The Irish Market Services Sector:
An Econometric Investigation*

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Abstract: Using new time series data a structural econometric model of a three way disaggregation of the market services sector is constructed. The elasticities of demand for the factors of production (capital and labour) in two of the sub-sectors were found to be moderate in size with elasticities proving rather small in transport and communications. While prices, in the long run, are set as a mark-up on costs, in two of the sub-sectors short-term pricing decisions were found to be significantly affected by capacity utilisation.

I INTRODUCTION

The market services sector is the biggest employer in the Irish economy accounting for around 38 per cent of total employment in 1987. The value added in that sector is almost equal to that of the industrial sector. In spite of their obvious importance, in Ireland services have attracted little interest from researchers, a notable exception being the study by Norton (1984) which addressed the need for a coherent public policy for private services. Bannon and Moore (1989) note that "only in the late 1980s, with the development of international trade in services, has there been a consistent attempt to formulate a policy for services and to support this policy with hard information and research". Our paper uses new data to construct a comprehensive model of the market services sector. The results throw new light

on the behaviour of the sector and the model provides a useful framework for analysing the potential impact of 1992 on the Irish economy in the 1990s.[1]

The availability of new data has allowed us to disaggregate the market services sector into three sub-sectors: distribution, professional and financial services, and transport and communications. The first two of these sub-sectors are largely private firms or individuals; in transport and communications a small number of state owned firms account for most of the output and employment. The sub-sectors showed different patterns of behaviour highlighting the importance of the disaggregation in obtaining satisfactory behavioural models. An earlier model of this sector as an aggregate (Bradley et al., 1989) proved much less satisfactory than the results shown here.

A set of four behavioural equations are specified in the model of each sub-sector. The pivotal variables identified as determining each sub-sector's behaviour are domestic cost conditions and the level of activity in the general economy. The crucial links between the market services sector and the rest of the economy are through the demand from the rest of the economy for the sector's output, and the determination of output prices in the sector. Firms set prices and then supply output to meet market demand. Cyclical fluctuations in demand impact on the demand for factors and on cost mark-up decisions. Factor demand equations for each sub-sector are derived using a cost minimisation framework. At the level of sectoral disaggregation described above, data limitations meant it was only possible to model the supply-side within a value-added framework using two factors, labour and capital.

The plan of the paper is as follows. Section II gives some background detail on the broad characteristics of the three sectors. Section III describes the model used to estimate the behaviour of the three sub-sectors. Sections IV through VI give the results for the three sub-sectors and conclusions are set out in Section VII.

II A SECTORAL OVERVIEW OF IRISH MARKET SERVICES

The increasing importance of the services sector is typically associated with the processes of economic development. As an economy grows and develops, the relative importance of the industrial sector usually declines and that of services increases. A cursory glance at the data for Irish services supports this hypothesis, since employment in services accounted for 57 per cent of total employment in 1987, an increase of 14 percentage points on its 1970 share.

At the same time, the agricultural sector's share of total employment was in secular decline, another trend associated with economic development.

We initially separated the services activities of the economy into two components: market and non-market services. Non-market services includes the administrative and regulatory activities of central government and local authorities and the non-market component of health and educational services. In this paper we examine the behaviour of the market services sector.

As shown in Table 1, market services is now the largest single sector in the economy in terms of employment, increasing its share by 7 percentage points from 1970 to 1987. Over the same period its share of total output (value-added) remained virtually unchanged, being roughly equal to the industrial sector's share in 1987. However, given the diversity of services activities, this masks a variety of factors which can be more usefully examined at a disaggregated level.

Table 1: *Sectoral Employment and Output Shares, Per Cent*

	Employment		Output	
Sector	*1970*	*1987*	*1970*	*1987*
Agriculture	27	15	12	10
Industry	30	28	33	38
Total Services	43	57	55	43
Market Services	32	38	37	36
Non-Market Services	12	19	18	17

We disaggregate total market services into three sub-sectors: distribution, transport and communications, and a residual sector, professional and financial services (other market services). These three sectors accounted for 40.4 per cent, 16.0 per cent and 43.5 per cent of employment respectively in 1987. Even at this level of disaggregation these three sub-sectors each embrace a heterogeneous set of activities. However, limitations on data quality and availability prevented any further systematic disaggregation. Indeed, most published data sources for Ireland — most importantly the CSO National Accounts — do not distinguish between the distribution and the transport and communications sectors.

The distribution sector is traditionally considered under two headings, wholesaling and retailing. This distinction is by no means clearcut and changing economic conditions have led to considerable integration of the two functions.

Price setting behaviour in this sector is of especial interest and particular impor-
tance in assessing its competitiveness and the likely impact of 1992.[2] The
determination of distribution margins could be expected, *a priori*, to be very
different to that of transport and communications, where there has been
extensive government interference in price setting.

