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Church Competition, Religious Subsidies and the Rise of Evangelicalism: a Dynamic Structural Analysis

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1 Introduction

In the last few decades the global religious landscape has undergone profound transformations. Despite the multifaceted nature of these changes, two important trends have been highlighted by scholars (Putnam et al., 2012; Barro and McCleary, 2019). The first concerns the falling levels of overall religiosity experienced by different populations across the world, irrespective of socio, cultural and political traditions.[1] Many important works in the economics of religion have highlighted the role of demand and supply side factors in explaining the process of secularization (Iannaccone, 1991; Stark and Finke, 1992; Montgomery, 2003; Barro and McCleary, 2005, 2003; McBride, 2008; Gruber and Hungerman, 2008).

Less is known about the driving forces behind the second key shift in the world of religion – namely the dramatic rise of Evangelicals, especially Pentecostal and Charismatic churches, which now command a quarter of world Christianity (Pew, 2006b).[2] Brazil, the largest Catholic nation in the world, has seen the simultaneous spread of Evangelicals and the decline of its Catholic majority in the last decades, and a corrosion of the Roman Church's influence across various dimensions (Alves et al., 2017). 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 explanations for this trend include the role of Evangelical mass media (Corbi and Komatsu, 2019; McCleary, 2017), a different set of values and beliefs (Pew, 2006a), and church community as a source of informal insurance (Auriol et al., 2020).

This paper studies the under-explored topic of how public financial support to religions affects the relative shares of Catholics and Evangelicals and discusses some important consequences of this phenomenon to modern societies. Our focus on the interplay between

[1]Levels of religiosity in terms of belief and practice are at historically low levels across most OECD countries; and agnosticism and/or atheism have been steadily rising (Pew, 2018). The process of secularization is also occurring in the United States, too, albeit at a very slow pace that has masked the decline (Voas and Chaves, 2016).

[2]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 section 2.1 for more details.

subsidies to churches and the structure of religious markets is motivated by the fact that state subsidies are central to understand religious finance – more than other factors, such as church's theology, practices and polity (Iannaccone and Bose, 2010) – and, therefore, the evolution of religion markets.[3] Moreover, subsidies to one or more religions are pervasive and adopted by a large number of countries in all continents (Pew, 2017).

While churches likely grow as a result of the sizeable financial benefits that most countries grant to one or more churches in the form of subsidies (Pew, 2017; Cragun et al., 2012), understanding their consequences to the structure of religious markets is not straightforward. The effect of subsidies on the distribution of market shares across denominations will depend not only on the form of the subsidy (Dunne et al., 2013; Fan and Xiao, 2015; Maican and Orth, 2018) but also on asymmetries in the technologies employed by churches to build and operate places of worship – or the business model – which, as we document in this paper, seem to differ significantly between Evangelicals and the Catholic Church.[4] The main objects behind these technologies, i.e. sunk entry costs and fixed operating costs, are, nonetheless, 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 – and through which channels – government subsidies to religion may have altered the balance of power between the Catholic and Evangelical churches in Brazil. To estimate the primitives of the model – including sunk entry costs and fixed operating costs – we employ data on entry/exit of temples in Brazilian municipalities between 1991 and 2018. Next we simulate counterfactual time-series of the number of temples of the Catholic church and the main Evangelical denominations imposing different tax rates on churches variable

[3] Indeed, 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 this paper we will use the terms "technology to build and operate temples" and "business model" interchangeably. Also, the "term" temple is used as synonym to place of worship or congregation.

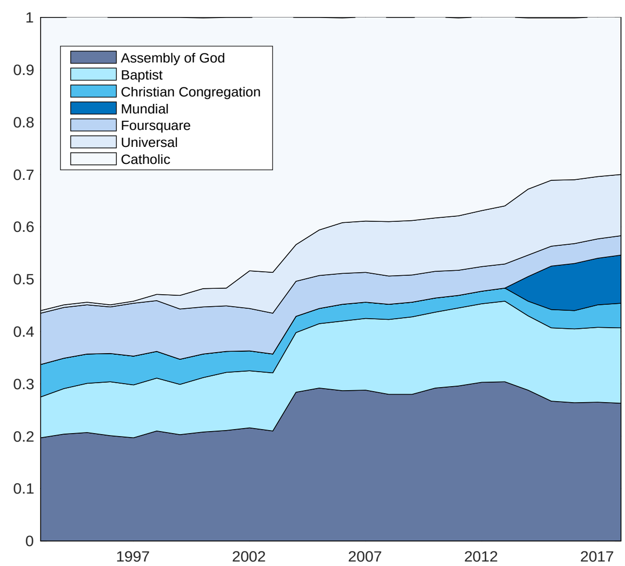
profits. Our counterfactual exercises show that the tax exemption policy had important consequences for the distribution of market shares between Catholic and Evangelical churches in Brazil. Further scrutiny of these findings indicates that the Evangelical growth does not happened because the technology adopted by Evangelicals is superior to the technology adopted by the Roman church but, instead, because subsidies to variable profits tend to benefit smaller players at the expenses of the larger.

