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MODELLING AND ESTIMATION OF NATIONALIZATIONS AND INVESTMENT FLOWS IN LESS DEVELOPED COUNTRIES*

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Abstract: The selective nationalizations of foreign-owned affiliates and the flows of direct investment across developing countries are modelled as a two-equation model. In the investment flow equation least squares estimators are employed for the annual panel data and fixed effects under assumptions of serial correlation and heteroskedasticity. For the dichotomous dependent variable nationalization equation, a fixed effect linear probability model is given. A maximum likelihood estimator based on the log-generalized F distribution is used to study distributional properties in the presence of fixed country effects and to give final estimates. The estimated model is used to study the consequences spatially as well temporally of various economic policies.

1. Introduction

A country's option to nationalize (i.e. seize foreign-owned equity with or without compensation) is often argued to prevent direct investment from being undertaken (e.g., Williamson, 1986), but this has not been supported by econometric evidence. Large 'political' nationalizations in, e.g., Cuba were from the late 1960s followed by more selective nationalizations. These were widely spread and accompanied by measures to attract new investment. Economic factors have become important and political ones less so (e.g., Jodice, 1980). The view adopted here is that nationalization of foreign-owned affiliates can be seen as an outcome of economic decisions.

Direct investment initially requires sunk costs in, e.g., equipment, while benefits accrue later as profit repatriation. For the host country benefits accrue in the early stage, and costs later as capital outflows. As improved access to technology and export markets would increase this ability of developing countries

* A full account of the economic background and implications are reported in Andersson and Brännäs (1990). AnnaMaria Bengtsson, Stockholm School of Economics, assisted with the data. Financial support from Svenska Bankforskningsinstitutet and the Swedish Research Council for the Humanities and Social Sciences is gratefully acknowledged.

to run projects under domestic ownership, the theory of obsolescing bargain (Vernon, 1971) holds that 'political risk' grows over time. This theory seemed supported as a substantial share of all direct investment in developing countries was nationalized in the early 1970s (e.g., Kobrin, 1980). From the mid 1970s nationalizations became less frequent and flows of direct investment were stagnating. In response to the belief that political risk continues to play a role, the Multilateral Investment Guarantee Agency was established in 1989. The empirical literature has, however, not been able to pin down the cause and effect of nationalization (Jodice, 1980; Green, 1974; Thunell, 1977).

Different host countries compete for investment projects (Guisinger, 1985). Andersson and Brännäs (1988, 1989) and Andersson (1990) examine the cross-country pattern in nationalizations as well as the policy's decline in the late 1970s. Here, we add to these studies by investigating the mutual dependence between nationalizations and investment flows across developing countries.

In this paper we estimate a two-equation model using panel data. Year-wise observations between 1970 and 1985 of investment flows and nationalization decisions serve as dependent variables. The investment flow equation is estimated by least squares estimators under a fixed effect specification and under assumptions of serial correlation and heteroskedasticity. For the dichotomous dependent variable nationalization equation, a fixed effect estimator building on the linear probability model is used. The resulting estimates are used to initialize a fixed effect maximum likelihood estimator based on the log-generalized F distribution. Fixed effect logit and probit models are among the special cases in this general model class.

In Section 2 a theoretical framework and the specification of the model are given. The data are presented in Section 3. The estimators are introduced in Section 4, and the estimation results given in Section 5. Section 6 contains a small policy study to reflect on the properties of the model over time and across countries. Some additional remarkson the statistical analysis are offered in the final section.

2. Theoretical Framework and Model

Each firm and country seeks to gain as much as possible from direct investment. Since firms may move elsewhere, host countries' taxation of profits is limited (Andersson, 1990). This raises a motive for nationalization.

Given that there are many potential host countries ($i = 1,...,m$), a firm invests where the expected profit $(1-r_i)(1-\phi)\pi_i - s$ is the largest. The investment is 0 (no country) in case the sunk cost (s) is not covered by the profit (π_i) adjusted for tax (ϕ) and the risk of nationalization (r_i).

Each country i maximizes its return from direct investment by its decision what proportion of projects to nationalize. A host country earns the whole profit from the share of investment that is nationalized, and tax revenue from that which is not. In addition, there is a cost of discouraging direct investment in subsequent periods. The amount discouraged is determined by the occurrence of nationalizations across countries. The cost depends on the level of tax and the extent of nationalization subsequently. Nationalization occurs only when profit under domestic ownership exceeds the tax income under foreign ownership, since it cannot pay for a host country otherwise. The effect of discouraging future direct investment is crucial for preventing nationalization, as is consequently the policies pursued by other developing countries. The closer competitors countries are for direct investment, the more important how other ones behave. The above summarized representation allows us to develop hypotheses for empirical testing.