The transport and communications sector is dominated by a few large
organisations, most of whom are in the public domain and are subsidised either
directly or indirectly by the state.[3] In contrast to the other two sectors, which
adjust rapidly to changing market conditions, this sector's response pattern
is more complicated. Although the sector seems to operate within an optim-
isation framework in the long term, its short-run behaviour is subject to some-
what arbitrary public policy interference. Short-run pricing behaviour operates
in response to signals other than those normally associated with market ser-
vices, e.g., demand changes, degree of market power, market segregation, etc.[4]

The professional and financial services sector includes professional services,
personal services (hotels, restaurants, hairdressing, etc.), entertainment, sport,
financial services, and the market component of health and educational ser-
vices. This sector is determined residually as it is not separately identified in
most published data sources, being included with non-market health and edu-
cational services. Hence the data are subject to a wider margin of error than
the data for the other sub-sectors.

III THE MODEL

The structural econometric model described in the following section is a
first attempt to identify the fundamental behavioural relations underlying the
performance of each sub-sector of Irish market services. Output (added-value)
determination is modelled first. Then the demand for the two factors of pro-
duction, labour and capital, is studied, and the investment decision is derived.
Finally, the determination of the producer price is examined.

3.1 *Output Determination*

We assume that output in market services is driven by market demand. Firms
are assumed to supply all that is demanded and the determination of the price
is the key decision variable for the firm. We construct a measure of weighted

2. For a review of the likely impact of 1992 on the distribution sector see Fitz Gerald (1989).
3. Examples of state involvement include the telecommunications company Bord Telecom, the bus
and rail transport company CIE, the postal services company An Post, the air transport company Aer
Lingus, in their present and previous incarnations.
4. For example, a high level of subsidies was transferred from the state to CIE and An Post over the
period, and while this has been diminishing in importance in recent years, it makes the modelling of
short-run pricing behaviour more intractable.

final demand using the 1975 input-output table, being the most recent available. The behavioural specification used allows the coefficient on the weighted final demand variable to change over time in a restricted manner, thus permitting a limited change in the otherwise fixed input-output coefficients (Fitz Gerald, 1987, pp. 24-26). This change can be interpreted as measuring variations in the composition of each sectors' output which would be reflected in changes in their final destination and/or changes in trend margins.[5]

The common equation specification used for all three sub-sectors is as follows:

$$Q = a_1 + (a_2 + a_3 . T).FDW \qquad (1)$$

where
   FDW = weighted final demand variable.

3.2 Demand for Labour and Capital

Assuming cost minimisation behaviour on the part of firms, the factor demand for the two factors of production, capital and labour, is derived from an underlying cost function with second-order conditions (concavity of the cost function) assumed satisfied. Two distinct cost-function specifications were tested for each sector. The first treats both factor inputs as variable while the second treats capital as a "quasi-fixed" factor.

Variable Inputs Specification: The variable inputs specification was derived from the translog cost function, one of a class of flexible functional forms which provide a local approximation to any arbitrary unit cost function. Invoking duality theory, this in turn summarises all the relevant aspects of the firm's technology. This basic specification has been adopted frequently in the past in modelling the industrial sector.[6] Under the assumption of constant returns to scale the translog cost function can be written as:

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5. The output of the distribution sector is complementary to other goods included in the demand variable. Distribution added-value is expected to fall over time due to the more efficient organisation of its wholesaling and retailing functions, i.e., an attributed "productivitiy" effect due to the rationalisation of the sector (the "supermarket" effect). This also requires a specification which allows the coefficient on the demand variable to change over time.
   6. For example, see Boyle and Sloane (1982).

$$\ln(C/Q) = \ln(c) = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2} \sum_i \sum_j \beta_{ij} \ln p_i \ln p_j. \qquad (2)$$

where
   C = total cost,
   Q = value added output,
   p_i = input price of factor i.

Using Shephard's Lemma, we can derive factor share equations,[7]

$$\frac{\partial \ln(c)}{\partial \ln w} = \frac{\partial(c)}{\partial w} \cdot \frac{w}{(c)} = S_L = a_0 + a_1 \ln \left(\frac{w}{p_k}\right) + a_2 T \qquad (3)$$

where
   w = wage rates,
   p_k = the price of capital,
   S_L = labour's share of added value,
   T = time.

Homogeneity and symmetry conditions are imposed in the specification of Equation (3). The trend term (T) has been added to the specification to allow for bias in technical progress between factors.

   The equation as specified does not incorporate any dynamic effects. Morrison (1989) highlights the possibility that the temporary (quasi) fixity of one factor may result in the observed price of an input (e.g., capital) temporarily differing from the factor's marginal product. For example, if capital changes slowly and, if there is a surge in demand, the return to capital may rise above its long-run cost. There are a number of different ways of dealing with this problem. A specification which recognises the quasi-fixity of one or more factors is considered below. Alternatively, we can append a capacity utilisation term (CUR) to the factor share equation as a proxy for the disequilibrium or short-run effect of changing rates of utilisation on the *ex post* return to capital, defined as the share of added-value which accrues to capital. This can be interpreted as capturing two possible effects.

   (i) In any one time period a firm faces a certain level of fixed costs (e.g., set-up costs) which on average must be covered by the *ex ante* return to capital. These costs do not impinge on the marginal factor employment decision. However, given such fixed costs and assuming a fixed

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7. The estimated capital share equation can be determined residually from the estimated labour share in Equation (3).

output price, cyclical changes, as captured by the capacity utilisation variable, can be expected to alter *ex post* profit margins.

