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Church Tax Exemption and Structure of Religious Markets: a Dynamic Structural Analysis

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I Introduction

A key shift in the global religious landscape that took place during the last few decades was the dramatic growth of Evangelicals, especially Pentecostal and Charismatic churches, which now command a quarter of world Christianity (Pew, 2006b).[1] Brazil, the largest Catholic country in the world, has experienced a rapid change in the composition of its religious market as a result of the growth of Evangelical denominations and the decline of its Catholic majority, as well as the erosion of the Roman Church's influence in various dimensions (Alves et al., 2017).[2] A similar pattern can be found to a varying degree in most of Latin America and among US Latinos, as well as in many parts of Africa and Asia. Some driving forces behind this trend include the role of Evangelical mass media (Corbi and Komatsu, 2019; McCleary, 2017) and the introduction of innovative practices and doctrines by Evangelical denominations (Putnam et al., 2012), among others.

Despite its importance in sustaining formal religious institutions, less is known about the role of public financial support to churches in explaining such movements in the structure of religious markets. As Iannaccone and Bose (2010) put it: "*Without adequate income, congregations fold, denominations fail, and the faithful flock to greener pastures.*" Of all the factors that help gather material support for churches, none is likely more essential than preferential tax treatment provided by the state (Barro and McCleary, 2019).[3] Financial incentives to religion such as tax-exemption are pervasive across countries and regions (Pew, 2017).[4]

Using the Brazilian experience as a showcase, this paper studies the interplay between public financial support to religions in the form of tax-exemption and the structure of re-

[1]The term *Evangelical* encompasses most theological conservative Protestants (Putnam et al., 2012). In Latin America, it is commonly used as an umbrella concept that includes first and foremost Pentecostals, Neo-Pentecostals, and Neo-Charismatic movements. Members of the Historical Protestant churches, such as Lutherans and Calvinists, are not covered by the term. See Appendix A for more details.

[2]The growth of Evangelicals in Brazil was also accompanied by a decline in overall religiosity as measured by the fraction of the religious unaffiliated, from close to zero in 1970 to just above 8% in 2010.

[3]According to Barro and McCleary (2019), an important issue in the economics of religion is "*(..) how religiosity responds to economic developments and to government regulation, subsidy and suppression. Other questions concern (...) how state subsidies and regulation influence religious activities.*"

[4]In the United States alone, Cragun et al. (2012) estimates indicate that the government exempts churches of tax payments to the order of US$71 billion per year. To put into perspective, this is equivalent to roughly 40% of the combined total of US government subsidies to agriculture in 2009 or the entire 2011 state government's budget in Florida.

ligious markets. Brazil constitutionally grants exemption from taxes levied on property, payroll and income to all religious organizations without distinction. We focus on the role of tax-exemption policies in determining the relative shares of Catholics and Evangelicals and discuss further consequences of this type of policy on political representation.

While churches likely grow as a result of tax-exemption policies (Pew, 2017; Cragun et al., 2012), understanding their consequences on the structure of religious markets is not straightforward. The effect of the policy will likely depend on asymmetries in the technologies employed by churches to build and operate places of worship which, as we document in this paper, seem to differ significantly between Evangelicals and the Catholic Church.[5] Nonetheless, the main objects behind these technologies, i.e. sunk entry costs and fixed operating costs, are typically not observed by researchers.

To overcome these challenges, we use insights from the industrial organization literature to develop a dynamic game of church entry (Ericson and Pakes, 1995; Aguirregabiria and Mira, 2007; Bajari et al., 2007; Pesendorfer and Schmidt-Dengler, 2008). Based on the model we study how tax-exemption to churches may have altered the structure of religious markets in Brazil. Throughout our main analysis, we assume that churches make entry and exit decisions with the objective of maximizing profits – or, equivalently, that churches maximize membership and attribute a constant "markup" on each member. Consistent with this assumption, we present extensive evidence that Brazilian churches have increasingly adopted business-like practices, which may account for the substantial and growing revenues generated by their activities. Closer to our paper is Walrath (2016) who assume a reduced form value (or profit) function similar to ours to estimate a (static) entry/exit game between churches in the US.[6]

We estimate the primitives of the model by exploiting data on entry/exit of temples in small isolated Brazilian municipalities between 1992 and 2018.[7] Our estimates show that

[5] In this paper, the term "temple" is used as synonym to place of worship or congregation.

[6] Robustness checks also show that our main findings are valid in several scenarios where we assume that only a fraction of churches payoffs correspond to financial gains and can, therefore, be taxed, while the remaining fraction, correspond to non-financial motives that are not taxed.

[7] As discussed in Section III, this restriction ensure precise market delimitation (which would be impossible if we included larger Brazilian cities in the sample). Following Bresnahan and Reiss (1991), this type of sample restriction is common in empirical models of firm entry and exit; see, for example, Sanches et al. (2016). Although the restricted sample reflects trends seen in larger markets (particularly the expressive

sunk entry and fixed operating costs are highly asymmetric across denominations. Evangelical churches face lower entry costs but higher fixed operating costs, while Catholics encounter higher entry costs but lower fixed operating costs. These findings are consistent with the fact that Evangelical temples typically operate in rented spaces, which tends to reduce entry costs while increasing fixed operating costs. Catholic temples are more elaborate and typically operate in properties owned by the Roman Church, which tends to increase entry costs while decreasing operating costs. We also show that competition between churches is empirically relevant to explain the structure of this market; counterfactual simulations show that if the opening of a temple of any competing church (Catholic or Evangelical) had no effect on the payoffs of Catholic and Evangelical incumbents, the number of temples in 2018 would have been about 17% higher.

Next, we simulate the counterfactual number of temples of the Catholic Church and the main Evangelical denominations imposing different tax rates on churches variable profits. Our counterfactual studies show that tax-exemption increased church entry overall, with a relatively greater impact on entry rates of Evangelical churches. The combined share of Evangelical temples increased by approximately 20 percentage points as a result of the tax-exemption policy. The asymmetric effects of tax-exemptions on the Catholic and Evangelical churches can be attributed to two reasons. Firstly, tax rate reductions generally lead to increased entry of all churches. As the pool of potential entrants in all markets includes various Evangelical denominations, the aggregate effect on them surpasses that on the Catholic Church alone; thus, the combination of religious freedom and tax-exemption appears to be important to explain the decline in the share of the Catholic Church. Secondly, our experiments demonstrate that tax-exemptions have a disproportionately larger impact on entry rates for "marginal" potential entrants, i.e. those with higher expected entry gains. Due to its higher entry costs, expected entry gains of the Catholic Church are lower. This also explains why it experiences a mitigated effect of exemptions compared to Evangelical denominations.

The growth of Evangelical churches was accompanied by a notable rise in their political representation worldwide (Pew, 2006a). In Brazil, the number of representatives af-

growth of Evangelical denominations), our findings may not necessarily be applicable in other contexts.

filiated with Evangelical groups surged from 27 in 1994 to 187 in 2018. To explore this phenomenon, we simulate the impact of religious tax-exemption on the composition of the Brazilian Congress. Using an event-study framework, we estimate the responses of the vote share received by Evangelical members of Congress to the entry of Evangelical churches in Brazilian municipalities. The estimates show that Evangelical church entry triggers a sharp increase in the Evangelical vote share. Combining the event-study with the counterfactuals produced by the dynamic game, we show that religious tax-exemptions may have contributed to a significant increase in the size of the Evangelical caucus in the Brazilian Congress.

To our knowledge, there are few quantitative studies on the explicit role of religious financing and church expansion.[8] Bazzi et al. (2020) show that a large transfer of resources from rural elites to Islamic institutions in 1960 was a key factor behind the ability of the Indonesian Islamic movement to entrench its conservative ideology and influence the course of politics. Cantoni et al. (2018) document a massive reallocation of resources from religious to secular purposes as a consequence of the religious competition during the Protestant Reformation, playing an important role in the secularization of the West. We add to this literature by showing that tax-exemption to religions in general may affect not only religiosity levels but also the allocations of market shares across different religious groups.

This paper also builds on a still incipient literature that uses insights from (empirical) industrial organization to study religious markets. The pioneering works of Rennhoff and Owens (2012) and Walrath (2016) use a static version of our model to study competition between churches in the US. Differently from these papers, we use a dynamic game to model churches behavior. An advantage of our framework is that it allows us to fully recover the cost structure of churches, including sunk entry costs and fixed operating costs. As shown in this paper, these elements are important to the evolution of this market during the last decades.

Finally, we contribute to the industrial organization literature that studies the heteroge-

[8] On the other hand, different strands of the literature focus on religious markets and competition (Barro and McCleary, 2005; Montgomery, 2003; Ekelund et al., 2002), donations (Hungerman and Ottoni-Wilhelm, 2021), religiosity as insurance to adverse shocks (Auriol et al., 2020; Bentzen, 2019; Ager and Ciccone, 2018; Chen, 2010), locational choice of religious missions (Jedwab et al., 2017) and spatial diffusion of the Reformation (Cantoni, 2012; Rubin, 2017), and on the secularization hypothesis which predicts that religiosity declines with income or education (McCleary and Barro, 2006; Glaeser and Sacerdote, 2008; Becker and Woessmann, 2013; Buser, 2015; Costa et al., 2019; Hungerman, 2014).

neous effects of subsidies on market structure. For instance, Dunne et al. (2013), Fan and Xiao (2015), Sanches et al. (2016) and Maican and Orth (2018) use a dynamic structural model similar to ours to study how subsidies on different cost components affect entry and exit of firms in the US market of dentists and chiropractors, in the US telephone industry, in the Brazilian banking industry and in the Swedish retail food sector, respectively. We build upon this literature by specifically examining the effects of tax-exemptions on variable profits and showing their significant impact on the structure of the Brazilian religious market.

This paper is organized as follows. Section II describes the institutional background; Section III describes the data and presents a descriptive analysis on the determinants of churches entry and exit decisions; Section IV develops the dynamic game of church entry. Section V discusses identification and estimation of the model and shows the estimates of churches payoff function. Section VI shows the fitting of the model to the data and our counterfactual results. Section VII estimates the impact of temple entry on Evangelical vote share and provide back-of-envelope calculations of the effects of tax-exemption to churches on votes to Evangelical candidates. The last section summarizes our conclusions.

II Institutional Background

The religious landscape in Brazil is briefly described in this section, with an emphasis on aspects like churches expansion, churches objectives, and institutional mechanisms that ensure tax-exemptions to religious institutions. Appendices B and H complement the descriptions of this section with additional details.

II.A Churches Business Models, Temple Entry and Exit

The religious landscape in Brazil has seen an important transformation in recent years, shifting from the Catholic Church's undisputed domination to a considerably more diverse situation where a number of other denominations – mostly Evangelicals – have gained significant market share.[9] In fact, despite substantial racial miscegenation and religious syncretism[10], Catholicism prevailed as the official religion through Portuguese domination in the colonial period (1500-1821) and the monarchy era after independence (1822-1888).[11] The first historical protestants arrived in Brazil with the first waves of Anglican and Lutheran immigrants in the 19^{th} century. Successive waves of Pentecostal denominations helped induce a dramatic shift in the Brazilian religious landscape from the beginning of the 20^{th} century, threatening the Catholic hegemony (Mariano, 2014). This change has had a remarkable scope. Some predictions indicate that the proportion of evangelicals in the Brazilian population, which was 4.8% in 1945, may reach 40% in 2032, exceeding the proportion of Catholics, which was over 95% in 1945 and is anticipated to fall to roughly 39% in 2032 (Alves et al., 2017).

The changes in the religious landscape were accompanied by a striking rise in the number of temples belonging to diverse religious traditions, especially those belonging to the Catholic and Evangelical faiths. According to data from the Brazilian Internal Revenue Service (see Section III for more information), the number of temples of the main Evangelical denominations increased by an astounding 138 percent between 1992 and 2018, while the number of Catholic temples increased by almost 40 percent during the same time period.

The fact that Catholics and Evangelicals used different "business models" to handle this expansion is particularly relevant to our investigation. Catholic temples usually own their self-standing real estate and furnish interiors according to minimal standards, while Evangelical temples are often housed in functional rented properties with simpler fittings. These differences are likely to have an impact on the cost structure of these churches, which may be important in explaining how tax-exemptions influenced the growth of Catholics and Evangelicals in Brazil. Also relevant to our analysis is the fact that the net exit costs, i.e. exit costs minus scrap value churches eventually receive when shutting down a temple, appear to be minimal, independent of their different "business models" — at least in small isolated markets, which are the focus of our empirical analysis (see Section III).

Indeed, given that the temple is the only relevant infrastructure in this market, churches

[9] In Appendix A we explain the taxonomy of Brazilian religious denominations that we use throughout this paper and provide a brief historical account of this phenomenon.

[10] Religious syncretism refers to the blending of two or more religious belief systems into a new system, or the incorporation into a religious tradition of beliefs from unrelated traditions.

[11] Indeed, 99% of the population self-reported as Catholic in the 1890 Census.

net exit costs depend crucially on what happens to these structures once the church decides to leave a market. In the case of Evangelical churches exit costs are primarily determined by the contractual fine they eventually have to pay to return a building before the lease expires. In the Appendix B we show plausible estimates indicating that costs Evangelical churches pay to break a lease in Brazil appear to be negligible. The Catholic Church which, as we argued, typically builds and operates its own temples, often abandons these structures when it decides to exit a market. Official statistics are non-existent but anecdotal evidence of abandoned churches is widely available on the internet; see Appendix B.[12] This is not a phenomenon unique to the Brazilian branch of the Catholic Church[13] and it may be related to the fact that the sale of Church real estate in the event of bankruptcy frequently necessitates the approval of the Holy See (i.e., the Vatican), making the process lengthy and bureaucratic.[14]

Jointly, these discussions indicate that net exit costs appear to be negligible for both types of churches. In Section IV we use these evidences to justify restrictions on the structure of our model that are required to ensure its identification.

II.B Religious Finances and Church Objectives

The activities conducted in places of worship serve as the primary source of funding for church expansion. As shown in Figure 1, aggregate churches' revenues have grown from R$19 billion in 2006 to R$24 billion in 2013 in 2013 values (US$ 8.8 to 11.1 billion).[15] To put these figures in context, the combined revenues of all churches in 2013 was equivalent to the revenues of the 18th largest Brazilian corporation.[16] The actual figures may be significantly higher in practice as revenues are self-reported and churches are not routinely audited by Brazilian

[12]See http://aurelioschmitt.blogspot.com/2013/03/igrejas-abandonadas-pedacos-da-historia.html?m=1 for a (incomplete) list of abandoned churches in 13 out of 26 states in Brazil.

[13]In particular, for pictures of more than 1000 abandoned temples in Italy, see https://romanrobroek.nl/chiesa-the-decline-of-the-church-in-italy/.

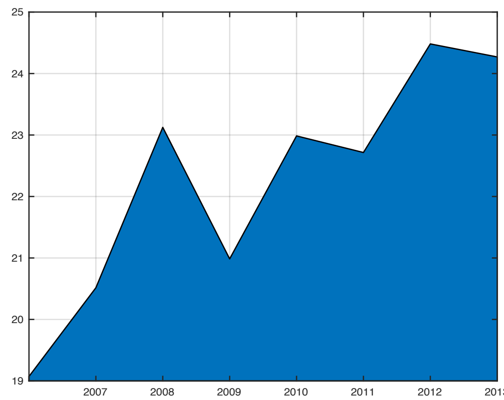
[14]https://www.catholicnewsagency.com/news/44951/diocesan-bankruptcies-could-require-vatican-approval-vatican-official-reminds-bishops.

[15]Values use the Brazilian official inflation index (IPCA/IBGE) as deflator and the average 2.16 BRL to USD exchange rate in 2013. Chuches revenue extracted from https://www1.folha.uol.com.br/mercado/2019/08/receita-de-igrejas-quase-dobra-em-oito-anos-e-vai-a-r242-bi.shtml.

[16]https://www.correiobraziliense.com.br/app/noticia/economia/2014/01/26/internaseconomia,409644/no-brasil-igrejas-catolicas-e-evangelicas-movem-r-21-5-bilhoes-ao-ano.shtml

authorities due to their tax-exemption status; see Section II.C. It is important to note that of these revenues, roughly 72% come from churchgoers' donations, with the remainder coming mostly from real estate, and fixed and variable income investments (Amorim, 2014).

Figure 1: Churches Revenues in BRL Billions of 2013 (2006-2013)



Another important aspect is that the growth in churches revenues seems very consistent despite the fact that the number of Brazilians who are not affiliated with any religion nearly doubled between 1992 and 2010 (Alves et al., 2012). Part of this success can be attributed to the professionalization of churches staff and, more broadly, to the adoption, by these churches, of practices that resemble those of conventional profit-maximizing companies. Some examples of this behavior include the implementation, by many Brazilian Evangelical churches, of pay-for-performance for clergy who succeed in increasing the revenues of their congregations.[17] There is also evidence that clergy migrate between congregations based on performance: those who exceed particular revenue targets are transferred to larger congregations, while those who do poorly are transferred to more isolated places (Nascimento, 2019). Catholic priests and bishops are also paid according to the revenues of their dioceses.[18] Such incentives may also explain the surge in popularity of "church consultants", who specialized in assisting congregations to raise their revenues[19] and an affluent industry of courses on temple management, many of them offered by Catholic Universities, that has contributed to

[17]https://economia.uol.com.br/noticias/estadao-conteudo/2020/04/30/receita-aplica-pesadas-multas-a-igrejas.htm.

[18]https://super.abril.com.br/mundo-estranho/padres-recebem-salario/

[19]https://noticias.gospelmais.com.br/consultor-abertura-novas-igrejas-negocio-visando-lucro-61397.html

the supply of managerial capital to the sector.[20]

These behaviors were already documented in the literature. Hartzell et al. (2010) and Engelberg et al. (2016) show, using a large dataset containing detailed information on clergy pay and performance, that the same incentives are adopted by US churches. Historical evidence relating churches (in particular the Catholic Church) to practices that resemble practices of profit-maximizing firms are also common in the literature; see for example Ekelund et al. (2002, 1996); see also Hull and Bold (1989) and Iannaccone (1998) for discussions on this issue.

Some of the funds raised through temple activities have also gone directly to religious authorities. According to *Forbes* Magazine, the "faith industry" (to use a Brazilian jargon) has transformed prominent figures in this sector into multi-millionaires that are among the richest religious leaders in the world. Table 1 illustrates this point. In 2015 the same *Forbes* listed Pastor Macedo – the first name in Table 1 – as the 1638st richest person in the World, with a net worth of US$1.1 billion. In a 2015 issue *Forbes* describes Macedo as:[21]

> *"Edir Macedo, founder of the Universal Church of the Kingdom of God, is among the richest religious leaders in the world (...). Raised a Catholic, he converted to evangelical Christianity in the early 1970s. In 1977 he founded his own sect in Rio de Janeiro, which follows 'prosperity theology', asserting that faith and commitment to a church are rewarded with wealth."*

The history of the other leaders in Table 1 is remarkably similar to Macedo's. Most of them come from humble origins and built their fortunes from the tithe and other donations made by members of their churches.[22] Overall, this discussion seems to imply that a significant portion of the revenues generated by church activities was distributed to church leaders rather than redirected to social or charitable activities in local communities.