Nationalization has an impact on a country's image as 'friendly' or 'unfriendly' towards foreign investors. Viewing this impact as partial and transitory, we expect nationalization to effect investment flows and the occurrence of nationalizations in the subsequent period. Setting up a two–equation model, we write the flow of direct investment to a country at time t, and the occurrence of nationalization, as functions

$$y_{1t} = y_{1t}(\underset{-}{y_{2t-1}}, \underset{+}{g_{t-1}}, \underset{-}{\phi_t}, \underset{+}{\pi_t}, \underset{-}{s})$$

$$y_{2t} = y_{2t}(\underset{+}{g_{t-1}}, \underset{-}{\delta}, \underset{+}{{}_n\pi_t}, \underset{-}{\phi_t}, \underset{-}{\pi_t})$$

with the sign of derivatives given below. In these expressions ${}_n\pi_t$ is the profit under domestic ownership, and δ is the discount factor. The latter should be negatively related to nationalizations as a great deal of discounting makes a country insensitive to future losses of direct investment.

In the investment function a negative effect of y_{2t-1} on y_{1t} is expected and a positive one of g_{t-1}. No previous studies have been able to verify an effect of y_{2t-1} on y_{1t}. We expect such an effect which is larger the fewer nationalizations there are in other countries, whereas there should be a positive impact of g_{t-1} on y_{1t} when the country itself does not nationalize. For these reasons we expect to find significant multiplicative effects.

The other explanatory variables are not directly observable in most instances, and the many small countries included in this study makes it difficult to obtain data for coherent proxy variables. Hypotheses are formulated in three categories (see Andersson and Brännäs, 1990, for motivations);

Category 1 (variables associated with the efficiency requirement for nationalization)
– The rate of growth (x_1): Negative impact on y_{2t} and positive on y_{1t}.
– Export prices (x_2): Positive impact on y_{2t}.
– GDP/capita (x_3): Ambigous influence on y_{2t}, but positive on y_{1t}.
Category 2 (variables associated with a country's ability to attract direct investment and with the discouraging effect of nationalization on direct investment)
– The stock of direct investment (x_4): Positive impact on y_{1t}, and ambigous on y_{2t}.
– GDP'(x_5): Positive impact on y_{1t}, and ambivalent on y_{2t}.

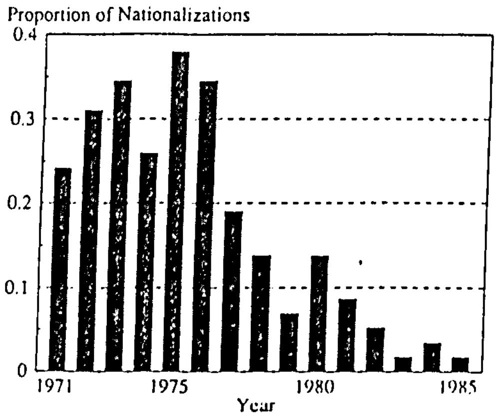

Figure 1: Year-wise proportions of nationalizations across countries.

Category 3 (indirect effects of nationalization)
– External indebtedness (x_6): Negative impact on y_{2t}.

We have the following two equation system, with y_{1it} the flow of direct investment into country i in year t and η_{2it} a latent nationalization pressure variable;

$$y_{1it} = \beta_{10}+\beta_{11}g_{it-1}y_{2it-1}+\beta_{12}g_{it-1}(1-y_{2it-1})+\beta_{13}x_{3it}+\beta_{14}x_{4it}+\beta_{15}x_{5it}+\varepsilon_{1it} \quad \ldots \quad (1)$$

$$\eta_{2it} = \beta_{20}+\beta_{21}x_{1it}+\beta_{22}x_{2it}+\beta_{23}x_{3it}+\beta_{24}x_{4it}+\beta_{25}x_{5it}+\beta_{26}d_t x_{6it}+\beta_{27}g_{it-1}+\varepsilon_{2it}\,. \quad \ldots \quad (2)$$

The nationalization pressure, η_{2it}, can only be observed in a dichotomous form, i.e.

$$y_{2it} = \begin{cases} 1, & \eta_{2it} \geq 0 \\ 0, & \eta_{2it} < 0, \end{cases}$$

is the observed nationalization decision.

The g_{t-1} variable is the proportion of nationalizations in other countries in the previous year, and d_t is a dummy for the period 1974–1978. The occurrence of nationalizations in other countries, g_{t-1}, enters the investment and the nationalization equations, but only in lagged form. If the g_{t-1} variable was replaced by current nationalization decisions, g_t, the separate country models would be linked and in the end make η_{2it} dependent on the observed y_{2it} instead of on y_{2it-1}. By the present construction the two–equation model is logically consistent (e.g., Maddala, 1983, ch. 5).

