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Non-profit Firm Models and Museum Demand Estimation*

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Abstract

A version of Hansmann (1981) economic model of non profit institutions is analyzed to derive museums pricing schedules. These are paired with demand for museum attendance derived from utility maximisation by heterogeneous consumers that care for museum characteristics, in order to provide an empirical strategy to identify museum demand based on the usual micro database including museum prices, attendance and characteristics, as well as socio demographic indicators of hosting towns. Following the empirical literature we address the endogeneity of observed prices and the large number of zero price observations. To tackle them we propose an instrumental variable estimation, while also using selection correction techniques. The model is estimated using data from the 2007 Census of Uruguayan Museums. We do not find a significant effect of price on attendance.

Keywords: Economics of museums, Economics of arts and culture.

JEL Classification: Z1.

1. Introduction

Demand estimation is a useful input for the evaluation of pricing policies for museums. The interest in this discussion has been renewed since museums had recently faced tighter budget constraints. Museums are pressed for resources, which they obtain from a combination of public funding, donations, profit from services offered at the premises such as restaurants and gift shops, and admission fees. Usually fees represent a small share of total funding. Generally, estimated elasticities are low, indicating that there may be scope for enhancing museum incomes by raising entry fees. The obvious trade off is that between revenue and attendance, *i.e.* a movement along the demand curve. Its magnitude is summarized by a single parameter, the price elasticity.

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At the same time, pricing decisions of museums can be more adequately described by models other than profit maximizing. It is generally understood that museums pursue a set of sometimes conflicting objectives through their pricing policies (see Frey and Steiner, 2010)[1]. This affects the interpretation of our commonly observed data, *i.e.* pairs of attendance, price observations, plus museum and demographic controls.

This paper contributes to the literature in the following manner. Previous studies have analysed the socioeconomic characteristics of visitors, such as Fernández-Blanco and Prieto-Rodríguez (2004) and Frateschi, Lazzaro and Palma-Martos (2009). An attempt to estimate demand function parameters has been made by Luksetich and Partridge (1997), that concludes that museum demand is price inelastic and that museum quality has effects on demand. In this paper a theoretical approach is outlined to integrate the two approaches, by putting pricing decisions in the context of the Hansmann (1981) model for non profit organizations, and deriving the pricing schedule for a museum as a function of its characteristics[2]. This is matched with a museum demand function, in order to give structure to conventional museum data. The identification problems are discussed and a strategy proposed to recover demand function parameters from available data. This is based on Luksetich and Partridge (1997) instrumental variable approach, which is extended by using the tobit regression first stage suggested by Wooldridge (2002). Evidence is analysed from the Uruguayan Museum Census undertaken in 2007, which is interesting in the sense of comparing results on museums in a developing country to those obtained for developing economies.

2. Museum demand and pricing

In what follows the theoretical approach to consumer demand and utility maximisation by museums is presented.

2.1. Demand and attendance

To identify demand function parameters, we may consider museum attendance and price data as market-level aggregate statistics arising from individual level discrete choices on attendance, in the spirit of Berry, Levinsohn and Pakes (1995). This approach is suited for datasets where aggregate market shares, prices, product and demographic characteristics are available.

Museums can be thought of as differentiated products according to their collection and display characteristics, some of which are observable in the data. Attendance also depends on consumer's preferences over observable and unobservable characteristics. Discrete choice can be reasonably argued as the relevant model, if recreational repeated (for instance, weekly) decisions are considered by heterogenous households, which may choose each time one

and only one of a set of alternatives indexed by $k = 0, 1, 2, ..., K$ (including not to attend). Different markets may correspond to different cities, in which one or more museums are available. In each city data are available on attendance (quantities) prices and museum (product) characteristics.

