Identifying Football Ticket Demand Elasticities in the Presence of Dependence Among Matches

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Resumo
Na literatura sobre demanda por futebol, permanece uma lacuna quanto ao tratamento da interdependência entre partidas dentro dos campeonatos ao se analisar a demanda por ingressos. Este estudo aborda essa lacuna ao estimar elasticidades de demanda na presença de dependência transversal entre partidas do Campeonato Brasileiro ("Brasileirão") ao longo de oito temporadas (2012–2019). Especificamente, o estudo detecta formalmente a dependência transversal, demonstra como tal dependência pode comprometer a identificação e a validade interna das estimativas de elasticidade da demanda e propõe uma estratégia para controlá-la. Os resultados mostram que variáveis de transmissão televisiva — em especial a televisão aberta — eliminam de forma eficaz a dependência entre os jogos. Em combinação com os instrumentos selecionados e outras covariadas, essas variáveis permitem a identificação consistente da demanda por ingressos de futebol.
Palavras chaves: Dependência Transversal, Futebol Brasileiro, Demanda por Ingressos de Futebol

Abstract
In the football demand literature, a gap remains regarding the treatment of interdependence among matches within championships when analyzing ticket demand. This study addresses this gap by estimating demand elasticities in the presence of cross-sectional dependence across matches in the Brazilian Championship ("Brasileirão") over eight seasons (2012–2019). Specifically, it formally detects cross-sectional dependence, demonstrates how such dependence can compromise the identification and internal validity of demand elasticity estimates, and proposes a strategy to control for it. The results show that broadcasting variables—particularly broadcast TV—effectively eliminate cross-sectional dependence across games. In combination with the selected instruments and other covariates, these variables allow for the consistent identification of football ticket demand.
Keywords: Cross-Sectional Dependence; Brazilian Football; Football Ticket Demand.

JEL Classification: C23, C26, Z29.

Área Enaber 2: Análise de Dados Espaciais e Econometria Espacial

1. Introduction

In the early literature on the determinants of paying attendance at football matches, several econometric and methodological issues received limited attention (García and Rodríguez, 2009). For example, many studies chose to omit price and income variables due to the lack of available data. From the mid-1990s onwards, the inclusion of these variables became common in empirical analyses. The second phase is distinguished by the widespread adoption of panel data methods, enabling disaggregated match-level analyses across multiple seasons and a more rigorous control of unobserved heterogeneity. Variables related to product quality, such as historical rivalry, weather conditions, team age, among others, were incorporated at this stage (García and Rodríguez, 2009). In recent empirical studies on the demand for football tickets, increasing attention has been given to the issues of endogeneity and causal identification (BRANDES et al., 2012; NOLL, 2013).

Despite these methodological advancements, to the best of our knowledge, a gap remains in the literature regarding the treatment of dependence among football matches when analyzing ticket demand. This cross-sectional dependence has arisen by the presence of time-varying unobserved factors in this context. Among these factors, two stand out: the possibility of a fan supporting more than one team ("second favorite team") and the role of "rival haters" – fans who root against rival teams, wishing for their failure in the competition. There are no documented attempts in the literature to control for these time-varying unobserved factors, which divert attendance from certain matches, manifest in the error term, and may be correlated with key variables for estimating demand elasticities, such as price, income, or fan base size. Consequently, the absence of such control may result in biased and inconsistent estimates of demand elasticities.

Hence, this study seeks to identify demand elasticities in the context of cross-sectional dependence among football matches in the Brazilian Championship ("Brasileirão") over eight seasons (2012–2019). To this end, it first formally detects the presence of cross-sectional dependence, demonstrates how it can undermine the identification and internal validity of demand elasticity estimates, outlines the direction of the resulting bias, and proposes an approach to control for it. Given that supporters of "second favorite teams" and "rival haters" often express their support or opposition by watching games on television broadcasts, pay TV, or streaming, these time-varying unobserved factors will be controlled by incorporating information about these viewing options into the demand equation.

When empirical studies in the sport literature incorporated data on television broadcasts, the objective was not to control for cross-sectional dependence among matches to avoid identification issues in estimating ticket demand elasticities but rather to investigate the direct effect of broadcasts on paying attendance. Consequently, in the literature, broadcasting is typically treated as a variable of interest rather than as a control variable (covariate) in regression analysis. Falter and Perignon (2000) and Martins and Cró (2016) argue that television broadcasting may contribute to a decline in fan attendance at stadiums. García and Rodríguez (2002) found a similar effect, with a decline in attendance when matches were broadcast for free on public television channels. Similar results in terms of reduction in attendance were reported by Czarnitzki and Stadtmann (2002), Buraimo and Simmons (2008, 2009), Forrest and Simmons (2006), Buraimo et al. (2010), and Alan and Roy (2015).

However, it is important to account for a potential positive general equilibrium effect on attendance over the course of the championship. For instance, Alan and Roy (2015) state that league and club managers view broadcasts positively, as the expansion of television coverage can lead to greater exposure for the competition and teams, resulting in increased revenue, sponsorships, and the attraction of new fans. In other words, while live broadcasting may reduce attendance at a particular match, it can simultaneously stimulate greater interest in the competition as a whole, ultimately leading to an overall increase in attendance across the season (Borland and MacDonald, 2003).