(ii) A second possible effect is that output prices themselves can be expected to respond to cyclical changes, an issue taken up in Section 3.4 below.

The optimal capital stock is derived from this variable factor demand system as the capital stock implied by the capital share equation when the CUR variable is evaluated at its mean (equilibrium) level $(\overline{CUR})$ over the estimation period. Thus:

$$K^* = \frac{(1 - S_L^*).C}{P_k} \qquad (4)$$

where

K^* = the optimal capital stock,

$S_L^* = a_0 + a_1 \ln\left(\frac{w}{P_k}\right) + a_2 T + a_3 \overline{CUR}.$

Quasi-Fixed Input Specification: The quasi-fixed factor specification was derived from the approach proposed by Morrison (1988) and is described in some detail in Bradley, Fitz Gerald and Kearney (1990b). Firms are assumed to minimise variable cost (G) subject to the constraint that the volume of capital is fixed in any given period. The price of the variable factor is w and the *ex post* price of the quasi-fixed factor capital is P_k.[8]

$$G = f(Q, w, K) \qquad (5)$$

$$\frac{\delta G}{\delta w} = \frac{\delta f}{\delta w} = L \qquad (6)$$

The shadow price of the quasi fixed factor capital P_k^* is obtained by differentiating the variable cost function G with respect to the quasi-fixed factor K:

$$-\frac{\delta G}{\delta K} = -\frac{\delta f}{\delta K} = P_k^*. \qquad (7)$$

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8. The *ex post* price of capital is the value of the operating surplus divided by the volume of capital. Thus it measures the *ex post* return on capital.

The functional form used here is a variant of the Generalised Leontief restricted cost function as adapted from the approach developed in Morrison (1988).

$$G = Q\{\alpha_{ll}w + \delta_{tl}wT^{0.5} + \gamma_{tt}Tw\} + Q^{0.5}\{\delta_{lk}wK^{0.5} + \gamma_{tk}T^{0.5}K^{0.5}w\}$$
$$+ \gamma_{kk}Kw. \tag{8}$$

The labour share (in volume) equation is derived from the variable cost function by differentiating with respect to the price of labour and dividing through by the volume of output:

$$\frac{\delta G}{\delta w} \cdot \frac{1}{Q} = \frac{L}{Q} = \alpha_{ll} + \delta_{tl}T^{0.5} + \gamma_{tt}T + Q^{-0.5}\{\delta_{lk}K^{0.5} + \gamma_{tk}T^{0.5}K^{0.5}\}$$
$$+ Q^{-1}\gamma_{kk}K. \tag{9}$$

When the variable cost function is differentiated with respect to the quasi-fixed factor capital the resulting equation defines the shadow price of capital, i.e., the change in variable costs yielded by an increment of capital. For estimation purposes this can be estimated using the *ex post* return to capital, $P_k = \dfrac{(P_q Q - G)}{K}$ on the left hand side.

$$-\frac{\delta G}{\delta K} = P_k = -\gamma_{kk}w - 0.5Q^{0.5}K^{-0.5}\{\delta_{lk}w + \gamma_{tk}T^{0.5}w\} \tag{10}$$

If the factor demand equation and either the variable cost function itself or the equation for the shadow price of capital are estimated as a system, then the long-run optimal level of the capital stock, K*, can be derived. This is done by replacing the shadow price of capital by the actual *ex ante* price of capital P_k^* and reversing the equation to solve for K*.

$$K^* = \left\{ \frac{-0.5Q^{0.5}(\delta_{lk}w + \gamma_{tk}T^{0.5}w)}{(P_k^* + \gamma_{kk}w)} \right\}^2 \tag{11}$$

The gap between K and K* reflects the extent of subequilibrium in terms of input levels. This is the dual equivalent to the concept of capacity utilisation.

It should be clear from the above equation that the long-run demand for the quasi-fixed factor, K, is invariant with respect to a proportional change in all factor prices, including the price of capital. Thus homogeneity holds in both the short run and the long run.

3.3 Investment

The adjustment of the actual capital stock to its optimal value was deter-
mined using an ECM as follows:

$$I = \gamma_1 \Delta K^* + \gamma_2 (K^*_{-1} - K_{-1}) + \delta K_{-1} \qquad (12)$$

where

$I \quad = \Delta K + \delta K_{-1}$

I: investment

K*: optimal capital stock as derived in Section 3.2 above,

δ : depreciation rate on the capital stock.

3.4 Producer Price Determination

The determination of producer prices in market services is radically dif-
ferent to the industrial sector, where industrial output prices are essentially
determined by world prices (Callan and Fitz Gerald, 1988). In contrast, pro-
ducer prices for market services are assumed determined within the domestic
economy, the price equation being formulated as a simple cost mark-up model.
Market demand adjusts to these prices and firms then supply to meet demand.
Therefore the price equation acts as a key equation in the overall sectoral
model, providing the feedback link between the suppliers and the consumers.
Various specifications of the price variables were tested, the evidence in all
cases suggesting that market services producer prices adjust rapidly to changes
in variable costs. While, in the long run, prices are set purely as a mark-up on
costs, the mark-up may be affected in the short-run by capacity constraints.
Thus capacity utilisation is included as an additional explanatory variable,
having a purely temporary effect on the level of prices.