The level of indirect utility that a consumer attains from attending a museum is a function of a vector of individual attributes ζ, and a vector of museum characteristics (x, ξ, p), where p is price and x and ξ are respectively observed and unobserved (by the econometrician) museum attributes. Indirect utility attained by consumer j from attending museum i is given by

$$U = f(\zeta_j, p_i, x_i, \xi_i; \theta) \tag{1}$$

where θ is a vector of parameters. Consumer j would choose to consume good i if for all $k \neq i$ it holds:

$$U(x_i, \xi_i, p_i, \zeta_j, \theta) > U(x_k, \xi_k, p_k, \zeta_j, \theta) \tag{2}$$

This condition implicitly defines the set of values of the unobservable preference indicators ζ_j that result in the choice of i, denoted by B_i. Given a probability distribution of ζ, $f(\zeta)$, product i market share can be defined as the probability of ζ being observed in B_i, which is given by

$$s_i(x, \xi, p, \theta) = \int_{\zeta \in B_i} f(\zeta) d\zeta \tag{3}$$

Different assumptions on the distribution of ζ, result in different functional forms for market shares. Given a mass of consumers M, attendance to museum i is given by $n_i = Ms_i$.

Due to limited data availability the estimation strategy resulting from this approach cannot be pursued. As a constrained version of this approach we consider more conventional demand functions for museum attendance n_i including the standard right hand side variables, particularly prices (p_i) as well as variables related to museum heterogeneity including type indicators and observed and unobserved measures of quality (x_i, ξ_i). Variables that indicate consumer heterogeneity in preferences, such as incomes Y_m, and number of senior citizens, population in schooling age and share of population with higher educational level in the museum area (included in a vector A_m) would also shift the demand function. Summarizing:

$$n_{im} = g(p_i, Y_m, x_i, \xi_i, A_m) \tag{4}$$

2.2. Museum pricing

Museum preferences can be described by a utility function along the lines proposed by Hansmann (1981) for a non profit enterprise. A museum i cares for attendance (n_i), and qual-

ity (ξ_i in which to simplify we include observed and unobserved quality). Their objective function can be defined as $V(n_i, \xi_i)$, with $V_n > 0$, $V_\xi > 0$, $V_{nn} < 0$, $V_{\xi\xi} < 0$, being V_n and V_ξ the derivatives and V_{nn} and $V_{\xi\xi}$ the second derivatives of the museum's utility function with respect to its arguments. Museums can take decisions in order to enhance quality (size can be thought of as a dimension of quality) of their collections, but in the short term ξ_i may be considered fixed.

The assumed –at least locally– limited substitutability for the museum's services, implies that it can set the price p_i along the demand curve defined before $p_i = p(n_i,\xi_i)$ –taking as fixed income and demographics– with partial derivatives $p_n < 0$, $p_\xi > 0$. Donations D are positively related to ξ_i and negatively to p_i, hence positively to n_i. Total costs are $C = C(n_i, \xi_i)$ with $C_n > 0$, $C_\xi > 0$, being C_h the derivative of costs with respect to argument h. The non profit condition implies net revenues must be zero:

$$R = n_i\, p(n_i,\ \xi_i) + D(n_i,\ \xi_i) - C(n_i,\ \xi_i) = 0. \tag{5}$$

The museum's constrained maximization problem in the short run (ξ_i is thus fixed) is

$$Max\ V(n_i,\xi_i) \tag{6}$$

subject to

$$n_i\, p(n_i,\ \xi_i) + D(n_i,\ \xi_i) - C(n_i,\ \xi_i) = 0. \tag{7}$$

This yields the following first order condition:

$$V_n = -\lambda\ (n_i\, p_n + p_i(n_i,\ \xi_i) + D_n - C_n) \tag{8}$$

being V_n, C_n and D_n the derivatives of the museum utility function, costs and donations with respect to attendance and λ is a Lagrange multiplier. This gives the pricing rule

$$p^*_i = \frac{-V_n\ /\ \lambda - D_n + C_n}{1 + 1\ /\ \varepsilon} \tag{9}$$

where p^*_i is the optimal price and ε the price elasticity of demand, implying a markup over marginal utility of attendance (in money terms) minus marginal donation net of cost. Assuming the museum is on the elastic portion of the demand curve yields a greater than zero denominator. However, the numerator can be positive or negative as long as the museum values attendance and is able to elicit donations from higher attendance levels. In practice only positive and zero prices are observed. In this sense p^*_i is a latent variable and the price decision is summarized, for museum i, by the following discrete choice equation:

$$p_i = \begin{cases} p_i^* \ if \dfrac{-V_n / \lambda - D_n + C_n}{1+1/\varepsilon} > 0 \\ 0 \ \ otherwise \end{cases} \tag{10}$$

From this expression it can also be recalled that price depends on observed and unobserved quality ξ_i. The impact of quality on pricing depends on the net effect on costs, donations and attendance. Though in the short run quality may be reasonably thought of as fixed, quality variables can be seen as price shifters in the cross section context.

