is maintained if other controls are included, that are generally present in profitability studies of this kind. Column (3) applies the I.V. estimation procedure outlined above. As (tentatively) predicted above, the absolute value of the estimated demand elasticity coefficient is about five times higher than the one in column (2). The other right-hand-side variables are instrumented with their own values lagged three periods. The R^2 and the partial-R^2 on the excluded instruments are 0.16 and 0.14 respectively, showing that, although a small part of the explanatory power of the instrument set is not relevant for the elasticity variable, it still explains a significant part of the elasticities' variation over time. The F-statistic on the joint significance of the household characteristics in the elasticity equation confirms the relevance of the instruments. If these characteristics are not included in the instrument set, the elasticity coefficient drops (in absolute value) back to -0.034 (0.036).

In column (4), lagged values of the elasticity variable are included *instead of* the household variables. Perhaps surprisingly, the elasticity coefficient also shows up very strongly and precisely estimated. The R^2 and the partial-R^2 on the excluded instruments are 0.14 and 0.13 respectively (lower than in column (3)) and the F-statistic also rejects the null of instrument irrelevance. The similarity between the results of columns (3) and (4) is very reassuring and points to the inclusion of both set of instruments in the same specification, which is done in

Table 7.3: **Demand Elasticity and Profitability**

D(Profits/Sales)	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-0.006	-0.006	-0.004	-0.004	-0.005	-0.005
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Demand Elasticity	-0.043	-0.042	-0.212	-0.261	-0.231	-0.145
	(0.016)	(0.020)	(0.111)	(0.104)	(0.093)	(0.061)
Market share	-	0.117	0.495	0.635	0.696	0.401
		(0.115)	(0.361)	(0.448)	(0.476)	(0.325)
Capital/Sales	-	-0.029	0.009	0.015	0.009	0.016
		(0.022)	(0.023)	(0.030)	(0.028)	(0.026)
Concentration	-	-0.042	0.017	-0.001	-0.024	0.001
		(0.023)	(0.051)	(0.055)	(0.053)	(0.051)
Import Penetration	-	-0.051	-0.455	-0.402	-0.367	0.270
		(0.036)	(0.136)	(0.134)	(0.123)	(0.100)
Profitability (-1)	-	-	-	-	-	0.489
						(0.100)
R^2 (Instruments)	-	-	0.161	0.141	0.228	0.238
Partial R^2 (Instr.)			0.140	0.130	0.212	0.221
F (excluded Instruments)	-	-	2.15	3.86	2.17	2.16
(p-value)			(0.00)	(0.00)	(0.00)	(0.00)
Sargan	-	-	67.76	63.88	74.82	81.73
(p-value)			(0.417)	(0.516)	(0.643)	(0.792)
SC1	1.174	0.799	0.772	0.837	0.806	-2.858
(p-value)	(0.240)	(0.424)	(0.440)	(0.403)	(0.420)	(0.004)
SC2	-1.910	-2.033	-2.038	-2.024	-2.037	-1.602
(p-value)	(0.056)	(0.042)	(0.042)	(0.043)	(0.042)	(0.109)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Number of Firms	161	161	161	161	161	161
Sample Size	1592	1592	1592	1592	1592	161

Notes to Table

Standard Errors in Parentheses. All Models estimated in First-Differences. OLS estimates in columns 1 and 2. Instruments used in column 3: household composition variables plus lagged values (t-3) of RHS variables except for elasticity. Instruments used in column 4: lagged values of all RHS variables. Instruments used in column 5: those in column 3 + column 4. Instruments used in column 6: those in column 5 + lagged values of profitability.

column (5). As expected, the standard error in this specification is lower than in the previous columns and the estimated coefficient does not change much. Finally, column (6) includes a lagged dependent variable as a robustness test that confirms the results obtained so far, although the size of the coefficients decreases somewhat. The results in this column suggest that, at mean profitability and elasticity values in the sample, an increase of one standard deviation in the absolute value of the elasticity (37%) would decrease profitability in the long run by around 121%, which is a very tangible effect.

With respect to the other determinants of profitability, the results of column (5) are somewhat mixed. The market share coefficient is very high but only significant at the 15% level. The import penetration variable enters strongly and significantly, while the concentration coefficient is insignificantly different from zero. As it is well known, economists have long debated whether the impact of market structure variables on profitability reflects tacit collusion or differential efficiency [10]. The fact that demand elasticities have been estimated in this paper can shed some more light on this issue from a different point of view.

