Value Relevance Of Institutional Investors

George Karathanassis
Department of Business Administration,
Athens University of Economics and Business
Nikolaos Philippas
Department of Financial and Banking Management,
University of Piraeus
Efthymios G. Tsionas
Department of Economics,
Athens University of Economics and Business
and Demosthenes Hevas
Department of Business Administration,
Athens University of Economics and Business

Abstract

In this paper we investigate the influence of institutional investors on share prices using data from companies quoted on the Athens Stock Exchange. For finance theorists the value of an investment, real or financial, is a function of its expected benefits and the riskiness of these benefits. Whatever influences are exerted by the structure of equity ownership are diversified away by efficient risk-averse investors. Managerial and agency theorists argue that the particular ownership structure may have an effect on share value or returns. Their arguments are based (mainly) on the consequences of the separation of ownership from control. In addition to traditional methods of estimation we have used Chamberlain's (1982) multivariate panel data estimator, which allows for arbitrary patterns of error autocorrelation and parameter temporal behavior. Among all alternative methods of estimation used, only this one produced a statistically significant and econometrically well specified relationship between share prices and institutional shareholdings.

1.   Introduction

Researchers wishing to determine the extent to which stock price market behavior can be explained by theoretical valuation constructs have tested a number of empirical valuation models[1]. All extant empirical valuation mod-

els implicitly assume that equity ownership structures are value irrelevant. More specifically the distribution of shares among managers, individual shareholders, institutions, block-holders and others does not exert any appreciable influence on share prices. Yet a number of influential theoretical works conclude that the structure of equity ownership may be a variable with value relevance within the framework of an empirical valuation model[2]. In this paper we investigate the value relevance of ownership distribution on share prices with data from the Athens Stock Exchange using panel data analysis an approach virtually ignored in the area of finance.

Previous studies use cross sectional analysis of US (mainly) and UK data. Cross sectional analysis cannot capture such dynamic relationships as changes in share ownership structure. Use of panel data is very important in capturing changes in ownership over time. Further the potential influence of ownership structure on various measures of performance has been studied in the absence of the effect exerted upon share prices and other measures of performance of other important valuation variables. In this paper we have attempted to address some of the issues, largely ignored by previous works, via (i) panel data analysis, (ii) explicit share valuation models, and (iii) appropriate estimation techniques.

In addition, we depart from all past papers in that we used Chamberlain's (1982) multivariate panel data method. This estimator allows one to have arbitrary error autocorrelation, and parameter temporal behavior. Contrary to previous studies using panel data, this estimator is significantly less restrictive. Existing implementations of panel estimators rely on the unrealistic assumption that parameters are the same over time, and there is no autocorrelation in the residuals, or that autocorrelation is of special form. It turns out that careful specification tests reveal the inadequacies of standard fixed or random effect estimators, and the superiority of the multivariate panel data method. Finally, it should be stressed that among all alternative methods of estimation used, only this one produced a statistically significant and econometrically well specified relationship between share prices and institutional shareholdings.

The remainder of this paper is structured as follows. In section 2 we briefly review the theoretical and empirical relationships between share prices and the structure of stock ownership. In section 3 we set out the economic model to be tested, while section 4 is devoted to the development of the appropriate statistical models. In section 5 we present and interpret the empirical findings while section 6 concludes the paper.

2.   Theoretical constructs
2.1   Efficient pricing of shares

Within an efficient markets framework share prices are a function of the risk adjusted benefits expected from shares. Shares are priced according to the expected benefits and systematic risks. Influences such as those that might be caused by the particular ownership structure of a company can be thought of as belonging to the specific risk category and as such are diversified away within the CAMP framework. Under this pricing regime the presence of institutional holdings and/or blockholders is value irrelevant. All shareholders (both, inside and outside) are value maximisers and homogeneous.