2.3. Attendance outcomes

Observed data are the result of supply and demand interactions, hence prices are endogenous in the strict sense that they are jointly determined by the demand and pricing schedules and represent their combined outcome. In the case of a museum, some specific considerations can be made with respect to supply decisions.

Museum decisions do not require specific service quantities to be determined at each period, but rather imply establishing a general collection size and/or quality plus its exhibition space. Then services to individuals have the characteristics of a local public good. Attendance as a measure of quantity will always be set by the demand level up to the congestion point when capacity constraints will be binding. Due to the fact that there are no Uruguayan "superstar" museums, it may reasonably concluded that when attendance is observed this is directly equal to demand at the price set by the museum.

However there is a clear consequence arising from the structure of museum decisions, *i.e.* prices are correlated with unobserved quality in the museums. The Hansmann (1981) approach implies that museums know the values of quality attributes, and fixed their prices accordingly. This would render inconsistent regression estimation and call for instrumental variables techniques.

3. Data

Data come from the first Uruguayan National Museum Census by the Culture and Education Ministry[3]. A descriptive analysis of the survey is provided by Cóppola and González (2009). A valuable previous descriptive presentation of Uruguayan museums can be found in Rappetti (2000).

For the 2007 Museum Census a registry of all Uruguayan museums was constructed for the first time. A museum was defined as "a permanent institution, non profit, with a material

endowment to manage, preserve, communicate and exhibit to the population, with study, education or recreation purposes". In this sense the traditional museum concept was emphasized, hence excluding natural, archeological and ethnographic sites, as well as historic sites; institutions holding collections of live specimens of plants or animals, such as zoos, botanical gardens, aquariums, etc.; science centers and planetariums; non profit art galleries, conservation institutes, exhibition galleries and cultural centers, and natural reserves. Museums open at pre established times were included as well as those that can be visited by previously agreeing on an appointment. 166 open museums were registered.

No for profit institution was excluded from the Census, and the registry encompassed virtually all museums in the country. Finally 100 museums returned the complete census survey. Some refused to participate in the survey, particularly those dedicated to the military and managed by the Defense Ministry. Some very small museums were difficult to contact and interview.

The survey includes 67% public museums, 26% private museums and 7% with mixed public-private ownership. The museum type distribution shows a majority of history (48%) and arts (17%) museums, while 24% are combined museums and 8% were classified as science[4].

A dollar valuation of its endowment was provided by each museum. 53% of them valued their endowment less than 100 thousand dollars, while 23% valued it more than one million dollars.

Total attendance of all museums in the sample during 2007 was 1,293,214. 67% of the visits recorded in the sample went to public museums, 21% to privately owned museums, and 12% visited mixed public-private museums. On average, the public museums in the sample received 13,261 visitors, private museums 9,934, and mixed museums 21,393.

To this paper it is important to analyse pricing behaviour. In table 1 mean attendances by price level are shown. Of all 100 museums for which price and attendance data are present, only 12 charge prices for attendance. When comparing with other countries' data, this proportion does not seem odd. Statistics provided by the European Group on Museum Statistics (EGMUS) (2015) included the UK where all museums had free admission in 2012, as well as France where only 11% of them did in 2010. For a similar estimation to this paper's, Luksetich and Partridge (1997) indicate that in their sample "most" or a "large proportion" of museums charge no admission fee, but do not provide the specific figure.