Another possible explanation for obtaining a positive estimate of the effect of broadcasting on attendance relates to the challenges in isolating causality. In fact, Borland and MacDonald (2003) and Buraimo et al. (2009) caution against interpreting such effects without considering potential simultaneity bias. Broadcasters—especially free-to-air channels—tend to select matches with characteristics similar to those that attract large in-stadium crowds. As a result, while broadcasting can influence paying attendance, matches with substantial audiences are also more likely to be chosen for broadcast, thereby confounding the causal relationship.

In sum, the literature indicates that free-to-air, pay TV, and streaming broadcasts can affect paid attendance in either direction, depending on the competition's context or econometric factors. Perhaps more importantly, these broadcasts may also be correlated with the determinants of football ticket demand—such as price, income, and fan base size. Higher ticket prices tend to increase the share of fans who watch matches on television, while lower prices reduce this share. Similarly, lower supporter income levels are associated with a greater likelihood of following the match on TV, whereas higher incomes reduce this tendency. Furthermore, the larger the number of supporters of a second-favorite team and *rival haters*—who are not accounted for in the data on fan base size—the stronger the correlation with the fans observed in the data, namely, those supporting their primary favorite team. Nonetheless, no studies have investigated the dependence among games caused by these time-varying unobserved factors in an analysis of demand for football.

This paper contributes to the literature in four main ways. First, to the best of our knowledge, it is the first study to identify cross-sectional dependence in football matches. Second, it uncovers the source of this dependence, showing that it arises from two types of fans who follow certain matches on television or other platforms while diverting attendance from others: supporters of a "second favorite team" and "rival haters." Third, it develops and applies a method to control for this dependence using detailed broadcasting information (free-to-air television, pay TV, and streaming). Finally, it highlights the importance of accounting for broadcasting when estimating the demand elasticities for football match tickets. Failure to properly control for broadcasting in the demand equation may lead to biased, inconsistent and inefficient elasticities, thereby undermining the internal validity of the estimates.

The main results reveal that the broadcasting variables, specially broadcast TV, is capable to expunge the cross-sectional dependence among games. These variables along the instruments and other covariates allow the identification of the football ticket demand, using a panel data with information of matchday reports about the Brazilian Championship ("Brasileirão").

In addition to this introduction, the remainder of the paper is structured as follows. Section 2 presents the empirical strategy. Section 3 describes the dataset. Section 4 discusses the results. At last, section 5 concludes.

2. Empirical Strategy

Cross-sectional dependence among matches is primarily generated by two unobserved factors that vary over time: the "second favorite team" fans and "rival haters". Regarding the first factor, it is assumed that fans who support more than one team tend to follow the one performing better in the competition. When this team is not performing well, the same individual may choose to follow the other club on television or even attend the stadium, generating an unobserved factor in the attendance data. However, the other option is less common since the second team is usually located in a different city from where the fan resides and actively supports their primary team. Moreover, appreciation for this second team does not appear in the data for two reasons. First, the size of a club's fan base is often estimated based on the total population of the city where the club is headquartered. Second, public opinion surveys on fan preferences typically ask only for the respondent's primary favorite team, without considering a second favorite team.

Regarding the second time-varying unobserved factor, we observe not only the team supporters but also the presence of "rival haters"—a distinct type of "reverse fan" who may set aside their support for their own team to follow a rival club, rooting against it, usually by watching on television to take pleasure in the rival's misfortune. This behavior can create a substitution effect: when a rival hater chooses to watch their rival's match on TV, they may simultaneously reduce stadium attendance for their own team's games, thereby redistributing demand across matches.

In this context, the main challenge in identifying football demand elasticities stems from the unobserved presence and time-varying behavior of these two groups of supporters. These factors influence paid attendance at matches and are correlated with key variables such as price, income, and fan base size, potentially leading to omitted variable bias in the estimated elasticities. If TV broadcasts reduce attendance, their positive correlation with price and negative correlation with income bias price elasticity estimates downward and income elasticity estimates upward. The opposite holds when broadcasts increase attendance.

It is first necessary to empirically assess whether cross-sectional dependence is present in the regression. For this purpose, a cross-sectional dependence (CD) test is performed on the panel data. Given the structure of the dataset—380 matches across eight seasons—the CD test proposed by Pesaran (2004) is the most appropriate choice. Rejection of the null hypothesis of cross-sectional independence indicates the presence of dependence across units. If unobserved factors influencing matches are correlated with the regressors in the demand equation, the resulting estimates will be biased and inconsistent. Controlling for cross-sectional dependence in the residuals is therefore essential to obtain reliable estimates of football match ticket demand. Moreover, accounting for such dependence improves the efficiency of the estimates.

These two types of fans are not directly represented in the data, and they constitute unobserved factors that vary over time. As a result, a traditional two-way fixed effect estimator cannot account for them. Therefore, it is necessary to find a proxy for these factors and incorporate it into the football ticket demand equation. Since supporters of "second favorite teams" and "rival haters" express their support or opposition through free-to-air broadcasts, pay TV, and pay-per-view, these time-varying unobserved factors will be proxied by including information about these viewing options in the demand equation.

As mentioned in the previous section, several studies have analyzed the positive or negative association between TV broadcasts and match attendance in football. Nevertheless, the type of broadcasting can influence fan preferences, as matches broadcast on free-to-air channels tend to be more attractive than those available only on subscription channels (FORRENT and SIMMONS, 2006; BURAIMO et al., 2009). This approach is appropriate since almost all matches are broadcast on either free-to-air or subscription TV channels, according to information obtained from the Brazilian Football Confederation (CBF) website.