Even the most collusive group of firms is impotent to increase prices and profits if facing a very elastic demand pattern. Therefore, if industry concentration facilitates collusion (that translates into higher profits) and import penetration hinders it, then both the positive concentration and the negative import penetration effects on profitability will be stronger in industries where product demand is relatively inelastic. If, on the other hand, both effects were found to be stronger in industries where the potential for consumer exploitation is low, then the collusion hypothesis would not be very attractive and some variant of the differential efficiency argument would be more compelling in explaining the results.

Column (1) in Table 7.4 reports O.L.S. estimation of specifications that interact the demand elasticity with the market structure variables. There is some evidence that both the market share effect and the negative import effect are stronger in more elastic industries. The results of column (2), where all household characteristics and lagged values of the right-hand-side variables are used as instruments, show that both the concentration and the import penetration effects are much stronger in the more elastic industries which, as seen above, does not lend support to the collusion hypothesis. It seems however, that the market share result is not robust to

[10] See discussion in chapter 5.

Table 7.4: **Demand Elasticity and Structural Variables**

D(Profits/Sales)	(1)	(2)	(3)	(4)	(5)
Constant	-0.005	-0.006	-0.003	-0.001	-0.003
	(0.003)	(0.002)	(0.002)	(0.019)	(0.015)
D(Demand Elasticity)	0.003	-0.195	-0.219	-0.091	-0.028
	(0.038)	(0.172)	(0.100)	(0.109)	(0.122)
D(Market share)	-0.390	0.055	0.656	1.119	0.741
	(0.216)	(0.382)	(0.416)	(0.556)	(0.434)
D(Capital/Sales	-0.030	0.008	0.003	-0.016	-0.015
	(0.022)	(0.027)	(0.027)	(0.030)	(0.028)
D(Concentration)	-0.030	-0.138	-0.158	-0.332	-0.234
	(0.031)	(0.111)	(0.119)	(0.144)	(0.124)
D(Import Penetration)	0.121	0.162	0.141	0.341	0.227
	(0.053)	(0.113)	(0.124)	(0.126)	(0.103)
D(Demand Elasticity) X	0.577	0.454	-	-	-
D(Market share)	(0.229)	(0.526)			
D(Demand Elasticity) X	-0.028	0.168	0.185	0.361	0.252
D(Concentration)	(0.051)	(0.103)	(0.112)	(0.150)	(0.133)
D(Demand Elasticity) X	-0.266	-0.688	-0.680	-0.789	-0.594
D(Import Penetration)	(0.079)	(0.170)	(0.185)	(0.218)	(0.184)
Profitability (-1)	-	-	-	0.950	1.337
				(0.033)	(0.117)
Profitability (-2)	-	-	-	-	-0.349
					(0.104)
Sargan	-	120.88	111.73	110.59	105.26
(p-value)		(0.546)	(0.333)	(0.520)	(0.636)
SC1	0.674	0.603	0.533	0.899	-2.298
(p-value)	(0.500)	(0.546)	(0.594)	(0.369)	(0.022)
SC2	-2.060	-1.971	-1.990	-1.808	-1.588
(p-value)	(0.039)	(0.049)	(0.047)	(0.071)	(0.112)
Time Dummies	Yes	Yes	Yes	Yes	Yes
Number of Firms	161	161	161	161	161
Sample Size	1592	1592	1592	1592	1592

Notes to Table

Standard Errors in Parentheses. OLS estimates in column 1. First-Differences Specification in columns 1, 2 and 3. Quasi-Differences Specification in columns 4 and 5. Instruments used: Household Characteristics + Lagged values (t-3) of all included variables.

endogeneity so that, in column (3), the market share interaction is dropped with no effect in the main results.

In columns (4) and (5), the results of a quasi-differences specification are set out. This specification, first suggested by Holtz-Eakin et al (1991) is more general than the first-differences one, allowing for a time-varying fixed effects coefficient and including the level of the variables in the regressions as well.

$$Y_{it} = \alpha_0 + \gamma_t \alpha_i + \beta X_{it} + \varepsilon_{it} \tag{7.7}$$

where α_0 is a constant, α_i is the firm specific effect, γ_t and β are parameters to be estimated and ε_{it} is a random error term. By lagging (7.7) one period, solving for α_i and substituting back in (7.7) one gets a quasi-differences specification [11]:

$$Y_{it} = (1 - \gamma_t/\gamma_{t-1})\alpha_0 + \beta X_{it} - (\beta\gamma_t/\gamma_{t-1})X_{it-1} + (\gamma_t/\gamma_{t-1})Y_{it-1} + \varepsilon_{it} - (\gamma_t/\gamma_{t-1})\varepsilon_{it-1} \tag{7.8}$$