The following describes the final specification for the output price equation:

$$\ln(P_Q) = a_1 + a_2 \ln(UCL) + (1 - a_2) \ln(UCL)_{-1} + a_3 \ln(CUR) \qquad (13)$$

where
UCL = (w.L)/Q = unit labour costs.

IV THE DISTRIBUTION SECTOR

We now present our empirical results for the three subsectors of market
services, starting with distribution. The order of presentation will be the
same in each case: output determination; factor demands; investment; pro-
ducer prices.

4.1 *Output Determination*

As noted above, we regard output in distribution as being determined by demand conditions, where the different components of final demand are weighted using the 1975 input/output table and where the specification allows for the coefficient on the demand variable to change over time.

$$Q = c_1 + (c_2 + c_3 T)\text{FDW} \tag{14}$$

$\overline{R}^2 = 0.977$ SE $= 32.3$ DW $= 2.03$ DFFITS $= 1.11$ Range $= 1970$ to 1987

Coef	Estimate	T-statistic
c_1	48.6983	0.24
c_2	15.5952	2.83
c_3	-0.007484	-2.71
RHO	0.677536	4.19

The coefficient on the time variable itself (as nested within the coefficient on the demand variable) is negative, which suggests that distribution margins were falling over time. Such an increase in "productivity" ties in with the significant rationalisation of this sector which occurred over the period (especially the growth in the large supermarket chains). A second effect which this specification may be capturing is a change in the composition of the markets for this sector's output, although the two effects are not separable.

The coefficient on the demand variable fell over the period 1970 to 1987 from 0.85 to 0.72. It is likely that the competitive implications arising from 1992 will see a continuation of this downward trend in the immediate future.

4.2 *Demand for Labour and Capital*

The variable factors translog specification provided the best results for the distribution sector. The capacity utilisation variable is defined as actual output divided by trend output.

$$S_L = c_1 + c_2 \log \left(\frac{w}{p_k}\right) + c_3 T + c_4 \text{CUR} \tag{15}$$

$\overline{R}^2 = 0.718$ SE $= 0.021$ DW $= 1.73$ DFFITS $= 1.37$ Range $= 1970$ to 1987

Coef	Estimate	T-statistic
c_1	16.8699	6.55
c_2	0.034448	1.42
c_3	-0.007912	-6.27
c_4	-0.737251	-5.99

The results for the labour share equation highlight some very interesting properties. For example, Figure 1 plots the labour share of value-added. There is a downward trend in the variable, while its short-run behaviour is highly cyclical. The coefficient on relative factor prices is not significant suggesting that factor substitution has a small impact on the demand for factors. The negative coefficient on the time trend variable means that technical progress is labour-saving, thus capturing the long-run downward trend in the labour share. However, the most important result is the coefficient on the capacity utilisation variable which captures the cyclical behaviour as seen in Figure 1. The negative sign on this coefficient implies that cyclical upswings in activity in this sector reduce labour's share of value-added.

Figure 1

Labour's Share of Value Added
in the Distribution Sector
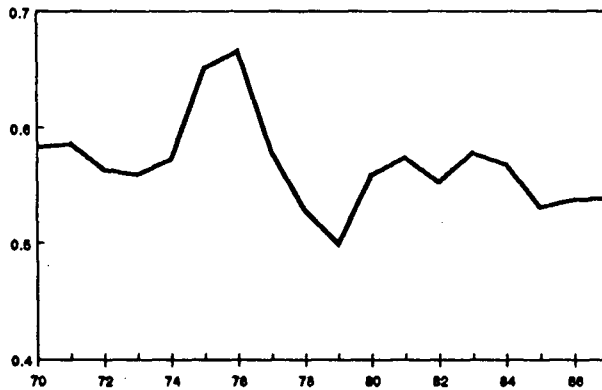
Elasticities of Demand for 1987

	Labour	*Capital*
Labour	−0.397	0.397
Capital	0.464	−0.464

The own- and cross-elasticities of demand for capital and labour are fairly low, though generally higher than those observed for the manufacturing sector (Bradley, Fitz Gerald and Kearney, 1990b). However, the magnitude of these elasticities remains uncertain in the light of the low t-statistic on the coefficient on relative factor prices. The elasticity of substitution between capital

and labour is almost constant over time at around 0.86. Estimation using a CES specification yielded a similar value (0.94) for the elasticity of substitution.

4.3 Investment

Calculating the optimal capital stock from the factor demand system, the standard ECM adjustment mechanism is applied to estimate the investment equation.

$$I = c_1 \Delta K^* + c_2 (K_{-1}^* - K_{-1}) + 0.05.K_{-1} \tag{16}$$

$\overline{R}^2 = 0.732$ SE = 49.05 DW = 0.913 DFFITS = 0.873 Range = 1971 to 1987

Coef	Estimate	T-statistic
C_1	0.1071	3.41
C_2	0.122901	6.09

The equation displays significant autocorrelation. Figure 2 plots the fitted against the actual investment series. While the autoregressive nature of the equation is apparent in the graph, the fitted series does on average capture structural shifts in actual investment, e.g., the increase in the late 1970s and early 1980s. The C_2 parameter, measuring the speed of adjustment to equilibrium, is close to the corresponding estimate for the professional and financial services sector. Correction for autocorrelation caused the parameter significance to collapse, indicating the unsatisfactory nature of the equation.