Though the sample is not large, this does not rule out a significant price effect on attendance. In fact, there is a clear positive correlation between price and attendance. So, this sets an unfavourable *a priori* scene for the proposed estimation. According to the theoretical interpretation proposed, such positive correlation reflects unobserved quality, and the effect should change sign or disappear in a controlled estimation.

Table 1
MEAN ATTENDANCE TO MUSEUMS BY PRICE LEVEL

Price (pesos)	Mean attendance (visitors)	Number of museums
0	10,894	88
15	5,000	1
20	7,500	1
25	23,000	4
30	3,000	1
40	31,000	2
50	30,000	1
60	85,000	1
85	50,000	1
All	12,932	100

Source: Author's elaboration based on Census of Museums.

While 22% of private museums charge fees, 4% of public museums do. Of the fee charging museums, 50% are public museums and 25% private.

Visits to museums are also concentrated: 10% of the museums –the most visited 10– gathered 42% of the visits, while the 50% of museums with less attendance attracted about 9% of the public. In the ten most visited museums, three (2 private, 1 public) charge entrance fees and 7 (all public) do not. Museums in the capital of Uruguay, Montevideo, account for 54% of the visitors in the sample, those in the Department of Maldonado for 13%, and in Department of Colonia for 10%. The profile of visitors according to their origin (foreign, local or from other regions of Uruguay) was not available in this sample.

4. Estimation

The estimation seeks to identify price and income demand elasticities using data from a cross section sample of museums. Price and attendance are measured at the museum level while incomes will be averages from a population of the relevant surrounding influence area. Several other variables describing the museums' budget constraint and management decisions are also available.

All Uruguayan museums respondent of the 2007 Census are not for profit institutions (this is the case for those included in the Luksetich and Partridge 1997 study). This is in line with the model proposed to analyze this data. In our sample many of the museums are public and may combine public funding with private donations. However, some of the publicly owned or mixed private-public museums charge admission fees.

As Luksetich and Partridge (1997) do, the museum demand function is estimated using an instrumental variables strategy in order to tackle the endogeneity of the price variable. The first stage equation is estimated using a Tobit model to account for the binary nature of the pricing decision, which translates in the data in a high number of observed zero admission prices.

The dependent variable is the log of annual attendance. Population size in the museum areas is heterogeneous, particularly given the fact that the capital, Montevideo, accounts for roughly half of Uruguay's population. In the capital there are more museums (34 out of 100) than in any other city but the average attendance is not the highest. The differences in average attendances are much smaller than differences in average town size, hence this suggests not to perform the per capita correction of attendances as Luksetich and Partridge (1997) do. The tourist population could also considered, since in some cases along the Uruguayan coast the tourist population in summer months multiplies several times the number of locals. Some number of tourist estimations by region are available in Uruguay, but they are measured at different aggregation levels than the resident population statistics used for this paper, so they will not be used.

As it was mentioned before we have a large number of museums charging zero prices. A log price specification gives the elasticity directly, so zero prices are substituted by unity to obtain a lower bound of zero for log prices.

Quality controls include values of collections, classified in intervals using dummy variables. Luksetich and Partridge (1997) estimate separate demand functions by museum type. In this case, the sample size leads to include museum type controls as a set of dummy variables.

Income in the relevant museum area (defined as the town hosting the museum) is measured by the mean per capita household income as estimated from the 2007 Uruguayan Household Survey records. Unlike Luksetich and Partridge (1997) that use fractions of population within given income intervals, average income is used.

According to the proposed theoretical approach, demographic controls are included, measured as averages in the museum hosting town, that indicate taste shifts in the population. A set of alternatives was considered, including education levels, attendance to schooling and age structure of the population, in the same spirit of the Luksetich and Partridge (1997) paper. Fractions of the population by age intervals, education level and attendance to school were obtained from the 2007 Uruguayan Household Survey[5]. In our case several of such measures are pairwise collinear, so only the fraction of the population over 60 years old and the share of population attending the educational system were include in our second stage. The percentage of population attending school ranges between 17 and 33% with an average 28%, while the fraction of population above 60 years of age ranges between 11 and 32% with an average 19%.

