The choice between public and private schools with or without subsidies in Spain

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Introduction

What choice for Spanish parents?

- The majority of parents with children of compulsory schooling age face a choice between a state school and a *concerted* private school, neither of which will, in principle, charge fees because they are both funded through the taxpayer, and are supposed to provide their services free. In practice, parents do meet some out-of-pocket expenses, but much smaller than those faced by the small fraction of parents that send their children to non-concerted fee-paying private schools.
- A concerted school is a private school, typically Catholic (80%), that signs a long-term concert with the government by which it becomes fully subsidized in exchange for implementing a state school-like admission policy. The concert stipulates that teachers' salaries are paid directly by the government, and that the school should have an external governing body with the power of hiring and firing the school head.
- Large scale subsidies to the private sector began in the post-Franco period, and concerted schools were introduced in 1984. The aims were to ensure the provision of free places and to preserve a role for Catholic schools, following the reform that ordered free and compulsory schooling from age 6 to 14.

Concerts, voucher programs, and charter schools

- Public subsidies to private schools exist under different schemes in several countries.
- A feature of Spanish concerted schooling is the large size of the scheme, with an enrollment rate of about 25% and public funding of 3,7 billion euro in 2003.
- Another feature is that the system was not designed to create competition between schools, as is the case with voucher programs whereby a private school receives a voucher for each enrolled student.
- Voucher programs often allow households to choose private schools without residence restrictions. However, admission to Spanish concerted schools is subject to the same residence requirements as state schools.
- Concerted schools bear resemblance with but are different from charter schools as exist in the US and other countries. A charter school is an autonomous public school that is freed from some of the rules of ordinary public schools in exchange for some form of accountability for schooling outcomes. Instead, a concerted school is a privately owned school that is tied by the rules of ordinary public schools in exchange for public funding.

Concerted schools and immigration

- Recently, public policy towards concerted schools has been the subject of controversy in the wake of previously unseen immigration flows from non-EU countries; e.g. the number of immigrant children in Madrid increased by 350% between 1999 and 2003.
- Applications for concerted schools, specially in large urban areas, have soared. In 1999 the number of concerted schools increased substantially in the Madrid region, after the transfer of public education from the central to the regional government, which favored parents' "freedom of choice" and that the allocation of funds should be determined by supply and demand. A similar path has been followed in other regions.
- Critics argued that in practice concerted schools are not service-free because they offer an additional, nominally optional, hour of teaching, which is charged as voluntary aid, among other extracurricular activities.
- Their argument is that students with special needs (basically immigrants) concentrate in public schools, which are disproportionately located in low-income and rural areas, and that an excessive concentration may have an adverse effect on the others.
- Conversely, by locating in affluent areas and charging higher (yet highly subsidized) fees, concerted schools could self-select children from parents with highly educated backgrounds and hence enjoy more peer-effect capital and less social conflict than state schools, so that concerted schooling operates as a subsidy for middle class parents.

This paper

- A natural ingredient of an empirical assessment of concerted schooling is to see how much individual probabilities of attending a given school type differ by parental education and income, after controlling by household composition, location, and preferences for religious education. Unfortunately, school choice is conspicuously absent from the major Spanish socioeconomic household surveys.
- An exception is the last large cross-sectional family expenditure survey (EPF), conducted in 1990. This survey provided detailed information on household composition, income, and expenditures, including schooling expenditures, and whether children, if present, went to a public or private school. However, the survey made no distinction between concerted and non-concerted private schools.
- In this paper we provide evidence on the determinants of the choice between public, concerted, and fee-paying private schools using data drawn from the EPF survey.
- Our strategy to identify separately probabilities for concerted and non-concerted school choices is to rely on schooling expenditure variables, which induce a natural separation in the data. We achieve this by specifying a joint mixture likelihood model of school choice and education expenditures.
- Moreover, we construct a measure of preferences for religious schooling from a binary model of church attendance estimated on a complementary dataset.

Outline

1. Theoretical framework.
2. The Spanish schooling system.
3. Data.
4. Econometric methodology.
5. Empirical results.

Theoretical framework

- The Spanish schooling system is characterized by two different levels of choice: choice among school enrollment areas ("area de influencia") and choice between public, concerted, and private schools.

Choice of residential location

- The former takes place by choosing a residential location. Spanish authorities operate a scheme of catchment areas for all primary and secondary public and concerted schools. There is no guarantee of a place for pupils resident within a catchment area, but living in a catchment area gives pupils a higher priority for admission.
- Assuming that households choose a location based on the quality of the schools and house prices, Nesheim (2005) shows that in an economy populated by households with heterogeneous incomes and abilities in which the quality of schools in a location is only determined by the residents of the location, a sorting equilibrium results.
- In this setting, an influx of immigrants may change the distribution of incomes and abilities, hence altering the sorting equilibrium.

Choice of school type given location

- The second level of choice is between public, concerted, and private schools within a residential location. There is evidence that concerted schools are not evenly distributed across areas but that tend to be over-represented in relatively high income locations.
- Within a location, the school choice of households can be analyzed in a model of competition between private and public schools with peer-group externalities as in Epple and Romano (1998).
- Suppose household's utility is increasing in consumption and the child's educational achievement. Let y be income, p_j $(j = 1, 2, 3)$ tuition expenditure by school type, and $a = a(\theta_j, b)$ achievement (e.g. test scores) as a function of child's ability b and the mean ability of the students at the school attended θ_j. The utility of alternative j is
$$U_j = U(y - p_j, a(\theta_j, b)).$$
- A household is characterized by an ability–income pair (b, y). The achievement function captures the peer effect. Households choose a private or public school taking p and θ as given, but in equilibrium an Epple-Romano type of model will predict a hierarchy of school qualities with public schools having the lowest ability peer group.
- Households' valuation of the quality of the school may depend on its preferences for Catholic schooling, in which case the utility of alternative j should be augmented by a preference parameter r_j.