One comment needs to be made with respect to the stock of direct investment x_{4it}. The stock is by definition $x_{4it} = y_{1it} + x_{4it-1}$. Actual measures do not satisfy the identity. In the present data y_{1it} is in average only 4 per cent of x_{4it}. In addition, a regression of y_{1it} on $(x_{4it} - x_{4it-1})$ has an R^2 as low as .68. This is a reasonable empirical excuse for not dealing with the additional complexities in estimation that arise for a lagged endogenous variable in the left hand side of (1).

3. Data

The data over nationalizations of foreign affiliates by developing countries have been obtained by Kobrin for 1960–1979, and Minor for 1980–1985. The unit of analysis comprises the taking of all firms in an industry in a country in a given year. The data are collected at firm level, and later aggregated (into 'acts'). This data base allows for the most comprehensive coverage possible for 1960–1985 as a whole. An 'act' is the most reasonable unit of aggregation as the taking of individual firms is not comparable. In addition, there is no information on the dollar value taken, the amount of compensation, etc. Therefore nationalizations are treated as dichotomous. This is consistent with the signalling effect on a country's reputation. In Figure 1 the year–wise proportions of nationalization across the countries are given.

Concerning investment and explanatory variables, year–wise values are obtained from secondary sources.[1] To allow for an inclusion of as many countries as possible the test period is limited to 1970–1985. For the investment equation observations on 56 countries are available, and 57 for the nationalization equation. Countries with missing observations are excluded.

4. Estimation

We add to the specification in (1) a fixed country effect. The fixed effect reflects countrywise heterogeneity that is not picked up by other variables. The equation may compactly be written as

$$y_{1it} = x_{1it}\beta_1 + \alpha_{1i} + \varepsilon_{1it}, \tag{3}$$

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1 Data on flows and stocks of investment are obtained from UNCTC (1988), OECD, and the World Bank. Explanatory variables are obtained from the United Nations (1977, 198?, 1986), International Monetary Fund, the World Bank, and UN data printouts.

where the fixed effect α_{1i} incorporates β_{10}. By assuming a fixed effect we limit the generalizability of the results to the studied countries (e.g., Hsiao, 1986, ch. 3). The results are generalizable in the time direction, however.

In a similar manner we write equation (2) in a compact form with a countrywise fixed effect α_{2i} that includes β_{20},

$$\eta_{2it} = x_{2it}\beta_2 + \alpha_{2i} + \varepsilon_{2it}. \quad (4)$$

The covariance matrix ($2mT$x$2mT$) of the stacked (over T time units and m countries) disturbance term is

$$\Omega = Cov\begin{bmatrix}\varepsilon_1\\ \varepsilon_2\end{bmatrix} = \begin{bmatrix}\Omega_{11} & \Omega_{12}\\ \Omega_{21} & \Omega_{22}\end{bmatrix}.$$

Different assumptions are possible about the blocks of the Ω matrix. We assume throughout that the disturbance terms in the two equations are uncorrelated, i.e. that the blocks $\Omega_{12} = \Omega_{21}' = 0$. Before attempting to estimate the unknown parameters under the fixed effect assumption we have to give explicit structure to the other parts of the covariance matrice. For the Ω_{11} block we employ a structure that allows for diagonal blocks (within country) with possibly different variances for the different countries. In addition, we recognize the potential prevalence of a first order autoregressive serial correlation generated by

$$\varepsilon_{1it} = \rho_i \varepsilon_{1it-1} + u_{it}.$$

The heteroskedasticity then arises both from ρ_i and $V(u_{it}) = \sigma_i^2$.

We adopt the conventional procedure of first removing the fixed effects by subtracting means from variables, i.e.

$$y_{1it} - \bar{y}_{1i} = (x_{1it} - \bar{x}_{1i})\beta_1 + (\varepsilon_{1it} - \bar{\varepsilon}_{1i}), \quad (5)$$

where

$$\bar{y}_{1i} = T^{-1}\Sigma_t y_{1it}, \bar{x}_{1i} = T^{-1}\Sigma_t x_{1it}, \text{ and } \bar{\varepsilon}_{1i} = T^{-1}\Sigma_t \varepsilon_{1it}.$$

The ordinary least squares (OLS) estimator is used to estimate β_1 in (5). The resulting estimated residuals are used to estimate ρ_i for the individual countries. After a Prais–Winsten type transformation for each country and OLS estimation on the transformed data we may estimate σ_i^2 (assumed constant within countries) and use a weighted LS estimator to produce the final estimates (e.g., Kmenta, 1986, ch. 12).