This expression can be estimated by applying an I.V. approach to:

$$Y_{it} = a_t + b_1 \Delta X_{it} + b_2 X_{it-1} + cY_{it-1} + v_t \tag{7.9}$$

Where $a_t = (1 - \gamma_t/\gamma_{t-1})\alpha_0$, $b_1 = \beta$, $b_2 = (\beta - \beta\gamma_t/\gamma_{t-1})$, $c = (\gamma_t/\gamma_{t-1})$ and $v_t = \varepsilon_{it} - (\gamma_t/\gamma_{t-1})\varepsilon_{it-1}$. A test for the first-differences specification, in which $c = 1$ and $b_2 = 0$ resulted in χ^2 (8) = 15.70 with p = 0.047, marginally rejecting the first-differences specification. Moreover, an increase in all coefficients show that this specification does indeed make a difference. The qualitative results, however, do not change. In the last column, another lag of the dependent variable is included as a robustness test, which does not change the main results either. This can be seen as evidence that the impact of concentration on the firms' mark-ups in this period does not seem to be related to collusive practices and that the import penetration effect also decreased profitability through its effect on the prices of more competitive industries.

[11] This is like imposing a common factor of γ_t/γ_{t-1} to the model.

7.6 Conclusions

The aim of this chapter was to bring together consumer behaviour and the Structure-Conduct-Performance models traditionally estimated in the empirical Industrial Organization literature. Two issues that have hindered similar studies on this issue were considered in detail here: obtaining demand elasticities at the appropriate level of aggregation and the identification procedure. The availability of very disaggregated goods in the consumer surveys allowed the products in the demand side to be defined so as to match the industry definitions used in profitability studies. Moreover, the household characteristics, also available from the household surveys, were used to construct an instrument set that is uncorrelated with firms' supply decisions.

The price elasticities estimated in the last chapter were included, in first-differenced form, in firm level profitability equations, to examine the impact of consumer demand on firms' performance. The results indicated that demand elasticities have a significant and sizable effect on profitability and that controlling for their exogeneity substantially increases the absolute value of the estimated coefficient, by around five times. Similar results were obtained when household characteristics and lagged values of the elasticities were used alternatively in the specifications.

Finally, the relationship between the demand elasticities and firms' mark-ups allowed us to shed more light on the long standing debate between the efficiency and collusion explanations for the impact of market structure variables on firms' performance. It seems that industry concentration and import penetration have a more pronounced impact on profitability in more competitive environments, which is not in line with the collusion argument.