Cobb-Douglas model

- Assuming a Cobb-Douglas specification of the utility function

$$U_j = (y - p_j)\,\theta_j^{\gamma} b^{\beta} e^{r_j} \qquad (j = 1, 2, 3)\,,$$

  a logistic assumption leads to the following odd ratios

$$\ln \frac{\Pr(2)}{\Pr(1)} = \ln\left(\frac{y - p_2}{y}\right) + \gamma \ln\left(\frac{\theta_2}{\theta_1}\right) + r_2 \simeq \gamma \ln\left(\frac{\theta_2}{\theta_1}\right) - p_2 \frac{1}{y} + r_2$$

$$\ln \frac{\Pr(3)}{\Pr(1)} = \ln\left(\frac{y - p_3}{y}\right) + \gamma \ln\left(\frac{\theta_3}{\theta_1}\right) + r_3 \simeq \gamma \ln\left(\frac{\theta_3}{\theta_1}\right) - p_3 \frac{1}{y} + r_3.$$

- The parameter γ, which captures household preferences for school quality, may be related to observable characteristics such as parental schooling.
- Relative school qualities θ_j/θ_1 will vary with income and ability across locations, and therefore will be associated with location variables such as house prices.
- There will be endogenous variation in the supply of different types of school by location.
- Community models with peer group effects predict that the distribution of household characteristics is one of the main determinants of the shape of the sorting equilibrium.
- Therefore, across large geographical areas, such as provinces or regions, we would expect individual reduced-form school choice probabilities to vary with regional-level distributional characteristics, like income, after conditioning on individual attributes.

The Spanish school system

- Three major bills (1970, 1985, and 1990) built the modern Spanish school system. The 1970 act mandated free and compulsory schooling for children 6 to 14, but at the time there were not enough places to enforce the law. A program of school construction was insufficient to cover the demand created by regional migration and the "baby boom".
- At the return to democracy in 1977, a high proportion of pupils (40%) were in fee-paying private schools, and there was an unsatisfied demand for state school slots.
- The government's answer was to subsidize private schools to enable them provide their services free. Most private schools accepted the deal.
- At first, government funded private schools retained the freedom to choose admission policies. This situation changed with the 1984 reform, which made funding conditional on state-school admission policy and free education. However, some kept charging for nominally voluntary contributions, usually on account of extracurricular activities.
- A relatively small number of private schools chose to remain non-concerted. These are fee-paying schools that in this way retained the ability to choose selective admission and tuition policies. This category includes academically or socially selective schools, some religious denominations, and foreign-language oriented schools.
- Finally, the 1990 reform extended compulsory education to the age of sixteen, and undertook to provide free but optional pre-school education to children aged 4 to 6.

Evidence on public and private school outcomes from test scores

- There are two recent sources of information about average scores from standardized cognitive tests administered to 6th grade children (aged 11–12).
- The first one was conducted at schools in the region of Madrid in 2005.
- As shown in Table 1, average maths scores at concerted and private schools are 8 and 11 percent higher, respectively, than the public school maths score. The difference for the reading scores is almost twice as large, probably reflecting a higher fraction of foreign-born pupils at public schools.

Table 1

Average test scores at age 11–12[f]

	Public	Concerted		Private	
test	score	score	% public	score	% public
Reading	55	63	15%	67	22%
Maths	56	60.5	8%	62	11%
No. of schools	701 (60%)	356 (31%)		103 (9%)	

[f] Pupils from all schools in the region of Madrid tested in 2005.

Source: Trillo del Pozo et al. (2006), tables 3 and 4.

Test scores (continued)

- The other piece of information is a test administered to a sample of pupils from 450 Spanish schools as part of a government evaluation exercise (see INECSE, 2003).
- Unfortunately, this source does not distinguish between concerted and non-concerted private schools.
- Scores for general knowledge, reading, and maths tests at public schools were 64, 64, and 56, respectively, to be compared with 69, 68, and 61 at private schools.
- The differences are broadly comparable with those from the previous source, specially for the maths scores.
- These figures provide relevant background for our empirical analysis, but they are only indirectly relevant to the results we present, which belong to an earlier period.

The data

- The cross-sectional micro data used in this paper comes from the 1990 Spanish household expenditure survey (EPF). We selected a sample of households with:

  (a) children aged less than 16, in elementary school.

  (b) the same type of school for all children when more than one is present.

- The EPF contains detailed information about family expenditures, including expenditures on registration and tuition fees, and other schooling-related expenditures.

- A limitation: the EPF provides information on whether children are in a public or private school, but without distinguishing between concerted and non-concerted schools.

- The final sample consists of 5427 households, of which 77% chose a public school.

- Public school families have less educated parents, earn lower salaries, have a higher proportion of non-working mothers, are less likely to have a second home, and live in smaller districts (Table 2B).

- Table 3 shows expenditures in education by type of school. In principle, registration and tuition fees should be zero for both public and concerted schools, but in practice some concerted schools are perceived by parents as charging for such concepts.

- Table 4 shows registration and tuition expenditure quantiles. We use this variation to identify separate determinants of choice of concerted and non-concerted schools.

Table 4

Quantile distribution of registration and tuition fees in private schools[f]

Percentile	Centile registration fees	Centile tuition fees
5	0	0
40	0	0
50	0	15.02
60	0	72.12
70	0	129.94
75	0	158.07
80	9.02	198.33
85	18.03	256.75
90	28.67	420.71
95	42.07	715.81
99	102.17	1622.73

[f] In euros.

An econometric model for school choice with incomplete data

- We show how to estimate a multinomial model of the choice between the three types of schools (public, concerted and private) when we only observe if the household chooses a public school or not, but we have information on expenditure in education.
- Let D_{1i}, D_{2i}, and D_{3i} be indicators of public, concerted private, and fee-paying private school, respectively.
- Only D_{1i} is observable, but we also observe expenditure on educational items.
- The idea of our method is to consider the joint likelihood of schooling expenditure and observed binary school type as a function of the underlying multinomial probabilities.
- Letting w_i denote the schooling expenditure of household i, the joint likelihood of expenditure and observed school type is:

$$\mathcal{L} = \prod_{D_{1i}=1} f(w_i|D_{1i}=1)\Pr(D_{1i}=1) \prod_{D_{1i}=0} f(w_i|D_{1i}=0)\Pr(D_{1i}=0).$$