The growth of the Evangelical churches was accompanied, among other changes, by a remarkable increase in the political representation of Evangelical groups in various political instances across countries (Pew, 2006a). In Brazil, where the number of representatives directly tied to Evangelical groups jumped from 27 in 1994 to 187 in 2018, this phenomenon is particularly evident. Motivated by this fact, we also simulate the effects of religious subsidies on the composition of the Brazilian Congress. To do this we explore the staggered timing of church entry decisions across municipalities within an event-study framework and estimate the responses of the vote share received by Evangelical members of Congress to the entry of Evangelical churches in Brazilian municipalities.[5] Then, combining these estimates with the counterfactuals produced by the dynamic game, we show that subsidies to churches had a substantial effect on the vote share received by Evangelical candidates.

We structured our analysis as follows. In Section 2 we describe institutional details of religious markets in Brazil. More precisely, (i) we provide a brief historical account of the rise of Evangelical churches; (ii) a description of religious subsidies; and (iii) document differences in the business models adopted by Evangelical and Catholics. In particular, we highlight the fact that, in Brazil, all churches are exempt from paying taxes to any level of the public administration. This type of policy is not a Brazilian peculiarity. Instead, religious subsidies of some form are observed in more than 80 countries in various parts of the world. We also document differences in the business models adopted by the Catholic and the Evangelical churches: Catholics usually own their self-standing real estate and furnish interiors according

[5] More precisely, the outcome of interest is the vote share of elected members of the Evangelical Parliamentary Front (FPE, in portuguese), the Evangelical caucus in Brazil.

Figure 1: Market Shares of Religions in a Sample of Brazilian Municipalities (1991-2018)



to minimal standards, while Evangelical temples are often housed in rented properties with less intricate fittings (see Figure 2). These differences, in turn, may have repercussions on the cost structure of Evangelical and Catholic temples and, therefore, may be relevant to explain how religious subsidies are asymmetrically captured by the two religious groups.

In Section 3 we describe our data on entry and exit of temples of different denominations in Brazilian municipalities.[6] We observe that during the period of our analysis (1991-2018) there was a massive increase in the number of temples operating in Brazilian municipalities. The stock of temples of the Catholic and the main Evangelical denominations grew steadily during the period but the Evangelical churches, specially those created recently, grew faster than the Catholic church. As illustrated in Figure 1 the result was a decline on the market share – measured as the number of temples of a denomination over the total number of temples in our sample – of the Catholic church. Using a set of descriptive regressions Section 3 also shows that entry and exit of temples of the different denominations in a given

[6]Our sample includes only smaller isolated municipalities. Temples are relatively small establishments with limited maximum capacity, unlike typical evangelical megachurches that are widespread in large Brazilian cities or in the US. See sections 2.2 and 3 for more details.

market depends not only on market characteristics but also on strategic interactions between churches. In particular, the presence of a temple of an incumbent church in a given market reduces significantly the probabilities of entry of other churches in that market. This exercise suggests that strategic interactions between churches may be also relevant to explain the structure of religious markets in Brazil.

Building on the descriptive analyses of the previous sections, we develop a dynamic game of church entry in Section 4. We assume churches maximize a discounted sum of reduced form payoffs which are a flexible function of sunk entry costs, fixed operating costs, entry decisions of competing churches and municipalities characteristics (Rennhoff and Owens, 2012; Hanson and Xiang, 2013; Walrath, 2016).[7] Sunk entry costs in this market appear to be large compared to period payoffs. Likewise, when deciding to open a new temple it seems reasonable to assume that churches are factoring in not only the current conditions of the market but also their expectations about the evolution of state variables in that market (Sanches et al., 2016). This may justify why churches in this paper are modelled as forward-looking entities. Our objective is to use the model to understand whether subsidies to churches explain the growth in the market share of Evangelical churches as shown in Figure 1. In Section 5 we briefly discuss the identification of the primitives of our model, the estimation of the model and show the estimates of the structural parameters. Following Hotz and Miller (1993), we estimate the model using a two-step approach. We first estimate churches Conditional Choice Probabilities (CCPs) directly from the data. In the second stage the primitives of the structural model are estimated from the structures of the dynamic game using the Ordinary Least Squares estimator proposed by Miessi Sanches et al. (2016).