Another consistent but less efficient estimator is the OLS estimator applied after the Prais–Winsten transformation. The covariance matrix of this estimator can be estimated by the heteroskedasticity consistent covariance matrix estimator of White (1980),

$$(X'X)^{-1} X' S_{11} X (X'X)^{-1} ,$$

where S_{11} is a diagonal matrix with squared residuals on the diagonal, and X is the transformed data matrix. A straightforward adaptation of the related Newey and West (1987) consistent covariance matrix estimator for heteroskedasticity and serial correlation of unknown form to the present setting could be applied after OLS estimation on the mean differenced data. Presently, this estimator is not utilized.

The estimated countrywise fixed effects are obtained from

$$\hat{\alpha}_{1i} = \bar{y}_{1i} - \bar{x}_{1i} \hat{\beta}_1 .$$

Concerning the nationalization equation without a fixed effect and an assumption of a diagonal Ω_{22} matrix, several alternative estimators are available for the estimation of unknown parameters. Until recently such estimators were generally based on explicit distributional assumptions and maximum likelihood estimation (e.g., Gourieroux, 1989). For the estimation of models with fixed effects and only very few time periods a logit specification is suggested to be the only feasible one (e.g., Chamberlain, 1984; Maddala, 1987). Conditioning on a sufficient statistic eliminates the incidental parameter problem in this case. By this approach it is not possible to obtain predicted probabilities. For consistent estimation of the fixed effects the number of time periods has to grow faster than the number of countries. This is a characteristic of our data. For estimation along the conventional lines one has two options. Either one can extend the logit approach of, e.g., Chamberlain (1984), which gives estimates of β_2, by solving for α_{2i} from their likelihood equations, or one can use a conventional likelihood estimator that is not necessarily based on a logit specification. The latter results in many parameters to estimate at one time.

There is reason to question the universal validity of a logit specification and predicted probabilities are of considerable interest for policy studies. A specification that offers the latter feature is the linear probability model (e.g., Pindyck and Rubinfeld, 1981, ch. 10). The extended specification with fixed effects can still be conveniently estimated. The parameter estimator is consistent, and we suggest a consistent estimator of the associated covariance matrix. As a by-product estimates of the fixed effects are obtained. Computationally the procedure is not more complex than the ones for the investment flow equation and very much faster than any estimator for a logit or related fixed effect specification. This estimator may also serve as a convenient generator of initial parameter estimates for maximum likelihood estimation.

The difference from means form is

$$y_{2it} - \bar{y}_{2i} = (x_{2it} - \bar{x}_{2i})\beta_2 + (\varepsilon_{2it} - \bar{\varepsilon}_{2i}) , \tag{5}$$

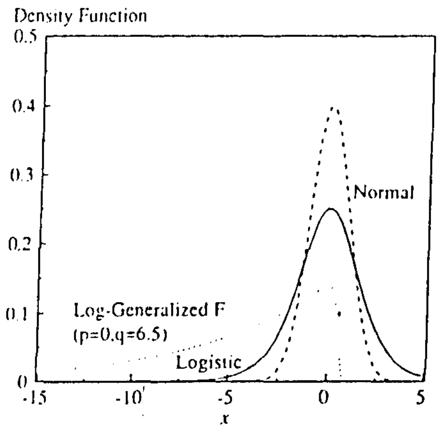

Figure 2: Standard normal and logistic densities together with a log-generalized F density evaluated at $q = 6.5$ and $p = 0$.

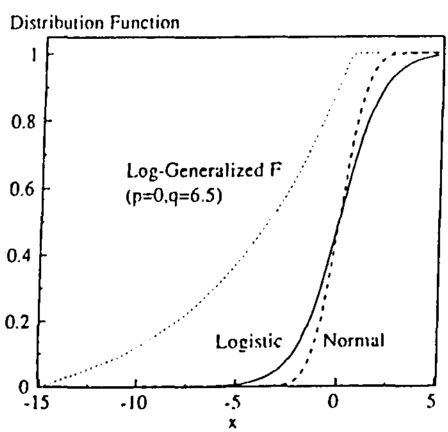

Figure 3: Standard normal and logistic distribution functions together with a log-generalized F distribution evaluated at $q = 6.5$ and $p = 0$.

where

$$\bar{y}_{2i} = T^{-1}\Sigma_t y_{2it},\ \bar{x}_{2i} = T^{-1}\Sigma_t x_{2it},\ \text{and}\ \bar{\varepsilon}_{2i} = T^{-1}\Sigma_t \varepsilon_{2it}.$$

The OLS estimator of β_2 is consistent, while the corresponding conventional OLS covariance matrix estimator is not. The covariance matrix for the vector of disturbances in (5) for country i is additive, i.e.