- The conditional density of schooling expenditure for households in non-public schools is a mixture of two components for concerted and fee-paying private schools:

$$\begin{aligned} f(w_i|D_{1i} &= 0) = f(w_i|D_{1i}=0, D_{2i}=1)\Pr(D_{2i}=1|D_{1i}=0) \\ +f(w_i|D_{1i} &= 0, D_{3i}=1)\Pr(D_{3i}=1|D_{1i}=0) \\ &= f(w_i|D_{2i}=1)\frac{\Pr(D_{2i}=1)}{\Pr(D_{1i}=0)} + f(w_i|D_{3i}=1)\frac{\Pr(D_{3i}=1)}{\Pr(D_{1i}=0)}. \end{aligned}$$

- Thus, the log likelihood function will have the following form:

$$L = \sum_{D_{1i}=1} \log f\left(w_i | D_{1i}=1\right) + \sum_{D_{1i}=1} \log \Pr\left(D_{1i}=1\right) + \sum_{D_{1i}=0} \log\left[f(w_i|D_{2i}=1)\Pr\left(D_{2i}=1\right) + f\left(w_i|D_{3i}=1\right)\Pr\left(D_{3i}=1\right)\right].$$

- That is, we can distinguish two different contributions to the log-likelihood function:
  (a) Households choosing a public school, contribute with the probability of choosing this type of school and the density of the expenditure they made.
  (b) Private school households (fee-paying or concerted) contribute with the density of the mixture that arises because of lack of information on the school chosen.
- Given the log-likelihood function, we can estimate the effect of different variables on the probability of choosing each type of school after specifying a functional form for these probabilities and for the density of household expenditure.
- For estimation of the multinomial model, the density $f\left(w_i|D_{1i}=1\right)$ does not need to be modelled. So estimation can proceed on the basis of the partial likelihood:

$$L_2 = \sum_{D_{1i}=1} \log \Pr\left(D_{1i}=1\right) + \sum_{D_{1i}=0} \log\left[f(w_i|D_{2i}=1)\Pr\left(D_{2i}=1\right) + f\left(w_i|D_{3i}=1\right)\Pr\left(D_{3i}=1\right)\right].$$

Concerted schooling as a censored indicator.

- For some households in the non-public group, we observe zero schooling expenditures ($D_{\text{Ei}} \equiv 1(w_i > 0) = 0$, say). If we assume that such households are in concerted schooling with certainty, D_{2i} and D_{3i} become censored variables as opposed to fully latent variables. Under this assumption, we have

$$f(w_i|D_{1i}=0) = \begin{cases} f(w_i|D_{2i}=1)\frac{\Pr(D_{2i}=1)}{\Pr(D_{1i}=0)} + f(w_i|D_{3i}=1)\frac{\Pr(D_{3i}=1)}{\Pr(D_{1i}=0)} & \text{if } w_i > 0 \\ \Pr(w_i = 0 \mid D_{2i}=1)\frac{\Pr(D_{2i}=1)}{\Pr(D_{1i}=0)} & \text{if } w_i = 0, \end{cases}$$

- Thus, that the partial log likelihood becomes:

$$\begin{aligned} L_2 = & \sum_{D_{1i}=1} \log \Pr(D_{1i}=1) + \\ & \sum_{(D_{1i}=0, D_{\text{Ei}}=1)} \log\left[f(w_i|D_{2i}=1)\Pr(D_{2i}=1) + f(w_i|D_{3i}=1)\Pr(D_{3i}=1)\right] \\ & + \sum_{(D_{1i}=0, D_{\text{Ei}}=0)} \left[\log \Pr(w_i = 0 \mid D_{2i}=1) + \log \Pr(D_{2i}=1)\right]. \end{aligned}$$

Empirical specification

- In the empirical analysis, we specify a multinomial logit model for school choice:

$$\Pr\left(D_{ji}=1\right)=\frac{e^{z_i\beta_j}}{1+e^{z_i\beta_2}+e^{z_i\beta_3}},\qquad (j=2,3)$$

and linear normal models for the densities of schooling expenditures in concerted and fee-paying schools, with censoring at zero in the case of concerted schooling.

- Thus, the partial log likelihood that we take to the data is of the form:

$$\begin{aligned}
L_2 \;=\; & \sum_{D_{1i}=1}\log\left(\frac{1}{1+e^{z_i\beta_2}+e^{z_i\beta_3}}\right)\\
& +\sum_{(D_{1i}=0,D_{\mathrm{Ei}}=1)}\log\left[\frac{e^{z_i\beta_2}}{\left(1+e^{z_i\beta_2}+e^{z_i\beta_3}\right)}\frac{1}{\sigma_2}\phi\left(\frac{w_i-x_i\alpha_2}{\sigma_2}\right)\right.\\
& \left.+\frac{e^{z_i\beta_3}}{\left(1+e^{z_i\beta_2}+e^{z_i\beta_3}\right)}\frac{1}{\sigma_3}\phi\left(\frac{w_i-x_i\alpha_3}{\sigma_3}\right)\right]+\\
& \sum_{(D_{1i}=0,D_{\mathrm{Ei}}=0)}\left[\log\left(\frac{e^{z_i\beta_2}}{1+e^{z_i\beta_2}+e^{z_i\beta_3}}\right)+\log\Phi\left(-\frac{x_i\alpha_2}{\sigma_2}\right)\right]
\end{aligned}$$

where $\phi\left(.\right)$ and $\Phi\left(.\right)$ denote the standard normal *pdf* and *cdf*, respectively.