In consonance with previous findings of the literature (Rennhoff and Owens, 2012; Walrath, 2016) and with the descriptive studies discussed in Section 3, we indeed observe that competition between churches is relevant to explain entry and exit of temples in Brazilian municipalities. Churches appear to behave strategically. More importantly, the estimates

[7] By following these authors, we take an "agnostic" view concerning the actual objective of the church. For further discussion about the potential objectives of a church, see Subsection 4.1.

confirm that Evangelical and Catholic churches adopt very distinct technologies to build and operate temples: entry costs of Evangelical churches are substantially smaller than the entry costs of the Catholic church; on the other hand, fixed operating costs of Catholic temples are much smaller than fixed operating costs of Evangelicals. As illustrated in Section 2, these findings are consistent with the fact that Evangelical temples are more functional and usually operate in rented spaces – which tend to reduce entry costs and increase fixed operating costs – while Catholic temples are more elaborated and operate in properties owned by the Roman Church.

In Section 6 we solve the model and show that it reproduces well the market shares of the different denominations during 1992-2018. We then simulate counterfactual time-series of the number of temples of the Catholic church and the main Evangelical denominations imposing different tax rates on churches variable profits. We show that tax exemption policies are key to explain the continued growth of the market share of Evangelicals in Brazil. Indeed, if the government had imposed a tax rate of 30% – close to the average corporate taxes paid by firms in Brazil (34%) – on churches variable profits the share of Catholic temples over the total stock of temples operating in Brazil would have been, in 2018, 22 percentage points larger than under the baseline (tax exemption) scenario.

Using a set of linear projections of the time-series of temples simulated from the equilibrium of the model we illustrate that the growth of Evangelical churches is not explained by comparative efficiencies of their technologies – lower entry costs and higher fixed operating costs – but by the fact that subsidies in the form of variable profits tax exemption tend to asymmetrically benefit smaller churches. We finally use the structure of the model to compute a long-run Laffer curve with endogenous market structure and show that the optimal tax rate is relatively large, around 68%. This finding, again, appears to reflect aspects of the technologies of Evangelicals and of the Catholic Church: when the tax increases the stock of Evangelical temples reduces quickly but the stock of temples of the Catholic church remains stable even for relatively higher tax rates, sustaining the growth of government revenues.

In Section 7 we shift our focus to the consequences of the rapid spread of Evangelicalism on Brazilian politics. First, we use administrative data on the timing of church entry per municipality to estimate the impact of Evangelical temple building on the Evangelical vote share. After entry, we find an increase of 3.5 percentage points in the vote share received by members of Congress that form the Evangelical Parliamentary Front (FPE, in portuguese) – the evangelical caucus in Brazil.[8] Importantly, our results indicate that the entry timing of a Pentecostal temple is not designed as a response to trends in political outcomes. Part of the effect comes from mobilization through higher turnout.[9] Finally we combine these estimates with the counterfactual scenarios estimated in Subsection 6.2 show that the Evangelical vote share in Congressional elections would have been on average approximately 20% lower if churches were taxed.

Literature

Our paper offers new insights to the literature on the determinants of religion (see Iyer (2016) for a survey). 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).

To our knowledge, there are few quantitative studies on the explicit role of religious financing and church expansion. Bazzi et al. (2020) show that a large transfer of resources

[8] Related to this result, Corbi and Komatsu (2019) document that religious media complement the effect of temples in increasing membership and evangelical political participation.

[9] These findings are in consonance with survey evidence that shows that faithfuls of Pentecostal denominations are more prone to follow political orientations of their churches than faithfuls of other religions. See Datafolha survey at http://arte.folha.uol.com.br/poder/2016/12/25/evangelicos-catolicos-costumes/.

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 subsidies to religions in general may affect not only religiosity levels but also the allocations of market shares across different religious groups depending on the type of the subsidy and on the expansion models adopted by different churches. Our findings support the notion that the institutional features that determine the allocation of resources to or away from religions play a significant role in their ability to grow.

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.

In addition, we contribute to the industrial organization literature that studies the effects of taxes on firms behavior. Dunne et al. (2013), Fan and Xiao (2015) and Maican and Orth (2018) use a dynamic structural model similar to ours to study how subsidies affect entry and exit of firms in the US market of dentists and chiropractors, in the the US telephone industry and in the Swedish retail food sector, respectively. We contribute to this literature by estimating a Laffer curve with endogenous market structure and by showing that the effects of taxes on entry/exit of firms is relevant to explain tax revenues.[10]

[10] See also Miravete et al. (2018) for an empirical analysis of optimal taxation in a static oligopoly model with exogenous market structure.

2 Religious Traditions, Institutional Background and Church Subsidies

This section provides a brief description of the religious landscape in Brazil, focusing on details that are most relevant to our analysis. First we discuss the classification of churches across religious traditions. Then we consider differences in organizational structure and style of temple building as drivers of different cost structures and expansion strategies across denominations. Next we provide a short account of the evolution of state subsidies to religions and its institutional details.