Put together, the evidence presented in this subsection seems to support the notion that profits are a central element in the objectives of all churches. In particular, at least in terms

[20] A search on Google using the terms "curso gerenciamento igreja" ("church management course" in English) returns a wide range of choices, from quick courses to 2-3 years college degree level courses.

[21] https://www.forbes.com/profile/edir-macedo/?sh=68696c12fcff

[22] Paradoxically, after publicizing these lists *Forbes* was prosecuted by some Brazilian religious leaders what, ultimately, may explain why more recent issues of the magazine do not have any mention to Brazilian religious leaders and their net worth. For more details, see: https://wwrn.org/articles/39034/.

of clergy compensation, as in Hartzell et al. (2010) and Engelberg et al. (2016), the behavior of Brazilian churches is consistent with the principles of a standard principal-agent model. We lean on these arguments to assume in our empirical model described in Section IV that churches make entry and exit decisions in order to maximize profits or, alternatively, that churches make entry and exit decisions to maximize membership and attribute a constant "markup" on each member – the latter being also consistent with the findings in Hartzell et al. (2010).[23] In Section VI we provide a discussion on how our results might change if we modify this assumption.

Table 1: Richest Religious Leaders in Brazil *Forbes* Magazine (2014)

	Pastor	Networth (US$ MM)	Religious Organization
1	Edir Macedo	$950	Igreja Universal do Reino de Deus
2	Valdemiro Santiago	$220	Igreja Mundial do Poder de Deus
3	Silas Malafaia	$150	Assembléia de Deus
4	R. R. Soares	$125	Igreja Internacional da Graça de Deus
5	Estevam e Sônia Hernandes	$65	Igreja Renascer

II.C Tax Exemption in Brazil

A key driver of religious finance is state support (Iannaccone and Bose, 2010). Public funding of religion takes many forms across countries, from tax-exemption of church educational programs, property or other religious activities, up to directly including clergy on the state's payroll. Also, some societies channel most resources to one or more preferred religions, while others fund all religions indiscriminately. Common to most is the fact that religious activities are often favored by the state (Fox, 2018).

Two legislation changes introduced during the re-democratization period consolidated the details of the current church tax landscape. First, article 150 of the 1988 Federal Constitution defined that religious organizations of any faith are exempt from federal, state, and municipal taxes levied on property or income from services related to the essential purpose of religious

[23]Findings in Hartzell et al. (2010) indicate that revenues of congregations grow with the addition of a new member regardless of the characteristics of the new member.

entities.[24] Hence it concedes not only corporate tax-exemption – as for any regular non-religious non-profits – but also allows religious organizations to avoid property taxes, similar to churches in the US. Second, article 22 of law 8.212/91 stated that the *pastoral prebend* – the stipend paid to a clergyman – is not to be considered salary and thus is exempt from social payroll taxes.[25] Hence, Brazilian churches enjoy substantial tax advantages – considerably larger than their American counterparts.[26]

The central aim of this paper is to examine the effects of this legal tax-exemption framework on the relative expansion of different denominations in the last 3 decades, as discussed in Section II.A and II.B. We develop our analysis in the sections that follow.

III Data and Descriptive Analysis

We will now introduce the dataset we used to estimate our models and discuss descriptive analyses of variables of interest.

Data. Our temple-level dataset comes from the Brazilian Internal Revenue Service (BRASIL, 1991-2018) and comprises all legal entities registered in Brazil since records began. We keep all entities registered as a Religious Organization under the Brazilian Industry Classification (CNAE). Establishment-level start-date, end-date, address, as well as entity name are available. Based on this information, we classify each of the 216,364 religious establishments as belonging to one of the denominations listed in Table 6 in Appendix A and structure the data

[24]From a historical perspective, Catholicism was the official state religion and the only faith to enjoy the freedom of worship in Brazil under the Monarchy (1822-1888). With the proclamation of the First Republic in 1889, the separation between state and religion was instated and religious freedom became a right. The 1946 Constitution introduced for the first time the possibility of tax-exemption for temples of any faith or cult, but tax-exemption remained *de facto* possible only for Catholics.

[25]Social security contributions are the most relevant component of payroll taxes. The rate of social security contribution is higher in Brazil (20%) than in the US (12.4%). Income tax rates for individuals are progressive, ranging from 7.5% to 27.5% in Brazil and 10% to 37% in the US.

[26]Aggregate estimates of the importance of the tax-exemption policy to churches in Brazil are unavailable. However, according to Figure 1, revenues accrued directly from church-related activities summed up to R$24.2 billion in 2013, which may give a rough idea of the impacts of the churches' tax-exemption policy on the government budget. Tax exemption to churches is hardly unique to Brazil. In the United States alone, Cragun et al. (2012) estimates indicate that the costs of the policy are around US$71 billion (i.e. taxes that are not collected because of churches tax-exemption). To put into perspective, this is equivalent to roughly 40% of the combined total of US government subsidies to agriculture in 2009 or the entire 2011 state government's budget in Florida.

retrospectively as an yearly panel with a total of $3,427,626$ denomination-municipality-year observations from 1992 to 2018. All municipalities in Brazil have at least one establishment across the sample period.[27] Yearly population estimates from the Brazilian Census Bureau (IBGE, 1991-2010b) will be used in our analysis as a measure of market size.[28]

Following Bresnahan and Reiss (1991) we restrict our analysis to a sample of isolated municipalities. Differently from larger cities and conurbation areas, isolated cities constitute a clear and delimited market. We define markets as municipalities with 2010 population below $50,000$ that are at least 30km away from any neighbouring municipality and have at most 6 Evangelical establishments at any point in time.[29] This entails that the temples used in our analysis are relatively small establishments with limited maximum capacity, unlike typical Evangelical megachurches that are widespread in large Brazilian cities or in the US. Moreover, low car ownership rates and a precarious transportation system likely render these temples truly local places of worship. After this selection we ended up with 246 markets.

We study entry and exit decisions of temples of the six largest Evangelical denominations – according to the observed number of temples of all denominations in 2018 – and the Catholic Church. The Evangelical denominations are: Assembly of God, Baptist, Universal, Mundial, Christian Congregation and Foursquare. According to Figure 2 panel (a), jointly, the Catholic church and these six Evangelical denominations had more than 91% of the temples in our sample in any year. The other Evangelical denominations are much smaller and less representative in the Brazilian society.[30]

[27]Municipality boundaries in Brazil change substantially throughout the period of our analysis. In order to allow us to consistently compare units across time, we define municipality as the widely used "Minimum Comparable Areas" (AMC). See Ehrl (2017) for details on the methodology.

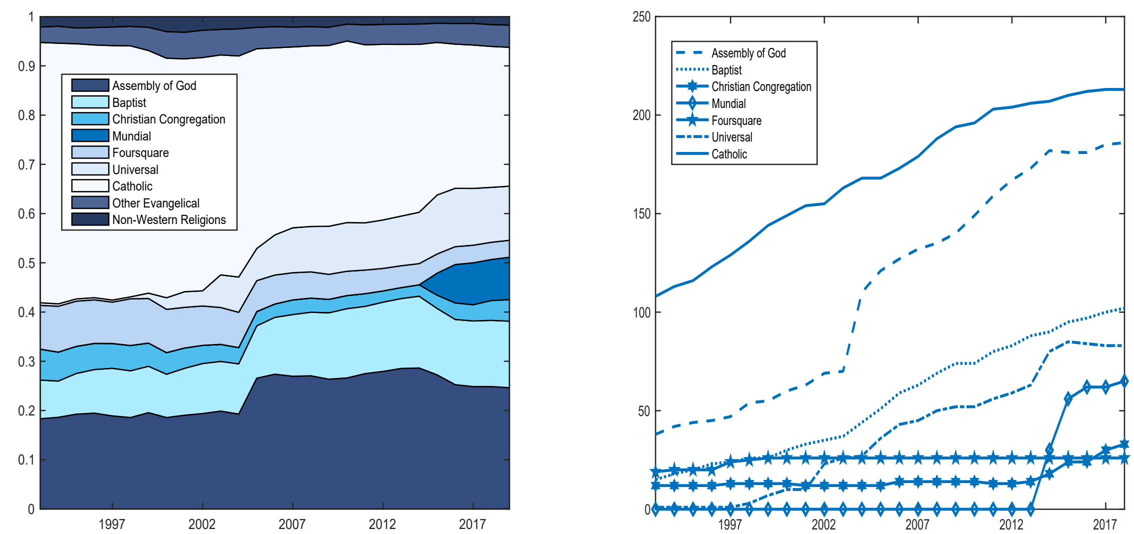
[28]Population is the only demographic variable available for all years and all municipalities in Brazil. The Ministry of Labor and Employment collects yearly data on wages and employment at the municipality level since the 1980s but this information covers only formal workers which, for the small/isolated municipalities we have in our sample, is a poor indicator of economic activity (informal labor in Brazil corresponds to 40% of the workforce and these numbers are much higher in small cities). To account for differences in demographic variables across municipalities and years that may influence church entry, our structural model includes a time-varying market level unobserved component in church payoffs. For more information, see Section IV.

[29]Sanches et al. (2016) uses a similar strategy to select isolated markets in a study of banking competition in Brazil.

[30]We restricted the number of denominations because the state space of the structural model we will estimate in the next sections grows exponentially with the number of players. The computational costs to solve the model (and compute counterfactual scenarios), in turn, grows exponentially with the dimension of the state space of the model.

Figure 2 panel (b) illustrates the evolution of the number of temples in our sample. It shows that Assembly of God, and Baptist churches grew consistently over the period. The stock of temples of the Christian Congregation and Foursquare remained relatively stable over time. In the first years of our sample, Universal and Mundial had few temples; in 2018, they had 83 and 65 temples, respectively. Despite the growth of the Catholic church Figure 2 panel (a) shows that its share decreases continuously over time, from 56% in 1992 to 30% in 2018. During the whole period the Catholic and the Evangelical churches built in total 564 new temples (449 new Evangelical temples and 115 new Catholic temples). Exit rates were relatively low. Throughout the entire period, we observed 37 exit movements in all municipalities (34 of Evangelical temples and 3 of Catholic temples).

Figure 2: Market Shares and Number of Temples of Different Denominations in a Sample of Brazilian Municipalities (1992-2018)



(a) Market Shares

(b) Number of Temples

Descriptive Analysis. Before presenting the theoretical model, we examine the relevance of (i) strategic interactions and (ii) observed and unobserved market characteristics to explain the evolution of the number of active temples of these denominations as illustrated in Figure

2 panel (b). Our descriptive study is based on the following Probit Model:[31]

$$P\left(a_{im}^{t}|a_{im}^{t-1},n_{im}^{E,t-1},n_{im}^{C,t-1},p_{m}^{t}\right)=$$
$$\Phi\left(\rho_0+\rho_1 a_{im}^{t-1}+\rho_E^E n_{im}^{E,t-1}d_i^E+\rho_E^C n_{im}^{E,t-1}d_i^C+\rho_C^E n_{im}^{C,t-1}d_i^E+\rho_4 p_m^t+\mu_i+\mu_m+\mu^t\right) \quad (1)$$

where, $a_{im}^t \in \{0,1\}$ is Church i's action in municipality m, period t, with $a_{im}^t=1$ meaning that Church i has a temple at municipality m, period t and zero otherwise; $n_{im}^{E,t-1}$ is the number of temples of Evangelical competitors of Church i at municipality m, period $t-1$; $n_{im}^{C,t-1}$ is the number of Catholic temples competing with Church i at municipality m, period $t-1$; d_i^E is a dummy variable that assumes 1 if i is an Evangelical church and zero otherwise; $d_i^C=1-d_i^E$; p_m^t is the population in market m, period t; μ_i, μ_m and μ_t are, respectively, Church, municipality and year fixed effects; and $\Phi(\cdot)$ represents the CDF of a standard Normal distribution. To estimate the model we pool the 6 largest Evangelical denominations – Assembly of God, Baptist, Christian Congregation, Mundial, Foursquare and Universal – and the Catholic Church.

Columns 1-3 in Table 2 shows the estimates of model 1. The first column shows the estimates of ρ_E^E (which captures the reactions of Evangelical churches to the number of Evangelical competitors in any market), ρ_E^C (which captures the reactions of the Catholic Church to the number of Evangelical churches present in the market) and ρ_C^E (which captures the reactions of Evangelical churches to the presence of the Catholic Church in any market) from model (1) without municipality and year fixed effects. In this model the coefficient ρ_E^E is positive and significant; ρ_E^C and ρ_C^E are also positive but not significant. When market and time fixed effects are included in the model the three coefficients get negative but only ρ_E^E and ρ_E^C are statistically significant (at 1%).[32]

[31] As approximately 80% of the municipalities in our sample have at most 1 temple of the same denomination, we model only the decision to have (or not) a temple at each market/period of time.

[32] For any panel of finite length estimators of fixed-effects are biased. In non linear models fixed-effects cannot be "partialled-out" as in linear models and therefore, this bias can be transmitted to the other parameters of the model (Heckman, 1987). For this reason, some papers estimate non linear models in two steps (Collard-Wexler, 2013; Lin, 2015; Sanches et al., 2016), using fixed effects estimates from a first-step Linear Probability Model (LPM) to control for unobserved effects in the second-step Probit model. Table 9 in the Appendix shows the coefficients in Table 2 estimated from the two-step approach. All the coefficients have the same sign and the same order of magnitude as the coefficients shown in Table 2.

We summarize our interpretation of these correlations in two points. First, churches appear to respond to the actions of other churches. In particular, Catholic and Evangelical churches prefer to enter markets where the number of Evangelical competitors is lower. Second, the exclusion of market/time fixed-effects leads to a positive bias in the parameters capturing strategic interaction between churches. This pattern is expected as market/time unobserved heterogeneity affects at the same time entry probabilities and the number of incumbents in operation in a given market (Igami and Yang, 2016; Sanches et al., 2016; Collard-Wexler, 2013). The latter finding also highlights the importance of unobserved heterogeneity across market/time to explain churches entry/exit decisions. The model we develop in the next section takes into account these two features of the market.

Table 2: Probit Church Activity Decisions

	[1]	[2]	[3]
ρ_E^E	0.060***	0.032*	-0.181***
	[0.01]	[0.02]	[0.03]
ρ_E^C	0.014	0.004	-0.238***
	[0.03]	[0.04]	[0.04]
ρ_C^E	0.042	0.059	-0.102
	[0.04]	[0.08]	[0.09]
Observations	44,772	44,772	44,772
Market Dummies	No	Yes	Yes
Year Dummies	No	No	Yes

Note: Standard-errors clustered at the municipality level in brackets. (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.10$. All models include one lag of the dependent variable, population and denomination dummies as controls.

IV Dynamic Game of Church Entry and Exit

This section develops a dynamic game of incomplete information which incorporates relevant aspects of this market as discussed in Section II and III. Following the evidences in Section II.B, throughout our main analysis we assume that churches make entry and exit decisions with the objective of maximizing profits or, equivalently, that churches maximize membership and attribute a constant "markup" on each member. Closer to our paper is Walrath (2016) who assume a reduced form value (or profit) function similar to ours to estimate a (static) entry/exit game between churches in the US.[33] In Section VI we discuss the sensitivity of our results to alternative interpretations of the payoff function.

The sequence of events of our model is as follows. At any market churches observe past actions of all churches – i.e. which Church had/had not a temple in that market – and a set of characteristics of that market and draw a payoff shock from a given distribution. The realization of the shock is private information to the Church. The distribution of shocks is common knowledge. The shock denotes elements that are (payoff) relevant to this Church but are unobserved by other churches. Churches simultaneously choose to have (or not) a temple in that market to maximize the discounted sum of payoffs taking as given beliefs on the actions of other churches.[34] Churches collect period payoffs. The transition laws for the state vector determine the distribution of states in the next period. The games restarts.[35]

IV.A Elements of the Game

We now formalize churches decision problem. Time is discrete, denoted by $t = 1, \ldots, \infty$ and there are $m \in M = \left\{1, 2, ..., \bar{M}\right\}$ markets. In each market we observe $N^E > 0$ Evangelical churches and the Catholic Church. We represent by $\mathbb{E}$, with cardinality N^E, the set of Evangelical churches and by $\mathbb{C}$ the unitary set containing the Catholic Church. Churches actions at market m, period t, are denoted by $a^t_{im} \in \{0, 1\}$, where 1 means that the Church has a temple operating at that market and period and 0 otherwise.[36] Occasionally, we use $\mathbf{a^t_{-im}}$ to describe the actions of all churches other than church i. The vector $\mathbf{s^t_m}$ denotes an element of the (publicly observed) state space at market m, period t. This vector contains the actions of all churches at that market in the previous period, $\mathbf{a^{t-1}_m}$, and the popula-

[33] See also Iannaccone (1998) for a review of works which treats churches as a profit maximizing firms in order to explain various aspects of religious organizations.

[34] Other works have already applied related methodologies to examine strategic interactions between churches – see, for example, Rennhoff and Owens (2012) and Walrath (2016). Differently from this literature, we model churches as forwarding looking entities. Forward looking behavior of churches may be justified by the magnitude of sunk costs churches have to pay when deciding to open a temple in a given market. These sunk investments tend to be relatively large. Hence, when deciding to open a temple, it is reasonable to think that churches weigh sunk investments and the expected streams of payoffs generated by the investment.

[35] Since the seminal contribution of Ericson and Pakes (1995), this type of game is commonly used to model dynamic competition between firms in markets of differentiated goods – for more a detailed discussion on this literature see Arcidiacono and Ellickson (2011), Aguirregabiria and Nevo (2013) or Pesendorfer (2013).

[36] We emphasize that, because most of the municipalities in our sample has either 0 or 1 temples of each denomination, we will model only entry and exit decisions.

tion of market m at period t, p_m^t. The vector $\mathbf{s_m^t}$ evolves according to the transition law $H_m(\mathbf{s_m^{t+1}}|\mathbf{s_m^t}, \mathbf{a_m^t}) \in [0,1]$. It characterizes next period probability distribution of observed states conditional on the current state vector and churches actions profile.