Incorporating aggregate data

- D_{2i} and D_{3i} are latent or censored, but the aggregate proportions of children attending concerted and fee-paying schools in 1990, p_2 and p_3, are known from census.
- This information contributes the following additional marginal moment restrictions to the estimation problem
$$E\begin{pmatrix} \Pr\left(D_{2i}=1 \mid z_i;\theta\right)-p_2 \\ \Pr\left(D_{3i}=1 \mid z_i;\theta\right)-p_3 \end{pmatrix} \equiv E\psi_m\left(z_i,\theta\right)=0$$
where θ denotes the full vector of parameters to be estimated.
- These moments add information to our likelihood because it is a conditional likelihood given the covariates, and the extra moments are restrictions on the marginal distribution of the covariates (Imbens and Lancaster, 1994).
- Let $\ell_i\left(\theta\right)$ be unit's i contribution to the partial log likelihood, so that $L_2=\sum_i \ell_i\left(\theta\right)$. The maximizer of L_2 is the method-of-moments estimator based on the expected FOCs
$$E\left[\frac{\partial \ell_i\left(\theta\right)}{\partial\theta}\right]=E\psi_{si}\left(\theta\right)=0.$$
- Thus, the information provided by the likelihood can be combined with the marginal restrictions by considering a GMM estimator based on the moments
$$\psi_i\left(\theta\right)=\begin{pmatrix} \psi_{si}\left(\theta\right) \\ \psi_m\left(z_i,\theta\right) \end{pmatrix}.$$

Incorporating aggregate data (continued)

- From GMM theory, an optimal weight matrix is a consistent estimate of the inverse of $Var\left[\psi_i\left(\theta\right)\right]$. Because of the conditional zero-mean property of the score, $\psi_{si}\left(\theta\right)$ and $\psi_m\left(z_i,\theta\right)$ are uncorrelated. The implication is that an optimal GMM criterion is
$$\overline{\psi}_s\left(\theta\right)'\widehat{H}_{ss}^{-1}\overline{\psi}_s\left(\theta\right)+\overline{\psi}_m\left(\theta\right)'\widehat{H}_{mm}^{-1}\overline{\psi}_m\left(\theta\right),$$
where $\overline{\psi}_s\left(\theta\right)=\sum_i\psi_{si}\left(\theta\right)$, $\overline{\psi}_m\left(\theta\right)=\sum_i\psi_m\left(z_i,\theta\right)$, and $\widehat{H}_{ss}$ and $\widehat{H}_{mm}$ are consistent estimates of $Var\left[\psi_{si}\left(\theta\right)\right]$ and $Var\left[\psi_{mi}\left(z_i,\theta\right)\right]$.
- Finally, it can be verified that optimal GMM is asymptotically equivalent to the estimator that maximizes the following modified partial likelihood:
$$L_p=L_2-\overline{\psi}_m\left(\theta\right)'\widehat{H}_{mm}^{-1}\overline{\psi}_m\left(\theta\right)$$
- The adjustment to L_2 is a quadratic in the aggregate constraints acting as a penalty term.

Identification

- The multinomial model of school choice is identified from incomplete data on the choices, supplemented with data on the expenditures implied by these choices, and macro data on the school choice aggregates.
- However, we achieve identification in a parametric setting that entails specific distributional assumptions about the densities of schooling expenditures and choice probabilities.
- Parameters of interest from mixture models are usually nonparametrically identified to belong to a certain set, but point identification is not available (Manski, 2003).
- The nonparametric identification status of marginal effects on the multinomial probabilities in our case remains to be analyzed.

A model with misclassification

- Suppose that the indicator of public school observed in the data, d_i say, does not coincide with D_{1i} as assumed up to now because some parents with children in a concerted school erroneously are classified as having $d_i = 1$.
- So, we allow for the following non-zero probability of misclassification:
$$\Pr(d = 1 \mid D_2 = 1) = \rho$$
- In principle, ρ may vary with covariates: $\Pr(d = 1 \mid D_2 = 1, z) = \rho(z)$. One possibility is to treat it as a constant. Others are to specify it as $\rho(z) = \rho \Pr(D_1 = 1 \mid z)$, or $\rho(z) = \rho\kappa(z)$ where $\kappa(z) = \left(1 + e^{z\beta_3}\right)^{-1}$ is the probability of alternative 1 as a second-best, having alternative 2 as a first best. They capture the notion that misclassification is more likely for households that are closer to the public school option.
- The basic model assumed that $\rho = 0$. We maintain the assumptions of no classification error for public school and private parents, namely:
$$\begin{aligned} \Pr(d = 1 \mid D_1 = 1) &= 1 \\ \Pr(d = 1 \mid D_3 = 1) &= 0. \end{aligned}$$

- Letting w_i denote the schooling expenditure of household i, the joint likelihood of expenditure and observed school type is:

$$\mathcal{L} = \prod_{d_i=1} f(w_i|d_i = 1)\Pr(d_i = 1) \prod_{d_i=0} f(w_i|d_i = 0)\Pr(d_i = 0).$$

where

$$\Pr(d = 1) = \sum_{j=1}^{3} \Pr\left(d = 1 \mid D_j = 1\right)\Pr\left(D_j = 1\right) = \Pr\left(D_1 = 1\right) + \rho \Pr\left(D_2 = 1\right).$$

Moreover,

$$\begin{aligned} f(w|d \;=\; 0) &= f(w|d = 0, D_2 = 1)\Pr\left(D_2 = 1 \mid d = 0\right) \\ +f(w|d \;=\; 0, D_3 &= 1)\Pr\left(D_3 = 1 \mid d = 0\right) \end{aligned}$$

or

$$\begin{aligned} f(w|d \;=\; 0)\Pr(d = 0) &= f(w|d = 0, D_2 = 1)\Pr\left(d = 0 \mid D_2 = 1\right)\Pr\left(D_2 = 1\right) \\ +f(w|d \;=\; 0, D_3 &= 1)\Pr\left(d = 0 \mid D_3 = 1\right)\Pr\left(D_3 = 1\right) \\ = f(w|d = 0, D_2 &= 1)\left(1 - \rho\right)\Pr\left(D_2 = 1\right) + f(w|d = 0, D_3 = 1)\Pr\left(D_3 = 1\right). \end{aligned}$$

- Thus, the relevant partial log likelihood in this case is

$$L_2 = \sum\nolimits_{d_i=1} \log\left[\Pr\left(D_{1i} = 1\right) + \rho \Pr\left(D_{2i} = 1\right)\right] +$$

$$\sum_{d_i=0} \ln\left[f(w_i|d_i = 0, D_{2i} = 1)\left(1 - \rho\right)\Pr\left(D_{2i} = 1\right) + f(w_i|d_i = 0, D_{3i} = 1)\Pr\left(D_{3i} = 1\right)\right]$$