$$\Xi_{2i} = \theta_{1i} + \theta_{2i},$$

where $\theta_{1i} = diag(Ey_{2it}(1-Ey_{2it}), t=1,...,T)$ and θ_{2i} has zeroes on the main diagonal and off-diagonal elements

$$-T^{-1}[Ey_{2it}(1-Ey_{2it}) + Ey_{2is}(1-Ey_{2is})] + T^{-2}\Sigma_t Ey_{2it}(1-Ey_{2it}). \quad (t \neq s)$$

The covariance matrix estimator is then

$$(X'X)^{-1}X'S_{22}X(X'X)^{-1},$$

where S_{22} is block diagonal with estimated diagonal blocks Ξ_{2i}, and X is in differences from the means. The expectation $Ey_{2it} = Pr(y_{2it}=1)$ is consistently estimated by

$$\hat{y}_{2it} = \hat{\alpha}_{2i} + x_{2it}\hat{\beta}_2 = \bar{y}_{2i} + (x_{2it} - \bar{x}_{2i})\hat{\beta}_2,$$

since $\hat{\alpha}_{2i} = \bar{y}_{2i} - \bar{x}_{2i}\hat{\beta}_2$. Since the off-diagonal elements of Ξ_{2i} are small and tend to zero as T grows it is expected that the heteroskedasticity consistent covariance matrix estimator of White (1980) will give approximately the same results.

The linear probability model is based on a distributional assumption that may be questioned (see, e.g., Pindyck and Rubinfeld, 1981, ch. 10). The maximum score estimator (e.g., Manski and Thompson, 1976) is based on weak distributional assumptions and appears a promising alternative. This estimator has not been employed for fixed effects and it could due to size limitations of available programs not be used here.

To allow for a more general distributional specification with estimable fixed effects we adopt the log-generalized F family of distributions (Prentice, 1975). In reparameterized form the distribution is characterized by two parameters q and p. The logit ($q = 0$ and $p = 1$), probit ($q = 0$ and $p = 0$), and extreme-value ($q = 1$ and $p = 0$) models are among the special cases in the family. Figures 2 and 3 gives illustrations. Within the family it is possible to simultaneously estimate the unknown parameters α_{2i} and β_2 and to find that distribution, through q and p, which is best supported by the data. Empirical applications of the slightly narrower log-generalized gamma family ($p = 0$) are reported by, e.g., Farewell and Prentice (1977) for censored regressions, and Brännäs and Laitila (1989) for truncated regressions.

The likelihood to be maximized takes the form

$$L = \Pi_{it}\ Pr(\eta_{2it} \geq 0)^{y_{2it}}\ Pr(\eta_{2it} < 0)^{1-y_{2it}},$$

where $Pr(\eta_{2it} < 0)$ is the distribution function of the log-generalized F. The estimation may be numerically tricky and time consuming as the distribution function is explicit only for the logit and extreme-value specifications. When distribution functions are explicit, these may be utilized. The iterations are throughout performed with the method of scoring. For the log-generalized gamma distribution ($q > 0$ and $p = 0$) we have the incomplete gamma integral

$$Pr(\eta_{2it} \geq 0) = Pr(\varepsilon_{2it} \geq -\alpha_{2i} - x_{2it}\beta_2) = \{\Gamma(q^{-2})\}^{-1} \int_a^\infty t^{q^{-2}-1} e^{-t}\, dt,$$

where $a = exp(-\alpha_{2i} - x_{2it}\beta_2 - ln\ q^2)$ and $\Gamma(.)$ is the gamma function. The gradient vector has elements

$$\sum_{i=1}^{m} \sum_{t=1}^{T} x_{2itk} f_{2it}$$

for regressor parameters and for fixed effects

$$\sum_{t=1}^{T} f_{2it},$$

where $f_{2it} = q\phi(y_{2it} - I)/(I(1-I))$ and where $I = Pr(\eta_{2it} \geq 0)$, and $\phi = \{-\Gamma(q^{-2})\}^{-1} \cdot exp(q^{-2}\ ln\ a - exp(ln\ a))$. The information matrix has elements of the form;

$$q^2 \sum_{i=1}^{m} \sum_{t=1}^{T} x_{2itk} x_{2itp}\, \phi^2/(I(1-I)),$$

$$q^2 \sum_{t=1}^{T} \phi^2/(I(1-I))$$

and

$$q^2 \sum_{t=1}^{T} x_{2itp}\, \phi^2/(I(1-I))$$

for regressor parameters, fixed effects, and their covariation, respectively. The information matrix evaluated at final estimates (with q treated as a fixed

Table 1: Parameter estimates (t-values in parentheses) for the investment flow model (n=840, 56 countries). OLS/HCSE is the OLS estimator and the heteroskedasticity consistent covariance matrix estimator, SC is the OLS estimator based on the Prais-Winsten transformation, SC/WEIGHT is based on weighted least squares.