2.2   Managerial and Agency Theories

The separation of ownership from control has given rise to the development of managerial[3] and agency[4] theories. In the modern corporation the separation of ownership from control may lead to a divergence of interests between managers and shareholders. Proponents of managerial theories argue that managers use firm resources to operate the firm in their own interests. Management controlled firms are more likely to adopt non-wealth maximizing policies than owner controlled firms. Agency theorists distinguish between inside shareholders who manage the firm and outside shareholders. Managers who do not own shares tend to act in their own interests adopting investment and financing policies beneficial to them and not necessarily to the company shareholders. However, as management equity ownership increases management and outside shareholders interests coincide. The central idea of these studies is that the modern corporation may be viewed as a coalition of various groups (managers, individual, shareholders, trade unions, pension funds, mutual funds, debtholders etc.). Each group in order to protect its own interests monitors the management of the firm. The managers are viewed as a separate group with different interests from the other groups in the coalition. For example debtholders may opt for the acceptance of less risky investment projects, shareholders may press for long term performance, mutual funds may be interested in short term results while managers may be interested in the maximization of the growth of the firm. The net outcome of these conflicting interests will depend on the strength of the objectives of each group and the financial capacity to undertake the significant agency costs involved in pursuing this endeavor. This line of reasoning suggests that the issue as to the direction of the relationship between ownership structure and share prices can not be settled ex-ante but is essentially an empirical issue. Ex-ante we could not be certain as to whether management controlled

firms are more value relevant than owner controlled firms[5]. Against this we should cite the argument that competition in the managerial labor market and the presence on the board of outside shareholders would limit management discretionary powers[6].

2.3   Institutional Investors and Blockholders

Should we expect institutional investors and blockholders to be:
short-term speculators ; or
long-term wealth maximizing investors ;
The first type of behavior stems from the fact that fund managers, in particular, are themselves constantly being appraised for good quarterly/yearly performance[7].

When institutional investors hold large amounts of shares of a firm, short-term reductions in earnings per share may cause them to sell their shares lest they become locked into a losing stock. These transactions will cause a decline in the price of the stock possibly leading up to a hostile takeover bid. In an effort to reduce the probability of a takeover bid top managers may invest less in R & D projects, market development projects, management development programs and other long-term projects. This line of thought would predict a negative association between share prices and institutional holdings. This kind of behavior may further be reinforced by the fact that a significant proportion of shares exposes the fund to a high degree of specific risk. This perspective points to a negative association between share prices and the presence of institutional shareholders.

2.4   Efficient Monitoring Hypothesis

According to this hypothesis[8] institutional investors and large blockholders, unlike small individual shareholders, find it cost effective to monitor management behavior. The monitoring process of management actions compels the high echelon of management hierarchy into adopting value maximizing policies. According to this hypothesis we would expect no significant association between share prices and the presence of institutional investors and large blockholders. What we have therefore are various conflicting views and hypotheses regarding the effect of stock ownership on share prices.

2.5   Earlier Results

Many researchers have sought to shed light on the issues stated above. Their results are just as conflicting as are the competitive hypotheses they sought to investigate.

Regarding the issue of ownership controlled firms Short and Keasey (1997) found no influence on the company. Similar conclusions were reached by Holderness and Sheehan (1988). Leech and Leahy (1991) reported opposite results in that ownership controlled firms were associated with higher valuation ratios whereas Thonet and Pensgen (1979) found that management controlled firms were associated with higher market values but that owner controlled firms had higher growth in total assets.

There was no significant association between corporate value and block-holders as found by Hermalin and Weisbach (1988) Murali and Welch (1989) as found by Morck et al (1988). The issue of the effect of institutional holdings on firm performance did, (empirically), not fare any better. Whereas Pound (1988) and Graves (1988) report negative associations between value and institutional holdings and R and D and the size of institutional ownership respectively, Hansen and Hill (1991) found a positive association between R & D and institutional holdings. Two more studies found a positive association between value/return and the proportion of shares held by institutional investors. McConnell and Servaes (1990) and Chagnanti and Damanpour (1991).

As with all firm performance studies the results are mixed. Since the issues examined empirically have important implications for portfolio management and market efficiency, new and possibly more efficient examination procedures are called forth. For it is only through repeated testing with data from different market structures (and cultures) and different degrees of economic development that new knowledge may be derived.

2.6   Research Objectives

The present paper investigates the relationship between share prices and equity ownership of companies quoted on the Athens Stock Exchange (ASE). In this paper unlike others, we use panel data analysis and apply appropriate statistical techniques to measure empirical relationships. As we argue in section 4 panel data has a number of advantages over both cross section and time series data and allows us to obtain efficient and consistent estimates.

Our research hypothesis is based upon the theoretical valuation models and managerial/organizational perspectives surveyed in section 2 of this paper. Our basic empirical valuation model rests on the theoretical framework

developed by Ohlson (1989,1995) which is equivalent, to the dividend valuation model developed by Miller and Modigliani (1961).