Concerted schooling as a censored indicator

- For some households in the $d_i = 0$ group, we observe zero schooling expenditures ($D_{\text{Ei}} \equiv 1(w_i > 0) = 0$, say). If we assume that such households are in concerted schooling with certainty, we have

$$f(w|d=0) = \begin{cases} f(w|d=0, D_2=1)\frac{(1-\rho)\Pr(D_2=1)}{\Pr(d=0)} + f(w|d=0, D_3=1)\frac{\Pr(D_3=1)}{\Pr(d=0)} \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \text{if } w > 0 \\ \Pr(w=0 \mid d=0, D_2=1)\frac{(1-\rho)\Pr(D_2=1)}{\Pr(d=0)} \quad \text{if } w = 0, \end{cases}$$

- Thus, the partial log likelihood becomes:

$$\begin{aligned} L_2 = &\sum_{d_i=1} \log\left[\Pr(D_{1i}=1) + \rho\Pr(D_{2i}=1)\right] + \\ &\sum_{(d_i=0, D_{\text{Ei}}=1)} \log\left[f(w_i|d_i=0, D_{2i}=1)(1-\rho)\Pr(D_{2i}=1)\right. \\ &\qquad \left. + f(w_i|d_i=0, D_{3i}=1)\Pr(D_{3i}=1)\right] \\ &+ \sum_{(d_i=0, D_{\text{Ei}}=0)} \left[\log\Pr(w_i=0 \mid d_i=0, D_{2i}=1) + \log\Pr(D_{2i}=1) + \log(1-\rho)\right]. \end{aligned}$$

- If we assume that $f(w|d=0, D_2=1) = f(w|D_2=1)$ and $f(w|d=0, D_3=1) = f(w|D_3=1)$, the expenditure side of the model remains unaltered. Otherwise, the empirical densities should be reinterpreted as conditional on $d=0$.

Empirical results

- Estimates are in Tables 5 (school choice) and 6 (expenditures). Initial values from approximate classification (Appendix C.). Reference category is public school.
- We group explanatory variables in 4 roles:

  (a) income and tuition effects;

  (b) determinants of household preferences for school quality and Catholic education;

  (c) proxies for heterogeneity in the scope of choice and school supply;

  (d) proxies for school quality across provinces.
- The provincial level of aggregation is probably too wide, but we do not observe membership of smaller geographical areas.

Table 5

Maximum likelihood estimates of the multinomial model of school choice

	Concerted		Private	
Variable	Coeff.	t-ratio	Coeff.	t-ratio
Constant	−22.2	(5.6)	−29.7	(2.1)
2 children	0.23	(1.8)	−0.12	(0.3)
3+ children	−0.38	(2.4)	−0.13	(0.3)
One daughter	0.34	(4.0)	0.52	(1.9)
Illiterate father	−0.51	(1.7)	–	–
Primary educ. f.	−0.41	(3.8)	−0.80	(2.0)
College father	0.17	(1.1)	0.37	(1.0)
Illiterate mother	−1.34	(4.2)	−1.29	(0.6)
Primary educ. m.	−0.16	(1.3)	−0.41	(1.1)
College mother	0.78	(2.9)	0.55	(0.9)
Working mother	0.23	(2.2)	0.11	(0.3)
Working college m.	−0.83	(2.7)	−0.97	(1.4)
Religiosity index	0.45	(1.4)	−2.2	(2.1)
Second home	0.34	(2.8)	0.61	(1.7)
Rent payment (ln)	0.24	(4.2)	1.10	(4.0)
Family income (ln)	0.27	(2.9)	0.99	(2.6)
Munic. 100–500k	0.80	(8.6)	1.32	(3.7)
Munic. >500k	1.03	(6.8)	1.09	(2.0)
% immigrants	−2.91	(3.7)	−0.48	(0.2)
Separate language	0.69	(3.2)	1.08	(1.5)
Immigrants×separate	−1.13	(1.3)	−3.20	(1.1)
Prov. income (ln)	2.17	(5.6)	2.40	(1.8)
Gini coefficient	0.18	(0.1)	7.18	(1.1)
% children compul. s.	−2.70	(0.7)	3.66	(0.3)
% private s.	1.00	(1.2)	−2.69	(0.8)
% concerted s.	3.03	(4.0)	2.11	(0.7)
% catholic private s.	1.64	(1.8)	−4.03	(0.8)
% catholic concerted s.	1.08	(2.7)	−2.86	(1.4)

Notes: $n = 4910$; outer product-based t-ratios in parenthesis.

Table 6
Maximum likelihood estimates of the expenditure equations[a]

	Concerted (censored)		Private (linear)	
Variable	Coeff.	t-ratio	Coeff.	t-ratio
Constant	−1.52	(1.6)	2.79	(0.2)
2 children	−0.06	(2.2)	−0.06	(0.2)
3+ children	−0.08	(2.0)	−0.44	(1.1)
One daughter	−0.03	(1.4)	0.05	(0.2)
Illiterate father	0.11	(1.5)	–	–
Primary educ. f.	−0.01	(0.5)	0.25	(0.8)
College father	−0.01	(0.3)	0.15	(0.6)
Illiterate mother	−0.14	(1.8)	1.25	(0.0)
Primary educ. m.	−0.02	(0.6)	−0.39	(1.2)
College mother	−0.08	(1.5)	0.05	(0.1)
Working mother	−0.03	(1.3)	−0.06	(0.2)
Working college m.	0.06	(1.0)	0.17	(0.4)
Religiosity index	−0.03	(0.3)	0.76	(0.7)
Second home	−0.06	(2.1)	−0.14	(0.6)
Rent payment (ln)	−0.01	(0.6)	−0.03	(0.2)
Family income (ln)	0.06	(2.4)	0.37	(1.2)
Munic. 100–500k	0.08	(3.2)	−0.25	(0.7)
Munic. >500k	0.08	(2.3)	1.05	(2.6)
% immigrants	−0.18	(1.0)	0.36	(0.1)
Separate language	0.16	(3.0)	0.52	(0.7)
Immigrants×separate	0.00	(0.0)	−0.08	(0.0)
Prov. income (ln)	0.15	(1.6)	−0.59	(0.4)
Gini coefficient	−0.27	(0.6)	6.39	(1.0)
% children compul. s.	0.90	(0.9)	6.94	(0.6)
% private s.	0.57	(2.8)	1.99	(0.5)
% concerted s.	0.50	(2.8)	−0.34	(0.1)
% catholic private s.	0.07	(0.3)	0.07	(0.0)
% catholic concerted s.	0.07	(0.6)	−0.33	(0.2)

Notes: $n = 4910$; outer product-based t-ratios in parenthesis.
[a]Expenditure per pupil in 1990 pta. $\times 10^{-5}$. $\widehat{\sigma}_c^2 = 0.06$, $\widehat{\sigma}_p^2 = 0.39$.