7.7 Appendix

7.8 Figures

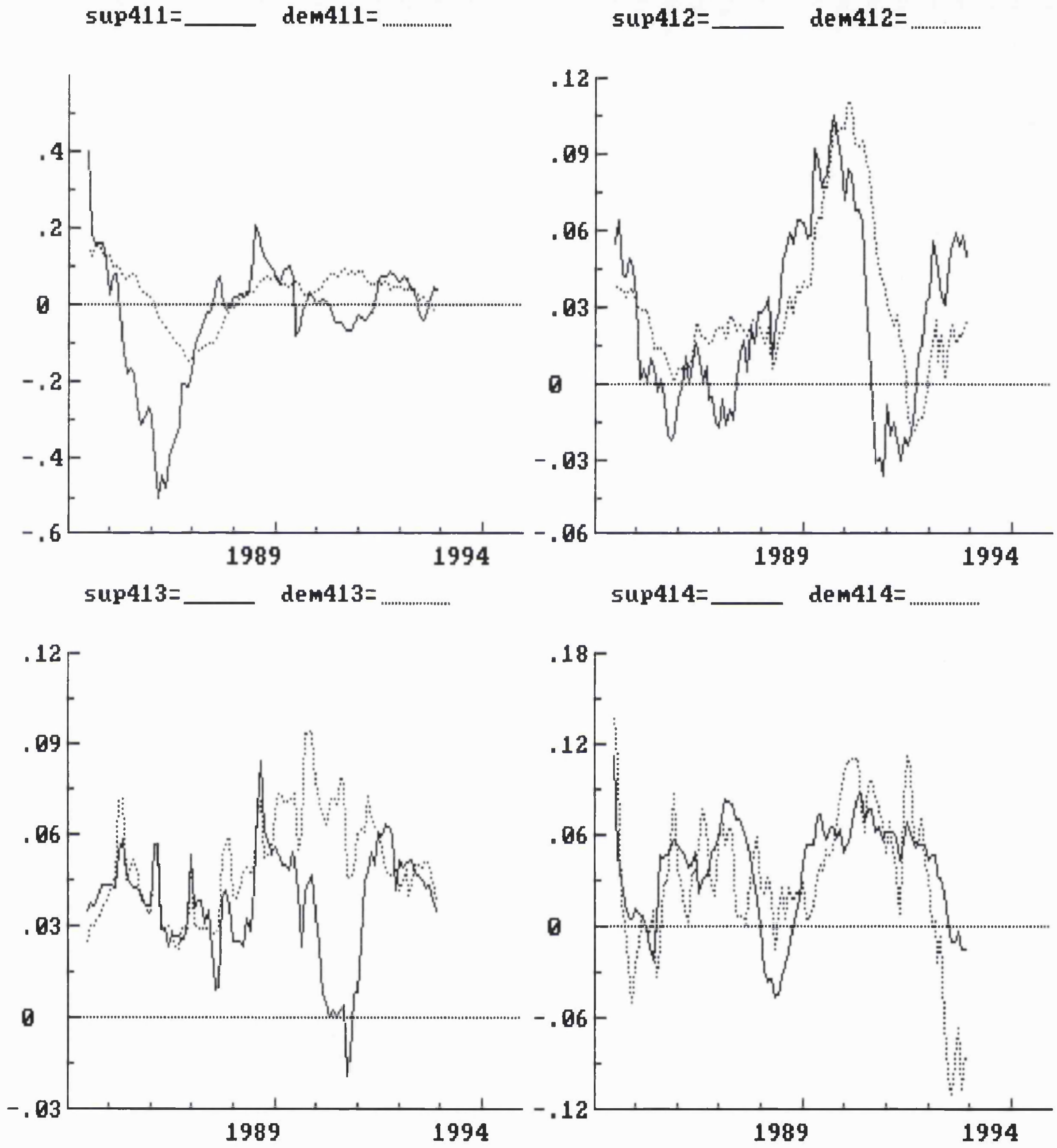

Figure 7-1: 12th Differences of Supply and Demand Prices 1

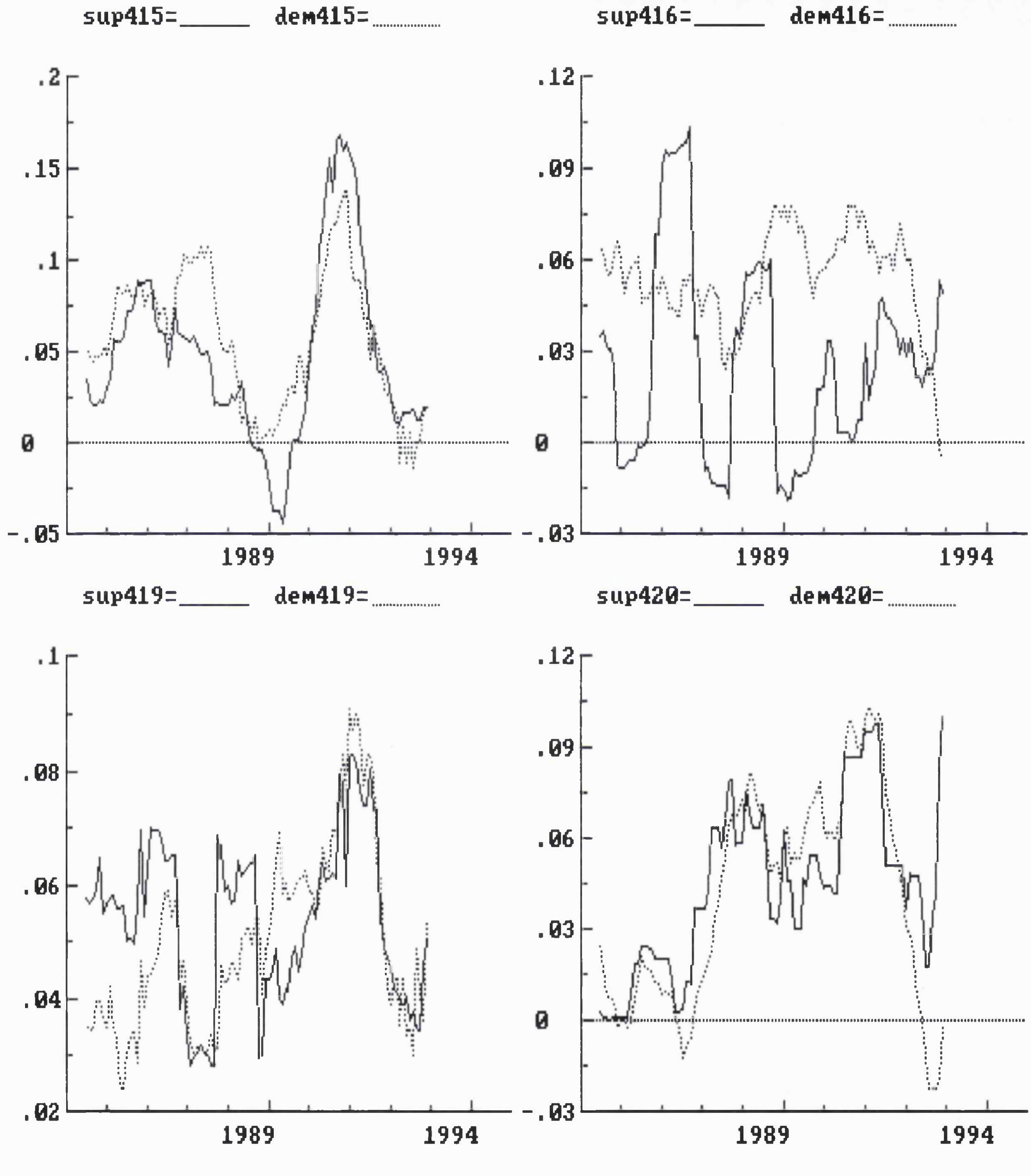

Figure 7-2: 12th Differences of Supply and Demand Prices 2

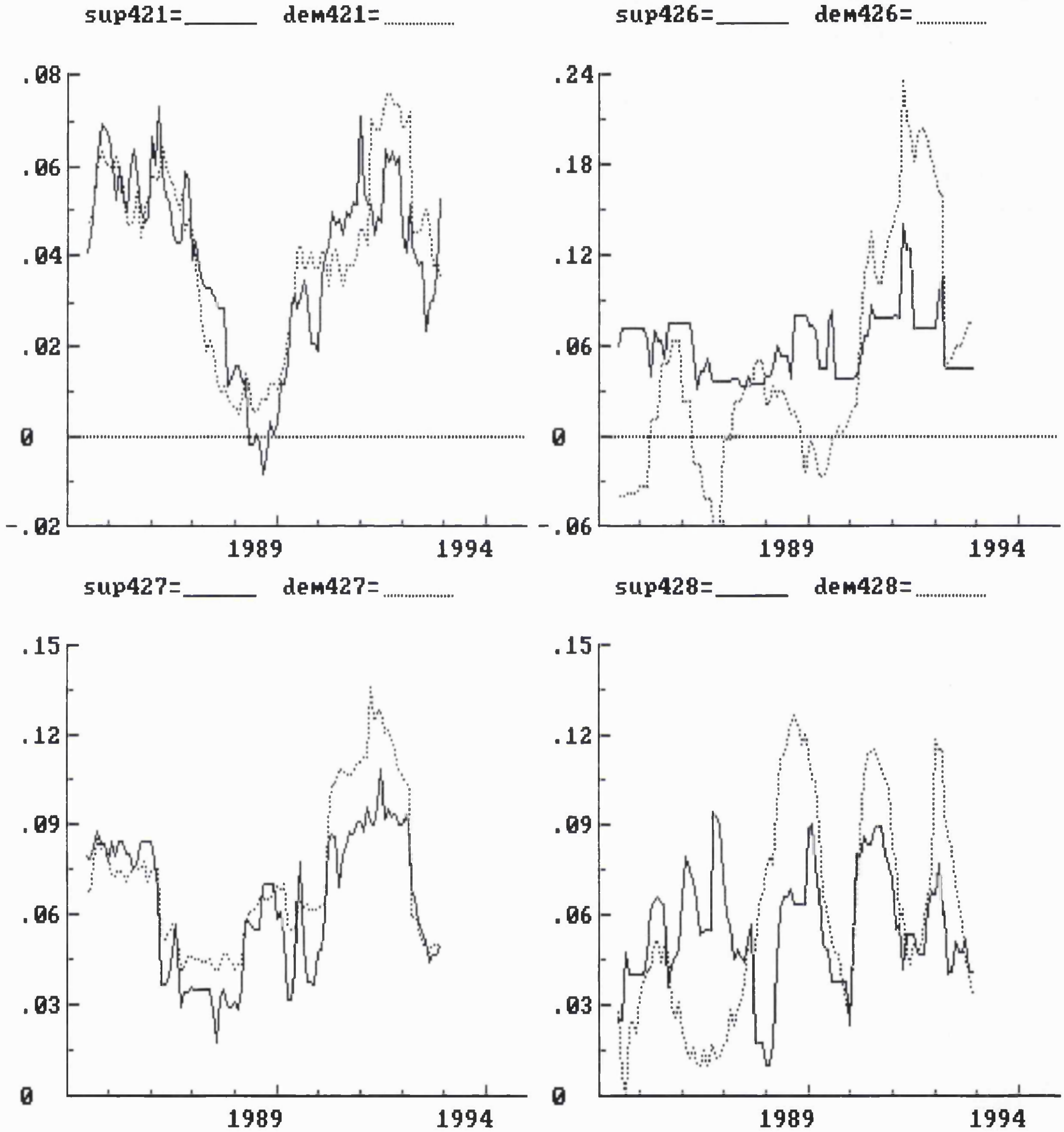

Figure 7-3: 12th Differences of Supply and Demand Prices 3

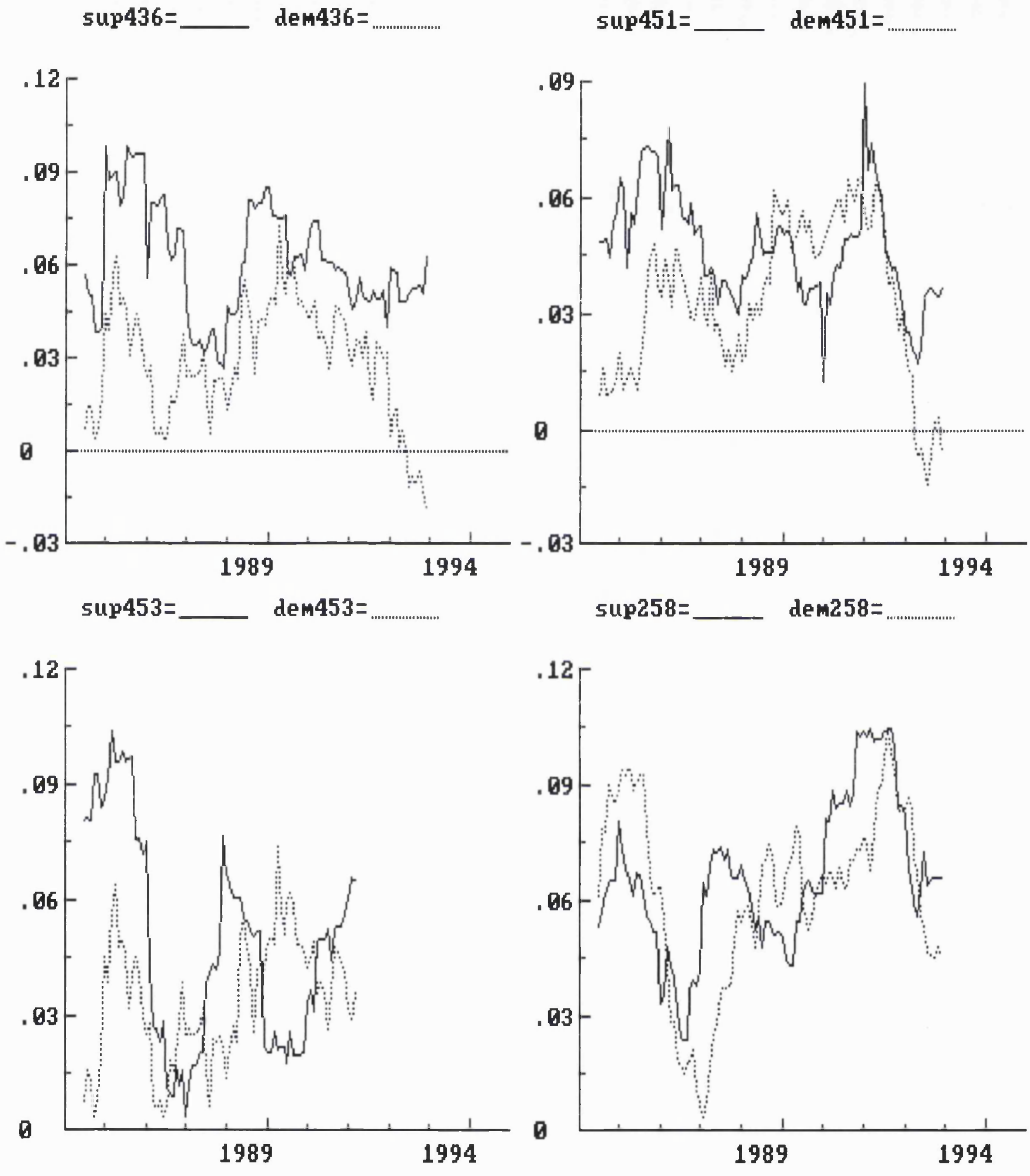

Figure 7-4: 12th Differences of Supple and Demand Prices 4