Figure 2

Investment in Distribution
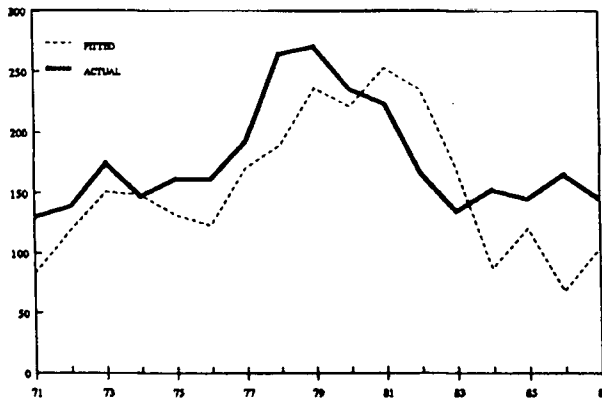
4.4 *Producer Prices*

$$\log(P_Q) = c_1 + c_2 \log(CUR) + c_3 \log(UCL) + (1 - c_3) \log(UCL)_{-1} \quad (17)$$

$\overline{R}^2 = 0.493$ SE = 0.044 DW = 2.39 DFFITS = 1.58 Range = 1970 to 1987

Coef	Estimate	T-statistic
c_1	0.598603	11.04
c_2	1.04222	2.91
c_3	0.746142	4.00
RHO	0.787715	5.85

The coefficient c_3 indicates that prices adjust rapidly to changes in unit labour costs, with 75 per cent of the adjustment taking place within one year. The evidence from the equation suggests that, in the short run, firms have significant market power. The coefficient on the capacity utilisation variable indicates that a 1 per cent increase in output in this sector over trend will lead to a 1.04 per cent increase in the output price of the sector. This is an important element in the sectoral model and it serves as an important feedback mechanism ensuring that the product market clears. However, in the long run, prices are purely a function of costs.

V THE PROFESSIONAL AND FINANCIAL SERVICES SECTOR

Having been largely determined residually, the data for this sub-sector are subject to a wider margin of error than the data for the other two sub-sectors. The employment data in particular are problematic prior to 1975 (the year of the first CSO Labour Force Survey). For some of the equations, inconsistencies evident in the data meant that estimation could only be done from 1974 onwards.

5.1 *Output Determination*

$$Q = c_1 + (c_2 + c_3 T)FDW \quad (18)$$

$\overline{R}^2 = 0.989$ SE = 41.82 DW = 2.287 DFFITS = −1.16 Range = 1974 to 1987

Coef	Estimate	T-statistic
c_1	1491.93	6.73
c_2	−56.5251	−11.42
c_3	0.028815	11.72

The positive coefficient on the time variable is opposite to that for the distribution sector. The coefficient on the demand variable rises from 0.24 in 1970 to 0.73 in 1987. Some possible explanations are as follows:

(a) The sector includes producer services which are intermediate inputs into the industrial sector. With the growing complexity of production processes the demand for such services increases.

(b) In economically developed Western societies, at the margin, consumers spend a higher proportion of expenditure on so-called "superior" goods (e.g., leisure activities, restaurants and hotels, etc.) — a positive income effect implying a shift in composition within the sector in favour of such labour-intensive products.

(c) This result may be capturing a classification bias. Several of the activities which are now classified within this sector are ones which were previously performed in-house by the industrial sector and, therefore, classified as industrial activities.

5.2 Demand for Labour and Capital

$$S_L = c_1 + c_2 \log \left(\frac{w}{P_k}\right) + c_3 T + c_4 CUR \qquad (19)$$

$\bar{R}^2 = 0.55$ SE = 0.015 DW = 1.76 DFFITS = −1.22 Range = 1974 to 1987

Coef	Estimate	T-statistic
C_1	−4.49995	−1.97
C_2	−0.047167	−2.20
C_3	0.002926	2.60
C_4	−0.599042	−2.62

The coefficient on the relative factor prices is almost significant at the 5 per cent level while the coefficient on the capacity utilisation variable suggests that margins in this sector increase in a cyclical upswing.[9] The distinguishing feature of this sector is that the coefficient on the time trend is positive, implying that technical progress is biased in favour of labour. However, because the labour share variable is defined in value terms, rather than in physical units, it may be capturing a human capital effect. Average earnings in this sub-sector, which were 68 per cent of average earnings in industry in 1970, had risen to 87 per cent of average industrial earnings by 1987.

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9. The capacity utilisation variable used here is defined in the same way as for the distribution sector as a deviation from trend.