3.   Share valuation models
3.1   The Economic Model

According to Ohlson (1989, 1995), under clean surplus accounting and assuming that the time series behavior of abnormal accounting earnings satisfies a certain stochastic process, a firm's market value is determined as follows:

$$MV_t = \mu\, A^a_t + \nu\, EQ_t + \varphi\left[V_t\right] \qquad (1)$$

where:
MV_t: is the market value of the equity for period t;
A^a_t: are the abnormal accounting earnings for period t;
EQ_t: is the book value of equity for period t;

$\left[V_t\right]$:   is a vector that contains all other non- accounting value relevant
        variables not yet affecting A^α_t and EQ_t.

For the purposes of our analysis, we will assume that the ownership variables are included in the $[V_t]$ and consequently we will be testing the following version of Ohlson's model:

$$P_t = a_0 + a_1 A^a_t + a_2\, EQ_t + a_3\, PO_t \qquad (2)$$

where :
P_t: is the common share price;
A^a_t: the abnormal earnings per share for period t;
A_t: the accounting earnings per share for period t;
EQ_t: the book value of equity per share at the end of period t;
R_f: the risk free rate of return at the beginning of period t;
PO_t: the percentage of shares held by investment trusts and mutual
            funds at the end of period t ;

3.2 Expected signs of the relationships

On the basis of the above analysis and in conjunction with the discussion of the theoretical constructs of the managerial/agency theories we expect the following relationships between the variables included in the economic model:

1. $\dfrac{dP}{dA^{\alpha}} > 0$. i.e. The greater the abnormal earnings per share the greater

   the price of a share.

2. $\dfrac{dP}{dEQ} > 0$ i.e. The greater the book value of equity per share, the greater

   the price of a share.

   3a. $\dfrac{dP}{dPO} = 0$ Changes in the proportion of equity held by institutional

investors have no effect on the price of a share. Apparently the market prices shares efficiently.

   3b. $\dfrac{dP}{dPO} < 0$. Changes in the proportion of the equity held by institu-

tional investors have a negative effect on share prices. In this case institutional investors are short-term traders causing management to adopt suboptimal policies.

   3c. $\dfrac{dP}{dPO} > 0$. Changes in the proportion of the equity held by institu-

tional investors constitute a factor of value.

   Thus, our approach specifies a certain number of variables as being important determinants of share valuation and in addition it specifies the sign of relationships that share prices may be expected to bear towards the variables affecting them.

   We have, therefore, a testable hypothesis and only by resorting to empirical testing will we be able to measure the response coefficients in question.

4. The sample
4.1 Sample Description and Data Sources

   The sample includes 59 firms listed on the Athens Stock Exchange for which all relevant ownership information were available for a six year period from 1991 to 1996 inclusive. Accounting and stock market data were taken from the Athens Stock Exchange database, the portfolios of the mutual funds and investment companies were constructed from primary data provided to us by institutional investors. Finally, the risk free rate was obtained from publications of the Bank of Greece.

4.2 Definition of Variables

For the purpose of testing empirically the model described by equation (2) the dependent and independent variables included are defined as follows:

P_t: is the common stock price six months after the end of fiscal year t:

A_t: is the accounting earnings per share for period t.

A_t^a: represents abnormal earnings per share for period t, that is $A_t^a = A_t - R_f EQ_{t-1}$. A_t^a could alternatively be defined as pure profits, it being the difference between earnings per share (A_t) minus the opportunity cost of these earnings ($R_f EQ_{t-1}$), according to Ohlson (1989,1995) and Feltham and Ohlson (1995) contributions.

EQ_t: represents the book value of equity per share for period t.

R_t: is the annual rate of return on one-year government bills at the beginning of period t.

PO_t: represents the percentage of shares held by investment trusts and mutual funds at the end of period t.

5. Econometric models

Researchers testing economic relationships analyse, as a rule, time series or cross section data. The main advantage of using time-series analysis is that it enables one to discover dynamic forces affecting the dependent variable in question. The main disadvantage is that time-series data may pose autocorrelation and multicollinearity problems. On the other hand, cross-section data may not pose serious problems of autocorrelation and multicollinearity but suffer from problems of heteroscedasticity and may not enable the researcher to detect dynamic forces, which may affect the dependent variable.