To be more specific, the dummy variable ($broadTV_{it}$) will take the value of one for matches broadcast on free-to-air TV (Globo TV/Band TV) and zero otherwise. This variable is expected to act as a near-perfect substitute for attending matches in stadiums, representing a significant alternative for fans due to its zero cost. The second dummy takes the value of one for matches broadcast on pay-per-view (PPV_{it}) and zero otherwise. Finally, the third dummy variable ($payTV_{it}$) takes the value of one when the match is broadcast on at least one pay TV channel—namely, Sportv and/or TNT—and zero otherwise. Although these last two variables may proxy "second favorite team" fans and "rival haters," their impact may be less pronounced in the Brazilian context, as accessing these services entails subscription costs for pay TV channels.

Considering the factors that influence attendance at the stadium, a two-way fixed effect model for "Brasileirão" is specified as follows:

$$\log(attendance_{it}) = \beta_0 + \beta_1 \log(price_{it}) + \beta_2 \log(income_{it}) + \beta_3 \log(fans_{it}) + \tau_1 broadTV_{it} + \tau_2 payTV_{it} + \tau_3 PPV_{it} + \rho' \boldsymbol{D}_{it} + \theta' \boldsymbol{Q}_{it} + a' \boldsymbol{A}_{it} + o' \boldsymbol{O}_{it} + \varepsilon' \boldsymbol{E}_{it} + \mu_i + \phi_t + u_{it} \qquad (1)$$

where $attendance_{it}$ stands for the total paying attendance at the stadium on match day; $price_{it}$ is the average ticket price estimated in the first stage; $income_{it}$ indicates the proxy for fan income in the city where the match is held, and $fans_{it}$ denotes the fan base size. Next, in Equation (1), three covariates are included to control for broadcasting: $broadTV_{it}$ is a dummy variable indicating free-to-air broadcasting, $payTV_{it}$ is a dummy variable representing pay TV transmission, and PPV_{it} denotes pay-per-view transmission. Additionally, $\boldsymbol{D}_{it}$ indicates the distance traveled by the visiting team; $\boldsymbol{Q}_{it}$ pertains to the vector of variables regarding match quality; $\boldsymbol{A}_{it}$ is the vector of variables related to the game's attractiveness; $\boldsymbol{O}_{it}$ represents the vector of variables concerning the opportunity cost of attending a match; and $\boldsymbol{E}_{it}$ refers to the set of variables linked to the structure of the stadium where the match takes place. In this case, the match is used as the cross-sectional unit i, and the season as the time indicator t. Additionally, μ_i represents unobserved match-specific factors that are time-invariant, while ϕ_t denotes the season time dummies, both capturing unobserved heterogeneities. The β_j terms are the scalar coefficients to be estimated, while τ_j, ρ, θ, α, o, and ε are vectors of coefficients. Finally, u_{it} denotes the error term.

The identification of income elasticity and fan base elasticity is based on the assumption that income and fan base size are independent of the error term after controlling for $broadTV$, $payTV, PPV, \boldsymbol{D}_{it}, \boldsymbol{Q}_{it}, \boldsymbol{A}_{it}, \boldsymbol{O}_{it}, \boldsymbol{E}_{it}, \mu_i, \phi_t$. In other words, income and fan base size can be considered exogenous variables in the football ticket demand equation, provided that all necessary controls for observed and unobserved factors correlated with income and/or fan base size—while also influencing total paying attendance at stadiums—have been included in the demand equation.

In contrast, the ticket price variable is typically endogenous, reflecting the simultaneous interaction of supply and demand in equilibrium. Accordingly, identifying its coefficient requires a valid set of instruments to isolate its effect on total paid attendance at stadiums. To address this source of endogeneity, the football ticket demand equation will be estimated using two-stage least squares (TSLS), employing three instrumental variables will be used in the estimation of the football ticket demand equation, namely: (i) the proportion of half-price tickets sold relative to total tickets sold; (ii) the home and away teams' standings in the previous season; and (iii) a dummy variable indicating whether the away team competed in the Second Division (Série B).

It is important to note that decisions regarding the availability of half-price tickets are exogenous and based on legal regulations at the federal, state, or municipal levels. Federal Law No. 12,933, enacted on December 26, 2013, guarantees half-price admission to sports events in Brazil for regularly enrolled students. The law also extends this benefit to people with disabilities and their companions, as well as to young people aged 15 to 29 with an updated registration in the Federal Government's Unified Registry for Social Programs. The legislation mandates that at least 40% of the total available tickets for each event be allocated to these categories.

Moreover, in several states, laws and public policies ensure the availability of ticket discounts for certain groups, such as students, the elderly, or people with disabilities. The inclusion of these complimentary or half-price tickets requires an adjustment in the prices of other tickets, which can be observed in some matches. Regarding the independence condition, it is assumed that these instruments are directly related to ticket prices but uncorrelated with the error term in the demand equation. In particular, the implementation of half-price tickets is determined by specific legislation that varies across state and municipal levels, thereby providing the exogenous variation required for the use of these instruments.

The second type of instruments is based on the performance of the teams in the previous season and consists of two variables: the ranking of both teams in the previous season, and a dummy variable indicating participation in "Série B"[1] in the previous year. It is expected that teams that participated in lower divisions in the previous year will face implicit price constraints due to the type of product they offer, which in this case are the matches. When these clubs access the top division, they cannot simply adopt the same prices as the renowned teams. Thus, it is assumed that there is a direct correlation between these instruments and the ticket price, but that this correlation does not extend to the error term in the structural demand equation.