The price and income elasticities are estimated using the instrumental variables method. The estimated equation is as follows:

$$\ln n_i = \alpha + \beta \ln p_i + \gamma Y_{ij} + \delta A_{ij} + \theta S_i + \sum_{k=l}^{K} \mu_k T_{ik} + u_i \tag{11}$$

where n_i is attendance, p_i is price in pesos, Y_{ij} is per capita household income of the museum town j, A_{ij} is a set of demographic controls measured at town level, S_i is number of items exhibited, T_{ik} are museum type dummies, and u_i is unobserved heterogeneity affecting attendance.

Wooldridge (2002)[6] discusses the case of instrumental variables estimation when the first stage equation is used to obtain predicted probabilities using a probit model, and provides a procedure to obtain statistically valid standard errors for the second stage estimates. He suggests running a first stage regression of the endogenous variable on all the rest of the variables included in the second stage plus a set of exogenous instruments, and compute the predicted values.

Then, in the second stage instead of running a regression of the dependent variable on the rest of the variables included in the equation plus the predicted values for the endogenous regressor from the first stage estimation, he indicates to perform an instrumental variable procedure where the instruments for the endogenous variable are the predicted values from the first stage. Then the standard errors provided will be statistically valid. The same method is used in this paper, since this case –where the first stage equation is a Tobit model– is analogous.

For the first stage equation a set of instruments was included, correlated with price but that can be thought of as reasonably uncorrelated with the error term in the demand equation. The microfoundation for this choice is given by the pricing equation obtained in section 2.2. The instrument set included a dummy for public ownership, and the log of total museum budget as a measure of cost. Public ownership impacts costs via differences between private and public wages. The use of the budget variable (indicator of costs) is due to the fact that it is an argument in the pricing equation, and based on the assumption that in the short run museum decisions are not affecting quality. The method used gives a just identified instrumental variables second stage equation hence no overidentification restrictions can be tested for exogeneity of instruments. Though evidence in favor of lack of correlation between our instruments and u_i cannot be provided, it can be tested their correlation with prices (relevance) by running the regression of museum prices on the set of instruments.

5. Results

In table 2 the results for the (tobit) regression of price on the set of instruments are presented. This regression is not part of the demand parameter estimation, but is intended to provide complementary evidence on the suitability of instruments. In this estimation, due to missing values in some of the regressors 87 observations are used, of which 10 charge positive prices.

Table 2
FIRST STAGE TOBIT REGRESSION
DEPENDENT VARIABLE IS LN OF ADMISSION PRICE

Log likelihood= –36,86				**Number of obs = 87** **LR chi2(2) = 31,23** **Prob > chi2 = 0,00** **Pseudo R2 = 0,30**
	Coef.	**Std. err.**	t	**P>|t|**
Public Ownership	–7.61	2.57	–2.96	0.00
In Total Budget	1.27	0.68	1.88	0.06
In Number of items on display	–0.69	0.58	1.19	0.24
Constant	–18.14	8.4	–2.16	0.03
/sigma	4.25	1.16		

Source: Author's elaboration based on Census of Museums.

Results in table 2 show that both variables are significantly related to price. As a control for quality, the number of items in the museum collection was added as a regressor, but it turned out to be non statistically significant.

In table 3 the results of the (second stage) instrumental variable estimation for the logarithm of museum attendance are presented. In this estimation the price variable was instrumented with the predicted valued from a first stage in which the exogenous instruments were included (public ownership, total budget) along the variables that belong in the demand equation (incomes, demographic controls and other museum characteristics)[7].

Table 3
F SECOND STAGE ESTIMATION
INSTRUMENTAL VARIABLES (2SLS)\ REGRESSION
DEPENDENT VARIABLE IS LN OF ATTENDANCE

Root MSE = 1,43				**Number of obs = 87** **Wald chi2(2) = 16,37** **Prob > chi2 = 0,01** **R-squared = 0,35**
	Coef.	**Std. err.**	z	**P>|z|**
Ln price	–0.29	0.35	–0.86	0.39
Ln per capita income	1.23	0.6	2.06	0.04
Ln number of items exhibited	0.19	0.12	1.65	0.10
Share population 60 years old or more	0.07	0.07	2.92	0.00
Share population attending schooling	0.24	0.08	2.93	0.00
History museum dummy	-0.3	0.31	-0.95	0.35
Constant	–13.89	5.67	-2.45	0.01
Instrumented: lpr				

Source: Author's elaboration based on Census of Museums.