Algebraically the relationship can be represented as follows:

$$Y_{it} = \mu_i + \lambda_t + \sum_{k=1}^{K} \beta_k X_{kit} + \varepsilon_{it} \qquad i = 1, ..., N \qquad (3)$$
$$t = 1, ..., T$$

where Y_{it} represents the value of the dependent variable for cross-section i at time t, X_{kit} is the value of the k*th* explanatory variable for cross-section i at time t, μ_i is an unobserved cross-section effect, λ_t is an unobserved time effect and ε_{it} is the unobserved overall remainder. The above relationship may be estimated by making two assumptions; firstly that the μ_i and λ_t are fixed parameters and secondly that they are random. The first assumption

leads to the **dummy variable model**[9] while the second leads to the **error components model**[10].

The estimation of the coefficients involves the use of a modified Aitken procedure consisting of two stages. In the first stage the estimate of the variance of the error components were obtained using least squares with dummy variables residuals, a method proposed by Amemiya (1971), while in the second stage use is made of the familiar generalized least squares estimator:

One problem with the fixed-effects or random-effects formulations is that although the intercept β_{1it} is assumed to vary over individuals and/or time, a parameter constancy assumption is made regarding the remaining parameters. This is usual practice in applied econometrics.

The **SUR model** applied to panel data was proposed by Chamberlain (1982), and does not make restrictive assumptions about the autocorrelation of error terms, since it accommodates arbitrary patterns of autocorrelation. It also does not make restrictive assumptions about inter-temporal parameter stability as all parameters (or, of course, subsets of the parameter vector) can be time varying without restrictions on the pattern of inter-temporal variation. Moreover, likelihood ratio tests can be devised in a straightforward manner to test that certain parameters are constant over time, and / or serial correlation is absent. All these features are quite important over the more restrictive fixed- or random-effect treatments.

Formally, the specification is given by the following:

$$Y_{it} = \sum_{k=1}^{K} \beta_{kt} \cdot X_{kit} + \varepsilon_{it} \qquad (8)$$

to capture the idea that model parameters vary over time.

Writing (8) as

$$\underset{(1x1)}{Y_{it}} = \underset{(1xk)}{X'_{it}} \cdot \underset{(kx1)}{\beta_{t}} + \underset{(1x1)}{\varepsilon_{it}} \qquad (9)$$

where $X'_{it} = [X_{1it} \quad X_{2it} \ldots X_{kit}]$, and stacking all cross-section observations for a given time period, we obtain:

$$\underset{(Nx1)}{Y_{t}} = \underset{(Nxk)}{X_{t}} \cdot \underset{(kx1)}{\beta_{t}} + \underset{(Nx1)}{\varepsilon_{t}} \qquad t=1\ldots T \qquad (10)$$

This model can be estimated using SUR. For purposes of estimation, the SHAZAM computer program has been used. Notice that the standard assumption in SUR estimation is $\varepsilon_t \sim N(0,\Sigma)$. In this case, the covariance matrix Σ measures the correlations of ε_t's implying that no prior restrictions are placed on the autocorrelation of error terms. Similarly, by estimating different β_t 's no restrictions are placed on the temporal behavior of regression parameters.

6. Empirical findings
6.1 Diagnostic Tests For O.L.S.

As an initial step we present results of a number of diagnostic tests for Ordinary Least Shares (O.L.S.) (TABLE-1-). As can be seen from table 1, O.L.S. estimates seem to be associated with several problems such as: (i) non-normality in the equations for 1993-96, based on results of the Jarque-Bera test, (ii) heteroscedasticity for 1991 and 1993 (Breusch -Pagan and Gle-jser tests), (iii) functional form misspecification for 1991,1992 and 1996 (Ramsey test), and (iv) cross-section parameter instability as evidenced by the Chow break-point test. For these tests, see Greene (1997).

Although (ii) could be attributed to (i) and (iii) to (iv) the fact that test statistics reject so often the null hypothesis implies that O.L.S. estimates are unsatisfactory. For this reason we have decided to use random- effect model (RE) and SUR estimation in order to obtain better estimates. We consider it very important that the RESET test rejects the null hypothesis of correct functional specification. This finding accords well with findings reported in McConnell and Servaes (1990) and Morck, Schleifer and Vishny (1988) according to which the relationship should be curvilinear.

6.2 Diagnostic Tests For Alternative Estimating Techniques

Next we performed diagnostic tests for alternative estimating techniques (TABLE-2-).