3. Data

Several sources were used to compile the dataset, with the primary and most detailed being the matchday reports published on the CBF website since 2012. A panel data was constructed with 380 games per season of the *Brasileirão* from 2012 to 2019, totaling 3,040 observations. [2] These reports are considered one of the main data sources for football matches. The matchday reports provide data on average ticket prices and paid attendance for each match. They also detail the number of tickets available and sold for each target group—full-price, half-price, club members, and complimentary—enabling the construction of the first set of instruments to be tested.

The second most frequently used source is the official website of the Brazilian Football Confederation (CBF, 2020). The CBF website offers a wide range of match-related information, including final scores, match venues, dates, and times, team standings, total accumulated goals and points, match broadcasts, promoted and relegated teams, as well as the National Club Ranking, which is organized by the CBF. Finally, information regarding the real income of fans, population, and weather quality was obtained from the Ministry of Infrastructure, the Brazilian Institute of Geography and Statistics (IBGE), and the National Institute of Meteorology (INMET). The variables and instruments used in this study are summarized in Table 1.

Despite this, there are some challenges in finding suitable proxies for certain variables of interest in the analysis of football ticket demand. For example, per capita income or regional per capita GDP has traditionally been used as a proxy for football supporters'income. However, this proxy may be inadequate because the data are released only once a year. As a result, fans' real income would take on a constant nominal value for all matches of a given club throughout the season, being updated only for inflation. To address this limitation, an income proxy was developed for the Brazilian context based on vehicle fleet flows in the city where the match takes place. According to Daudt and Willcox (2018), the Brazilian automotive industry has shown a strong correlation with household income growth, particularly since the 2000s. The variable is constructed from the total fleet of cars, motorcycles, and mopeds registered monthly in the city, as these vehicle types are assumed to be more closely correlated with household

[1] The "Série B" is the second division of Brazilian professional football, where clubs compete for promotion to the elite "Série A".

[2] A total of 22 observations were excluded due to the absence of the match financial report published by the CBF, matches played behind closed doors, or walkovers (W.O.).

income than others primarily associated with production, such as trucks, buses, trailers, and tractors. The per capita vehicle flow for the host city is then calculated as the difference in the total number of registered cars, motorcycles, and mopeds between the match month and the previous month, divided by the city's total population.

Another challenge is operationalizing the size of the fan base ($Fans_{it}$). The standard approach in sports economics—using the logarithm of a host city's total population as a proxy for market size—is problematic in Brazil. This is because many Brazilian cities host multiple major clubs (e.g., Rio de Janeiro's Flamengo, Fluminense, Vasco da Gama, and Botafogo), meaning the total population does not accurately represent any single club's potential consumer market.

To address this issue, which has been noted by Brandes et al. (2012), this study deviates from the standard methodology. Instead, we calculate a partitioned population proxy. The city's total population is allocated to each club in proportion to the club's estimated share of the fan base (see Table 2). These shares are determined using data from random sampling surveys conducted by public opinion research institutes between 2012 and 2019. This method aims to mitigate the bias inherent in the conventional approach.

Table 1 –Variables and Instruments Used in the Demand Analysis

Variables	Notation	Measure	Source
Quantity of tickets sold	$\log(attendance_{its})$	Logarithm of the total paying attendance	Matchday reports
Real average ticket price	$\log(price_{its})$	Logarithm of the average real prices.	Matchday reports
Real income	$log(income_{it})$	Logarithm of the vehicle fleet flow per capita	Ministry of Infrastructure, Brazil
Fan base size	$log(fans_{it})$	Logarithm of the partitioned population of the city where the match takes place.	Brazilian Institute of Geography and Statistics
Television broadcast (**T**)	$broad_{it}$	Dummy variable: 1 for matches broadcast on open TV (Globo TV and/or Band TV, local channels); and zero otherwise.	CBF
	PPV_{it}	Dummy variable: 1 for matches broadcast on Première (per-pay-view); and zero otherwise.	CBF
	$payTV_{it}$	Dummy variable: 1 for matches broadcast on Sportv and/or TNT Sports (Brazilian cable TVs); and zero otherwise.	CBF
Distance (**D**)	$log(dist_{it})$	Logarithm of distance multiplied by two.	Google Maps
Stadium Characteristics (**E**)	$Arena_{it}$	Multiuse arena dummy (1 for matches held in multiuse arenas; 0 otherwise).	CBF
Match Quality (**Q**)	PosCas_{it}	Home team position in the standings	CBF
	PosVisit_{it}	Position of the visiting team in the standings	CBF
	PontAcuCas_{it}	Total points accumulated by the home team	CBF
	PontAcuVisit_{it}	Total points accumulated by the visiting team	CBF
	GolCas_{it}	Total goals scored by the home team	CBF
	GolVisit_{it}	Total goals scored by the visiting team	CBF
	DesempCas_{it}	Sum of the points earned by the home team in the last three rounds	CBF
	DesempVisit_{it}	Sum of the points earned by the visiting team in the last three rounds	CBF
Match attractiveness (**A**)	RNCHome_{it} RNCVisit_{it}	National Club Ranking Score	CBF
	$derby_{it}$	Dummy variable: 1 for local or historical derby (rivalry); and zero otherwise.	CBF
	big_{it}	Dummy variable: 1 for clubs from the States of Rio de Janeiro and São Paulo; and zero otherwise.	CBF
	$theil_{it}$ $theil_{it}^2$	Short-term uncertainty of outcome measured by Theil measure	ODDS.com
Opportunity costs (**O**)	$weather_{it}$	Dummy variable: 1 if it rained on match day; and zero otherwise.	National Institute of Meteorology, Brazil
	$night_{it}$	Dummy variable: 1 for matches that took place after 6 p.m.; and zero otherwise.	CBF
	$dayoff_{it}$	Dummy variable: 1 for matches played on Saturday, Sunday or national holidays; and zero otherwise.	CBF
Instruments (**I**)	$halfprice_{its}$	Ratio of half-price tickets to total tickets sold.	Matchday reports
	$ClassAntCas_{it}$	Home Team's ranking in the previous season	