Elasticities of Demand for 1987

	Labour	*Capital*
Labour	−0.578	0.578
Capital	0.611	−0.611

The elasticities of demand for the two factors are higher than for the distribution sector. As with the distribution sector, the elasticity of substitution of labour for capital is again constant over time at around 1.2.[10]

5.3 *Investment*

$$I = c_1 \Delta K^* + c_2 (K^*_{-1} - K_{-1}) + 0.05 K_{-1} \qquad (20)$$

$\overline{R}^2 = 0.909$ SE = 47.8 DW = 1.57 DFFITS = 0.99 Range = 1975 to 1987

Coef	*Estimate*	*T-statistic*
C_1	0.050351	4.05
C_2	0.140035	11.00

The estimation of the investment equation gives fairly robust results. While the speed of adjustment to equilibrium is reasonably quick (C_2), the instantaneous speed of adjustment to a change in the optimal capital stock is limited (C_1). The speed of adjustment to equilibrium (C_2) is close to that estimated for both the distribution sector and the transport and communications subsectors.

5.4 *Producer Prices*

$$\log(P_Q) = c_1 + c_2 \log(CUR) + c_3 \log(UCL) + (1 - c_3) \log(UCL)_{-1} \qquad (21)$$

$\overline{R}^2 = 0.789$ SE = 0.042 DW = 2.03 DFFITS = 1.14 Range = 1970 to 1987

Coef	*Estimate*	*T-statistic*
C_1	0.68251	14.23
C_2	1.1596	2.17
C_3	0.949327	5.32
RHO	0.458604	2.53

10. A simple CES estimation gave an estimate of 1.07.

The producer price adjusts instantaneously to changes in unit labour costs, with the coefficient C_3 being not significantly different from one. Price setting behaviour in the short run is strongly responsive to changes in the capacity utilisation rate. However, in the long run prices are set as a mark-up on costs.

VI THE TRANSPORT AND COMMUNICATIONS SECTOR

The transport and communications sector proved the most difficult of all the sectors to model, mainly because it is driven in part by non-market considerations and is dominated by a limited number of large government-owned organisations. Significantly, the data do not reject the implicit optimisation framework of the model. Rather they suggest that the time horizon for such optimisation is substantially longer than for the other two sectors. While government policy intervention in the sector may cause operation for a number of years at levels of output or factor demand which are sub-optimal, in the long run the sector will seek to minimise the cost of production.

6.1 *Output Determination*

The output decision would be expected to be *a priori* supply-driven, constrained by the long-run decision with respect to the installation of the capital stock. Short-run demand factors would then determine cyclical variations in capacity utilisation. A variety of specifications were used to approximate such behaviour, however they all proved unsatisfactory. The final equation used was a simple short-run demand-driven model, as outlined below. Hence, although output is ultimately capacity-constrained, the existing stock of capital at any one period seems to be sufficiently flexible to allow for intensive use in periods of high demand.

$$Q = c_1 + c_2 \, FDW + c_3 \, (T.FDW) \tag{22}$$

$\overline{R}^2 = 0.966$ SE $= 22.75$ DW $= 1.93$ DFFITS $= -1.06$ Range $= 1970$ to 1987

Coef	Estimate	T-statistic
C_1	616.415	3.41
C_2	−0.007887	−0.05
C_3	0.0116	3.37
RHO	0.6074	3.04

The coefficient on the demand variable is increasing over time (C_3) while the coefficient on demand itself is insignificant (C_2). This would suggest that while the sector historically was not very responsive to demand, reflecting the

substantial government ownership of the limited number of firms, it is becoming increasingly so over time.

6.2 Demand for Labour and Capital

The translog variable factor sspecification provided poor results for the transport and communications sector. This is not surprising since the installation of the capital stock takes a number of years, so that the capital stock within a one year period should be characterised as a quasi-fixed factor. Hence, firms choose labour inputs within the constraint of a given capital stock. The results reported here are from the Morrison (1988) version of the Generalised Leontief model, estimated treating capital as a quasi-fixed factor. The equations are estimated as a system using the iterative Zellner estimator.

$$L/Q = c_1 + c_2 T^{0.5} + c_3 (K/Q)^{0.5} + c_4 ((KT)/Q)^{0.5} + c_5 (K/Q) + c_6 T \qquad (23)$$

$$P_k = -c_5 P_1 - c_3 (0.5(Q/K)^{0.5} P_1) - c_4 (0.5((QT)/K)^{0.5} P_1) \qquad (24)$$

Coef	Value	T-statistic
c_1	2.32366	13.04
c_2	0.135251	2.03
c_3	-4.7148	-7.26
c_4	-0.187753	-3.43
c_5	3.85463	5.51
c_6	-0.021343	-1.85

Single Equation Statistics

Equation	$\bar{R}^2$	DW
23	0.787274	0.780962
24	0.974005	1.90562

All the coefficients determining the substitution between capital and labour are significant. The short-run elasticities of demand in 1987 are shown below and have the expected sign. The elasticity of labour with respect to capital refers to the responsiveness of labour to a change in the stock of (quasi-fixed) capital, and indicates that capital is a substitute for labour. Given a fixed capital stock in the short-run the output elasticity of labour is significantly greater than unity. This means that output is not homogenous of degree one with respect to labour in the short run since, with a given capital stock, labour is used more intensively at the margin per unit increase in output.