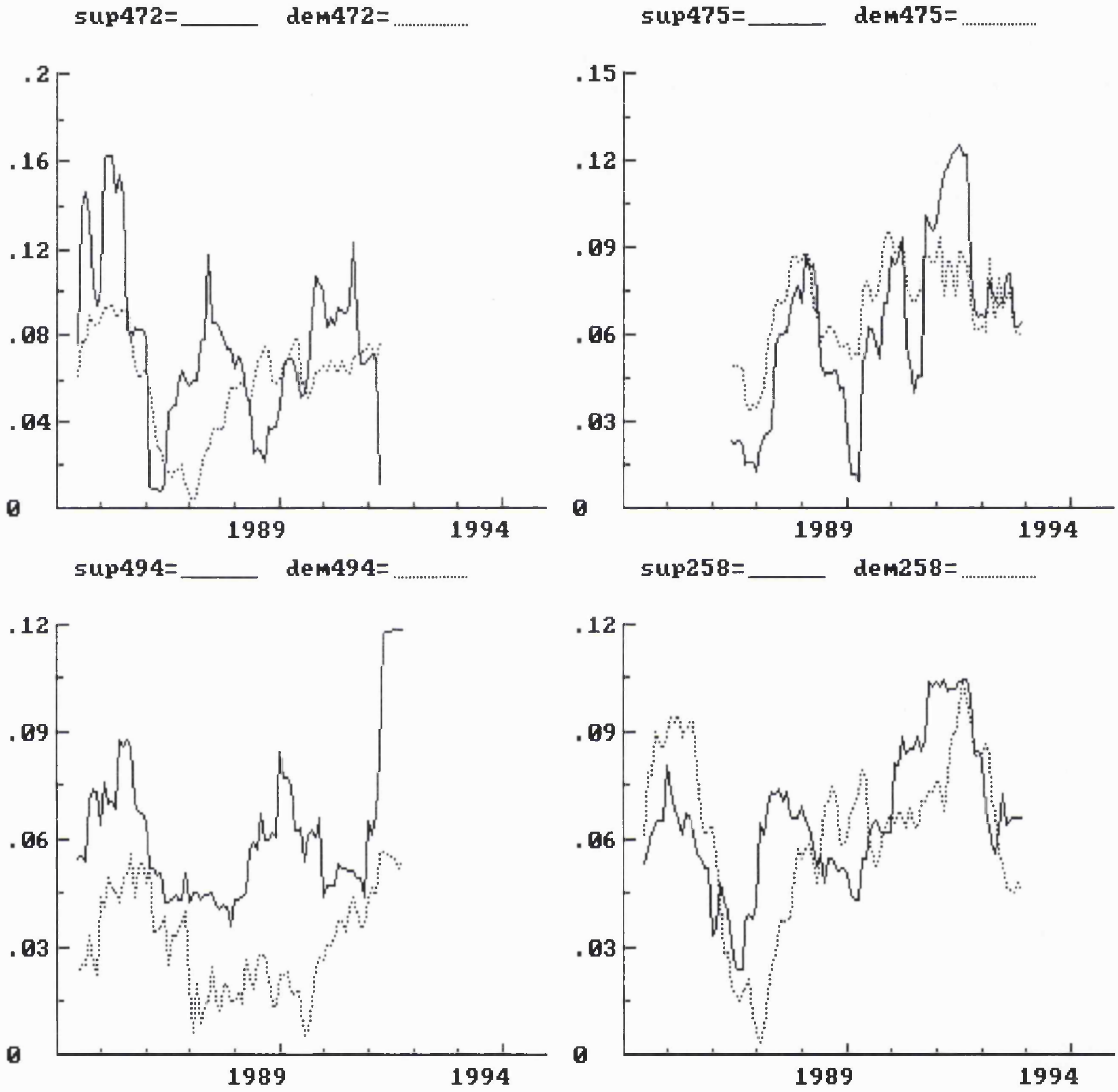

Figure 7-5: 12th Differences of Supply and Demand Prices 5

Chapter 8

Conclusions

As in any other research, the one carried out here did not intend to give definitive answers about the factors determining the economic performance of British companies and establishments. The aim was to shed some more light on the relationship between performance indicators, like profitability and R&D expenditures and factors usually overlooked in the literature, like unionism and consumer demand. This chapter will summarise the main results obtained throughout the research, as well as discuss the main limitations and possible extensions of it.

The general finding of this research seems to be that firms' and plants' economic performance does seem to be influenced by factors like unionization and consumer demand. With respect to the former, it was found in chapter 3 that unionization, on average, impacts negatively on the profitability of UK firms, even after controlling for firm specific effects. It was established theoretically that, in order for an increase in union power to impact negatively on profitability, some conditions relating to the profits and employment effects of an wage increase must be fulfilled, but those conditions do not seem very restrictive.