	$ClassAntVisit_{it}$	Visiting Team's ranking in the previous season	
	$SérieBCas_{it}$	Dummy for Serie B (1 if the home team played in Serie B in the previous season)	
	$SérieBVisit_{it}$	Dummy for Serie B (1 if the visiting team played in Serie B in the previous season)	

Notes: This table presents the variables, instruments, and data sources used in the demand analysis of Equation 1. The first column categorizes the variables, the second column displays their notation, the third column provides their descriptions, and the fourth column specifies the data sources.

Table 2 – Club Fan Base Size as a Proportion of the City's Population

City	Club	Proportion
Belo Horizonte*	América Mineiro-MG	2,10%
	Atlético Mineiro-MG	40,00%
	Cruzeiro-MG	37,50%
Curitiba**	Athletico Paranaense-PR	25,27%
	Coritiba-PR	21,33%
	Paraná-PR	8,27%
Florianópolis*	Avaí-SC	31,00%
	Figueirense-SC	36,00%
Fortaleza*	Ceará-CE	26,00%
	Fortaleza-CE	25,00%
Goiânia*	Atlético Goianiense-GO	7,30%
	Goiás-GO	39,30%
Porto Alegre*	Grêmio-RS	40,10%
	Internacional-RS	49,40%
Recife*	Náutico-PE	11,60%
	Santa Cruz-PE	24,10%
	Sport-PE	33,10%
Rio de Janeiro**	Botafogo-RJ	8,70%
	Flamengo-RJ	48,00%
	Fluminense-RJ	11,45%
	Vasco-RJ	18,90%
Salvador*	Bahia-BA	51,00%
	Vitória-BA	33,00%
São Paulo**	Corinthians-SP	36,00%
	Palmeiras-SP	12,75%
	Portuguesa-SP	4,00%
	São Paulo-SP	20,50%
	Santos-SP	5,50%

Notes: Research institutes and year of publication for municipalities with only one survey used: Belo Horizonte (Instituto de Pesquisa MDA – Jun/2015); Florianópolis (Lupi & Associados – Jun/2011); Fortaleza (Datafolha – Sep/2016); Goiânia (Fortiori Pesquisas – Aug/2012); Porto Alegre (Instituto Pesquisas de Opinião – Nov/2013); Recife (Instituto de Pesquisas Uninassau – Jan/2018); and Salvador (Instituto BABESP – Sep/2015). ** Research institutes and year of publication for municipalities where the average was used for the analysis: Curitiba (Pesquisa Ipsos/Marplan – Oct/2012 and Paraná Pesquisas – Jan/2017); Rio de Janeiro (Instituto GPP – Aug/2012 and Instituto Informa – Jun/2014); and São Paulo (Instituto Datafolha – Jun/2012; Oct/2012; Jun/2014; and Feb/2017). The proportions of residents who do not support any of the teams in the sample, or do not support any club at all, were not presented in the table. More than one survey was found only for the municipalities of São Paulo, Rio de Janeiro, and Curitiba. Therefore, the other averages represent the population proportion from the single survey available. Although Santos is not based in the city of São Paulo, the high number of its supporters in São Paulo was considered whenever the team played a home match in the city. On the other hand, when the team played in the city of Santos, the relevant population was that of the municipality itself. Source: Author's elaboration.

Table 3 presents the descriptive statistics (mean, standard deviation, minimum, and maximum) for the dependent variable and explanatory variables of interest.

Table 3 – Descriptive Statistics of the Variables

Variable	Obs.	Mean	SD	Min.	Max.
$Attendance_{it}$	3.018	16.599,47	12.131,41	338	67.011
$Price_{it}$	3.025	23,44	13,53	1,98	103,57
$Income_{it}$	3.040	0,039857	0,192130	0,0001	1,000
$Broad\ TV_{it}$	3.040	0,2671	-	-	-
PPV_{it}	3.040	0,8007	-	-	-
$Pay\ TV_{it}$	3.040	0,1941	-	-	-
$Fans_{it}$	3.040	989.176	1.042.279	1.083	4.410.728

Source: Author's elaboration.

4. Results and Discussion

Model 1 was estimated using pooled ordinary least squares (OLS), without control variables or fixed effects. In addition, the presence of cross-sectional dependence in the football match attendance equation was tested using panel data, to verify the possibility that fans may support more than one team ("second-favorite team fans") or act as "rival haters". For this purpose, Pesaran's (2004) CD test for unbalanced panels was applied to each estimated model. This test assesses the null hypothesis of cross-sectional independence across matches in the championship against the alternative of cross-sectional dependence. Overall, the football match attendance model estimated by pooled OLS (Pooled Model, Table 4), considering only average ticket price, supporters' income, and the average potential fan base, indicated the presence of cross-sectional dependence among matches at the 1% significance level (CD = 17.426; p-value = 0.000).

In the pooled OLS regression, the ticket price coefficient is positive and statistically significant, demonstrating the magnitude of the bias in the estimation. Cross-sectional dependence among games persists even after including fixed effects (Regression 2). Additionally, the sign and statistical significance of the price coefficient remain unchanged, as do the coefficients for income and fan base size.