Variable	Fixed Effects			No Fixed Effects		
	OLS HCSE	SC HCSE	SC WEIGHT	OLS HCSE	SC OLS	SC WEIGHT
$y_{2t-1}g_{t-1}$	8.89	93.78	11.35	89.79	193.81	131.53
	(.16)	(1.72)	(2.00)	(1.93)	(2.51)	(1.67)
$(1-y_{2t-1})g_{t-1}$	19.74	79.78	12.90	165.38	189.61	141.92
	(.41)	(1.41)	(2.70)	(2.95)	(2.72)	(2.00)
x_{3t}	.0761	.0644	.0117	-.0026	-.0127	-.0033
	(4.12)	(2.72)	(2.30)	(-.43)	(-1.73)	(-1.98)
x_{4t}	.0425	.0468	.0554	.0748	.0644	.0501
	(2.42)	(1.90)	(6.40)	(6.78)	(9.73)	(9.62)
x_{5t}	-.0019	-.0021	-.0007	-.0001	.0003	-.0001
	(-1.40)	(-1.10)	(-2.02)	(.30)	(.88)	(-1.06)
Constant	-	-	-	-35.17	-36.91	-56.07
				(-2.82)	(-1.75)	(-2.30)
R^2	.05	.04	.06	.44	.18	.13

parameter) therefore serves as a basis for the covariance matrix of parameters. To obtain a confidence interval for q we use the relative likelihood function $R(q) = 2[l(q)-l(q^*)]$, which asymptotically is $\chi^2(1)$-distributed (see, e.g., Farewell and Prentice, 1977). Here, q^* maximizes the likelihood function. The incomplete gamma integral is evaluated by function GAMMQ (cf. Press et al., 1986). The estimation is performed using a single precision Fortran code on PCs (80286/7 and 80486 CPUs).

To indicate the goodness of fit in the nationalization equation we may, e.g., calculate the proportion of correct fits or use the pseudo-R^2 of Laitila (1989);

$$R^2 = \hat{\beta}'S\hat{\beta}\,/(\sigma^2+\hat{\beta}'S\hat{\beta})\ .$$

This measure is an estimator of the R^2 in the underlying model (4). The covariance matrix of X, extended with dummies for fixed effects, is denoted S, and $\sigma^2 = \pi^2/3$

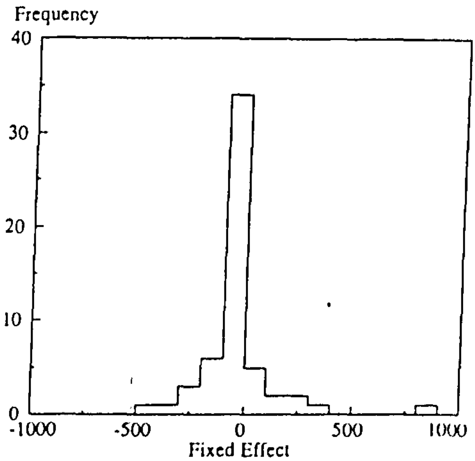

Figure 4: Estimated fixed effects for the investment flow model.

in the logit case, $\sigma^2 = 1$ in the probit case, and $\sigma^2 = \psi'(q^{-2})$ (i.e. $\partial^2 ln\Gamma(b)/\partial b^2$ evaluated at q^{-2} for $p = 0$). For large values on q, σ^2 will become large and dominate the pseudo–R^2, which as a result will be small.

5. Results

Table 1 gives the parameter estimates for the investment equation. In the first part of the table, fixed effects are taken into account. From the large variation in the fixed effects it follows that there is a great deal of country heterogeneity, cf. Figure 4. The most trust is placed in the fixed effect estimator that takes both heteroskedasticity and serial correlation into account. There is considerable variation in the ρ_i estimates (cf. Figure 5). This suggests that a specification with a constant ρ over the countries is less convincing. The stock of investment (x_4) and GDP per capita (x_3) both exert significant and positive effects on the flow of investment. Nationalizations in other countries appear to exert a positive influence on the flow to a country, and this is larger when the country is not nationalizing itself.

In Table 2 we give estimates for the nationalization equation with fixed effects and based on the linear probability model and two members of the generalized F. The relative likelihood function is given in Figure 6, and member densities and distributions in the generalized F class are plotted in Figures 2 and 3. The high value of q and the shape of the function suggest that logit and probit

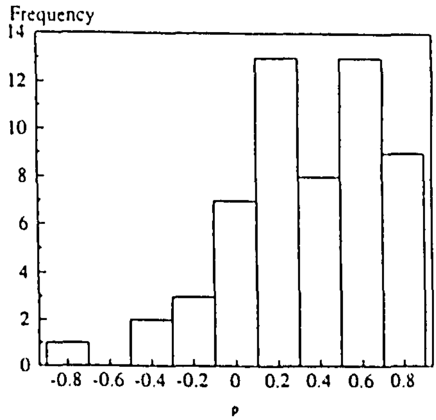

Figure 5: Histogram of estimated parameters ρ_i.