School choice

Income and tuition effects

- We included household (log) income and number of children.
- There will be unobserved heterogeneity in the tuition expenditures actually faced by parents, but we refrained from using provincial expenditure aggregates given their potential endogeneity for our identification strategy.
- The estimated income elasticity of the concerted/public odds ratio is 0.27 while the income elasticity for the private/public odds ratio is 0.99.
- Having more than one child and especially having three or more have an impact, although the effects are not easily interpretable because they are likely to capture both differences in preferences and differences in schooling costs.

Household preferences for school quality

- Gender composition of children. If parents have only one daughter, the probability of a concerted or private school is higher. This can be due to a higher proportion of girl-only Catholic schools, or at least that are perceived as being mostly-girl schools. But it could also capture differential preferences for boys and girls.
- Parental education. More educated parents are more likely to send their children to concerted or private school. Interestingly, the effect of mother's education is stronger than the father's at almost all levels of education for both concerted and private schools.
- Working mother. This is associated with a larger probability of a concerted school. However, the positive effect of having a college-educated mother on the choice of a concerted or a private school is much smaller for working mothers than housewives.
- Wealth indicators. (i) rent payments (actual or imputed), and (ii) 2nd home ownership. Both have positive effects on the probabilities of a non-public school, with a elasticity for the private/public odds 5 times larger than the elasticity for concerted/public odds.
- Provinces with a separate language. In regions with a language other than Spanish, public/private school preferences may be affected by differences in linguistic orientation across school types. Being in a separate-language province is associated with a larger concerted-school probability, but this effect disappears in provinces having a large fraction of adults not born in the region of residence.

Index of religiosity

- As a measure of household religiosity we used the propensity score for the probability of church attendance. To do so we estimated a probit model using data from a complementary survey (Arellano and Meghir, 1993) (more below).
- We used father's membership of the armed forces as a predictor of church attendance that is excluded from the school choice equations. Father's age is also excluded, and this helps with the precision of the effect of religiosity, but the military dummy is the critical exclusion restriction.
- We tested the exclusion of age and failed to reject by an ample margin.
- The effect of religiosity on the probability of choosing a concerted school is positive and large, although not very precisely estimated.
- The effect on the probability of a private school is negative and could be interpreted as reflecting that schools with a religious orientation are not so predominant among private non-concerted schools. However, this effect disappears when the model is estimated with provincial dummies, so we do not regard it as being robust.

A binary model of church attendance

- We estimated a probit model for the decision of going to church. These estimates are used to construct an index of religiosity for the EPF households.
- To obtain these estimates we use a complementary sample from the survey *Encuesta de Estructura, Conciencia y Biografía de Clase* (ECBC, 1991).
- The endogenous variable is a binary indicator that takes on the value 1 if the father declared going to church at least monthly.
- Explanatory variables are: regional dummies, 2 dummies for the number of children, age of the father, a dummy for illiterate fathers, and a dummy for working mothers.
- We also included an indicator of membership of the armed forces: a good predictor if religious and conservative values are predominant among military personnel.
- There is a complex pattern of variation in church attendance by region.
- Having more than two children and father's age have positive and significant effects.
- Illiterate fathers and those with a working spouse go to church less frequently.
- Being in the armed forces substantially increases the probability of church attendance.

- A histogram of the propensity score of church attendance is shown in Figure A.1.