Table 4: Estimated Demand for Football Tickets

Variables	Pooled	FE	TSLS1	TSLS2	TSLS3	TSLS4
	1	2	3	4	5	6
Price	0,4775****	0,4840***	-0,0915	-0,0857	-0,0835	-0,2608*
	(0,0206)	(0,0223)	(0,1319)	(0,1314)	(0,1313)	(0,1572)
Income	0,0132**	0,0148**	0,0090	0,0091	0,0092	-0,0130*
	(0,0057)	(0,0067)	(0,0079)	(0,0079)	(0,0079)	(0,0078)
Fans	0,2390***	0,2374***	0,2607***	0,2607***	0,2606***	0,1761***
	(0,0093)	(0,0102)	(0,0114)	(0,0114)	(0,0114)	(0,0093)
Broadcast TV			0,3145***	0,3233***	0,3709***	0,2144***
			(0,0433)	(0,0442)	(0,0628)	(0,0559)
Pay TV				0,0398	0,0408	0,0190
				(0,0332)	(0,0332)	(0,0321)
Pay-per-view					0,0662	0,1453***
					(0,0613)	(0,0558)
Other controls	No	No	No	No	No	Yes
Fixed effects	No	Yes	Yes	Yes	Yes	Yes
Instruments	No	No	Yes	Yes	Yes	Yes
CD test	17,426***	17,552***	-1,414	-1,461	-1,476	-1,604
	(0,0000)	(0,0000)	(0,1572)	(0.1441)	(0,1400)	(0,1087)
First-Stage F-Statistics			31,24	31,29	31,29	27,58
Sargan-Hansen test			22,836***	22,535***	22,135***	5,773
			0,000	0,000	0,000	0,1232

Notes: The dependent variable in all regressions is the logarithm of paid attendance. "Pooled" represents the grouped data model estimated by OLS; "FE" refers to the *two-way fixed effects model*, estimated using the *within-groups* method; "TSLS" corresponds to the *two-way fixed effects model* estimated by TSLS, after obtaining the mean-differenced equation, using the instruments (**I**) presented in Table 1. Other controls are the vectors **D**, **E**, **O**, **A**, and **Q** from equation (1) and Table 1. The CD test examines cross-sectional dependence in the residuals. The first-stage F-statistic assesses the relevance of the instruments, while the Sargan–Hansen test evaluates their validity. *Significant at 10%; ** Significant at 5%; *** Significant at 1%. Standard errors clustered by game are reported in parentheses. The p-values are reported below the indicated tests of TSLS models.

In light of this, a set of instruments was proposed and applied in Models 3 to 6, comprising: (i) the proportion of half-price tickets sold relative to total tickets sold; (ii) the home and away teams' standings in the previous season; and (iii) a dummy variable indicating whether the away team competed in the Second Division (Série B).

According to Stock et al. (2002), two criteria should be considered when assessing the quality of instruments in instrumental variable estimations: validity and relevance. Validity refers to the exogeneity of the instruments, meaning that the instrument should not be correlated with the error term of the structural equation. Relevance relates to the degree of correlation between the instrument and the endogenous variable.

Regarding relevance criterion, the literature generally follows the basic rule of Staiger and Stock (1997), which considers a set of instruments to be weak if the first-stage F-statistic from the OLS estimation is less than 10. However, for a more rigorous analysis, in the case of models with homoskedastic errors, the weak instrument test proposed by Stock and Yogo (2005) is recommended, based on the critical values specified (see Stock and Yogo, 2005, pp. 100–101) for one endogenous regressor, using a 5% critical level and the appropriate number of instruments for each model. For models with heteroskedastic errors, the Kleibergen–Paap (2006) Wald test is more appropriate and consistent. In both cases, instruments are considered weak if the statistics fall below the critical values defined by the respective authors, with the reference value used being the basic rule proposed by Staiger and Stock (1997).

Thus, to assess the validity of the instruments, the Sargan and Hansen overidentification restrictions tests were applied. These tests evaluate whether the instruments are uncorrelated with the error term of the structural equation. If the null hypothesis of no correlation is rejected, the validity of the instruments may be questioned. For Models 3, 4, and 5, the null hypothesis was rejected at the 1% or 5% significance level, indicating that the instruments can be considered exogenous. The test statistics for all models are presented in Table 4.

Hence, although these instruments are strong, they fail to meet the exogeneity requirement according to the Sargan-Hansen overidentification test. Consequently, the price elasticity of demand becomes negative but loses statistical significance. Notably, in regression (3), the inclusion of the free-to-air television variable (*broadTV*) eliminates the evidence of cross-sectional dependence among matches (CD statistics=-1,414, p-value=0,16).

Model 4 is estimated by TSLS with the same instruments, but in addition to the variable *broadTV*, it now includes the pay television variable (*payTV*), which is not statistically significant. Nevertheless, no cross-sectional dependence is again detected in the residuals of regression 4 (CD statistic = –1.461, p-value = 0.14).

Model 5 is also estimated by TSLS with the same instruments, but incorporates all television variables, namely *broadTV*, *payTV*, and *pay-per-view*. In both models, there is no evidence of cross-sectional dependence among the matches (CD statistic = –1.476, p-value = 0.14). However, the only statistically significant television variable is free-to-air television (*broadTV*).