Church i's decision problem at period t, market m, is to choose an action $a_{im}^t \in \{0,1\}$ to maximize the expected discounted sum of payoffs.[37] We denote the discounted sum of payoffs by $E_t \sum_{\tau=t}^{\infty} [\beta^{\tau-t}\Pi_{im}(\mathbf{a_m^\tau}, \mathbf{s_m^\tau}, \varepsilon_{im}^\tau)]$, where $\beta \in (0,1)$ is the discount factor and $\Pi_{im}(\cdot)$ denotes Church i's profit in period t at market m. The term ε_{im}^τ is a payoff shock privately observed by Church i at market m, period τ. We specify this shock later in this subsection. The cdf of the shock is known by all churches and by the econometrician. Following Bresnahan and Reiss (1991) we further assume that $\Pi_{im}(\cdot)$ can be decomposed as:

$$\Pi_{im}^t \left(a_{im}^t, \mathbf{a_{-im}^t}, \mathbf{s_m^t}, \varepsilon_{im}^t\right) = \left\{\pi_i \left(\mathbf{a_{-im}^t}, p_m^t\right) + \pi_{0i} + F_i \left(1 - a_{im}^{t-1}\right) + \varepsilon_{im}^t\right\} \times a_{im}^t, \qquad (2)$$

where, $\pi_i \left(\mathbf{a_{-im}^t}, p_m^t\right)$ denotes Church i's variable profits in market m, π_{0i} represents Church i's fixed operating costs; F_i is an entry cost and ε_{im}^t is a payoff shock summarizing parts of the profits that we do not observe. Entry costs are paid only at the period churches build a temple at the market. We assume that net exit costs – i.e. exit costs minus temples scrap value – churches pay when shutting down an existing temple is equal to zero. The latter assumption is necessary because operating costs, entry costs and net exit costs are not jointly identified in dynamic games (Aguirregabiria and Suzuki, 2014; Komarova et al., 2018).[38] The evidences presented in Section II and, with more details, in Appendix B, suggest that the restriction on exit costs appears to be fairly reasonable in the context of this paper. We resume this discussion in Section V.B, where we show the structural estimates and in Section VI and Appendix F, where we discuss the robustness of our results to alternative normalizations.

[37]In this model, incumbent churches always have the option of leaving the market and an exit movement occurs when, in the (endogenous) state $a_{im}^{t-1} = 1$, Church i plays $a_{im}^t = 0$. In other words, an exit movement corresponds to the transition of the (endogenous) state $a_{im}^{t-1} = 1$ to state $a_{im}^t = 0$. Analogously, an entry movement occurs when in the state $a_{im}^{t-1} = 0$ Church i plays $a_{im}^t = 1$ at period t.

[38]See Aguirregabiria and Suzuki (2014) for examples of various applications adopting different types of "normalizations" of one of these components. In particular, Collard-Wexler (2013) and Sanches et al. (2016) also assume that net exit costs are equal to zero in applications of the same methodology to study entry and exit of ready-mix concrete plants in the US and of bank branches in Brazil.

As in Bresnahan and Reiss (1991), because we observe only churches activity decisions (but not churches market shares), we assume that variable profits can be approximated by the following reduced form:

$$\pi_i\left(\mathbf{a^t_{-im}}, p^t_m\right) = \left\{\theta_{0i} + \theta_{1i} n^{E,t}_{im} + \theta_{2i} n^{C,t}_{im}\right\} \times p^t_m \tag{3}$$

where, $n^{E,t}_{im}$ is the number of Evangelical competitors of Church i, at market m, period t; and $n^{t,C}_{im}$ is the number of Catholic competitors of Church i, market m and period t;[39] $p^t_m \in \mathbf{s^t_m}$ is the population of market m at period t, and θ_{0i}, θ_{1i} and θ_{2i} are parameters; note that these parameters and also those in equation (2) are indexed to i, i.e. all payoff parameters are allowed to vary across churches. As in Bresnahan and Reiss (1991) we interpret the term in curly brackets as Church i's average variable profits *per capita*. According to this model, the parameter θ_{1i} reflects the effects of a temple of other Evangelical denominations on the average profits of Church i and the parameter θ_{2i} reflects the effect of a Catholic temple on the average profits of (an Evangelical) Church i. A close formulation was used in Walrath (2016), who estimates a (static) model of competition between churches in the US. In Section VI we discuss the results of an alternative model where we assume a different functional form for $\pi_i\left(\mathbf{a^t_{-im}}, p^t_m\right)$. Our main results appear to be robust to changes in the functional form of churches payoffs.

Finally we assume that the payoff profitability shock can be written as:[40]

$$\varepsilon^t_{im} = \gamma_i \cdot e^{\mu^t_m} + \varsigma^t_{im}, \tag{4}$$

where, μ^t_m is a market specific shock that varies over t, γ_i is a parameter and ς^t_{im} is an iid shock with Normal distribution. Its cdf will be denoted by $Q(\cdot)$.[41] We assume that the μ^t_ms are observed by all churches, but not by the econometrician. In practice we will treat γ_i (for all players) as another set of parameters to be estimated. The shock μ^t_m will be an

[39]Formally, $n^{E,t}_{im} = \left(\sum_{j\neq i, j\in\mathbb{E}} a^t_{jm}\right)$ and $n^{t,C}_{im} = a^t_{km}\mathbb{I}(k \neq i, k \in \mathbb{C})$, with $\mathbb{I}(\cdot)$ being an indicator function that assumes 1 if i is not the Catholic church and zero otherwise.

[40]See, for example, Collard-Wexler (2013) and Sanches et al. (2016) for a similar treatment of unobserved heterogeneity in dynamic games.

[41]We assume that the effect of μ^t_m on payoffs has an exponential functional form because with this formulation the model captures well the trend of the number of temples – see Section III.

element of the state space, $\mathbf{s_m^t}$. This element captures time varying unobserved market level heterogeneity affecting churches actions.[42] As we emphasized in the previous section, this type of heterogeneity appears to be important to explain churches entry/exit decisions. In the next section we show how we obtain estimates of μ_m^t from the data and give details about the estimation of the model in the presence of this object. The only source of asymmetric information in this model is ς_{im}^t.

We can rewrite the present value of the expected flow of payoffs in terms of beliefs and transitions of states and restate Church i's decision problem as a Bellman equation:[43]

$$V_{im}(\mathbf{s_m^t}, \varsigma_{im}^t; \sigma_{\mathbf{im}}) = \max_{a_{im}^t \in \{0,1\}} \Big\{ \sum_{\mathbf{a_{-im}^t}} \sigma_{im}(\mathbf{a_{-im}^t}|\mathbf{s_m^t}) \cdot \big[\Pi_{im}(a_{im}^t, \mathbf{a_{-im}^t}, \mathbf{s_m^t}, \varepsilon_{im}^t) \\ + \beta \sum_{\mathbf{s_m^{t+1}}} H_m(\mathbf{s_m^{t+1}}|\mathbf{s_m^t}, \mathbf{a_m^t}) \int V_{im}(\mathbf{s_m^{t+1}}, \varsigma_{im}^{t+1}; \sigma_{\mathbf{im}}) dQ(\varsigma_{im}^{t+1})\big] \Big\}. \quad (5)$$

In this expression, we use the notation $\sigma_{im}(\mathbf{a_{-im}^t}|\mathbf{s_m^t})$ to denote Church i's beliefs that given the state variable realization, $\mathbf{s_m^t}$, its rivals will play an action profile $\mathbf{a_{-im}^t}$; $\sigma_{\mathbf{im}}$ is the vector of Church i's beliefs on all possible $\mathbf{a_m^t}$ for all possible states that may be observed in market m and $V_{im}(\mathbf{s_m^t}, \varsigma_{im}^t; \sigma_{\mathbf{im}})$ is Church i's value function in market m when the state vector is $\mathbf{s_m^t}$ and the realization of the private information shock is ς_{im}^t. In the second part of this expression, we assume conditional independence of the distribution of private shocks and factorize the distribution of future states as $H_m(\mathbf{s_m^{t+1}}|\mathbf{s_m^t}, \mathbf{a_m^t}) \cdot Q(\varsigma_{im}^{t+1})$. This assumption is standard in this literature – see, for instance, assumption 2 in Aguirregabiria and Mira (2007); see also Rust (1987).

[42] Precisely, μ_m^t is useful to capture differences in municipalities demographic characteristics (such as income, education, age profile of the population, etc.) which may be important to explain entry and exit decisions of the different churches but are not in our dataset.

[43] An extremely common assumption within the literature on estimation of entry games is that, conditional on the vector of states, players actions in market m are independent of actions taken in any other market. In the Appendix E we present some empirical exercises that suggest that this assumption seems to be reasonable in our sample.

IV.B Equilibrium Concept

To solve the model, we focus on stationary pure Markovian strategies. This implies that churches optimal decisions only depend on the vector of states, $(\mathbf{s_m^t}, \varsigma_{im}^t)$. The history of the game until period t does not matter and every time Church i faces the same realization of the state vector it will play the same action.

Formally, the solution to Church i's maximization problem – see equation (5) – gives rise to a collection of best response functions mapping Church i's optimal decision on its beliefs for every possible realization of the state vector. Mathematically, let $V_{im}^1(\mathbf{s_m^t}; \sigma_{\mathbf{im}})$ be Church i's value function conditional on $a_{im}^t = 1$ net of the payoff shock ς_{im}^t when the vector of publicly observed states is $\mathbf{s_m^t}$ and $V_{im}^0(\mathbf{s_m^t}; \sigma_{\mathbf{im}})$ be Church i's value function conditional on $a_{im}^t = 0$ when the vector of publicly observed states is $\mathbf{s_m^t}$. Then Church i chooses to play $a_{im}^t = 1$ with probability:

$$P\left(a_{im}^t = 1|\mathbf{s_m^t}; \sigma_{\mathbf{im}}\right) = Q\left(V_{im}^1\left(\mathbf{s_m^t}; \sigma_{\mathbf{im}}\right) - V_{im}^0\left(\mathbf{s_m^t}; \sigma_{\mathbf{im}}\right)\right). \tag{6}$$

Stacking this equation for all possible players and states in market m we can write the vector of churches best response as $\mathbf{P_m} = Q(\sigma_{\mathbf{m}})$, where $\mathbf{P_m}$ is a vector that stacks $P(a_{im}^t = 1|\mathbf{s_m^t}; \sigma_{\mathbf{im}})$ for all players and states in market m and $\sigma_{\mathbf{m}}$ is the vector that stacks $\sigma_{\mathbf{im}}$ for all players in market m. Beliefs are consistent in equilibrium, i.e. $\mathbf{P_m} = \sigma_{\mathbf{m}}$, and are computed as a fixed point of the mapping $\mathbf{P_m} = Q(\mathbf{P_m})$. Proofs of equilibrium existence are available in Aguirregabiria and Mira (2007), Pesendorfer and Schmidt-Dengler (2008) and Doraszelski and Satterthwaite (2010).

V Identification, Estimation and Structural Estimates

This subsection discusses identification of the structural parameters of our model, the procedures we used to estimate these parameters and reports estimates of the parameters. We start with a brief discussion on identification and with a description of the estimation procedures. Subsequently, we show the estimates of the parameters of the model.

V.A Identification and Estimation

The identification of the vector of structural parameters, which from now on will be represented by $\mathbf{\Theta} = \left\{(\theta_{0i}, \theta_{1i}, \theta_{2i}, \pi_{0i}, F_i, \gamma_i)_{\forall(i)}, \beta\right\}$, follows the two step approach pioneered by Hotz and Miller (1993). We first identify beliefs (Conditional Choice Probabilities or CCPs), $\sigma_{im}(\mathbf{a^t_{-im}}|\mathbf{s^t_m})$, and state transitions, $H_m(\mathbf{s^{t+1}_m}|\mathbf{s^t_m}, \mathbf{a^t_m})$, directly from the data.[44] Having obtained these two objects and fixing the discount factor we can identify the parameters of the model in closed-form by exploring the system of best-responses characterized from equation (6); see also Pesendorfer and Schmidt-Dengler (2008).[45] Next we discuss the procedures we used to estimate the vector of structural parameters.

We estimate different models for each of the six largest Evangelical denominations and for the Catholic Church. To estimate the parameters of the model we use the two-step estimator proposed by Miessi Sanches et al. (2016). We first estimate beliefs and state transitions directly from the data. First stage estimates of beliefs and transitions are then plugged into the system of best response functions that arise from the solution of the maximization problem described by equation (5) and, in the second stage, the parameters of the model are obtained by forcing this set of equilibrium restrictions to hold approximately. Miessi Sanches et al. (2016) show that when payoffs are linear in the parameters the system of best responses associated to maximization problem (5) can be written as a linear function of the payoff parameters and, therefore, the model can be estimated using a simple OLS estimator. We focus here on the estimation of the first step CCPs and state transitions and leave technical details involved in the estimation of the second step in the Appendix C.

As explained, the first step requires the estimation of beliefs, $\sigma_{im}(\mathbf{a^t_{-im}}|\mathbf{s^t_m})$, and transitions, $H_m(\mathbf{s^{t+1}_m}|\mathbf{s^t_m}, \mathbf{a^t_m})$. Typically, in models of binary choices, beliefs are estimated using a Probit/Logit model, where the dependent variable is $a^t_{im} \in \{0, 1\}$ and the explanatory variables are flexible functions of $\mathbf{s^t_m}$ – see, for example, Ryan (2012) and Sanches et al. (2016).

[44] An important identification assumption of the structural parameters is stationarity – in particular, that, given the vector of states, the parameters of the structural model do not vary over time. Appendix E shows some exercises that suggest that this assumption is reasonable in our setting – see Figure 8 and discussions related to this figure in the Appendix. Another assumption, which is common in the literature, is that players actions are independent across markets conditional on the state vector. Table 10 and related discussions in the Appendix provides support to this assumption.

[45] More formally, using this argument, Appendix C shows that the vector of parameters can be expressed in closed-form as a function of transitions and beliefs.

In this paper, the challenge to estimate beliefs is that the state vector contains the shock μ_m^t that is observed by all churches but not by the econometrician. We obtain estimates for this object using a procedure similar to that employed in Minamihashi (2012), Collard-Wexler (2013), Lin (2015) and Sanches et al. (2016). Specifically, we run a linear probability model of a_{im}^t on a_{im}^{t-1}, the total number of competitors of Church i in market m, period $t-1$, Church dummies and interactions of market and year dummies. The vector containing the estimates of all interactions of year and market dummies will be our estimates of μ_m^t. To obtain the CCPs we estimate two Probit models, one for the Catholic Church and the other pooling all Evangelical denominations (with denomination fixed effects). In both models we use μ_m^t along with the other elements in $\mathbf{s_m^t}$ as controls.[46] The specification of these CCPs as well as their estimates are in the Appendix D.[47]

Having estimated μ_m^t we can estimate its transition. We discretized μ_m^t into five bins and estimated its transition using an autoregressive Ordered Logit. To estimate the transition of population we discretized this variable into ten bins and also used a first order autoregressive Ordered Logit. Transitions of the vector of past actions are deterministic, i.e. $a_{im}^t = a_{im}^{t-1}$. With beliefs and transitions we can estimate the parameters of the structural model.[48]

[46]In principle we could have run the Probit model including interactions of market and year dummies – instead of estimating these interactions from a linear probability model and using them as a control in the Probit. However, estimating a non linear model with more than 6400 parameters is computationally very difficult and, as discussed in Section 2, the two-step Probit model avoids the incidental parameters problem (Heckman, 1987).

[47]Typically dynamic games of incomplete information have multiple equilibria. Given the possibility of equilibrium multiplicity and that we are pooling markets to estimate CCPs our model will be identified if the same equilibrium is played in all markets (conditional on the vector of states) – see Aguirregabiria and Nevo (2013). This assumption is common in applied papers using this framework (Collard-Wexler, 2013; Sanches et al., 2016). When solving the model and performing counterfactuals we numerically show that the equilibrium of the model is locally stable – implying that the counterfactual exercises showed in this paper can be interpreted as typical comparative statics exercises.

[48]The shock μ_m^t was discretized into five bins (versus ten bins for the population) because the variation of this component in the data is much smaller than the variation of the population. We also experimented finer discretizations for μ_m^t but the estimates of the structural model are robust to the number of bins we use to discretize μ_m^t (and also the population). We considered here the model with five bins for μ_m^t because the state space of the model is already large, which complicates substantially the numerical solution of the model.

V.B Structural Estimates

We now present the estimates of the payoff parameters. To estimate these parameters we fixed $\beta = 0.8$. This discount rate is relatively low but it is consistent with interest rates in Brazil during most part of this period.[49] To obtain standard-errors of the estimates we block bootstrap beliefs and the state transitions 50 times. We note that the estimates of the model do not have a level interpretation because they are scaled by the standard-deviation of the payoff shock, ς_{im}^t. Hence, only the signs and the relative magnitude of parameters have a clear interpretation.

The structural parameters for the 7 denominations are shown in Table 3. Some aspects of these estimates deserve special attention. First, the coefficient θ_1 is negative for all churches (except for Mundial), indicating that entry of an Evangelical denomination in a given market reduces payoffs of incumbent churches. The coefficient is significant at 1% for all churches, except for the Christian Congregation. Second, the coefficient θ_2, which captures the effects of a Catholic temple on the payoffs of Evangelical churches is negative and significant at 10% only for Assembly of God and Foursquare, suggesting that the Catholic Church also exert competitive pressure on (some) Evangelical churches. To complement this discussion, in the next section we show the results of a counterfactual exercise that quantifies how competition between churches – summarized by the parameters θ_1 and θ_2 – affect the structure of this market. Third, the coefficient γ that captures the effect of the time-varying market shock on payoffs is positive and significant for all churches – particularly larger for Evangelical denominations – and the coefficient θ_0 – that can be interpreted as the effect of market size on monopoly profits – do not show any systematic pattern across churches.[50]

[49] Indeed, for the period 2011-2018 (period for which interest rates on credit operations are available) real interest rates charged on loans were on average 40% per year (source: Brazilian Central Bank). The official interest rates set by the Central Bank were around 10% since 1995 – period after the stabilization of the economy – reaching 30-40% in some periods. In this case, the real interest rate of 25% implied by $\beta = 0.8$ does seem reasonable. We also analyzed the behavior of the model assuming $\beta = 0.90$, $\beta = 0.95$ and $\beta = 0.99$. Using these discount rates we observed that the model was underestimating the number of active temples in the Brazilian market.

[50] When we include market and year dummies at the same time in the Probit models shown in Section III, the coefficient attached to population becomes statistically insignificant (while it is significant when either year or market dummies are out of the model). Our interpretation is that it is hard to identify with precision the effects of population on churches decisions when we control for market/time unobserved heterogeneity – which may be already taking into account the direct effects of different demographic characteristics on churches payoffs. The same patterns were found in other works; e.g. Igami and Yang (2016) or Sanches et al.