Elasticities of Demand in 1987

Short Run:

	Capital	Output
Labour	−0.600	1.693

Long Run:

	Labour	Capital
Labour	−0.269	0.269
Capital	0.463	−0.463

The long-run own-price elasticities of demand for both labour and capital are relatively low. In terms of marginal effects, increases in factor prices in this sector have a limited effect on the demand for factors.

6.3 *The Optimal Capital Stock*

The ratio of the desired to the actual capital stock is shown in Figure 3, where the desired capital stock is recovered from the factor demand system, as described in Section 3.2. It is then re-scaled to equal the actual capital stock in 1985. The series suggests that the sector was constrained by a shortage of capital in the late 1970s and that the increase in the cost of capital in the early 1980s had a dramatic effect on the optimal capital stock in that period.

Figure 3

Ratio of Desired to Actual Capital Stock
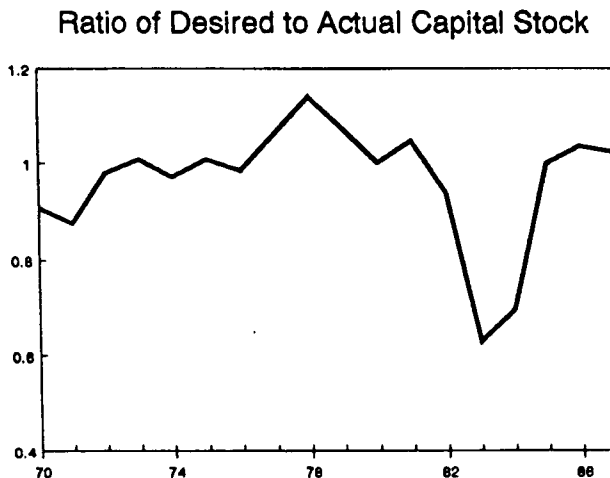
6.4 Investment

$$I = c_2 (K^*_{-1} - K_{-1}) + 0.05.K_{-1} \qquad (25)$$

$\bar{R}^2 = 0.862$ SE $= 66.73$ DW $= 2.25$ DFFITS $= -0.898$ Range $= 1971$ to 1987

Coef	Estimate	T-statistic
C_2	0.136545	3.397
RHO	0.644333	4.024

Because firms can be expected to react to changes in expected values of the desired capital stock this equation is estimated using a three-period moving average of the optimal long-run capital stock, calculated from the factor demand system. The C_1 parameter, measuring the instantaneous speed of adjustment to a change in the optimal capital stock, was insignificant and was dropped from the final equation.

When the pattern of investment shown in Figure 4, is contrasted with the movement in the desired capital stock, shown in Figure 3, it can be seen that the path of investment in this sector does not easily fit into an optimisation framework. As can be seen from Figure 3 above, a significant shortage of capital emerged in this sector in the late 1970s. However, given that many of the investment decisions were dictated by the state financed Public Capital Programme, it seems likely that the level of investment was held down artificially in the late 1970s by administrative factors which cannot be modelled

**Figure 4**

Investment
in Transport & Communications
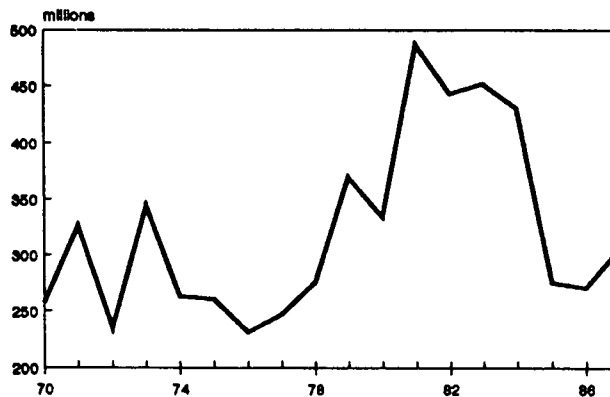
within an optimisation framework. A catch-up period occurred in the 1980s when the level of investment significantly overshot that which would be predicted by a short-run ECM of the type specified here. This period coincides with a massive investment programme in telecommunications equipment, the benefits of which have only recently come on stream. Even in the absence of administrative factors this behaviour would prove difficult to model because of its discrete nature, the long-run nature of the installation process, and its large size in absolute terms. However, the decision making process has become increasingly market-oriented in the late 1980s and the investment equation, reported above, may be expected to perform better in the future.

6.5 Producer Prices

Price setting behaviour in the transport and communications sector is complicated by the fact that a substantial subsidy was transferred from the state to the Post Office and CIE, particularly in the late 1970s and 1980s. This can be seen in Figure 5 which measures the rate of subsidy per unit of output received in the Transport and Communications sector from 1960 to 1987.