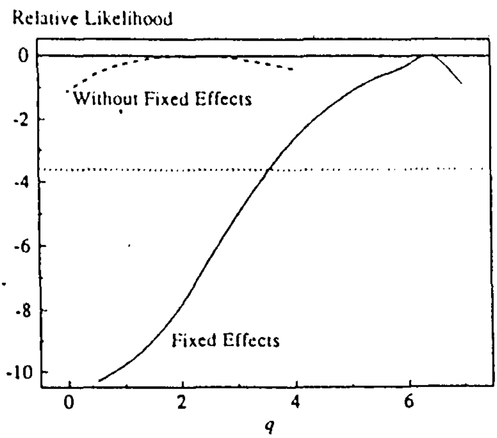

Figure 6: The negative relative likelihoods for the nationalization equation with and without fixed effects. The q indicates a specific member in the log-generalized F family when $p = 0$. The dotted line is placed at $-\chi^2(1, \alpha{=}.05){=}-3.84$.

Table 2: Parameter estimates (t-values in parantheses) for the nationalization model with and without fixed effects (n=855, 57 countries).

Variable	Fixed Effects			No Fixed Effects		
	Lin Prob	Logit	Gen F^a	Logit	Probit	Gen F^b
x_{1t}	-.0028	-.0173	-.0324	-.0389	-.0218	-.0195
	(-1.71)	(-2.53)	(-1.66)	(-2.81)	(-2.81)	(-2.61)
x_{2t}	.0016	.0105	.0227	.0096	.0056	.0059
	(3.51)	(5.16)	(3.58)	(3.70)	(3.70)	(2.78)
x_{3t}	6.8E-5	6.0E-5	8.3E-5	-3.0E-6	-6.4E-7	2.2E-6
	(.96)	(2.14)	(.85)	(-.14)	(-.05)	(.15)
x_{4t}	2.3E-5	1.3E-4	1.6E-4	-6.8E-5	-3.3E-5	-1.8E-5
	(1.64)	(2.08)	(.73)	(-.81)	(-.75)	(-.56)
x_{5t}	-2.7E-5	-4.2E-5	-4.2E-5	3.2E-6	1.6E-6	7.5E-7
	(-1.80)	(-6.77)	(-2.05)	(.95)	(.85)	(.48)
$D_t x_{6t}$	.0007	.0053	.0096	.0050	.0030	.0030
	(.73)	(1.58)	(1.01)	(.95)	(.97)	(.87)
g_{t-1}	.7487	7.008	11.016	6.638	3.693	3.283
	(6.55)	(15.93)	(7.02)	(7.25)	(7.44)	(7.21)
Constant	-	-	-	-3.230	-1.850	-.955
				(-12.63)	(-14.20)	(-10.70)
l	-	-265.39	-259.50	-325.29	-324.46	-323.90
% correct	83.7	85.3	84.1	84.6	84.6	84.6
Pseudo-R^{2c}	.13	.94	.00	.23	.24	.01

a q=6.5
b q=2.25
c Not for the linear probability model.

specifications can be rejected. Without fixed effects the relative likelihood function is much flatter and equally clearcut rejections can not be made. Fixed effect estimates are plotted in Figure 7. In Figure 8 predicted probabilities for the logit and the estimated log-generalized F models are compared. The latter ones are increasingly and significantly smaller. The t-values for the linear probability and the log-generalized F models are quite close. The fits of the two models are quite close as judged by the proportions of correct fits. The pseudo-R^2 suggests good fit for the logit model, while the fit is seemingly poor for the log-generalized F cases. This is due to extremely large σ^2's (1786.7 for q = 6.5 and 26.9 for q =2.25).

The estimators for the log-generalized F model converged rapidly when reasonable starting values were used. The corresponding free of fixed effect model estimates served satisfactorily in this respect; fixed effects were initialized at the value of the constant term. Convergence was generally reached in less than 30 iterations and only in a few minutes for the 64 parameters and 855 observations on an IBM 80486 PC.

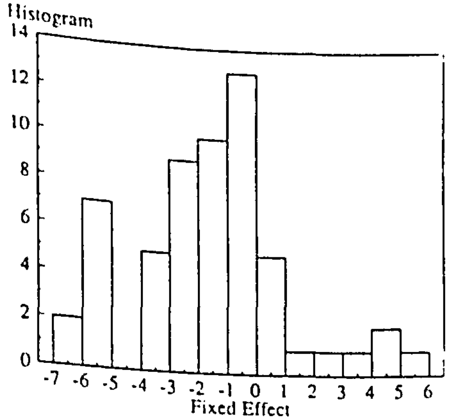

Figure 7: Estimated fixed effects for the nationalization model in the log-generalized F model formulation.