Figure A.1. Propensity score of mass attendance

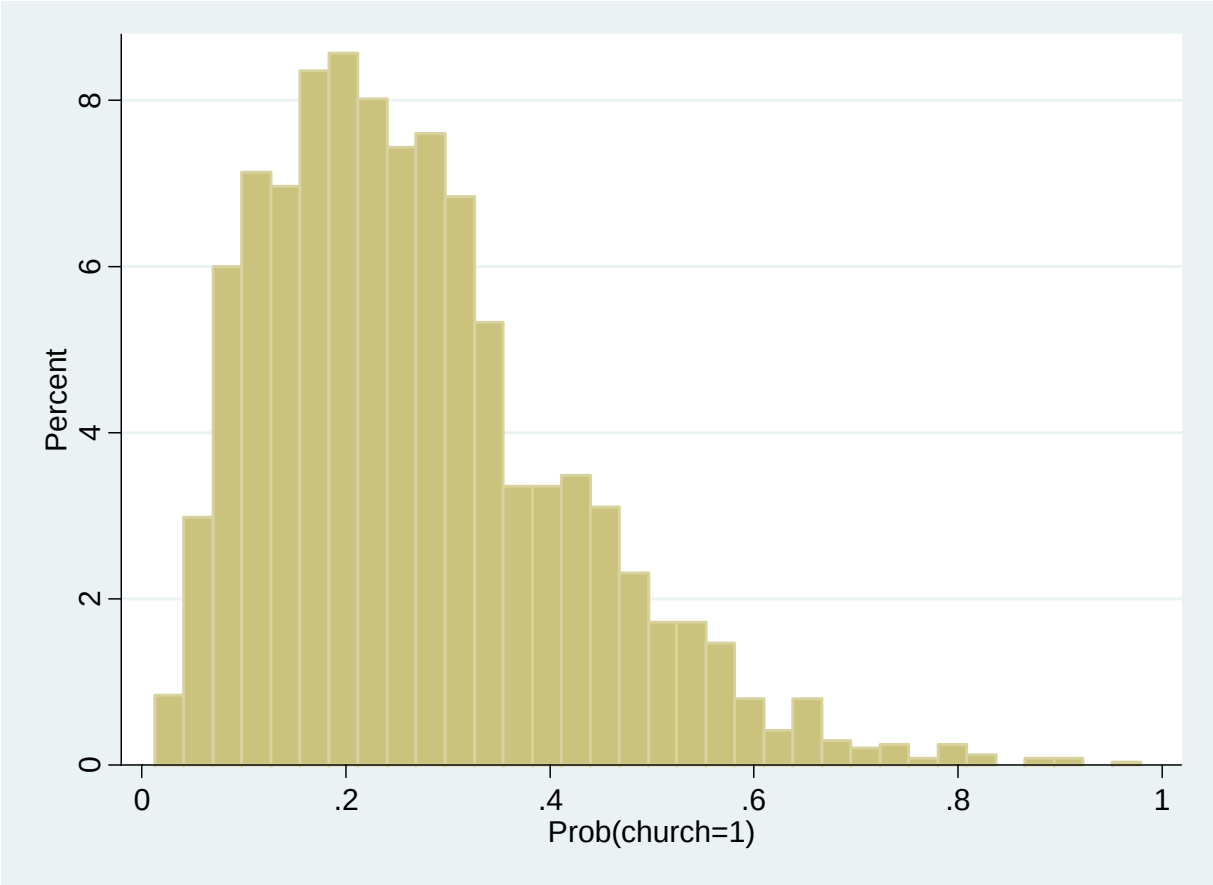

Table A.1

Probit model for Catholic Mass attendance

Variable	Coeff.	t-ratio
Constant	−2.54	9.77
Father's age	0.044	8.00
Two children	0.093	1.05
More than 2 children	0.45	3.75
Working mother	−0.13	1.51
Illiterate father	−0.44	2.32
Military father	0.88	3.39
Andalusia urban	0.59	3.28
Andalusia South	−0.01	0.06
Andalusia rest	0.82	4.10
Aragon	0.45	2.14
Asturias	0.45	1.80
Canary Islands	−0.35	1.09
Castile–La Mancha	0.44	2.10
Old Castile–Leon	0.38	2.24
Catalonia urban	−0.10	0.71
Catalonia rural	0.42	1.45
Levante North	0.31	1.72
Levante South	−0.21	1.00
Extremadura	0.57	1.84
Galicia	0.33	1.94
Navarre	0.35	1.06
Basque Country	0.33	1.74

No. obs: 1196 (E. de Estructura, Conciencia y Biografía de Clase, 1991).

The region of reference is Madrid.

Heterogeneity in choice opportunities

- Municipality size. We would expect effective opportunities for choice to increase with municipality size. In fact, in certain rural areas school choice may just not be available. We find large and positive effects of size on the odds of concerted and private schools.
- Provincial supply side variables. We considered the proportion of children of schooling age, the proportion of concerted schools, etc. The effects are large but difficult to interpret because of potential endogeneity relative to province-level unobservables.
- Fraction of adults not born in the region of residence. A large fraction of immigrant population is associated with a significantly smaller probability of concerted school choice. This can be interpreted as reflecting location effects. Regional migrants of the 1960s from rural Spain settled in new neighborhoods of urban provinces such as Madrid or Barcelona, which featured no concerted schools. Presumably, the new demand for schooling was mostly met through programs of new public school creation.

Aggregate school quality at provincial level

- Provincial per capita income and Gini coefficients. Provincial income has large and positive effects on the probabilities of concerted and private schools. We cannot read much from these estimates in a reduced form model but the results are consistent with what would be expected from a sorting model.
- Gini coefficients appear to have no effect on school choice.

Schooling expenditures

- Table 6 shows the estimates of the censored model for household expenditure in concerted schools, and the linear model for expenditure in private schools (obtained jointly with the estimates in Table 5).
- The implied income elasticity of demand for education expenditures per pupil at average expenditures is 0.27 for concerted schools and 0.95 for private schools. These figures are consistent with the perception of education as a normal good. Estimates of the income elasticity in the literature vary but the broad finding is that they are positive.
- Expenditure per pupil appears to be smaller in families with two or more children attending the same concerted school, but not in private schools.
- Living in a large municipality is associated with higher spending, especially in the case of private schools in the largest municipalities.
- Finally, spending in concerted schools is higher in provinces with a separate language.

Estimates incorporating aggregate data

- We use the idea that census provide nearly exact knowledge of marginal moments of the variables of interest. So, we combine the aggregate proportion of pupils in each type of school with the micro data to strengthen identification and efficiency.
- In 1990, the proportion of pupils enrolled in a fee-paying private school was 2.7 percent, whereas 32.3 percent attended a concerted school.
- In combining micro and macro data, we assume that aggregates are measured without sample error. Failing that, estimates remain consistent but st.errors need adjustment.
- In an earlier version, we obtained estimates using the penalized partial–likelihood method. Except for the intercepts, they were similar to those without aggregate information, and the main conclusions remained unchanged.
- The discrepancy in the intercepts may be due to stratification and non-response in the EPF, which tends to over-represent small municipalities. A re-estimation of the model with aggregate information using EPF population weights remains to be done.

Estimating probabilities of second-best alternatives

- The probability of alternative 3 as a second-best, having alternative 2 as a first best, is in general

$$\Pr\left(u_3 > u_1 \mid u_2 > u_1, u_2 > u_3, z\right) = \frac{\Pr\left(u_3 > u_1 \mid z\right) - \Pr\left(D_3 = 1 \mid z\right)}{\Pr\left(D_2 = 1 \mid z\right)},$$

  which for multinomial logit boils down to

$$\Pr\left(u_3 > u_1 \mid u_2 > u_1, u_2 > u_3, z\right) = \Pr\left(u_3 > u_1 \mid z\right) = \frac{e^{z\beta_3}}{1 + e^{z\beta_3}}.$$

- Here we obtain aggregate probabilities of second-best alternatives, which provide descriptive measures of proximity between public, concerted, and private school households taking into account their distribution of characteristics given school choice.