The most interesting finding in table 2 is the statistically significant Ramsey misspecification tests for POLS (Pooling Least Squares), LSDV (Least Squares with Dummy Variables), and RE (Random Effect) equations, for 1991,1992 and 1996. On the other hand, SUR estimation seems to be free from Ramsey- type functional form misspecification. Corroborating evidence is provided by the sequential break-point Chow (1960) test which indicates parameter instability for 1991 and 1992 for all estimating methods except SUR. We take this as evidence in favor of SUR and against POLS, LSDV and RE estimators. Since the RESET test is quite general (the alternative hypothesis includes a variety of possible nonlinear models) we take this as evidence that POLS, LSDV, and RE are not correctly specified as one would expect from the evidence in McConnell and Servaes (1990) and Morck, Schleifer and Vishny (1988). However, the SUR model does not suffer from functional form misspecification problems implying that we need not worry about a possibly curvilinear or more generally about a nonlinear relationship.

Turning now to heteroscedasticity, we have conflicting results: Although Harvey's $X^2_{(3)}$ statistic finds no evidence in favor of heteroscedasticity, the

Breusch and Pagan $X^2_{(3)}$ statistic supports heteroscedasticity for 1991 and 1993 in connection with POLS,LSDV and RE (but not SUR). The conflict among the tests may be resolved by noting that heteroscedasticity could be of the form $\hat{u}^2_t = X_t'\gamma + u_t$ rather than $\log \hat{u}^2_t = X_t'\gamma + u_t$. It is, however, interesting that neither the Breusch and Pagan nor the Harvey tests reject heteroscedasticity for the SUR equations.

Non-normality is a common problem across estimating techniques. However, the Jarque and Bera $X^2_{(2)}$ test, although significant, is significantly lower, across years, compared to the values of the Jarque-Bera statistic for POLS,LSDV and RE.

Overall, it appears that functional form misspecification, heteroscedasticity, non-normality and parameter instability problems either completely disappear or become considerably less important when SUR is used. Based on this evidence we may conclude that SUR appears to be superior in terms of specification.

6.3 Empirical Results

Empirical results are reported in table 3. For POLS, LSDV, RE the coefficients are assumed time-invariant and the relevant parameter estimates as well as t-statistics are reported in the column with the heading "1991".

The last column (with heading "pooling /SUR") reports results for the SUR model assuming all coefficients are time invariant. It has been shown in connection with likelihood ratio tests that this model can be rejected in favor of a SUR model with all parameters being time-varying (with the exception of PO). Results for this model are reported in the row headed "SUR".

(i) Coefficients of A[a]

Our results are in accordance with our a priori expectations. Parameters corresponding to A[a] are generally positive, ranging from 1.97(LSDV) to 3.84 (POLS) , and they are highly statistically significant. SUR results show that this parameter shows high dynamic variation ,ranging from 0.78 (1995) to 2.85 (1991). It is interesting that t-statistics drop from an average of 6.0 for the period 1991-1993 to about 2.0 for the 1995-96 period.

(ii) Coefficients of EQ

In general this finding accords with the sign of our economic relationship. These coefficients are positive and (with the exception of LSDV) statistically significant. According to "SUR" there exists a clear downward trend with an accompanying reduction in t-statistics. It is interesting that according to pooled OLS and SUR , estimates are greater than one. According to LSDV,RE and pooled/SUR the coefficients are less than one.

(iii) Coefficients of PO

It may be recalled that we had identified three alternative perspectives pointing to a different relationship between share prices and the size of institutional holdings. PO seems to have a positive effect only according to pooled OLS. All other estimating techniques agree that this effect is negative. Both LSDV and RE imply that this effect is statistically insignificant. SUR (and pooling/SUR to lesser extent) on the other hand, imply a statistically significant effect. The relevant estimates are -1437.9 (-2.51) for SUR and -1131.5 (-1.98) for pooling/SUR. Of course, the negative contribution of PO implies that institutional investors are short-term traders, see (3b) in section 3.2.

We attribute this difference to the much satisfactory behavior of SUR in terms of values of the diagnostic statistics. Although in general, pooled OLS seems to give the lowest standard errors, the assumption that coefficients are time invariant is at odds with the data (see diagnostics in table 1). Utilizing this information is crucial in dealing with the misspecification problems implied by the constant coefficient assumptions. The gain materializes in much lower standard errors for EQ and PO.