A major new finding was that the union effect on profitability in the UK has decreased dramatically over the 1980s. It was argued that this may bear a relationship with the anti-union legislation that took place during that period in Britain. This may be considered as "good news" for the Conservative government, that introduced those measures with the explicit objective of reducing union power, and for the economists who emphasize the "efficiency distortion" role of the trade unions. On the other hand, for those that view unionism as an important mechanism for trying to achieve a more equal society in distributive terms, the results are somewhat disappointing. This result, coupled with the finding that the union effect seems to be counter-cyclical, indicates that the union-profitability impact may have continued to decrease in the 1991/93 recession, especially after the effects of the 1990 anti-union legislation are also taken into account. One of the extensions of this research will draw on a new survey carried out in 1994 by the NIESR that asked similar questions to the ones used here, but for the 1991/93 period. Information from this survey can be used to verify the behaviour of the union-profitability effect after 1990.

Another interesting finding was that the union effect depends a great deal on the prevailing bargaining structure, as predicted by the model developed in the theoretical section of this chapter. It seems that union impact is much stronger in single-plant firms and in the multi-plant firms with unions recognized in all of the plants. The results also showed that the strongest effects are to be found where different unions bargain jointly with the firm as apart of an industry level bargain. Therefore, the industrial relations regime has an important say in the union capacity to extract rents.

In terms of the union effect on R&D, the results were somewhat surprising. It seems that, in Britain, the prediction that unions are negatively correlated to R&D expenditures also seems to hold. However, when human capital and technological opportunities are controlled for, the negative relation completely disappears. This result was obtained using two completely independent data sets, one at the firm and the other at the plant level. It seems that it is the negative association between trade unions and new, technology-intensive industries that is driving the raw correlation between unions and R&D. Furthermore, some evidence was found, both in the firm and in the plant level data, of a non-linear relationship between unions and R&D investment. An increase in unionization, from very low levels, may actually increase relative R&D expenditures, but eventually, at high unionization levels, it will always decrease it.

The main caveat of the analysis above relates to the small sample of firms with both R&D and union information. Particularly, this meant that more robust exercises using the derecognition variable, like the ones carried out in the chapter 3, were difficult to perform. An obvious extension of this work would be to use more recent data on R&D expenditures and also the more recent union survey mentioned above, so as to try and control more adequately for firm specific effects and also perform some experiments splitting the sample according to different technological characteristics.

In the theoretical appendix, it was showed that the prediction from the Grout (1984) model, that unionization is negatively correlated with investments, does not always generalize to the case where the R&D investment decision is explicitly modelled, firms compete in the product market and unions bargain over employment as well over wages. Moreover, it was shown that, under certain conditions, a non-linear relationship (of the kind uncovered in the data analysis) derives from the model.

In the second part of the thesis, an effort was made to incorporate the demand side of the economy to the Structure-Conduct-Performance models, traditionally used in the industrial organization literature. In order to do so, in chapter 6, disaggregated time-varying demand elasticities were estimated using data from the UK Family Expenditure Surveys. The estimated budget and price elasticities conformed to the demand theory, accorded to a very intuitive pattern and showed a great deal of variation over time. In the food sector, for example, goods like meat, fish, soft drinks, sweets/chocolates and fruits/vegetables were found to be luxuries, while cereal, bread, milk were necessities and oils/fats and sugar were inferior goods. Moreover, all compensated own-price elasticities were negative, with one exception (soft drinks).

In chapter 7, the information obtained about consumer behaviour was used to identify the demand effect on profitability. The product definitions used in chapter 6 were matched to the 3-digit Standard Industry Classification and the behaviour of the producer and the retail price series for each product-industry match was examined. The two series moved quite close together in most of the cases, indicating that the matching procedure was satisfactory. One of the main advantages of using two independent data sets is that the household characteristics, available from the Family Expenditure Surveys, can be used to identify the supply equation. The procedure used for identification was detailed in chapter 7, and tests of significance of the instruments, in a first-step regression, were reported after each regression. The results indicated that performance of the instrument set was quite satisfactory and that a GMM estimation procedure produced very similar results, which was quite reassuring.

The results obtained when the estimated elasticities were used as independent variables in profitability regressions indicated a sizable and significant demand impact on firms' mark-ups. It was also found that this impact can help assessing the different explanations for the effect of market structure on profitability. Interactions of the demand elasticities with industry concentration and import penetration showed that their effect on profitability is much stronger where consumer demand is elastic, which lends weight to the efficiency explanation, as opposed to the collusion one. The next step in this line research will be to compute different elasticities for different expenditure levels and examine their behaviour over the business cycle, following some recent customer pricing models (see Bils, 1989). Finally, the implications of an analysis like this to the relationship between consumer demand and profitability examined here can be assessed.

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