Table 3: [TABLE 3 REVISED] Structural Estimates

	Assembly	Baptist	Congregation	Mundial	Foursquare	Universal	Catholic
Constant (π_0)	-6.406	-6.167	-6.231	-5.911	-6.944	-6.217	-1.891
	[0.404]	[0.389]	[0.395]	[0.399]	[0.434]	[0.361]	[0.332]
Evang Comp (θ_1)	-0.019	-0.013	-0.001	0.013	-0.038	-0.017	-0.011
	[0.005]	[0.005]	[0.005]	[0.004]	[0.01]	[0.005]	[0.004]
Cat Comp (θ_2)	-0.026	-0.016	-0.010	0.003	-0.068	-0.030	
	[0.013]	[0.017]	[0.019]	[0.014]	[0.043]	[0.018]	
Population (θ_0)	0.006	-0.003	-0.024	-0.072	0.093	0.014	-0.100
	[0.015]	[0.014]	[0.015]	[0.012]	[0.031]	[0.016]	[0.019]
Shock (γ)	6.860	6.514	6.388	6.198	6.940	6.534	3.340
	[0.427]	[0.403]	[0.386]	[0.414]	[0.417]	[0.389]	[0.307]
Entry Costs (F)	-6.118	-6.172	-6.262	-6.211	-6.345	-6.184	-9.446
	[0.252]	[0.256]	[0.254]	[0.256]	[0.266]	[0.253]	[0.557]

Note: Robust standard errors estimated from 50 bootstrap repetitions in brackets. Population is local population divided by 10000. Average population in our sample across years and markets is 13452.

Finally, the estimates of entry costs, F, are negative, significant and relatively large and seem to be considerably higher for the Catholic Church than for Evangelical churches. On the other hand, the coefficient π_0, which is interpreted as fixed operating costs, has roughly the same magnitudes for Evangelical churches but is much smaller for the Catholic Church. In line with our descriptions in Section 2, a possible explanation to these results is that they are reflecting the fact that Evangelical churches usually operate in rented spaces (which implies lower entry costs but higher fixed operating costs), while the Catholic Church, in general, build its own temples (which implies higher entry costs but lower fixed operating costs).

To conclude the section, we discuss some caveats underlying the interpretation of the estimates in Table 3. As mentioned in Section IV, because of the normalization of net exit costs (i) our estimates of sunk entry costs, $\hat{F}_i$, correspond to entry costs plus net exit costs, and (ii) our estimates of fixed operating costs, $\hat{\pi}_{0i}$, correspond to π_{0i} minus $(1-\beta)$ times net exit costs – for proofs of these results, see Aguirregabiria and Suzuki (2014). In other words, differences in exit costs of Catholic and Evangelical temples may also explain differences in our estimates of F_i and π_{0i} across Catholic and Evangelical temples.[51] Additionally, if

(2016).

[51]Another plausible argument that could rationalize our findings is that churches take into account reputational costs when they decide to close a temple and that these costs are significantly larger for the Catholic

exit costs were relevant, our estimates of total payoffs net of entry costs would also depend on the magnitude of exit costs – because of point (ii). Therefore, counterfactual analyses involving a tax on total payoffs net of entry costs, as those performed in the next section, would be biased; see Aguirregabiria and Suzuki (2014) and Kalouptsidi et al. (2017) for a general discussion on identification of counterfactuals in dynamic discrete choice models. In light of these circumstances, we emphasize that our interpretation of the estimates in Table 3 and of our counterfactual analysis in Section VI rely on the evidences presented in Section II and Appendix B, which indicate that net exit costs are insignificant for both types of churches. To further address this concern, in the next section – see also Appendix F – we analyze the sensitivity of our results to alternative "normalizations" of the payoff function. Our main findings hold true even in extreme cases where we assume churches' net exit costs are relatively high.

VI Counterfactual Analysis

Now we use the model to study how tax-exemption to churches affected the share of Catholic and Evangelical temples in Brazilian municipalities. Before showing the results of our counterfactual experiments, we analyze the fitting of the model to the data and quantify how competition between churches affect the structure of the market.

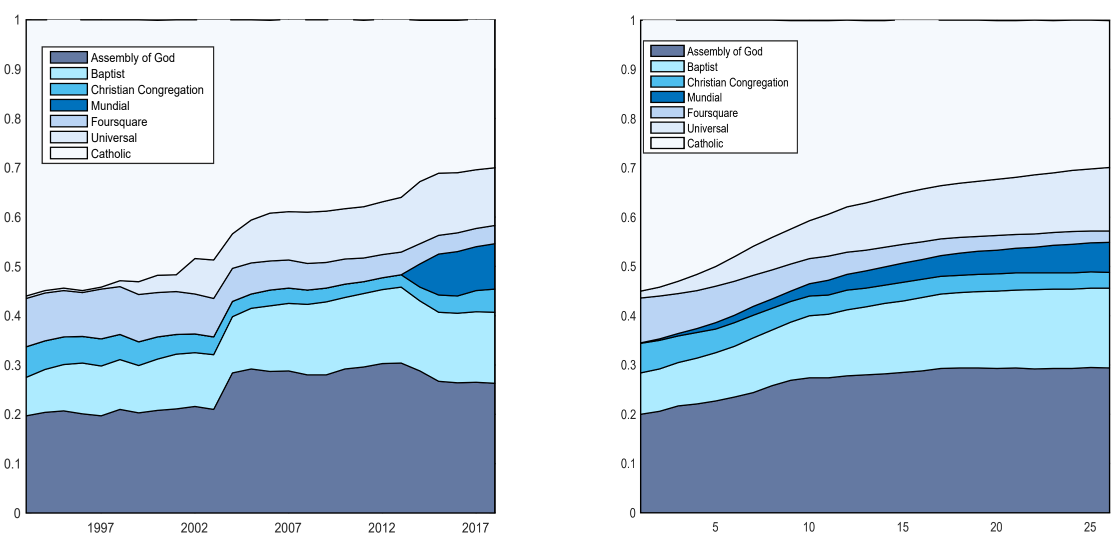
VI.A Model Fitting and Analysis of Competition Between Churches

Model fitting. The main interest of this paper is to understand the effects of taxes on the distribution of market shares across churches. Likewise, we inspect the performance of our model comparing the market shares – defined as the total number of temples of each religious group in a given year divided by the total number of temples operating in that year – of the 7 denominations during 1992-2018 as we observe in the data with the shares of these denominations during the same period as predicted by the model.

Church. However, for the particular case of our application, we believe that these costs are not relevant because our sample contains only small and geographically isolated markets with small-scale temples that do not have any symbolic value – due to size, or for historical reasons, for instance – to these churches.

To compute the time-series of temples predicted by the model we employ the following procedure. First, using the parameters in Table 3 we solve the model for the equilibrium vector of beliefs of each religious group. We describe the algorithm we use to solve the model in the Appendix C. Having computed the vector of equilibrium beliefs we forward simulate the model starting from the state vector observed by each church in 1992 in each municipality 26 years ahead, until 2018. In total we simulate 100 paths for each church-municipality pair and take the average number of temples of each church in each municipality across the 100 paths. We then compute the market share of all churches from 1992 to 2018. Figure 3 shows the shares of each denomination as observed in the data – same figure as shown in Section III – and the predictions of the dynamic model from 1992 to 2018. The dynamic model seems to reproduce very well the share of the seven religious groups.

Figure 3: Predicted Shares – Data and Model for all Years from 1992 to 2018



(a) Data

(b) Model

The equilibrium of the model is not necessarily unique. To check whether the equilibrium of the model is locally stable we fix the vector of parameters and recompute the equilibrium path of temples varying the initial guess of beliefs we use to solve the model. In all our attempts, the resulting path of temples is the same, suggesting that the equilibrium of the model is locally stable.

Church competition and market structure. The estimates of the model reported in Section V.B indicate that entry of rival churches in a given market leads to a reduction of payoffs of incumbent churches in that market. To quantify the importance of these effects we used the model to simulate the number of active temples of each denomination in a counterfactual world where the parameters θ_1 and θ_2, which capture competition between churches, are constrained to zero. We analyze three different scenarios. First, we fixed only $\theta_1 = 0$ (i.e. no competitive pressure from Evangelical temples), solved the model for the equilibrium probabilities consistent with this restriction, simulated the number of temples of all churches from 1992 to 2018 one hundred times and computed the average number of temples across paths (for each year and in all markets). We repeated the procedure restricting only $\theta_2 = 0$ (i.e. no competitive pressure from Catholic temples) and finally imposing both restrictions, $\theta_1 = 0$ and $\theta_2 = 0$. We compare the number of Catholic and Evangelical temples in 2018 in these three counterfactual scenarios with the number of Catholic and Evangelical temples in 2018 in the baseline scenario.

Table 4 shows the variation in the total number of temples in 2018 of all Evangelical denominations, of the Catholic Church and of the sum of Catholic and Evangelical temples in each counterfactual scenario *vis-à-vis* the baseline scenario (computed using the original configuration of parameters). First column shows these numbers for the scenario where $\theta_1 = 0$, the second for the scenario where $\theta_2 = 0$ and the third for the scenario where $\theta_1 = 0$ and $\theta_2 = 0$. We highlight three interesting results.

Table 4: Competition Between Churches and Market Structure in 2018

	$\theta_1 = 0$	$\theta_2 = 0$	$\theta_1, \theta_2 = 0$
Variation Evangelical Temples	10.13%	9.34%	22.27%
Variation Catholic Temples	3.66%	-0.39%	3.66%
Variation Evangelical and Catholic Temples	8.18%	6.42%	16.68%

First, according to the numbers in the last column of the table, by limiting competition between churches we observe that the number of active temples of the Catholic and Evangelical churches grows approximately 17% (in 2018). Second, the number of Evangelical temples appear to be particularly affected by competition from other Evangelical churches and from the Catholic Church. In the scenario where $\theta_1 = 0$ and $\theta_2 = 0$ the number of Evangelical temples is more than 22% larger than in the baseline scenario. Third, Evangelical churches seem to suffer slightly more from competition of other Evangelical churches than from competition of the Catholic Church: when we restrict $\theta_1 = 0$ (no competition from other Evangelical churches) the number of Evangelical temples grows 10.13%, while when we restrict $\theta_2 = 0$ (no competition from the Catholic Church) the number of Evangelical temples grows slightly less, 9.34%. Overall, these results indicate that competition between churches plays an important role to explain the structure of religion markets in Brazil.

VI.B Tax Counterfactuals

Now we employ the structural model to evaluate how churches tax-exemption affects the share of Catholic and Evangelical temples operating in Brazilian municipalities. We begin by recalculating the equilibrium of the model, assuming that at any period churches pay a proportional tax $\varrho \in [0, 1]$ on total expected payoffs net of entry costs. For any $\varrho \in [0, 1]$, we take the corresponding vector of equilibrium probabilities and simulate 100 times the number of temples of the 7 denominations for each year during 1992-2018 in each municipality. For each Church, market and year, we computed the total number of active temples and of enter/exit movements averaged across the 100 paths.[52] Our analysis is based on these simulations.

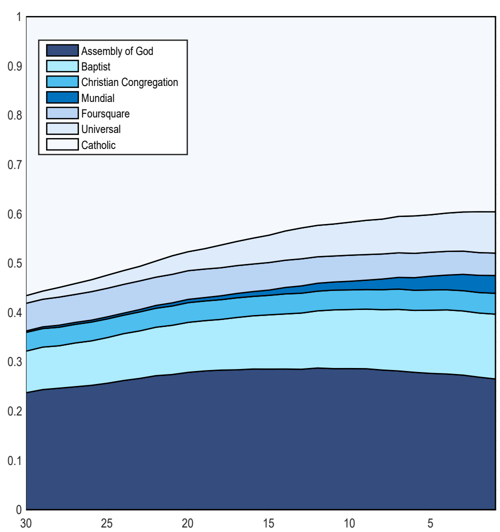
To illustrate the effects of tax-exemption on the market share of Catholic and Evangelical churches, Figure 4 shows churches average market share (across all years) for ϱ varying from 0% (tax-exemption) to 30%. We trimmed the analysis at 30% because this rate is close to the typical corporate tax paid by for-profit Brazilian firms (34%).[53] To facilitate the exposition, the horizontal axis is in reverse order, i.e. numbers corresponding to our baseline scenario of tax-exemption is on the extreme right of each figure. The figure shows that when we move

[52] We compute an entry (exit) movement for church i at period t and market m every time we observe in the simulated data a transition from $a_{im}^{t-1} = 0$ to $a_{im}^{t} = 1$ ($a_{im}^{t-1} = 1$ to $a_{im}^{t} = 0$).

[53] There are two possible interpretations for this counterfactual. The first is that churches payoffs represent profits and that, with the policy change, these profits would be taxed as profits of for profit organizations are taxed. Alternatively, as Brazilian churches currently do not pay payroll taxes (see Section II), we could interpret these payoffs as clergy income (revenues minus costs are distributed directly to the clergy) and that after the policy change churches would have to pay taxes on clergy income. In the latter case, the rate of 30% is also close to the payroll taxes paid by Brazilian firms. For reference see https://observatorio-politica-fiscal.ibre.fgv.br/reformas/tributacao/cunha-tributaria-no-brasil-estimativa-evolucao-e-comparacoes-internacionais.

from the left (30% tax) to the right (tax-exemption) on the horizontal axis, the combined share of all Evangelical churches grows and, consequently, the share of the Catholic Church falls. The effects of tax-exemption on the shares of Evangelical churches is substantial: the average share of Evangelicals jumps from approximately 42% in the scenario where churches pay the 30% tax to more than 60% in the scenario where churches are not taxed. It is also interesting to note that under this scenario the share of some Evangelical denominations (e.g. Universal and Mundial) would be very close to zero, indicating that the tax would also have an effect on the number of religious choices of the population. Figure 5 helps us to understand these results.

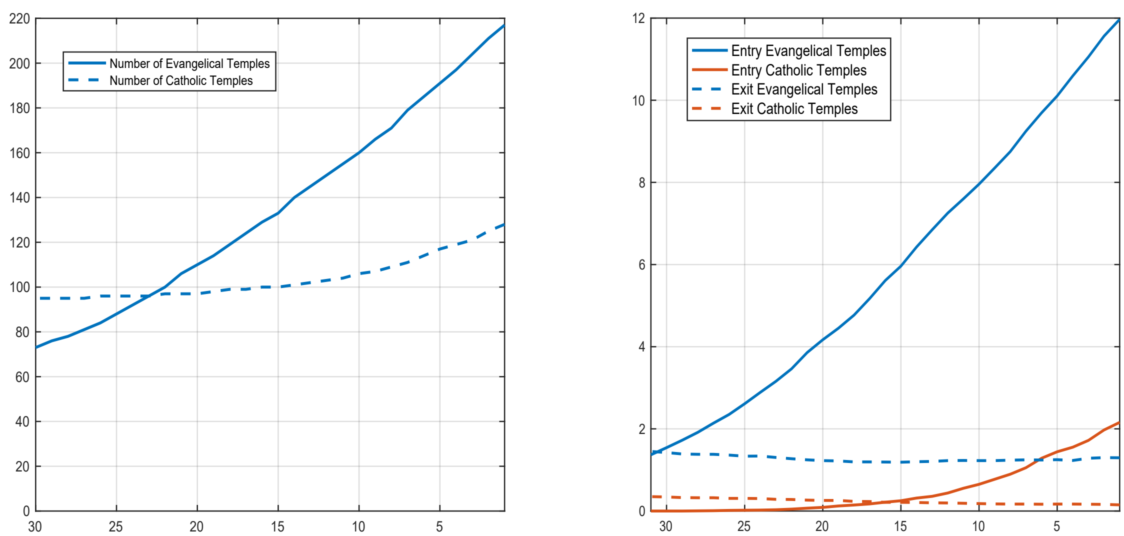
Figure 4: Average Share of Each Church for $\varrho \in [0, 0.30]$ (Horizontal Axis in Reverse Order)



Panel (a) in Figure 5 shows yearly averages of the stock of Catholic and Evangelical temples in all markets for different tax rates between 0% and 30%; panel (b) shows yearly averages of the number of new temples (entry) and of the number of closed temples (exit) by the Catholic Church and by all Evangelical churches for the same range of ϱ. As in Figure 4, the horizontal axis in both panels is in reverse order. Starting from the counterfactual scenario in which the tax rate is 30%, when we reduce the tax rate towards zero (on the extreme right of the axis), panel (a) shows a monotonic increase in the stock of Catholic and Evangelical temples. The effects of the reduction in the tax rate on the stock of temples, on the other hand, is much more pronounced for the group of Evangelical churches. Panel (b) shows that the increase in the stock of Catholic and Evangelical temples is explained mainly by an increase in entry movements – which are more pronounced for the group of Evangelical churches.

There are two factors explaining why the combined share of Evangelical churches increases and, consequently, the share of the Catholic Church falls when we reduce the tax rate, as shown in Figure 4. First, reductions in the tax rate tend to increase entry of all potential entrants; as the pool of potential entrants in all markets includes different Evangelical denominations the aggregate effect over this pool must be greater than the corresponding effect over the Catholic Church alone. In this sense, the combination of religious freedom – through which the State recognizes all religious organizations – and tax-exemption appears to be important to explain the decline in the share of the Catholic Church.

Figure 5: Number of Temples and Entry/Exit of Temples at Different Tax Levels (Horizontal Axis in Reverse Order)



(a) Average Number of Temples per Year

(b) Average Temple Entry/Exit per Year

Second, despite its higher expected operating profits, the Catholic Church's relatively higher entry costs tend to mitigate the effects of tax-exemptions on entry of Catholic temples. To illustrate this we decompose $V_{im}^{1}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right) - V_{im}^{0}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right) \equiv \Delta V_{im}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)$ in equation

(6), i.e. the expected discounted sum of payoffs conditional on $a_{im}^t = 1$ minus the expected discounted sum of payoffs conditional on $a_{im}^t = 0$, as:[54]

$$\Delta V_{im}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right) = \Delta V_{im}^{-F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right) + \Delta V_{im}^{+F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right), \tag{7}$$

in which, $\Delta V_{im}^{-F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)$ is the expected discounted sum of payoffs net of entry costs conditional on $a_{im}^t = 1$ minus the expected discounted sum of payoffs net of entry costs conditional on $a_{im}^t = 0$;[55] and $\Delta V_{im}^{+F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)$ is the same difference that is due to entry costs only.[56] It is important to note that both terms depend on the vector of equilibrium probabilities, $\sigma_{\mathbf{im}}$. This implies that a tax on variable payoffs net of entry costs may affect both components through changes in equilibrium probabilities.