The finding that the coefficient of PO is very close to statistical significance in pooling/SURE should not escape our attention. In this model, coefficients are also time invariant (as in POLS, LSDV, and SUR).This does not constitute a contradiction because (contrary to all other estimating techniques) both SUR and pooled SUR deal non-parametrically with the problem of auto-correlation (via the Σ matrix). This gives pooled SUR a t-statistic of -1.98 for PO, compared to 0.36 for POLS, -0.32 for RE and 1.62 for LSDV. The additional feature of SUR (abolition of parameter constancy assumption) further raises the t-statistic to -2.51 and moves the estimate downwards to -1437.9 (compared to -1131.5 for pooled SUR, -213.9 for RE, -1024.0 for LSDV and 262.8 for pooled OLS).

It may be noted that further support for the SUR model is provided by values of the R^2 statistic. This statistic is 0.936 for SUR, compared to 0.580 for POLS, 0.836 for LSDV 0.799 for RE and 0.737 for pooled SUR. Relying on our SUR results we could conclude that institutional investors appear to be short-term traders influencing negatively share prices.

7. Conclusions

We set out to investigate whether institutional holdings exert an independent influence on share prices. We used data from companies quoted on the Athens Stock Exchange, a market which, for some, is considered to be emerging whereas, for others, is already considered to be a developed stock market.

As to our main variable of interest, PO, we should stress the following. Based on LSDV and/or RE estimation this variable is value irrelevant that is insignificant. On the other hand, SUR estimation provides a statistically significant (as well as econometrically well specified) negative relationship. This result may be attributed to the restrictive assumptions about parameter temporal behavior made by LSDV and RE. Since SUR allows for an arbitrary pattern and seems to be free of functional misspecification problems the results obtained by SUR are more reliable.

Chamberlain's (1982) multivariate approach to estimating the economic relationships seems to be justified on empirical grounds. Among all alternative methods of estimation, only this method produced results in accordance with our expectations. Overall we could, therefore, argue that institutional investors appear to be investing for short periods of time, moving in and out of shares according to short-term results. This speculative behavior may compel management to cancel long-term financial policies resulting thus in future lower prices.

Notes

1. A large number of papers have been written on the subject matter of empirical valuation models see for instance Keenan (1970) and Karathanassis and Philippas (1988)
2. For an excellent review and critical appraisal of the relevant literature see Short (1994)
3. Williamson (1964).
4. Marris (1964). "The Economic Theory of Managerial Capitalism" MacMillan
5. Jensen and Meckling (1976)
6. Fama (1980) Demsetz (1983)
7. Drucker (1987).
8. Pound (1988)
9. The well known covariance analysis, which in the past had been used extensively in the area of production function. See Mundlak (1963) and Hock (1962).
10. Wallace and Hussain (1969)
11. Mundlak (1978) and Hausman and Taylor (1981)
12. For a number of variations of the error components model see Baltagi (1995).
13. Standard LR tests of parameter constancy indicate that all parameters (except the coefficient of PO) are time variant. Detailed tests are available upon request.

Table 1 Diagnostic statistics for OLS estimation

	1991	1992	1993	1994	1995	1996
Jarque –Bera Normality X^2_2	5.55	5.602	18.07*	17.051*	44.833*	55.159*
Heteroscedasticity						
Breusch-Pagan X^2_3	9.522*	2.897	13.405*	3.054	1.013	1.606
Harvey X^2	4.378	2.815	4.334	1.907	1.625	2.325
Glejser X^2_3	12.877*	4.995	16.040*	4.896	1.935	2.442
Ramsey Specification $F_{3.45}$	5.1469*	7.663*	0.614	1.481	0.966	5.849*
Harvey Tests (1990)						
Recursive t_{47} test	0.3076	0.8262	-0.1031	0.3139	-1.2393	0.3934
Heteroscedasticity test M=16	1.6365	0.7701	1.6342	1.3069	1.5833	1.009
Sequential Tests (Break out obs 26)						
$F_{22,22}$:Chow	2.615*	5.236*	1.715	0.299	0.884	0.458
$F_{22,22}$:Goldfeld-Quandt	0.527	1.021	1.277	0.635	0.627	0.322