With the inclusion of all other covariates, regression 6 constitutes the most robust TSLS-estimated demand model. As noted by Card (1995), a set of potential instruments may sometimes be valid only when controlling for other factors. The first-stage F-statistic exceeds the critical values recommended by both the Staiger and Stock (1997) rule of thumb and the Stock and Yogo (2005) test. In addition, the Sargan-Hansen test supports the validity of the instrument set. Collectively, these results indicate that the instruments are both strong and exogenous. Notably, in Model 6, the estimated price elasticity is negative and statistically significant, in line with theoretical expectations.

Once again, in Model 6, cross-sectional dependence is effectively expunged by including all television-related variables, with the coefficients of *broadTV* and *pay-per-view* remaining statistically significant. These results are consonant with the hypotheses concerning potential sources of inter-game dependence, particularly among fans who support rival teams or hold a secondary favorite team. Such fans often follow matches through broadcast networks, cable channels, and pay-per-view services. Therefore, the vector of television broadcasting variables provides an adequate control for cross-sectional dependence in the residuals of the football demand equation.

In Model 6, the price elasticity of demand is inelastic, as the coefficient of the price variable (-0.2608) is below unity and statistically significant at the 10% level (Table 5.2, Section 5.3). Accordingly, for instance, a 10% increase (decrease) in ticket prices would lead to an approximate 2.61% decrease (increase) in total paid attendance at the stadium. The finding of an elasticity below one, in absolute terms, is consistent with most studies in the established literature, except for García and Rodríguez (2002) and Benevides et al. (2017), whose deviations can be attributed to their neglect of price endogeneity. The inelasticity of ticket demand in Brazilian football corroborates previous findings (BAIMBRIDGE et al., 1996; BRANDES et al., 2012; SILVESTRI, 2016) that clubs do not operate as profit-maximizing entities. This view is further supported by the historical context of clubs as associations or non-profit organizations.

Meanwhile, the income elasticity of ticket demand (-0.013) suggests that football behaves as an inferior good, with the coefficient statistically significant at the 10% level (Table 5.2, Section 5.3), although its magnitude is very small. For instance, a 10% increase in fan income leads to only a 0.13% decrease in total paid attendance at the stadiums. Similar findings were reported by Souza (2004), Madalozzo and Villar (2009), Santana and Silva (2009), and Bortoluzzo et al. (2011) for the Brazilian Championship (Table 5.4). Souza (2004) and Santana and Silva (2009) attribute the classification of football as an inferior good to the poor conditions of hygiene, safety, and transportation to stadiums at the time of their analyses (2002 and 2007). These conditions can still be found in many Brazilian stadiums, which hosted about 70% of the matches analyzed up to 2019, that is, those that are not multi-purpose arenas. On the other hand, Madalozzo and Villar (2009) and Bortoluzzo et al. (2011) emphasize that football is an inferior good in Brazil due to its higher consumption among lower-income populations. As this population experiences an increase in income, it tends to seek alternative forms of leisure, such as streaming platforms, theaters, shopping centers, restaurants, bars, and other options.

The elasticity of the fan base (0.1761) is statistically significant at the 1% level. This indicates that the larger the share of the home team's supporters in the city where the match takes place, the greater their presence in the stadiums, ceteris paribus. This relationship aligns with considerations of regional concentration and the ease of fan travel to stadiums. Souza (2004), Benevides et al. (2015), and Benevides et al. (2017) also found similar results for the Brazilian case.

5. Final Remarks

As a pioneering contribution to the literature, this study identifies cross-sectional dependence in football matches and attributes its source to two distinct types of fans: supporters of a "second favorite team" and so-called "rival haters." To address this dependence, the study applies a strategy that incorporates detailed broadcasting information, including free-to-air television, pay TV, and pay-per-view services. The analysis concludes by emphasizing that accounting for broadcast availability is important to obtain unbiased, consistent, and efficient estimates of football match ticket demand elasticities.

The study's strategy for detecting cross-sectional dependence among matches provides a valuable tool for estimating demand elasticities not only in football but also in other sports like American football, baseball, basketball, rugby, cricket, etc. Consequently, this research contributes significantly to the sports economics literature, both in Brazil and internationally.

References

ALLAN, G.; ROY, G. **Does Television Crowd Out Spectators**? New Evidence from the Scottish Premier League. Journal of Sports Economics, v. 9, n. 6, p. 592-605, 2008.

BAIMBRIDGE, M.; CAMERON, S.; DAWSON, P. **Satellite Television and the Demand for Football:** A Whole New Ball Game? Scottish Journal of Political Economy, v. 43, n. 3, p. 317–33, 1996.

BENEVIDES, B. Í. L.; SANTOS, S. M.; CABRAL, A. C. A.; RIBEIRO, R. A.; HOLT, N. L. S. **Demanda por futebol no Brasil e na Inglaterra.** Revista Pensamento Contemporâneo em Administração, v. 9, n. 2, p. 96-112, 2015.

BENEVIDES, B. Í. L.; SANTO, S. M.; CABRAL, A.C. A. **A relação entre preço e demanda por jogos de futebol no Brasil.** Revista de Economia Contemporânea, v. 21, n. 2, p. 1-18, 2017.

BORLAND, J.; MCDONALD, R. **Demand for Sport.** Oxford Review of Economic Policy, v. 19, n. 4, p. 478–502, 2003.

BORTOLUZZO, A. B.; LAROPOLI, P. T.; MACHADO, S. J. **Demand for Brazilian Soccer:** A Censored Model Approach. INSPER: Instituto de Ensino e Pesquisa. Insper Working Paper (WPE: 237/2011), 2011.