Table 5 shows $\Delta V_{im}^{-F}(\cdot)$, $\Delta V_{im}^{+F}(\cdot)$, the sum of both components, $\Delta V_{im}(\cdot)$, and the corresponding entry probabilities, $P\left(a_{im}^t|\cdot\right)$, calculated at different tax rates for the Catholic Church and for Assembly of God, the largest Evangelical Church. Given that the effect of the tax on the stock of churches occurs mainly via changes in entry rates (see Figure 5), for each church, we averaged the value of each component across all states where that church was out of the market, i.e. for states in which, for that Church i, $a_{im}^{t-1} = 0$ – and, therefore, the component $\Delta V_{im}(\cdot)$ measures the average expected gains of a church that was out of the market at period $t-1$ and enters the market at period t.[57]

Table 5: Decomposition of Differences of Conditional Value Functions for Different Tax Rates on Churches Expected Payoffs Net of Entry Costs – Catholic Church and Assembly of God

	$\Delta V_{im}^{-F}(\cdot)$		$\Delta V_{im}^{+F}(\cdot)$		$\Delta V_{im}(\cdot)$		$P\left(a_{im}^t = 1|\cdot\right)$	
Tax Rate (%)	Assembly	Catholic	Assembly	Catholic	Assembly	Catholic	Assembly	Catholic
30	2.49	4.66	-6.04	-9.45	-3.55	-4.79	0.00	0.00
20	2.69	5.30	-5.88	-9.43	-3.19	-4.13	0.01	0.00
10	2.74	5.82	-5.61	-9.30	-2.87	-3.48	0.02	0.00
0	2.75	5.94	-5.33	-8.80	-2.59	-2.86	0.04	0.02

[54]More precisely, it can be shown – see, for example, Miessi Sanches et al. (2016) – that $V_{im}^{a}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)$, for $a \in \{0,1\}$, can be factored as $V_{im}^{a,-F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right) + V_{im}^{a,+F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)$, where the first component corresponds to the expected discounted sum of payoffs net of entry costs and $V_{im}^{a,+F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)$ to the part of churches conditional value function due to entry costs.

[55]Mathematically, $\Delta V_{im}^{-F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right) = V_{im}^{1,-F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right) - V_{im}^{0,-F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)$.

[56]Mathematically, $\Delta V_{im}^{+F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right) = V_{im}^{1,+F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right) - V_{im}^{0,+F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)$.

[57]For example, the value 2.49 in the first row, second column of the table, is the average of the component $\Delta V_{im}^{-F}(\cdot)$ of Assembly of God across all states in which the action of this church at period $t-1$ is equal to zero (and when the tax rate on variable payoffs is equal to 30%).

First, the results in Table 5 show that, at any tax rate on expected payoffs net of entry costs, payoff gains net of entry costs (i.e. $\Delta V_{im}^{-F}(\cdot)$) of a new Catholic temple are always much higher than of a new Evangelical temple. Second, we also see that variations in churches value function due to entry costs, $\Delta V_{im}^{+F}(\cdot)$, are relatively large (in absolute terms) and much larger for the Catholic Church. These two facts are consistent with the payoff estimates in Table 3. Because of the latter result, average expected gains of the Catholic Church if it opens a new temple, $\Delta V_{im}(\cdot)$, is much smaller than average expected gains of a new Evangelical temple. In any case, if the tax rate is 30%, expected gains of opening a new temple is "very" negative for both churches (-3.55 for the Assembly of God and -4.79 for the Catholic Church) implying entry probabilities $P\left(a_{im}^{t}=1|\cdot\right)$ close to zero, consistent with panel (b) in Figure 5.[58]

Table 5 also shows that when we decrease the tax rate, expected gains of a new temple net of entry costs ($\Delta V_{im}^{-F}(\cdot)$) increase more for the Catholic Church[59]. However, because entry costs of the Catholic Church are very high, implying much lower $\Delta V_{im}(\cdot)$ for the Catholic Church, the effect of the reduction of the tax on entry probabilities is less pronounced for the Catholic Church (last column of the table).[60] This pattern reflects non-linearities in equilibrium entry probabilities obtained from the solution of the structural model: when $\Delta V_{im}(\cdot)$ is *ex-ante* very negative any *exogenous* increase in payoffs has a more modest effect on $P\left(a_{im}^{t}=1|\cdot\right)$ than when $\Delta V_{im}(\cdot)$ is relatively large. Intuitively, this indicates that "marginal" potential entrants are more responsive to changes in the tax, even if payoffs net of entry costs (i.e. the tax base) of these types are lower than payoffs net of entry costs of "non-marginal" potential entrants. Figure 12 in the Appendix G further illustrates this point by showing that churches response to taxes is more (less) pronounced when entry fixed

[58]Panel (b) of Figure 5 shows that when the tax rate is 30%, the average number of Catholic temples opened per year in all 246 markets in our sample is close to zero; for the pool of Evangelical churches, this number is not zero (but very small, less than two new temples opened per year in 246 markets), precisely because this value aggregates the number of entry movements of the six Evangelical churches.

[59]E.g. when the tax changes from 30 to 20%, $\Delta V_{im}^{-F}(\cdot)$ of the Catholic Church moves from 4.66 to 5.30 (2.49 to 2.69 for the Assembly of God).

[60]Note that when we increase the tax on variable payoffs net of entry costs, the component $\Delta V_{im}^{+F}(\cdot)$ also decreases – as we explained, even though the tax does not fall upon entry costs, F, it affects $\Delta V_{im}^{+F}(\cdot)$ through changes in equilibrium probabilities. This happens, essentially, because expected entry costs conditional on $a_{im}^{t}=0$, $V_{im}^{0,+F}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)$, converge quickly to zero as entry probabilities get close to zero when the tax rate increases (and it is negative and relatively large in absolute terms when the tax rate is closer to zero).

costs are smaller (larger) – i.e. when entry payoffs are larger (smaller), keeping the tax base constant.

The results shown throughout this section depend on some restrictive assumptions, in particular that churches payoffs have the functional form described in Section IV, that their net exit costs are equal to zero and that payoffs represent pecuniary profits, i.e. pecuniary revenue minus pecuniary costs, which ultimately means that these payoffs can be taxed. In Appendix F we show that our main counterfactual results hold when we change the functional form of churches' payoffs, assume different "normalizations" for churches net exit costs and relax its interpretation.[61] We refer readers to that Appendix for further details.

VII Evangelicals and Politics in Brazil

The growth of Evangelical churches is likely to have consequences beyond the structure of religious markets. Perhaps, the most obvious of these consequences was the continuous rise of the participation of Evangelicals in various spheres of the Brazilian government (Mariano, 2014; Costa et al., 2019). Evangelical congress members usually organize an influential Evangelical caucus – the so-called Parliamentary Evangelical Front (Frente Parlamentar Evangélica or FPE) – to pursue political agendas informed by their shared religious beliefs and the interest of their denominations, as opposed to traditional party affiliation or political coalition. Appendix Figure 13 illustrates the growing Evangelical representation in politics in the last 6 elections. Evangelical representation has grown from less than 10% in 1998 to nearly 40% of all congressional seats.[62].

While a growing Evangelical presence in politics is not surprising given their importance in Brazilian society, we seek to isolate the effect of the geographical expansion of Evangelical denominations on voting for the FPE. Thus we explore the staggered timing of Evangelical temple entry on politics by comparing changes in voting patterns for municipalities that have

[61] Specifically, regarding the interpretation of payoffs, we examine how taxation would affect the relative market shares of the Catholic and Evangelical churches assuming that only a fraction of churches payoffs correspond to financial gains and can, therefore, be taxed, while the remaining fraction correspond to non-financial motives that are not taxed.

[62] We thank Fabio Lacerda for kindly providing data about Evangelical candidates (Lacerda, 2017). Members of the Frente Parlamentar Evangélica (FPE) 1994-2014 come from FPE (2012); DIAP (2002); Dantas (2011); BRASIL (2003, 2018-2020).

year of temple entry between 1992 and 2018.

Our key identification assumption is that the timing of temple establishment is uncorrelated with other determinants of changes in Evangelical vote share. Using our framework, we provide evidence that seems to corroborate this assumption. Our municipality panel is defined at electoral terms as units of time, instead of years. This is needed as vote shares are only available in election years, but temple entry may occur in any year, so we aggregate time at 4-year (electoral term) periods. In particular, we specify the following two-way fixed effect model for FPE vote share:

$$Y_{mt} = \sum_{\tau=-T}^{T} \beta_\tau D_{mt}^\tau + \gamma_m + \alpha_t + u_{mt} \tag{8}$$

where m and t index municipality and electoral term (time period), respectively. Y_{mt} denotes vote share of FPE. γ_m accounts for time-invariant municipality-specific factors such as geographical location and historical patterns that correlate with religion trends, and α_t are period fixed-effects. Treatment assignment is denoted by $D_{mt}^\tau = \mathbb{1}_{[t-e_m=\tau]}$ that is set to 1 if temple entry occurs τ periods away from the current period t in municipality m.[63] To obtain our estimates, we lean on the recent literature on the causal interpretations of two-way fixed effects models as suggested by de Chaisemartin and D'Haultfoeuille (2020).

Figure 6 plots the estimated β_τ coefficients from a regression of the form given in equation (8).[64] Prior to entry, there is no differential trend in vote share across treated and control municipalities. This suggests that the temple entry, despite potentially having a strategic component, was not designed as a response to trends in political outcomes. There is a sharp increase in the Evangelical vote share of 5 percentage points in the first election after entry, which seems to carry on to the next two elections with the same magnitude. All point estimates from Figure 6 are reported in column (1) of Appendix Table 13. Columns (2)-(4) add controls for population, a set of pre-determined socio-demographic characteristics

[63] We assume that any dynamics wear off after eight years or two terms. By limiting the analysis to a 5-year window pre/post treatment, we ensure that the event-time coefficients are identified off of a nearly balanced panel of municipalities.

[64] Robust standard errors are clustered at the municipal level. Our estimates are computed using the *did_multiplegt* Stata package as recommended by de Chaisemartin and D'Haultfoeuille (2020).

Figure 6: Evangelical Temple Entry and Election Outcomes

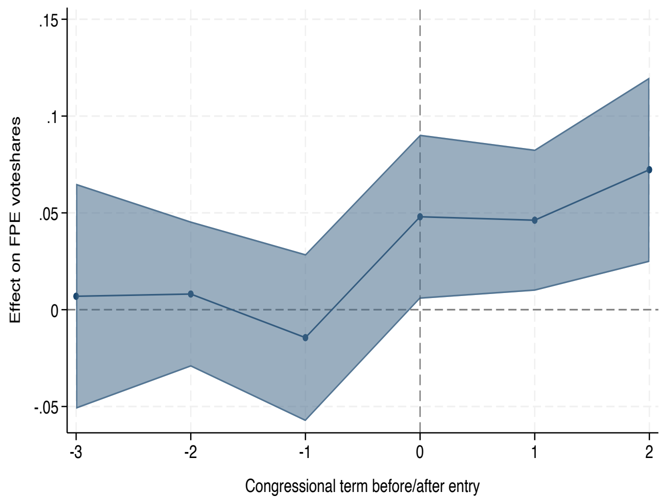
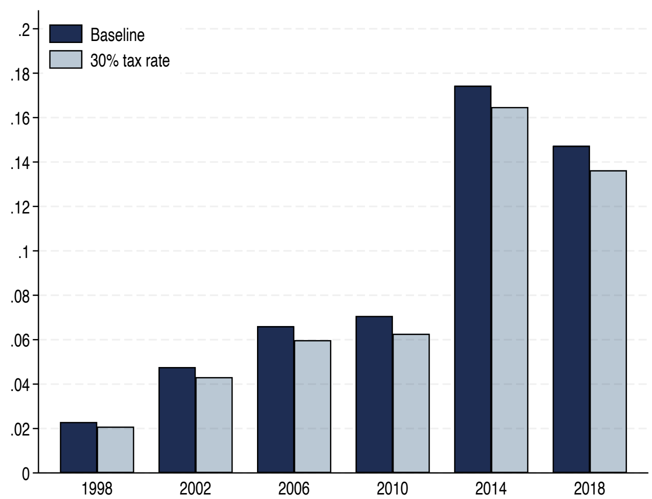


Figure 7: Evangelical Vote Share under Alternative Tax Rates



interacted with term dummies and state-terms fixed effects, respectively.[65] Using these same 4 specifications, Appendix Table 14 reports estimates from a simple two-way fixed effects of (continuous) number of temples on Evangelical vote share. Results are positive and significant in the range just below one percentage point, except for one specification.

By combining these estimates with our counterfactuals presented in Section VI.B, we now perform a simple exercise to grasp what the Evangelical caucus vote share would have been in

[65]Sociodemographics are calculated using data from the 1991 Census (IBGE, 1991-2010a) and include share of males, whites, evangelicals; individuals with primary, middle and college education, and average family income.

each election if the number of temples had been as in our 30% tax rate scenario as opposed to zero. This analysis is based on the full-fledged estimates reported in column (1) of Table 14. In essence, we calculate the predicted vote share $\widetilde{Y}_{mt}$ associated with a number of temples under the two alternative tax scenarios by computing $\widetilde{Y}_{mt}(\varrho) = Y_{mt} + (\tilde{n}_{mt}(\varrho) - n_{mt})\hat{\delta}_1$ where Y_{mt} and n_{mt} are the observed FPE vote share and number of Evangelical temples in the baseline scenario, respectively; $\tilde{n}_{mt}(\varrho)$ is a counterfactual number of temples given tax rates ϱ and $\hat{\delta}_1$ is the marginal effect of a temple on vote share. Figure 7 shows that tax-exemptions had non-negligible consequences on Evangelical vote share. For instance, in 2018 the vote share of Evangelicals would be 13.6% under a variable profit tax rate of 30% against 14.7% in the Baseline model. The fall in the share of votes caused by the 30% tax rate is around 8.5% on average, across the 1998-2018 elections.

VIII Conclusion

This paper develops a dynamic game of church entry in Brazil between the Catholic Church and major Evangelical denominations. It explores the impact of tax-exemption policies on the market shares of Catholics and Evangelicals. We find that tax-exemptions lead to increased Evangelical temple share and decreased Catholic temple share. Additionally, the study examines the effects of church tax-exemption on political representation. We estimate the responses of the vote share received by Evangelical members of Congress to the entry of Evangelical churches in Brazilian municipalities within a dynamic event-study framework. Back-of-the-envelope calculations that combine the results of our counterfactuals with the event-study estimates indicate that tax-exemption policies resulted in a non-negligible increase in the vote share of politicians affiliated with Evangelical groups.

Due to data limitations, we focus on the relationship between tax-exemption and the growth of Evangelical churches. The growth of Evangelicals is, nonetheless, a complex phenomenon involving many factors other than taxes, e.g. changes in preferences and demographic aspects. For example, one would be able to assess how these factors contribute to explaining the phenomenon with data on religious preferences and a richer collection of demographic variables. This seems to be an interesting direction for future research.

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Appendix

This Appendix is divided in eight parts:

1. Further details on the institutional background;
2. Anecdotal evidence that we use to support "normalizations" of churches payoff functions;
3. Technical details on the structural model;
4. Estimates of Conditional Choice Probabilities (CCPs) that correspond to the first stage of the structural estimation of the model;
5. Evidence to support key assumptions behind the structural model;
6. Estimates of the structural model and counterfactuals with an alternative payoff function, under alternative interpretations of churches payoffs and different "normalizations" of churches net exit costs;
7. Churches response to taxation depending on the magnitude of entry costs; and,
8. Additional tables and figures.

A Institutional Background Details

In this Appendix we explain the taxonomy of Brazilian religious denominations that we use throughout this paper and briefly describe the three successive waves of Pentecostal denominations that started to threat Catholic hegemony.

The taxonomy of Brazilian religious denominations that we use in this paper, which primarily follows Mariano (2014), is shown in Table 6. We group all denominations into 5 major traditions. The Catholic group (I) includes the Roman Catholic Church and the Orthodox Church, the latter group being inexpressive in terms of number of members. Mainline Protestants (II) include the main denominational families that share common foundational doctrines that can be more directly traced to the Reformation, and are typically seen as European immigrant's churches or "transplantation churches" in Brazil.

Groups (III) and (IV) have the main Evangelical denominations. According to Noll (2011), *"(...) evangelical traits have never by themselves yielded cohesive, institutionally compact, or clearly demarcated groups of Christians, but [rather] (...) identify a large family of churches and religious enterprises."* Taxonomy and classifications within this religious universe are not strictly consistent across languages, religious authorities, or research. In Latin America it is commonly used as an umbrella concept that includes first and foremost Pentecostals, Neo-Pentecostals, and Neo-Charismatic movements. Non-Pentecostal Evangelicals (III) include denominations typically associated with the *Second Great Awakening* movement of the early 19^{th} century in the United States. Pentecostal Evangelicals (IV) designate a wide range of younger and mainly indigenous churches that share several of the following features: a literal approach to the Bible, a belief that Jesus will return during their lifetime, and the prosperity gospel. Especially in Neo-Pentecostal denominations, worship services often involve divine healing, speaking in tongues, exorcism, and the receiving of direct revelations from God (Zilla, 2018). Non-Christian religions make up Group (V), which is significantly underrepresented in the Brazilian population compared to the other groupings.

Table 6: Religious Denominations in Brazil

	Group	Denominations
I	Catholic	Roman, Orthodox
II	Mainline Protestant	Lutheran, Anglican, Calvinist, Anabaptist
III	Non-Pentecostal Evangelical	Presbyterian, Congregationalist, Baptists, Methodist, Adventist
IV	Pentecostal Evangelical	Christian Congregation, Assembly of God, Foursquare, Universal Brasil para Cristo, Deus é Amor, Renascer, Mundial, Nazareno Casa da Benção, Casa da Oração, Maranata, Igreja da Graça
V	Other	Afro-Brazilian, Spiritism, Eastern Religions, Judaism, Islam

Pentecostalism in Brazil was consolidated over time in three different waves. The first wave brought "classic Pentecostalism" to Brazil via Europeans migrants who converted to the new movement in the United States. It started in 1910 with the foundation of the new churches of *Christian Congregation in Brazil* and, in 1911, with the *Assembly of God*.[66]

The second wave started in 1950 with the *Foursquare Church*, brought to Brazil from the US in 1951, and *O Brasil para Cristo* (Brazil for Christ), the first Pentecostal denomination founded by a Brazilian – radio-evangelist Manoel de Mello – in 1955.[67] This pattern of successful pastors who later founded their own church with intense use of mass media was a recurring phenomenon in the following decades (Lima, 2007).

The third (neo-Pentecostal) wave has as its most influential Church the *Universal Church of the Kingdom of God* (or IURD, in Portuguese), founded in 1977. Among other contemporaneous denomination, it followed an aggressive expansion strategy with the intense use of TV and radio and a combination of organizational structure and marketing strategies akin to those of a typical capitalistic corporation.[68] These churches had few traces of sectarianism and did not required followers for adherence to strict rules of conduct that characterized the Pentecostalism of the first generation. They also spread the Prosperity Gospel doctrine and strongly encouraged believers to tithe.