* denotes significance at 5%

Table 2 Diagnostic statistics for alternative model specifications

		1991	1992	1993	1994	1995	1996
Normality Jarque-Bera test X^2_2	POLS	5,550	5,602	18,07*	17,051*	44,833*	55,159*
	LSDV	5,710	5,840	19,21*	18,61*	52,714*	57,121*
	RE	7,21*	7,84*	20,01*	21,12*	52,810*	59,211*
	SUR	7,08*	7,17*	14,020	9,750	12,31*	25,71*
Heteroscedasticity Breusch-Pagan X^2_3	POLS	9,522*	2,897	13,405*	3,054	1,013	1,606
	LSDV	11,12*	2,991	13,515*	3,128	1,115	1,818
	RE	12,310*	3,070	13,71*	3,212	0,997	1,515
	SUR	1,156	1,162	1,112	2,010	1,970	2,140
Heteroscedasticity Harvey X^2_3	POLS	4,378	2,815	4,334	1,907	1,628	2,325
	LSDV	4,128	2,910	3,991	2,015	1,515	2,221
	RE	4,128	2,716	4,128	1,918	1,619	2,410
	SUR	3,951	2,615	3,951	2,156	1,714	2,156
Misspecification Ramsey $F_{3,45}$	POLS	5,147*	7,663*	0,614	1,481	0,966	5,849*
	LSDV	5,235*	7,912*	0,712	1,492	0,875	6,128*
	RE	5,276*	8,012*	0,815	1,384	0,915	6,145*

	SUR	1,128	1,146	0,314	0,996	0,985	1,106
Harvey	POLS	0,308	0,826	-0,103	0,314	-1,239	0,393
Recurcive t_{47} test	LSDV	0,415	1,110	0,147	0,414	-0,975	0,412
	RE	0,611	1,212	-0,152	0,401	-0,995	0,577
	SUR	0,712	1,115	0,037	0,215	-0,996	0,499
Sequential test	POLS	2,615*	5,236*	1,715	0,299	0,884	0,458
Chow $F_{22,22}$	LSDV	2,412*	4,892*	1,814	0,312	0,812	0,515
	RE	2,976*	5,415*	1,761	0,320	0,851	0,616
	SUR	1,071	1,084	0,616	0,315	0,416	0,515
Sequential test	POLS	0,327	1,021	1,277	0,635	0,627	0,322
Goldfeld - Quandt	LSDV	0,471	0,915	1,115	0,612	0,591	0,415
$F_{22,22}$	RE	0,352	1,215	1,385	0,719	0,732	0,566
	SUR	0,214	0,966	1,101	0,721	0,615	0,416

Notes For Table 2

POLS: Pooled Least Squares, LSDV : Least Squares Dummy Variables Estimation, RE: Random effect, SUR: Seemingly Unrelated Regression Estimation.

A (*) denotes significance at the 5% level of statistical significance.

Table 3:
Estimation results (t-statistics in parentheses) for alternative estimating methods

		1991	1992	1993	1994	1995	1996	Pooling/SUR
Cons-tant	POLS	523,1 (5,7)						
	LSDV	-						
	RE	987,1 (7,5)						
	SUR	316,46 (2,68)	523,78 (3,69)	721,18 (3,79)	836,86 (6,41)	968,92 (4,73)	1011,8 (4,62)	748,14 (6,695)
A [a]	POLS	3,84 (12,76)						
	LSDV	1,97 (6,74)						

Group	Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	RE	2,56 (8,61)		1,87 (3,46)	2,37 (7,26)	0,78 (1,03)	2,21 (3,35)	2,661 (10,574)
	SUR	0,59 (6,33) 3,375 (5,39)	2,85 (7,97)					
EQ	POLS	1,14 (16,31)						
EQ	LSDV	0,04 (0,39)						
EQ	RE	0,54 (6,33)						
EQ	SUR	1,68 (6,95)	1,16 (8,11)	1,17 (6,83)	0,85 (8,48)	0,51 (3,09)	0,54 (3,46)	0,879 (9,981)
PO	POLS	2,28 (0,36)						
PO	LSDV	-1024 (-1,62)						
PO	RE	-213,9 (-0,32)						
PO	SUR	-1437,9 (-2,51)						-1131,9 (-1,98)
	POLS	0,581						
	LSDV	0,836						

$\overline{R}^2$		
RE	0,799	
SUR	0,963	
POOL-ING SUR*	0,737	

* *Pooling SUR*: SUR applied to the model under the assumption that all coefficients are time-relevant.

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