BRANDES, L.; FRANCK, E.; THEILER, P. **The group size and loyalty of football fans:** a two-stage estimation procedure to compare customer potentials across teams. Journal of the Royal Statistical Society, v. 176, n. 2, p. 347-369, 2012.

BURAIMO, B.; SIMMONS, R. **Do Sports Fans Really Value Uncertainty of Outcome?** Evidence from the English Premier League. International Journal of Sport Finance, v. 3, p. 146-155, 2008.

BURAIMO, B.; SIMMONS, R. **A tale of two audiences:** Spectators, television viewers and outcome uncertainty in Spanish football. Journal of Economics and Business, v. 61, n. 4, p. 326-338, 2009.

BURAIMO, B.; FORREST, D.; SIMMONS, R. **Insights for clubs from modelling match attendance in football.** Journal of the Operational Research Society, v. 60, n. 2, p. 147-155, 2009.

BURAIMO, B.; PARAMIO, J.; CAMPOS, C. **The impact of televised football on stadium attendances in English and Spanish league football.** Soccer & Society, v. 11, n. 4, p. 461-474, 2010.

CARD, D. *Using Geographic Variation in College Proximity to Estimate the Return to Schooling*. In L. N. Christofides, E. K. Grant, & R. Swidinsky (Eds.), **Aspects of Labour Market Behaviour: Essays in Honour of John Vanderkamp**. Toronto: University of Toronto Press, 1995.

CBF. **Confederação Brasileira de Futebol,** 2025. Futebol Brasileiro, Detalhes do Jogo, Documentos. Disponível em: <https://www.cbf.com.br/futebol-brasileiro>. Access in august, 2025.

CZARNITZKI, D.; STADTMANN, G. **Uncertainty of outcome versus reputation:** Empirical evidence for the First German Football Division. Empirical Economics, v. 27, n. 1, p. 101–112, 2002.

DAUDT, G.; WILLCOX, L. D. **Indústria Automotiva.** In: BNDS - Banco Nacional de Desenvolvimento Econômico e Social. Visão 2035: Brasil, país desenvolvido: agendas setoriais para alcance da meta. 1 ed. Rio de Janeiro: BNDES, 2018.

FALTER, J. M.; PERIGNON, C. **Demand for Football and Intra match Winning Probability:** An Essay on the Glorious Uncertainty of Sports. Applied Economics, v. 32, p. 1757–65, 2000.

FORREST, D.; SIMMONS, R. **Outcome Uncertainty and Attendance Demand in Sport:** The Case of English Soccer. The Statistician, v. 51, n. 2, p. 229–41, 2002.

FORREST, D.; SIMMONS, R. **New Issues in Attendance Demand:** The Case of the English Football League. Journal of Sports Economics, v. 7, n. 3, p. 247–266, 2006.

GARCÍA. J; RODRÍGUEZ, P. **The Determinants of Football Match Attendance Revisited** Empirical Evidence from the Spanish Football League. Journal of Sports Economics, v. 3, n. 1, p. 18-38, 2002.

GARCÍA. J; RODRÍGUEZ, P. **Sports Attendance:** A Survey of the Literature 1973-2007. Rivista di Diritto ed Economia Dello Sport, v. 5, n. 2, p. 111-51, 2009.

KLEIBERGEN, F.; PAAP, R. **Generalized reduced rank tests using the singular value decomposition**. Journal of Econometrics, v. 133, n. 1, p. 97–126, 2006.

MADALOZZO, R.; VILLAR, R. B. A. **Brazilian Football:** What Brings Fans to the Game?. Journal of Sports Economics, v. 10, n. 6, p. 639–650, 2009.

MARTINS; A. M.; CRÓ, S. **The Demand for Football in Portugal:** New Insights on Outcome Uncertainty. Journal of Sports Economics, v. 19, n. 4, p. 473-497, 2016.

NOLL, R. G. **Endogeneity in attendance demand models.** *In:* RODRÍGUEZ, P.; KÉSENNE, S.; GARCÍA, J. The Econometrics of Sport. Cheltenham: Edward Elgar, 2013.

PESARAN, M. H. **General diagnostic tests for cross section dependence in panels.** Cambridge working papers in economics 0435. Faculty of Economics, University of Cambridge, 2004.

SANTANA, S.K.S.; SILVA, A.S. **The Determinants of Demand in Football Matches During the 2007 Brazilian Championship.** IASA/NAASE Working Paper Series, No. 09-06, 2009.

SILVESTRI, F. **Optimal ticket pricing in the sport industry.** The case of the Italian Serie A. 2016. Dissertação (Mestrado em Economia). Università Degli Studi di Verona, Departimento di Scienze Economiche, 2016.

SOUZA, F. A. P. **Um estudo sobre a demanda por jogos de futebol nos estádios brasileiros.** 2004. Dissertação de Mestrado (Mestrado em Administração). Faculdade de Economia, Administração e Contabilidade. Universidade de São Paulo, 2004.

STAIGER, D.; STOCK, J. H. **Instrumental Variables Regression with Weak Instruments.** Econometrica, v. 65, n. 3, p. 557-586, 1997.

STOCK, J. H.; WRIGHT, J. H.; YOGO, M. **A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments.** Journal of Business & Economic Statistics, v. 20, n. 4, p. 518-529, 2002.

STOCK, J. H; YOGO, M. **Testing for Weak Instruments in Linear IV Regression.** *In*: ANDREWS, D.W.K. Identification and Inference for Econometric Models. New York: Cambridge University Press, p. 80-108, 2005.