Neo-Pentecostal churches openly engaged in politics and started to nominate candidates in the late 1980s, who would participate go on to be part of the Constitutional Assembly

[66]These new churches emphasized gifts of the spirit such as speaking in tongues, casting out demons, and prophesying (Freston, 1995; Lingenthal, 2012).

[67]It distinguishing itself from the former wave through its emphasis on divine healing during worship as a gift of the Holy Spirit

[68]The third wave preached the existence of a spiritual warfare against the devil and his followers on Earth, who they would identify as the other religions, especially Afro-Brazilian religions Lingenthal (2012).

of 1988, and obtain radio and TV concessions later used as religious media (Freston et al., 1993). Indeed, recent works show that the strategy of aggressive geographic expansion of temple building complemented with mass TV and radio presence was key for the rise of neo-pentecostalism in Brazil in the last few decades (Corbi and Komatsu, 2019).

B Normalization of Exit Costs

This Appendix shows a series of evidences that serve to support the normalization of churches net exit costs, as we discussed in Section IV. In the municipalities that are part of our sample, the temple is the only relevant component of churches capital. Net exit costs churches pay to shut down a temple will depend on what happens to this structure once a church decides to leave any market. Given that Catholic and Evangelical churches operate based on different business models, the former acquiring this capital whereas the latter typically rents it, the components of exit costs may differ across the two groups of churches. Next, we provide a separate description of the main components of net exit costs for Catholic and Evangelical churches, arguing that regardless of these differences, the exit costs of both types of churches may be very close to zero.

Evangelical churches. As discussed in Section II, Evangelical places of worship are usually housed in functional rented properties. A case in point is the *Igreja Universal do Reino de Deus* (IURD) which has 7 million members in Brazil and rents 8.806 properties (Tavolaro, 2007) placing it as one of the top tenants in the country.[69]

Table 7: Household per Capita Income and Rental Expenditure – 2010 Census in R$ of 2010, Monthly

	Mean	Median	5th Percentile	95th Percentile
		Our Sample		
Household Rental Expenditure	184.7	150	50	500
Household Income (per Capita)	1541.8	900	30	4560
		National Sample		
Household Rental Expenditure	325.9	250	80	770
Household Income (per Capita)	2232.7	1320	112	6600

Note: All monetary values are in 2010 Brazilian Reais.

The source of exit cost in the case of rented properties would be related to breaking a real estate lease. According to local law, the fine for returning a building before the lease expires is equal to the proportional time remaining in the contract multiplied by three months' rent. However, in many instances, tenants are exempt from paying this fine if they occupy the

[69]The only Church for which we could find this kind of information is IURD.

property for a specific number of months. Next, using data from the Brazilian Census, we provide some (upper-bound) estimates of these fines.

Table 7, constructed from 2010 Census data (IBGE, 1991-2010a), reports that the mean (median) rent paid by a household in a municipality in our sample was R$184 (R$150), ranging from R$50 (5th) to R$500 (95th) percentile. The mean of monthly household income was R$1541 (R$900), ranging from R$30 (5th) to R$4560 (95th) percentile.[70] These statistics are around 40% lower than national averages as these are smaller and less urban municipalities. Assuming churches pay higher-than-average rents, equal to the 95th percentile, the maximum payable fine would be R$1500.

On the other hand, according to the Brazilian Internal Revenue Service, in 2010 the revenue of all Brazilian churches summed up to R$20 billions (in R$ of 2010) – see also Figure 1 in Section II – and the number of temples of all Christian denominations was 119142. This amounts to an average yearly revenue of R$167,866.92. Consequently, the maximum fine expected for an Evangelical church to pay in the event of breaking a lease would be approximately 0.89% of the average revenue of a Brazilian temple. Even if we consider that the revenues of the temples in our sample are (much) smaller than the revenue of an average temple in Brazil, these fines still appear insignificant.

Catholic Church. In contrast, Catholic temples are commonly owned by the Roman Church. When the Church decides to exit a particular market, the capital associated with these properties can potentially be sold or rented, which could contribute to mitigating the financial losses incurred by the Church in markets in decline. However, as we will argue below, in many cases, the Catholic Church does not exercise this possibility and instead chooses to abandon unused temples.

The legal possibility of alienating ecclesiastical goods generates questions in both civil and canonical spheres. The 1983 Code of Canon Law (abbreviated 1983 CIC from its Latin title Codex Iuris Canonici), also called the Johanno-Pauline Code, is the fundamental body of ecclesiastical laws for the Latin Church. According to it, the ecclesiastic estate is destined to serve the Church in achieving the salvation of souls; therefore, piety and charity must always be emphasized as the compass that must guide the management of the Church's estate. Notwithstanding, it leaves space for private law to regulate the managing of ecclesiastical goods and defines a set of limits and parameters on the sale of ecclesiastic properties in order to avoid illegal conduct. In any case, selling Church real estate in the event of bankruptcy is a lengthy and bureaucratic process because it frequently necessitates the approval of the Holy See (i.e., the Vatican).[71]

The aforementioned difficulties in selling properties is likely behind the numerous cases of Catholic Church buildings being abandoned across Brazil. This strategy seems to imply that the Catholic church's exit costs are also negligible because churches do not pay property taxes and generally have no liability for abandoned infrastructure.

Even though official statistics are non-existent, anecdotal evidence of abandoned churches is widely available on the internet. For instance, a project called "Conexão Expansionista"

[70] For comparison, in 2010, US$1 was equal to, approximately, R$1.7 (yearly average).

[71] https://www.catholicnewsagency.com/news/44951/diocesan-bankruptcies-could-require-vatican-approval-vatican-official-reminds-bishops.

has documented dozens of cases across the country – see website[72] for the whole list. It lists abandoned Catholic temples in 13 out of 26 states in Brazil. Important to say, this list is incomplete and there are possibly many more cases around the country, as our search on the internet appears to indicate. Even temple furnishings and fittings can be seen alongside abandoned buildings in many photos, which seems to confirm that Catholic temple exit costs are also very low.

This is hardly a phenomenon specific to the Brazilian branch of the Catholic church. For instance, as documented by project "Chiesa"[73] of Dutch photographer Roman Robroek, there are at least 1000 confirmed abandoned churches throughout Italy, although there are probably countless more, without even a name to go by, due to records that have been lost a long time ago.

C Structural Model Details

This Appendix describes (i) identification and estimation of the parameters of the structural model and (ii) the algorithm we use to solve and simulate the model.

Identification and Estimators. Following Miessi Sanches et al. (2016) the identification is constructive and in closed-form, leading to easy to compute estimands.

Specifically, from equation (5) define the ex-ante expected value function as – see, for example, Pesendorfer and Schmidt-Dengler (2008):

$$
\begin{gathered}
V_{im}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)= \\
\sum_{\mathbf{a_m^t}}\sigma_{im}\left(\mathbf{a_m^t}|\mathbf{s_m^t}\right)\left\{\Pi_{im}\left(\mathbf{a_m^t},\mathbf{s_m^t}\right)+\beta\sum_{\mathbf{s_m^{t+1}}}H_m\left(\mathbf{s_m^{t+1}}|\mathbf{s_m^t},\mathbf{a_m^t}\right)V_{im}\left(\mathbf{s_m^{t+1}};\sigma_{\mathbf{im}}\right)\right\} \\
+E\left[\varsigma_{im}^t|\mathbf{s_m^t},a_{im}^t=1\right]\sigma_{im}\left(a_{im}^t=1|\mathbf{s_m^t}\right),
\end{gathered}
$$

where, $V_{im}\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)$ denotes the expectation of the value function before payoff shocks, ς_{im}^t, are observed and actions are taken, $\Pi_{im}\left(\mathbf{a_m^t},\mathbf{s_m^t}\right)$ is the payoff described by equation (2) net of the payoff shock, ς_{im}^t, and $E\left[\varsigma_{im}^t|\mathbf{s_m^t},a_{im}^t=1\right]$ is the expectation of ς_{im}^t conditional on $\mathbf{s_m^t}$ and $a_{im}^t=1$. Let N_s be the cardinality of the state vector in market m and N_p the number of parameters of the model. Stacking the previous equation for every state $\mathbf{s_m^t}$:

$$
\mathbf{V_{im}}=\mathbf{\Pi_{im}}+\mathbf{D_{im}}+\beta\mathbf{G_{im}}\mathbf{V_{im}}. \tag{C.1}
$$

Here, $\mathbf{V_{im}}$ is a $(N_s\times 1)$ vector stacking the expected unconditional value functions for every possible state, $\mathbf{\Pi_{im}}$ is a $(N_s\times 1)$ vector stacking $\sum_{\mathbf{a_m^t}}\sigma_{im}\left(\mathbf{a_m^t}|\mathbf{s_m^t}\right)\Pi_{im}\left(\mathbf{a_m^t},\mathbf{s_m^t}\right)$ for every possible state, $\mathbf{D_{im}}$ is a $(N_s\times 1)$ vector stacking $E\left[\varsigma_{im}^t|\mathbf{s_m^t},a_{im}^t=1\right]\sigma_{im}\left(a_{im}^t=1|\mathbf{s_m^t}\right)$ for every possible state and $\mathbf{G_{im}}$ is a $(N_s\times N_s)$ transition matrix mapping $\mathbf{s_m^t}$ into $\mathbf{s_m^{t+1}}$ given $H_m(\cdot)$, $\sigma_{im}(\cdot)$ and $\mathbf{a_m^t}$. Solving equation (C.1) for $\mathbf{V_{im}}$ we have that:

[72] http://aurelioschmitt.blogspot.com/2013/03/igrejas-abandonadas-pedacos-da-historia.html?m=1

[73] Available at https://romanrobroek.nl/chiesa-the-decline-of-the-church-in-italy/.

$$\mathbf{V_{im}} = \left[\mathbf{I}_{N_s} - \beta\mathbf{G_{im}}\right]^{-1}\left(\mathbf{\Pi_{im}} + \mathbf{D_{im}}\right),$$

with $\mathbf{I}_{N_s}$ representing a $(N_s \times N_s)$ identity matrix. Notice that because $\Pi_{im}\left(\mathbf{a_m^t}, \mathbf{s_m^t}\right)$ is linear in the $(N_p \times 1)$ parameter vector, $\mathbf{\Theta_i} = (\theta_{0i}, \theta_{1i}, \theta_{2i}, \pi_{0i}, F_i, \gamma_i)'$, we can write $\mathbf{\Pi_{im}} = \mathbf{X_{im}}\mathbf{\Theta_i}$, where $\mathbf{X_{im}}$ is a $(N_s \times N_p)$ matrix stacking $\mathbf{X_{im}}\left(\mathbf{s_m^t}\right)$ for every state, and $\mathbf{X_{im}}\left(\mathbf{s_m^t}\right)$ is a $(1 \times N_p)$ known vector that depends only on states and beliefs. Using this fact we can write the vector of unconditional value functions as:

$$\mathbf{V_{im}} = \mathbf{\tilde{X}_{im}}\mathbf{\Theta_i} + \mathbf{\tilde{D}_{im}}, \tag{C.2}$$

where $\mathbf{\tilde{X}_{im}} = \left[\mathbf{I}_{N_s} - \beta\mathbf{G_{im}}\right]^{-1}\mathbf{X_{im}}$ and $\mathbf{\tilde{D}_{im}} = \left[\mathbf{I}_{N_s} - \beta\mathbf{G_{im}}\right]^{-1}\mathbf{D_{im}}$. Therefore, defining $\mathbf{\tilde{X}_{im}}\left(\mathbf{s_m^{t+1}}\right)$ as the $(1 \times N_p)$ vector in the row of $\mathbf{\tilde{X}_{im}}$ that corresponds to state $\mathbf{s_m^{t+1}}$ and $\tilde{D}_{im}\left(\mathbf{s_m^{t+1}}\right)$ as the element in the row of $\mathbf{\tilde{D}_{im}}$ that corresponds to state $\mathbf{s_m^{t+1}}$ we can write:

$$\int V_{im}\left(\mathbf{s_m^{t+1}}, \varsigma_{im}^{t+1}; \boldsymbol{\sigma}_{\mathbf{im}}\right) dQ\left(\varsigma_{im}^{t+1}\right) = \mathbf{\tilde{X}_{im}}\left(\mathbf{s_m^{t+1}}\right)\mathbf{\Theta_i} + \tilde{D}_{im}\left(\mathbf{s_m^{t+1}}\right). \tag{C.3}$$

On the other hand, the value function conditional on $a_{im}^t = 1$ net of the payoff shock ς_{im}^t – see equation (6) – is:

$$\begin{gathered} V_{im}^1\left(\mathbf{s_m^t}; \boldsymbol{\sigma}_{\mathbf{im}}\right) = \\ \sum_{\mathbf{a^t_{-im}}} \sigma_{im}\left(\mathbf{a^t_{-im}}|\mathbf{s_m^t}\right)\pi_i\left(\mathbf{a^t_{-im}}, p_m^t\right) + \pi_{0i} + \left(1 - a_{im}^{t-1}\right)F_i + \gamma_i \cdot e^{\mu_m^t} + \\ \beta\sum_{\mathbf{a^t_{-im}}} \sigma_{im}\left(\mathbf{a^t_{-im}}|\mathbf{s_m^t}\right)\left\{\sum_{\mathbf{s_m^{t+1}}} H_m\left(\mathbf{s_m^{t+1}}|\mathbf{s_m^t}, \mathbf{a^t_{-im}}, a_{im}^t = 1\right)\int V_{im}\left(\mathbf{s_m^{t+1}}, \varsigma_{im}^{t+1}; \boldsymbol{\sigma}_{\mathbf{im}}\right) dQ\left(\varsigma_{im}^{t+1}\right)\right\}. \end{gathered} \tag{C.4}$$

Substituting equation (C.3) into equation (C.4):

$$\begin{gathered} V_{im}^1\left(\mathbf{s_m^t}; \boldsymbol{\sigma}_{\mathbf{im}}\right) = \\ \left(\mathbf{X^1_{im}}\left(\mathbf{s_m^t}\right) + \beta E_{\mathbf{s_m^{t+1}}}\left[\mathbf{\tilde{X}_{im}}\left(\mathbf{s_m^{t+1}}\right)|\mathbf{s_m^t}, a_{im}^t = 1\right]\right)\mathbf{\Theta_i} + \\ \beta E_{\mathbf{s_m^{t+1}}}\left[\tilde{D}_{im}\left(\mathbf{s_m^{t+1}}\right)|\mathbf{s_m^t}, a_{im}^t = 1\right], \end{gathered} \tag{C.5}$$

where,

$$\begin{gathered} \mathbf{X^1_{im}}\left(\mathbf{s_m^t}\right) = \\ \left[\begin{array}{cccccc} p_m^t & p_m^t\sum_{\mathbf{a^t_{-im}}} \sigma_{im}\left(\mathbf{a^t_{-im}}|\mathbf{s_m^t}\right)n_{im}^{E,t} & p_m^t\sum_{\mathbf{a^t_{-im}}} \sigma_{im}\left(\mathbf{a^t_{-im}}|\mathbf{s_m^t}\right)n_{im}^{C,t} & 1 & \left(1 - a_{im}^{t-1}\right) & e^{\mu_m^t} \end{array}\right], \end{gathered}$$

and,

$$E_{\mathbf{s_m^{t+1}}}\left[\tilde{\mathbf{X}}_{\mathbf{im}}\left(\mathbf{s_m^{t+1}}\right)\mathbf{\Theta_i}+\tilde{D}_{im}\left(\mathbf{s_m^{t+1}}\right)|\mathbf{s_m^t},a_{im}^t=1\right]=$$

$$\sum_{\mathbf{a_{-im}^t}}\sigma_{im}\left(\mathbf{a_{-im}^t}|\mathbf{s_m^t}\right)\left\{\sum_{\mathbf{s_m^{t+1}}}H_m\left(\mathbf{s_m^{t+1}}|\mathbf{s_m^t},\mathbf{a_{-im}^t},a_{im}^t=1\right)\int V_{im}\left(\mathbf{s_m^{t+1}},\varsigma_{im}^{t+1};\sigma_{\mathbf{im}}\right)dQ\left(\varsigma_{im}^{t+1}\right)\right\}.$$

Simplifying the notation:

$$V_{im}^1\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)=\tilde{\mathbf{X}}_{\mathbf{im}}^{\mathbf{1}}\left(\mathbf{s_m^t}\right)\mathbf{\Theta_i}+\beta E_{\mathbf{s_m^{t+1}}}\left[\tilde{D}_{im}\left(\mathbf{s_m^{t+1}}\right)|\mathbf{s_m^t},a_{im}^t=1\right],$$

with $\tilde{\mathbf{X}}_{\mathbf{im}}^{\mathbf{1}}\left(\mathbf{s_m^t}\right)=\mathbf{X}_{\mathbf{im}}^{\mathbf{1}}\left(\mathbf{s_m^t}\right)+\beta E_{\mathbf{s_m^{t+1}}}\left[\tilde{\mathbf{X}}_{\mathbf{im}}\left(\mathbf{s_m^{t+1}}\right)|\mathbf{s_m^t},a_{im}^t=1\right]$. Using the same reasoning we can write the value function conditional on $a_{im}^t=0$ as $V_{im}^0\left(\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)=\tilde{\mathbf{X}}_{\mathbf{im}}^{\mathbf{0}}\left(\mathbf{s_m^t}\right)\mathbf{\Theta_i}+E_{\mathbf{s_m^{t+1}}}\left[\tilde{D}_{im}\left(\mathbf{s_m^{t+1}}\right)|\mathbf{s_m^t},a_{im}^t=0\right]$. Now, plugging $V_{im}^0(\cdot)$ and $V_{im}^1(\cdot)$ into equation (6) we have that:

$$Q^{-1}\left(P\left(a_{im}^t=1|\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)\right)=\left(\tilde{\mathbf{X}}_{\mathbf{im}}^{\mathbf{1}}\left(\mathbf{s_m^t}\right)-\tilde{\mathbf{X}}_{\mathbf{im}}^{\mathbf{0}}\left(\mathbf{s_m^t}\right)\right)\mathbf{\Theta_i}+\tilde{D}_{im}^{10}\left(\mathbf{s_m^t}\right),$$

where, $Q^{-1}(\cdot)$ is the inverse of the CDF of the iid shock, ς_{im}^t, and,

$$\tilde{D}_{im}^{10}\left(\mathbf{s_m^t}\right)=\beta\left(E_{\mathbf{s_m^{t+1}}}\left[\tilde{D}_{im}\left(\mathbf{s_m^{t+1}}\right)|\mathbf{s_m^t},a_{im}^t=1\right]-E_{\mathbf{s_m^{t+1}}}\left[\tilde{D}_{im}\left(\mathbf{s_m^{t+1}}\right)|\mathbf{s_m^t},a_{im}^t=0\right]\right).$$

Stacking this equation for all states and market types:

$$\mathbf{Y_i}=\left(\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{1}}-\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{0}}\right)\mathbf{\Theta_i},$$

where $\mathbf{Y_i}$ is a column vector stacking $Q^{-1}\left(P\left(a_{im}^t=1|\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)\right)-\tilde{D}_{im}^{10}\left(\mathbf{s_m^t}\right)$ for all states and market types. Multiplying both sides of the equation above by $\left(\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{1}}-\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{0}}\right)'$ and solving for $\mathbf{\Theta_i}$:

$$\mathbf{\Theta_i}=\left[\left(\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{1}}-\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{0}}\right)'\left(\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{1}}-\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{0}}\right)\right]^{-1}\left[\left(\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{1}}-\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{0}}\right)'\mathbf{Y_i}\right]. \tag{C.6}$$

From the estimates of beliefs and state transitions obtained in the first stage and given β, $\left(\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{1}},\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{0}},\mathbf{Y_i}\right)$ can be computed and $\mathbf{\Theta_i}$ can be estimated using this formula.