Figure 5

Subsidy per unit of Output
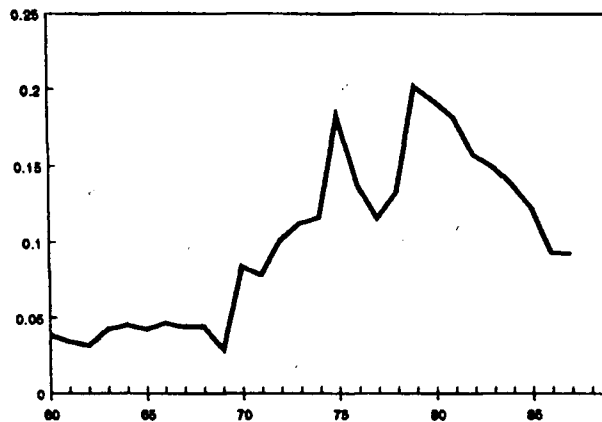
It is extremely difficult to interpret how such a subsidy impacts on the transport and communication sector's price setting behaviour. Although theoretically the subsidy level is set *ex ante*, in practice it has often been supplemented *ex post*. The inclusion of the subsidy as an explanatory variable in the output price equation gave rise to collinearity among the explanatory

variables. The approach adopted was to define the output price variable as inclusive of the subsidy, i.e., it is defined at factor cost.

$$\log(P_Q) = c_1 + c_2\log(UCL) + (1 - c_2)\log(UCL)_{-1} \qquad (26)$$

$\overline{R}^2 = 0.58$ SE = 0.04 DW = 1.65 DFFITS = -0.785 Range = 1970 to 1987

Coef	Estimate	T-statistic
c_1	0.418388	6.25
c_2	0.793253	3.77
RHO	0.853388	7.69

The coefficient on the unit labour cost variable indicates that prices adjust rapidly to changes in labour costs, i.e., almost 80 per cent adjustment within one year. In contrast to the other two services sub-sectors, the inclusion of a capacity utilisation variable worsened the fit of the equation. Again this serves to indicate the extent to which this sector is not market-oriented in the short term.

VII CONCLUSIONS

We have studied a three way disaggregation of the Irish market services sector: the distribution sector, the transport and communications sector and the professional and financial services sector. Using new time series data, a structural econometric model of these three sub-sectors was constructed.

Four equations are specified and estimated for each sector, modelling factor demand determination and the joint output/price decision. The model underlying these equations embodies a number of assumptions which are not tested:

(1) Cost minimisation is assumed.
(2) The optimal capital stock in the variable factors specification is determined in an *ad hoc* fashion. In all three sectors the specification of the investment equation is *ad hoc* in nature, not being derived within an overall optimisation framework.
(3) Prices are modelled as a mark-up on costs.

The estimation results indicated that:

(i) Factor demands in the professional and financial services sector and the distribution sector are best modelled assuming all factors are variable, using a translog cost function. The own- and cross-elasticities of

demand for capital and labour in both of these sectors were moderate in size. They suggest that government policy affecting relative factor prices (reducing the cost of capital) can generally be expected to lead to greater substitution of capital for labour in the services than in the industrial sector.

(ii) Technical progress in the professional and financial services sector was biased in favour of labour, the opposite was the case in the distribution sector. Cyclical increases in output benefit the *ex post* return to capital.

(iii) Factor demands in the transport and communications sector, on the other hand, were best modelled with capital treated as a quasi-fixed factor. Estimated substitution possibilities within this sector were low.

(iv) Output in all three sectors was modelled as being demand driven.

(v) Pricing behaviour in the distribution and the professional and financial services sector displayed a significant sensitivity of the mark-up on costs to capacity utilisation. In the long run price is set as a constant mark-up on costs.

To determine the sensitivity of output in the services sector to changes in costs the model, outlined in this paper, must be nested within a complete model of the Irish economy, where the demand for the output of the services sector is determined as a function of income and prices.

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DATA APPENDIX

A detailed description of the sources and methodology used to derive the
disaggregated data required for this study is available in Bradley, Fitz Gerald
and Kearney, 1990a. The series on employment were taken largely from the
CSO publication *The Trend of Employment and Unemployment*, 1979-1985.
The transport and communications sector is separately identified in this pub-
lication. However, for the other two sectors additional data from the *Labour
Force Survey* and the *Census of Population* were required. The investment
series were all taken from the *OECD National Accounts*. The data for the
volume and value of output, and the wage bill data were supplied by the CSO.
The capital stock series were generated using Henry's (1989) data for starting
values, the investment data and a common depreciation rate of 5 per cent.
The cost of capital variables for each sector take account of the corporation
tax rate, actual real interest rates, the rate of government grant assistance, and
a 5 per cent depreciation rate. The real interest rate is not allowed to fall
below 2 per cent in any year in the 1970s. The weighted final demand variables
for each sector were generated using adjusted weights from the 1975 Input-
Output Table. It is interesting to note here that a substantial proportion of
market services output acts as an input into the industrial sector so that "final
demand" is somewhat of a misnomer. This intermediate demand for services
output arises from the materials requirements of other sectors, therefore the
weights have been applied to the material inputs of the agriculture and the
industrial sectors, as well as to the components of final demand.

All of the time-series data used in this paper are available in the ESRI-
Department of Finance databank from 1960 onwards. However, the output
and wage bill series were only available from 1970 and had to be constructed
from secondary sources prior to that date. In addition, some of the other series,
such as employment, are not very reliable prior to 1970. Therefore, estimation
was only done on the data running from 1970 to 1987.

A complete set of the data on market services used in this study is available
in LOTUS 123 spreadsheet format (MS DOS) from the authors, on receipt
of a written request accompanied by a 5.25" or 3.5" floppy disk.