- Specifically, the marginal probability of having private school as a second best for households that chose a concerted school is

$$\begin{aligned}\Pr\left(u_3 > u_1 \mid D_2 = 1\right) &= \int \frac{e^{z\beta_3}}{1 + e^{z\beta_3}} dF\left(z \mid D_2 = 1\right) \\ &= \frac{1}{\Pr\left(D_2 = 1\right)} \int \frac{e^{z\beta_3}}{1 + e^{z\beta_3}} \Pr\left(D_2 = 1 \mid z\right) dF\left(z\right)\end{aligned}$$

  or

$$\Pr\left(u_3 > u_1 \mid D_2 = 1\right) = \frac{E\left[\frac{e^{z\beta_3}}{(1+e^{z\beta_3})} \frac{e^{z\beta_2}}{(1+e^{z\beta_2}+e^{z\beta_3})}\right]}{E\left(\frac{e^{z\beta_2}}{1+e^{z\beta_2}+e^{z\beta_3}}\right)}.$$

- In a partial equilibrium analysis that abstracts from externalities and public finance considerations, if $\Pr(u_3 > u_1 \mid D_2 = 1)$ is close to , the subsidy implicit to the concerted system does not create distortion because individual preferences are unaffected by its introduction (under the assumption that private and concerted goods are similar).
- If $\Pr(u_3 > u_1 \mid D_2 = 1)$ is close to 0, the subsidy creates a welfare loss, because a concerted school is not preferable to public school in the absence of the subsidy.
- Table 9 reports estimated conditional probabilities of private school as a second-best given concerted schooling as the first choice.

Table 9
Probability of private school as second-best
given concerted school as first choice

Subpopulation	%
$<$ 100,000 inhabitants	3.1
100,000 to 500,000 inhabitants	13.1
$>$ 500,000 inhabitants	12.5
All	8.7

- The overall second-best probability is about four percentage points higher than the marginal probability of private school. Note the steep increase for large cities.

Summary of empirical results

1. The provincial income elasticity of the concerted/public odds ratio is 8 times larger than the parental's income elasticity, which suggests that community-level differences in relative school quality or in effective choice opportunities matter more for school choice than differences in individual income. This is not surprising given that many concerted schools are only marginally more expensive than public schools. This speaks of the predominant role of residential location for school choice in Spain.
2. Parental education increases the preferences for non-public schools, but mother's education has a substantially stronger effect than father's education.
3. Parents' religiosity increases the preference for concerted schools other things equal. The concerted/public odds ratio of a religious household can be between 1.5 and 2 times larger than the odds ratio of a non-religious one.
4. The gender of children also affects the preference for concerted schools. The concerted/public odds ratio of parents with a single daughter is 1.4 higher than the odds ratio of parents with a single son.
5. Choice of a public school in 1990 was more frequent in provinces with a large fraction of inter-regional immigrants, especially in those with a separate language. We interpret this effect as reflecting differences in choice opportunities among immigrants linked to residential location.

Conclusions

- We exploit partial information on individual school choices together with data on schooling expenditures to identify a multinomial model of the choice between public, concerted, and private schooling by Spanish parents in 1990.
- We find small but significant household income effects on school choice. Other determinants of school choice are the level of education of mothers and fathers, the religiosity of parents, and the gender of their children.
- A substantial part of variation in observed choices is due to area-wide variables such as aggregate income, fraction of immigrants, or cultural diversity.
- Within our reduced form model we cannot separate aggregate effects due to differences in relative quality of school type from effects due to differences in choice opportunities.
- But our results strongly hint that heterogeneity in the effective choice set are a significant part of the story, and that aggregate differences matter more for observed choices than individual differences in income or parental background.
- The fact that these effects are estimated on data collected prior to the wave of immigration of recent years would suggest the possibility of even stronger effects today.
- A comprehensive evaluation of concerted schooling in Spain will have to focus at the micro level on the distributions of schooling outcomes, such as test scores, and labour market outcomes, which at present we do not observe at household level.

Approximate multinomial initial estimates

- Preliminary estimates of the multinomial school choice and expenditure decisions were used as initial values for the mixture likelihood estimation.
- We obtain them by assuming that only private-school parents with zero expenditures in registration fees, are in concerted schools. They may be affected by misclassification.
- Tables C.1 and C.2 show the estimates. The main conclusions, related to the choice of type of school are broadly similar to those obtained from the mixture model.
- But there are some differences in the relative magnitudes of household income effects for concerted and private schools, possibly reflecting biases due to misclassification.
- Comparison of the approximate classification with the mixture model classification:

  (a) Approximate classification: If (public=1) $\Longrightarrow$public; if (public=0 & registration fees=0) $\Longrightarrow$ concerted; if (public=0 & registration fees$>$0) $\Longrightarrow$ private.

  (b) Mixture-model classification: If (public=1) $\Longrightarrow$public; if (public=0 & registration + tuition fees $>$0) $\Longrightarrow$ private or concerted; if (public=0, registration fees=0, & tuition fees =0) $\Longrightarrow$ concerted.

D Distribution of predicted probabilities

Table D.1 shows some descriptive statistics of the distributions of predicted probabilities of the choice of public, concerted, and private schooling, which are obtained from the ML estimates of the mixture model reported in Table 5. Table D.2 provides similar information for the approximate multinomial estimates in the first two columns of Table C.1.

Table D.1
Predicted probabilities
(Mixture model ML estimates)

	Public	Concerted	Private
Mean	0.77	0.21	0.03
Min	0.05	0.004	0.00
Max	0.996	0.83	0.63
Q_{10}	0.49	0.03	0.001
Q_{25}	0.67	0.08	0.002
Q_{50}	0.82	0.17	0.007
Q_{75}	0.92	0.30	0.02
Q_{90}	0.97	0.44	0.07

Table D.2
Predicted probabilities
(Approximate logit estimates)

	Public	Concerted	Private
Mean	0.77	0.18	0.06
Min	0.06	0.003	0.00
Max	0.997	0.75	0.55
Q_{10}	0.49	0.03	0.004
Q_{25}	0.67	0.06	0.01
Q_{50}	0.82	0.14	0.04
Q_{75}	0.92	0.25	0.08
Q_{90}	0.97	0.39	0.13

The average proportion of private schools in Table D.1 is similar to the aggregate 1990 figure known from other sources, but the proportion of concerted schools is too small. This may be due to stratification in the EPF or to misclassification error in the EPF public/non-public indicator.