Model solution and simulation. The algorithm we use to solve the model is similar to that used by Sweeting (2013). The algorithm works as follows:

1. Given the initial guesses for beliefs, the state transitions, the discount rate and the vector of structural parameters estimated using equation (C.6), in step h we compute the vector of equilibrium probabilities implied by the model for all states, market types and players using equation (6):

$$P^h\left(a_{im}^t=1|\mathbf{s_m^t};\sigma_{\mathbf{im}}\right)=Q\left(V_{im}^1\left(\mathbf{s_m^t},\varsigma_{im}^t;\tilde{\mathbf{P}}_{\mathbf{im}}^{\mathbf{h-1}}\right)-V_{im}^0\left(\mathbf{s_m^t},\varsigma_{im}^t;\tilde{\mathbf{P}}_{\mathbf{im}}^{\mathbf{h-1}}\right)\right), \tag{C.7}$$

where, $\tilde{\mathbf{P}}^{\mathbf{h-1}}_{\mathbf{im}}$ is the vector of probabilities obtained in step $h-1$. We represent the vector of probabilities for all states and churches in market m obtained from equation (C.7) by $\mathbf{P}^{\mathbf{h}}_{\mathbf{m}}$.

2. If $||\mathbf{P}^{\mathbf{h}}_{\mathbf{m}} - \mathbf{P}^{\mathbf{h-1}}_{\mathbf{m}}|| < \lambda$ the algorithm stops; otherwise we set $\tilde{\mathbf{P}}^{\mathbf{h}}_{\mathbf{m}} = \mathbf{P}^{\mathbf{h}}_{\mathbf{m}}\psi + \mathbf{P}^{\mathbf{0}}_{\mathbf{m}}(1-\psi)$, where $\psi \in [0,1]$ is a parameter and $\mathbf{P}^{\mathbf{0}}_{\mathbf{m}}$ is the initial guess for beliefs, and go back to (1) substituting $\tilde{\mathbf{P}}^{\mathbf{h}}_{\mathbf{m}}$ on the right hand side of equation (C.7).

In practice we used $\lambda = 10^{-3}$ and $\psi = 0.75$. The advantage of this algorithm is that it is quite fast. Convergence was always achieved after a few iterations. All counterfactuals in this paper were computed using this algorithm.

With the equilibrium probabilities obtained in the previous step and with the estimates of state transitions we forward simulate the number of temples of each denomination in each market. What we do is:

1. Starting from the initial vector of states observed in every market, draw an action for every church from the equilibrium probability distribution obtained in the previous step for every market and compute the total number of active temples of every church across all markets, $\hat{n}_i^t = \sum_{m=1}^{\bar{M}} \mathbb{I}\left(a_{im}^t = 1\right)$, where $\mathbb{I}(\cdot)$ is an indicator function that assumes 1 if the argument of the function is true and 0 otherwise.

2. Using the transition function for the state vector, compute the state vector for $t+1$.

3. Repeat the procedure described in (1) and (2) to generate a time series of the total number of active temples until 2018.

4. Repeat this process S times and take the average number of temples for every denomination at every year across simulations.

D Conditional Choice Probabilities

This Appendix shows estimates for the CCPs. We estimated two models. One for the Evangelical churches and one for the Catholic Church. The model for the Evangelical churches pools the 6 largest Evangelical denominations – Assembly of God, Baptist, Christian Congregation, Mundial, Foursquare and Universal – in all markets and periods of time. The CCP estimates for the Evangelical churches are based on the following Probit model:

$$P\left(a_{im}^t | a_{im}^{t-1}, n_{im}^{E,t-1}, n_{im}^{C,t-1}, p_m^t, \mu_m^t\right) =$$
$$\Phi\left(\rho_0 + \rho_1 a_{im}^{t-1} + \sum_{j\in E} \rho_{2j} d_{ij} n_{im}^{E,t-1} + \sum_{j\in E} \rho_{3j} d_{ij} n_{im}^{C,t-1} + \rho_4 p_m^t + \rho_5 a_{im}^{t-1}\mu_m^t + \rho_6 \mu_m^t + \mu_i\right), \tag{D.1}$$

where, $a_{im}^t \in \{0,1\}$ is Church i's action in municipality m, period t, a_m^{t-1} is Church i's action in municipality m, period $t-1$, $n_{im}^{E,t-1}$ is the number of temples of (other) Evangelical churches competing with Church i in market m, period $t-1$; $n_{im}^{C,t-1}$ is the number of Catholic temples competing with Church i in market m and period $t-1$; d_{ij} is a dummy that assumes 1 if $i = j$ and 0 otherwise;[74] p_m^t is the population in market m, period t; μ_m^t is a variable capturing unobserved heterogeneity that varies across markets and periods of time – obtained in a first-step as explained in Section V; μ_i is Church i's fixed effect; and $\Phi(\cdot)$ represents the CDF of a standard Normal distribution.

For the Catholic Church we estimate an analogous model:

$$P\left(a_{im}^t | a_{im}^{t-1}, n_m^{E,t-1}, p_m^t, \mu_m^t\right) = \Phi\left(\rho_0 + \rho_1 a_{im}^{t-1} + \rho_2 n_m^{E,t-1} + \rho_3 p_m^t + \rho_4 a_{im}^{t-1} p_m^t + \rho_5 \mu_m^t\right), \tag{D.2}$$

where, $n_m^{E,t-1}$ is the number of Evangelical temples competing with the Catholic Church at period $t-1$ and municipality m; all other variables have the same interpretation as in equation (D.1).[75]

Estimates of the coefficients are in Table 8.[76] In the first column, the coefficients $n^E : i$, with i in the set of Evangelical churches, capture the effect of the number of Evangelical competitors of Evangelical Church i at period $t-1$ on the entry probabilities of Evangelical church i; the coefficients $n^C : i$, with i in the set of Evangelical churches, capture the effect of the number of Catholic temples at period $t-1$ on the entry probabilities of Evangelical Church i. In the second column, the coefficient $n^E : Catholic$ captures the effects of the number of Evangelical temples at period $t-1$ on the entry probabilities of the Catholic Church.

[74]Therefore, the interaction $d_{ij} n_{im}^{E,t-1}$ captures the effect of the number of Evangelical competitors of (Evangelical) Church i at period $t-1$ and municipality m on the activity probabilities of Evangelical Church i at period t in the same municipality; and, $d_{ij} n_{im}^{C,t-1}$ captures the effect of the number of Catholic temples at period $t-1$ in municipality m on the activity probabilities of Evangelical Church i at period t in the same municipality.

[75]Note that in equation (D.1) we included the interaction $a_{im}^{t-1} \mu_m^t$ and in equation (D.2) we included the interaction $a_{im}^{t-1} p_m^t$. The fitting of the structural estimated under these specifications was slightly superior to the fitting of alternative models where either $a_{im}^{t-1} \mu_m^t$ was included in both equations or $a_{im}^{t-1} p_m^t$ was included in both equations.

[76]In some alternative versions of these CCPs we also included interactions of population with the terms $d_{ij} n_{im}^{E,t-1}$ and $d_{ij} n_{im}^{C,t-1}$ for the pool of Evangelical churches and with the term $n_m^{E,t-1}$ for the Catholic Church. Most of these interactions were not statistically significant at 10%. Therefore, we kept the specifications above, without these interactions, as our baseline CCP specifications.

Table 8: Conditional Choice Probabilities (CCPs)

	Evangelical	Catholic
μ_m^t	15.214***	20.095***
	[0.57]	[1.39]
a_{im}^{t-1}	5.964***	6.019***
	[0.17]	[0.75]
p_m^t	0.000	-0.000**
	[0.00]	[0.00]
$\mu_m^t \cdot a_{im}^{t-1}$	10.038***	-
	[1.94]	-
$p_m^t \cdot a_{im}^{t-1}$	-	0.000
	-	[0.00]
n^E : Assembly	-0.131***	-
	[0.04]	-
n^E : Baptist	-0.098**	-
	[0.04]	-
n^E : Christian Congr	-0.007	-
	[0.06]	-
n^E : Mundial	0.109***	-
	[0.03]	-
n^E : Foursquare	-0.272***	-
	[0.06]	-
n^E : Universal	-0.125***	-
	[0.05]	-
n^E : Catholic	-	-0.166***
	-	[0.05]
n^C : Assembly	-0.190*	-
	[0.11]	-
n^C : Baptist	-0.121	-
	[0.14]	-
n^C : Christian Congr	-0.077	-
	[0.19]	-
n^C : Mundial	0.019	-
	[0.11]	-
n^C : Foursquare	-0.490*	-
	[0.25]	-
n^C : Universal	-0.238	-
	[0.16]	-
Observations	38,376	6,396

Note: Standard-errors clustered at the municipality level in brackets. (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.10$. The model for Evangelical churches include denomination dummies.

E Stationarity, Independence across Markets and the Two-Step Probit Model

This Appendix provides discussion on stationarity, independence of churches decisions across markets conditional on the vector of states and on the performance of the two-step Probit model we described in Section III (see Footnote 32).

Two-step Probit model. We run a model analogous to model (1) using the same two-step procedure used in Collard-Wexler (2013), Lin (2015), Minamihashi (2012) and Sanches et al. (2016). Specifically, in the first step we run a Linear Probability Model of actions of Church i in market m and period t on (i) the first lag of this variable, (ii) the number of competitors of Church i in that municipality at period $t-1$ (iii) church dummies and (iv) interactions of year and market dummies. We pooled all churches. We collected the coefficients attached to the interactions between market and year dummies and created a new variable, μ_m^t. In the second step we run the same Probit model in equation (1) including μ_m^t as an additional control instead of year and market dummies, i.e. excluding μ^t and μ_m from the model. The estimates of the coefficients ρ_E^E, ρ_E^C and ρ_C^E are shown in Table 9. All the coefficients have the same sign and roughly the same magnitudes as the coefficients shown in Table 2.

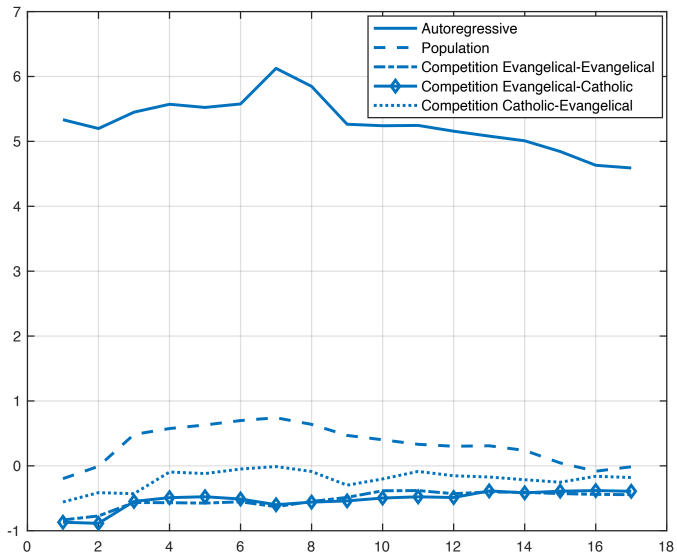
Table 9: Two-Step Probit Model

	Two-Step Probit
ρ_E^E	-0.073***
	[0.02]
ρ_E^C	-0.174***
	[0.04]
ρ_C^E	-0.189***
	[0.06]
Observations	44,772

Note: Robust standard errors estimated from 100 bootstrap repetitions in brackets. (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.10$.

Stationarity. To analyze the possibility of non stationarity in our data we estimate equation (1) for all 10 years rolling windows starting in 1992. We pool Evangelical denominations and the Catholic Church. Figure 8 shows the estimates of ρ_1 (autoregressive component), ρ_4 (population), ρ_E^E (competition Evangelical-Evangelical), ρ_E^C (competition Evangelical-Catholic), ρ_C^E (competition Catholic-Evangelical) for all time windows. All coefficients are relatively stable over time, except the autoregressive component, that seems to exhibit a negative trend in the last windows. This trend is, nonetheless, very mild. For example, the point estimate of the autoregressive coefficient is 5.33 (with 95% confidence interval [4.54; 6.13]) in the 1st window and it is 4.59 (95% confidence interval [4.35; 4.83]) in the last window, not far from the point estimate based on the full sample (which is 4.71 and 95% confidence interval [4.54; 4.88]). Based on this evidence we believe *that conditional on the* *state vector* – which includes, as explained in Section 4, a time varying market-specific shock in the same spirit as Minamihashi (2012), Collard-Wexler (2013), Lin (2015) and Sanches et al. (2016) – potential nonstationarity of our data does not seem to be a major source of bias to our results.

Figure 8: Rolling Probit Regressions



Independence across markets. To analyze whether churches entry decisions are independent across markets (conditional on the vector of state variables) we created a new variable K_i^{t-1} representing the sum of the temples of Church i in all municipalities of our sample (except municipality i) at period $t-1$ and included it in the Probit model described by equation (1) – same used in our descriptive regressions. Table 10 shows the results of the same Probit model estimated in column (3) of Table 2 including K_i^{t-1} (first column) as an additional control and K_i^{t-1} interacted with a dummy for the group of Evangelical churches and a dummy for the Catholic Church (second column).

The results show that, in the second column, the interaction between K_i^{t-1} and the dummy for Evangelical churches is negative and significant at 10%. The same coefficient is not significant for the Catholic Church. On the other hand, we also note that the magnitude of the coefficient is very small when compared with the coefficients capturing competition at the local level (e.g. the point estimate is approximately 50 times smaller than the coefficient ρ_E^E) and, importantly, the inclusion of this variable has very little effect on the other coefficients of our model, in particular, the coefficients capturing strategic interactions between churches – ρ_E^E, ρ_E^C and ρ_C^E in Table 10 are pretty close to the same coefficients in the 3rd column of Table 2.

That said, we believe that the performance (in terms of number of active temples) of the Church at the national level has little effect on the payoffs of the Church at the local level. A possible explanation to this fact is that our sample contains only small isolated municipalities which, until recently, did not have access to the internet, cable tv, etc. and, therefore, had little information about the performance of these churches at the national level.

Table 10: Probit Model with Churches Total Stock of Temples $\left(K_i^{t-1}\right)$ as Additional Control

	[1]	[2]
ρ_E^E	-0.186***	-0.189***
	[0.03]	[0.03]
ρ_E^C	-0.237***	-0.214***
	[0.04]	[0.04]
ρ_C^E	-0.099	-0.105
	[0.09]	[0.09]
K_i^{t-1}	-0.002	-
	[0.00]	-
K_i^{t-1} Evangelical	-	-0.004*
	-	[0.00]
K_i^{t-1} Catholic	-	-0.001
	-	[0.00]
Observations	44,772	44,772

Note: Standard-errors clustered at the municipality level in brackets. (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.10$.

F Structural Model: Robustness Checks

This Appendix discusses robustness of our results to changes in the interpretation of churches payoff function, in the functional form of churches payoffs and different "normalizations" of churches net exit costs.

Profit maximization. We assume that payoffs estimated in Section V represent a reduced form of churches profit function, i.e. pecuniary revenue minus pecuniary costs, which ultimately means that these payoffs can be taxed. Evidently, if churches payoff estimates also embed any non pecuniary motivation that is not susceptible to taxation – e.g. number of members, social welfare, or more abstract purposes (Hungerman, 2010; Iyer, 2016; Corbi et al., 2022) – the results of our analysis may change.

While the discussion in Section II.B suggests that profit is central to explain churches expansion, it does not rule out the possibility that temples entry and exit decisions are also motivated by more abstract, non pecuniary reasons. To attenuate this concern we examine how taxation would affect the relative market shares of the Catholic and Evangelical churches assuming that only a fraction of churches payoffs correspond to financial gains and can, therefore, be taxed, while the remaining fraction, correspond to non-financial motives that are not taxed.

Specifically, let $\Gamma_E \in [0, 1]$ and $\Gamma_C \in [0, 1]$ be, respectively, the fraction of expected payoffs net of entry costs of Evangelical churches and the Catholic Church that is subject to taxation.[77] Let $MS_E(\mathit{\Gamma}_E, \mathit{\Gamma}_C, \varrho)$ be the combined market shares of Evangelical denominations given Γ_E, Γ_C and $\varrho > 0$ and MS_E^0 the combined market shares of Evangelical denominations when $\varrho = 0$ (baseline tax-exemption scenario). Table 11 shows the differences $MS_E(\mathit{\Gamma}_E, \mathit{\Gamma}_C, \varrho) - MS_E^0$ for all combinations of $\Gamma_E, \Gamma_C \in \{0.25; 0.50; 0.75; 1.00\}$ and $\varrho = 0.3$, such that if $MS_E(\mathit{\Gamma}_E, \mathit{\Gamma}_C, \varrho) - MS_E^0 < 0$ the tax implies a decrease in the shares of Evangelical churches (and, consequently, an increase in the shares of the Catholic Church) given $(\mathit{\Gamma}_E, \mathit{\Gamma}_C, \varrho)$.

The results show that these differences are negative for almost all scenarios except in extreme cases where Γ_E is small and Γ_C high, i.e. our conclusion that Evangelical churches benefit more from tax-exemptions holds true in most alternative scenarios where churches pay taxes only on parts of their payoffs. In spite of its limitations (the most obvious being that monetary and non-monetary payoffs have the same functional form) the exercise may serve to mitigate concerns related to the compositions of churches payoffs.