The results show a mostly significant effect of the demand shifters and controls, which is also of the expected sign. The effect of demographic controls indicate that large shares of population in retirement ages (low opportunity cost of time) and large share of population attending school (shift in tastes) are associated to larger attendance. The regression picks a negative, non significant coefficient of the price variable in the demand estimation, therefore the estimation does not find a price effect on museum attendance. However it does find statistically significant the income impact, with an estimated elasticity somewhat above 2. This two results, combined, do not seem disconnected from the previous literature using data from developed economies.

6. Conclusions

This paper has proposed a way of modeling museum pricing decisions that fits within the Hansmann (1981) model. Beyond the result of the particular econometric exercise provided, it can be interesting as a conceptual framework for the analysis of museum price and attendance data.

The results lend support to the idea that museum attendance in Uruguay is not significantly sensitive to price changes. It is found however a significant and positive impact of income (with variation between museum areas of influence). With respect to the identification strategy, it can be reasonably argued that the estimation has been cleaned from endogeneity problems enough to regard the price effect obtained as a reasonable estimate of the demand price elasticity, which turned to be statistically indistinguishable from zero. The small sample size leaves few degrees of freedom available. The controls introduced in the estimation were often statistically non-significant. Some of them were defined at the town level, hence variation may not have been enough to identify the effects. However the significance of the estimated income and price parameters is not sensitive to the exclusion/inclusion of additional regressors, hence the basic result may be deemed as robust.

The results obtained do not prescribe any particular policy with respect to museum pricing in Uruguay or anywhere else. Museums balance a wide set of objectives in their supply and pricing decisions. The trade-offs involved are many. In that sense, evidence of the type presented in this paper is an important input for an informed decision though not the only one.

An interesting line to pursue that follows from the approach of this paper is the analysis of matched datasets, in which individual demographic and socioeconomic data are present as well as specific museum attendance choices, which could be linked to the vector of museum prices, costs and characteristics. This could lead to richer estimation techniques based for instance on the Berry, Levinsohn and Pakes (1995) approach.

Notes

1. Prieto-Rodríguez and Fernández-Blanco (2006) analyse a principal-agent model to uncover the role of incentives in management decisions. See also Frey and Meier (2006) for a general review of the literature on the economics of museums.
2. See Hansmann (1987) and Steinberg (2003) on economic theories of non-profit organizations.
3. See Departamento de Industrias Creativas, Ministerio de Educación y Cultura de Uruguay (2008).
4. The rest (3%) are included in the residual category "other".
5. Some museums were located in small towns not directly included in the Household Survey sample in 2007. Incomes and demographic indicators for adjacent areas were considered in such cases.
6. See Wooldridge (2002), chapter 18, pp. 623-625.
7. Two stage least squares estimation performed using command ivregress in Stata.

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Resumen

En este trabajo se analiza un versión del modelo de Hansmann (1981) de la economía de las instituciones sin fines de lucro para derivar funciones de determinación de precios de los museos, las que se combinan con demanda de asistencia a los mismos que surgen de la maximización de utilidad por consumidores que toman en cuenta las características de los museos. Se propone una estrategia empírica para identificar la demanda por los museos basada en las bases de datos micro usuales, incluyendo precios, asistencia, características de los museos y variables demográficas de las localizaciones de los mismos. En línea con la literatura se aborda los problemas de endogeneidad de los precios observados y la alta proporción de observaciones con precio cero. Se propone una estrategia que combina variables instrumentales y técnicas de corrección por selección. Se estima el modelo usando los datos del Censo 2007 de museos de Uruguay. No se encuentra un efecto estadísticamente significativo del precio en la asistencia.

Palabras clave: economía de los museos, economía del arte y la cultura.

Clasificación JEL: Z1