The occurrence of nationalizations in other countries (g) exerts an anticipated positive effect. The category 1 variables, the rate of growth (x_1) and export prices (x_2), had the expected signs albeit the former is significant only at the 10 per cent level in the log-generalized F specification with fixed effects. This supports the view that the prevalence of large profits to take and a great need of doing so has been a major motive for nationalization in developing countries. The variables of category 2 had the expected signs but only the size variable GDP (x_5) is significant. The external indeptedness (x_6) is not significant and of an unexpected sign.

6. Policy Studies

One way of improving our understanding of the model properties is through its implications. Policy experiments to study spatial and temporal effects is one step in this direction. The present within sample experiment is limited to 1980–1985. The focus is on the risk of widespread nationalizations with different behaviour in exogenous variables. The growth (x_1) and change in export prices (x_2) are the policy variables of prime interest.

The values recorded in 1979 for g_{t-1} and $x_{4\,it-1}$ are used as initial values. Future values on y_{1it}, η_{2it}, y_{2it}, g_{t-1}, and $x_{4\,it}$ are calculated. The policy variables

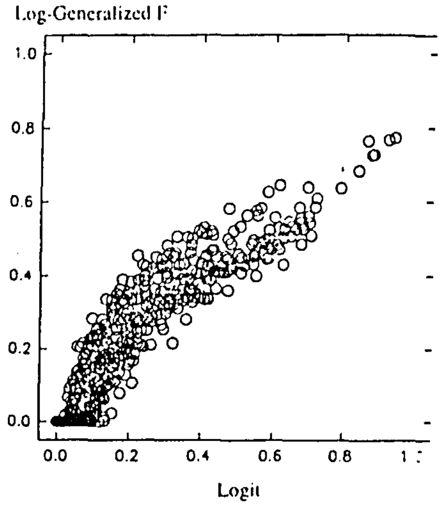

Figure 8: Predicted probabilities for fixed effect log-generalized F vs. logit model probabilities.

are changed from observed values with a constant proportion. For the growth rate we are interested in a decline, while in an increase for the export price. Other variables are as observed in the period. Parameter estimates are obtained from the log-generalized F specification with fixed effects for the nationalization equation and for the fixed effect, serial correlation,and heteroskedasticity specification for the investment flow equation.

For the calculations we assume the $x_{4it} = y_{1it} + x_{4it-1}$ identity to hold. Calculations are then performed on the reduced form for the three endogenous variables y_{1it}, x_{4it}, and η_{2it}. When $Pr(\eta_{2it} \geq 0) \geq 0.5$ we set $y_{2it} = 1$ and 0 otherwise. Based on the y_{2it}'s the g_t variable is calculated. The calculations are repeated until values for $t = 1985$ have been determined.

The results are obtained as matrices (over time and country) for each response variable. In Table 3 the expected number of years of nationalization ($p_{1980}+...+p_{1985}$) is given. The nationalization state is highly stable in these years and unrealistically large changes in policy variables have to be used in order to make a difference. Since the investment flow equation is affected only through y_{2it-1} and g_{t-1} the impact on this equation is even weaker.

The changes to these results by using another distributional specification for the nationalization equation are small.

7. Discussion

The present study has been based on more or less wellknown estimators for the investment flow equation. There are a number of statistical issues, where our understanding of estimator properties are limited. One such example is how one should best deal with country-wise specific first order autoregressive disturbance. Here, transformation was applied for each country even if some of the country-wise ρ_i parameters were very small. Perhaps it is better to abstain from transformation in case they are small and not significantly different from zero. The approach based on the OLS estimator and a consistently estimated covariance matrix (Newey and West, 1987) may be a good choice for hypothesis testing, while it seems natural to expect its properties in prediction situations to be less convincing. Whether this estimator could usefully be used for feasible GLS estimation is not known.

For dichotomous dependent variable models, such as our nationalization equation, issues related to serial correlation and heteroskedasticity have not been much studied. The maximum score estimator of Manski remains consistent under heteroskedasticy, while, at least, the probit maximum likelihood estimator remains consistent under first order serial correlation. Since dichotomous variable models are estimated under a restriction on the variance of the disturbance term, heteroskedasticity over countries implies a varying β_2/σ_i parameter vector for each country. A 'convenient' approach to deal with this is to assume a random coefficient specification. It remains convenient under normality assumptions in the probit case, but not necessarily so with other specifications.

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