Table 11: Variation in Market Shares of the Evangelical churches when $\varrho = 0.3$ and Different Values of $\mathit{\Gamma}$

	$\mathit{\Gamma}_E = 0.25$	$\mathit{\Gamma}_E = 0.50$	$\mathit{\Gamma}_E = 0.75$	$\mathit{\Gamma}_E = 1.00$
$\mathit{\Gamma}_C = 0.25$	-0.02	-0.09	-0.17	-0.24
$\mathit{\Gamma}_C = 0.50$	0.00	-0.06	-0.14	-0.22
$\mathit{\Gamma}_C = 0.75$	0.01	-0.05	-0.13	-0.21
$\mathit{\Gamma}_C = 1.00$	0.01	-0.05	-0.13	-0.20

Functional form of churches payoffs. Our counterfactual results also depend on the specific functional form we used to express churches payoffs, regardless of the discussion in the preceding paragraphs. We now assess the robustness our counterfactual findings to this assumption. With this goal in mind, we reestimate the model and the counterfactuals using

$$\pi_i\left(\mathbf{a}^{\mathbf{t}}_{-\mathbf{im}}, p^t_m\right) = \theta_{0i} p^t_m + \theta_{1i} n^{E,t}_{im} + \theta_{2i} n^{C,t}_{im}, \tag{F.1}$$

instead of equation (3). The only difference between this model and the model developed in Section IV is that, in the former, variable profits are a linear function of population while in the latter variable profits are proportional to population. This functional form is also very common in the literature and was used to represent firms profits in other contexts – see, for example, Berry (1992), Mazzeo (2002), Collard-Wexler (2013), Igami and Yang (2016), Seim (2006) and Sanches et al. (2016).

The estimates of this model are in Table 12. First we note that the estimates of sunk entry costs are identical across the two models. This result follows directly from Theorem 2 in Komarova et al. (2018), which shows that when the payoff is linear in the parameters entry costs in dynamic games can be identified independently of other components of the payoff function and the discount factor. Second, estimates of π_0 (operating costs) and γ (unobserved payoff shock) are also very similar across the two models. Qualitatively, the estimates of θ_1 and θ_2 (that measure competition across churches) are also robust to changes

[77] Equivalently, if the tax on profits is ϱ, in these exercises we are assuming that the effective tax rate is $\varrho \times \Gamma_E$ for Evangelicals and $\varrho \times \Gamma_C$ for the Catholic Church.

in the specification of churches payoff. Together these results imply that, as shown by Figure 10, the counterfactual results obtained from both models are very close.

Table 12: Structural Parameters – Alternative Payoff Function

	Assembly	Baptist	Congregation	Mundial	Foursquare	Universal	Catholic
Constant (π_0)	-6.367	-6.137	-6.225	-5.941	-6.927	-6.182	-1.865
	[0.402]	[0.385]	[0.394]	[0.397]	[0.478]	[0.362]	[0.333]
Evang Comp (θ_1)	-0.036	-0.025	-0.002	0.028	-0.075	-0.032	-0.02
	[0.01]	[0.009]	[0.009]	[0.008]	[0.02]	[0.01]	[0.009]
Cat Comp (θ_2)	-0.053	-0.033	-0.02	0.006	-0.139	-0.061	
	[0.027]	[0.035]	[0.039]	[0.029]	[0.089]	[0.037]	
Population (θ_0)	-0.052	-0.043	-0.033	-0.039	-0.03	-0.042	-0.13
	[0.006]	[0.005]	[0.006]	[0.005]	[0.006]	[0.006]	[0.012]
Shock (γ)	6.93	6.558	6.398	6.16	7.153	6.603	3.369
	[0.428]	[0.406]	[0.394]	[0.423]	[0.495]	[0.384]	[0.301]
Entry Costs (F)	-6.116	-6.17	-6.262	-6.211	-6.326	-6.183	-9.445
	[0.252]	[0.256]	[0.255]	[0.256]	[0.264]	[0.253]	[0.557]

Note: Robust standard errors estimated from 50 bootstrap repetitions in brackets. Population is local population divided by 10000. Average population in our sample across years and markets is 13452.

Figure 9: Predicted Shares – Data and Model for all Years from 1992 to 2018

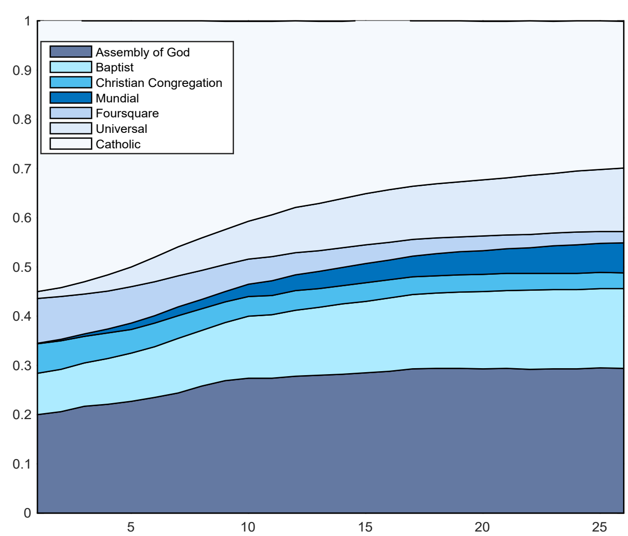
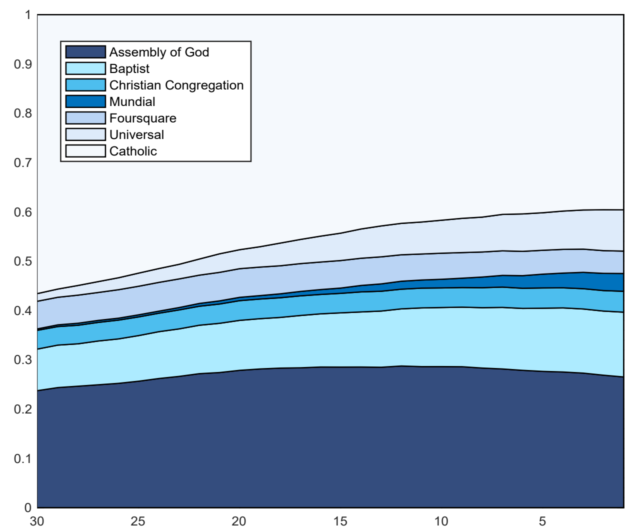


Figure 10: Average Share of Each Church for $\varrho \in [0, 0.30]$ (Horizontal Axis in Reverse Order)



Normalization of churches net exit costs. Finally, we assess the robustness of our counterfactual results to different "normalizations" of churches net exit costs. These "normalizations" are guided by anecdotal evidences in Section II and Appendix B, which suggest that net exit costs of Evangelical churches may be negative and related to fines they must pay to return a rented temple before the lease expires, and that net exit costs of Catholic Church may be positive and related to the value of its temples, which, in theory, can be sold if the Church decides to leave a declining market.

Specifically, we reestimated the model and recomputed our counterfactual exercises assuming that net exit costs of all Evangelical denominations are given by a proportion $\Upsilon_E \in [0, 1]$ of their operating costs – i.e. negative net exit costs proportional to operating costs, which embed rents paid by Evangelical churches – and that net exit costs of Catholic temples are equal to a proportion $\Upsilon_C \in [0, 1]$ of the negative of its entry costs – i.e. positive exit costs, proportional to entry costs, which represents the value of the temple built by the Church.[78]

Let $MS_E(\Upsilon_E, \Upsilon_C, \varrho)$ be the combined market shares of Evangelical denominations given Υ_E, Υ_C and $\varrho > 0$ averaged across years. To see how the different parametrizations – represented by different values of Υ_E and Υ_C – affect our results we computed the differences $MS_E(\Upsilon_E, \Upsilon_C, 0.30) - MS_E(\Upsilon_E, \Upsilon_C, 0)$ for $\Upsilon_E, \Upsilon_C \in \{0; 0.01; 0.05; 0.10; 0.20; 0.30\}$, such that if this difference is negative, for that parametrization, taxation has a negative effect on the shares of Evangelical churches (and positive on the share of the Catholic Church). Although anecdotal evidence suggest that Υ_E and Υ_C are very close to zero, we calculate

[78] As we argued, the estimates of F and of π_0 in Table 3 are equal to entry costs plus net exit costs and to operating costs minus $(1 - \beta)$ times net exit costs, respectively (Aguirregabiria and Suzuki, 2014). Hence, given the alternative parametrizations, net exit costs of each Evangelical church and of the Catholic Church, as well as churches entry and operating costs consistent with each parametrization, can be directly obtained from the estimates in Table 3.

these differences for a wide range of Υ_E and Υ_C to assess the plausibility of our findings even in less realistic scenarios.

Figure 11: Variation in Market Shares of the Evangelical Churches when $\varrho = 0.3$ under Different Normalizations of Churches Net Exit Costs

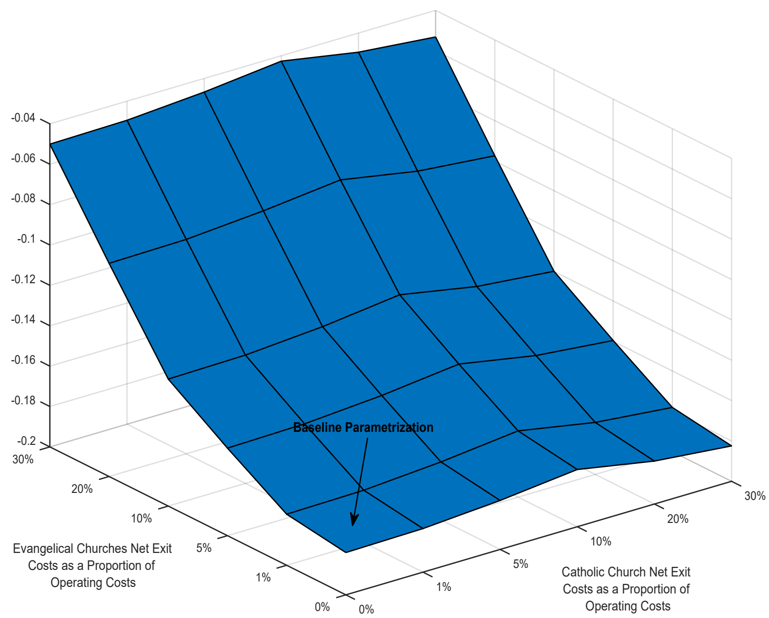
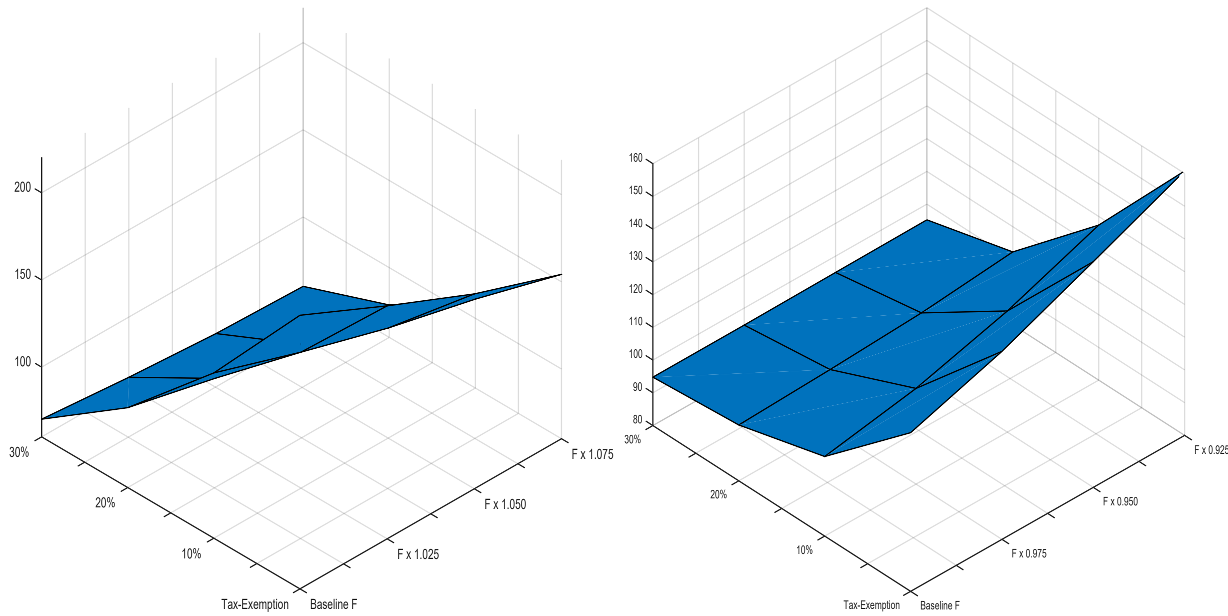


Figure 11 shows the results of the exercise. The value indicated by the arrow represents $MS_E(\Upsilon_E, \Upsilon_C, 0.30) - MS_E(\Upsilon_E, \Upsilon_C, 0)$ in the baseline scenario, i.e. when $\Upsilon_E = \Upsilon_C = 0$, given $\varrho = 0.3$. The figure reveals that increases in Υ_C has little effect on these differences independently of the Υ_E. In particular, if Υ_E is close to zero – which is consistent with the anecdotal evidence presented in this paper – the difference is roughy the same as in the baseline scenario even when Υ_C is very large; the normalization of net exit values of the Catholic Church to zero seems to do not have major effects on our conclusions that the tax has a more negative effect on Evangelical churches relatively to the Catholic Church. On the other hand, changes in Υ_E have a more pronounced effect on $MS_E(\Upsilon_E, \Upsilon_C, \varrho) - MS_E(\Upsilon_E, \Upsilon_C, 0)$ but, in any case, even when net exit costs of Evangelical temples are implausibly large, this difference continues to be negative, still suggesting that taxation has a more negative effect on the share of Evangelical temples. In more realistic scenarios where Υ_E is relatively small, we do not observe greater changes in our baseline results. In summary, our main conclusions that taxation seems to have a more negative effect on the combined share of Evangelicals appear to hold under different "normalizations" of churches net exit costs.

G Entry Costs and the Effects of Tax-Exemption on Church Entry

In line with our arguments in Section VI, this Appendix shows that the effect of tax-exemption on the number of temples is less pronounced when entry costs are higher.

Figure 12: Number of Evangelical (left) and Catholic (right) Temples for Different Tax Rates and Different Entry Costs



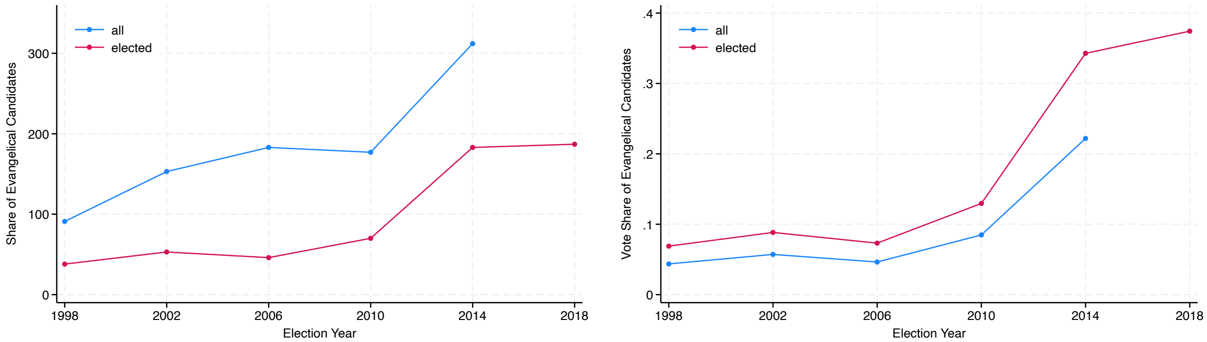
(a) Evangelical (b) Catholic

Specifically, panel (a) in Figure 12 shows yearly averages of the number of temples of Evangelical churches for different taxes (tax-exemption, 10%, 20% and 30%) when entry costs of Evangelical temples, F, are scaled up by different factors (1.025, 1.050 and 1.075). The graph shows that the reduction of the tax has a stronger effect on the number of Evangelical temples when entry costs are at the baseline level ("Baseline F" in the graph) than when entry costs are higher ("$F \times 1.025$", "$F \times 1.050$" or "$F \times 1.075$" in the graph). Analogously, panel (b) shows the number of Catholic temples for the same tax levels when entry costs of Catholic temples are multiplied by 0.975, 0.950 and 0.925. Again, it shows that the effect of tax-exemption on the stock of Catholic temples is more pronounced when entry costs are fixed at "$F \times 0.975$", "$F \times 0.950$" or "$F \times 0.925$", than under baseline F. Overall, these results indicate that differences in the entry costs of Catholic and Evangelical temples are important to explain the asymmetric effects of taxation on the relative shares of Evangelical and Catholic temples.

H Additional Tables and Figures

This Appendix shows additional tables and figures.

Figure 13: Evangelical Participation in Politics, 1998-2018



(a) Number of Candidates

(b) Vote share

Table 13: Temple Entry and Evangelical Voteshare

	(1)	(2)	(3)	(4)
-3 election term	0.0069	0.0078	0.0444	0.0160
	[0.0278]	[0.0309]	[0.0346]	[0.0267]
-2 election term	0.0080	0.0074	0.0159	0.0095
	[0.0197]	[0.0174]	[0.0141]	[0.0148]
-1 election term	-0.0144	-0.0158	0.0005	0.0033
	[0.0200]	[0.0188]	[0.0104]	[0.0113]
0 current term	0.0479	0.0479	0.0657	0.0490
	[0.0182]	[0.0175]	[0.0363]	[0.0267]
+1 election term	0.0462	0.0451	0.1113	0.0936
	[0.0193]	[0.0236]	[0.0681]	[0.0283]
+2 election term	0.0722	0.0706	0.0802	0.1203
	[0.0240]	[0.0246]	[0.1668]	[0.0484]
Observations	1462	1462	1462	1462
Population	No	Yes	Yes	Yes
Sociedemographics X year	No	No	Yes	No
State X year	No	No	No	Yes

This table reports estimates of Evangelical temple entry on FPE vote share. Standard-errors within square brackets. A unit of observation is a municipality-election-term, where terms represent four-year periods (1995-1998, 1999-2002, ..., 2014-2017). Sociodemographics are calculated using data from the 1991 Census and include share of males, whites, evangelicals; individuals with primary, middle and college education, and average family income. Robust standard errors are clustered at the municipal level. Our estimates are computed using the *did_multiplegt* Stata package as recommended by de Chaisemartin and D'Haultfoeuille (2020).

Table 14: Number of Temples and Evangelical Voteshare

	(1)	(2)	(3)	(4)
Number of temples	0.0097	0.0082	0.0072	0.0047
	[0.0037]	[0.0037]	[0.0038]	[0.0035]
Observations	1462	1462	1462	1462
Population	No	Yes	Yes	Yes
Sociedemographics X year	No	No	Yes	No
State X year	No	No	No	Yes

Note: This table reports estimates of the number of Evangelical temples on FPE vote share. Standard-errors within square brackets. A unit of observation is a municipality-election-term, where terms represent four-year periods (1995-1998, 1999-2002, ..., 2014-2017). Sociodemographics are calculated using data from the 1991 Census and include share of males, whites, evangelicals; individuals with primary, middle and college education, and average family income. Robust standard errors are clustered at the municipal level.