2.1 Mainline Protestants, Evangelicals and Catholics

The word Evangelical has its roots in the Greek term *Evangelion*, which means “good news” or “gospel.” In one of the most useful definitions, Bebbington (1992) identifies the key ingredients of evangelicalism as *conversionism* (an emphasis on the ”new birth” as a life-changing experience of God), *biblicism* (a reliance on the Bible as ultimate religious authority), *activism* (a concern for sharing the faith), and *crucicentrism* (a focus on Christ’s redeeming work on the cross as the only way of salvation). The Evangelical movement encompasses a variety of denominations and independent traditions. 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.

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 Mainline Protestant churches, such as Lutherans and Calvinists, are not covered by the term.

Table 1: 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

Table 1 describes the classification of Brazilian religious denominations we adopt here which largely follows Mariano (2014). We group all denominations into 5 major traditions. 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. 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).

Catholics and Mainline Protestants in Brazil tend to be less conservative than Evangelicals on social issues. In particular, they are less morally opposed to abortion, homosexuality, artificial means of birth control, sex outside of marriage, divorce and drinking alcohol, and are less likely to tithe and perform missionary work (Pew, 2013; Neri, 2007). Some of these patterns are not unique to Brazil, but common to most countries in Latin America and the Caribbean, and among US Latinos.

2.2 Hierarchies, Church Building and the Rise of Evangelicals

Brazilian colonial history witnessed the coming together of three cultural traditions: European Catholics, native Brazilians and African slaves, with clear hegemony of the former. Despite substantial racial miscegenation and religious syncretism[11], Catholicism prevailed as the official religion through Portuguese domination in the colonial period (1500-1821) and the monarchy era after independence (1822-1888).[12] 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).[13]

The dramatic geographical expansion of Evangelical churches may be partially associated with the organizational structure within each traditional. The Roman Catholic Church follows a hierarchical structure, with the local bishop having the responsibility for and control over planning new churches in his diocese.[14] On the other hand, although certain Protestant denominations are more hierarchical than others, Takayama (1975) argues that generally Protestant denominations are not as hierarchical as the Roman Catholic Church. Some denominations also exhibit decentralization within the denomination, where individual congregations retain the most authority (Walrath, 2016).

The style of church building also reveals the contrasting business models adopted by different traditions. 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, as illustrated by Figure 2. These differences

[11] 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.

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

[13] In Appendix A we provide a brief historical account of these waves in more detail.

[14] For more detailed information on the role of this hierarchical structure on entry of Catholic churches, see the *Planning for the Establishment of Parishes* from the *Directory for the Pastoral Ministry of Bishops* available at `http://www.vatican.va/roman_curia/congregations/cbishops/documents/rc_con_cbishops_doc_20040222_apostolorum-successores_en.html`, accessed on May 08, 2021.

Figure 2: Example of Catholic *vs* Evangelical church buildings

(a) Catholic church façade

(b) Evangelical church façade

(c) inside of a Catholic church

(d) inside of an Evangelical church

are likely to matter for the cost structure of these churches, which, in turn, is crucial to explain the expansion of Evangelical and Catholic establishments.[15] It should be noted that our sample includes only smaller isolated municipalities.[16] 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

[15] We resume this discussion in Subsection 5.2, where we show the estimates of sunk entry costs and fixed operating costs of Evangelicals and Catholics.

[16] We define markets as municipalities with population below 50,000 in 2010 that are at least 30km away from any neighbouring municipality and have at most 5 evangelical establishments at any point in time. See Section 3 for more details.

temples truly local places of worship.

2.3 Religious Finance and Tax Exemption in Brazil

State support is key to religious finance, trumping all other factors such as a church's theology, practices, and polity (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 highly subsidized. According to the *Religion and State* project, government of only 16 out of 182 did not fund religion in 2010 (Fox, 2018).

In Brazil, the proliferation of Evangelical churches discussed in Subsection 2.2 was accompanied by an evolving relationship between the church and state, from the monopoly of Catholicism until late 19^{th} century to the current religious market with free entry and substantial state subsidies for all denominations.[17] Catholicism was the official state religion and the only faith to enjoy 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. The 1988 Federal Constitution subsequently rectified this principle in its Article 150 which states that religious organizations are exempt from federal, state, and municipal taxes levied on property or income from services related with the essential purpose of religious entities. The legal interpretation of tax immunity evolved significantly after 1988, leading many religious organizations to become involved in a wide range of economic activities, especially related to real estate and media activities, taking

[17]Similarly, most American colonies had established churches, and ten of the thirteen original states funded these churches through taxes. Indeed, voluntary giving became central to church revenues in the US Christian churches only in the 20^{th} due to with increased competition as churches lost their capacity to tax (Iannaccone and Bose, 2010).

advantage of their non-commercial status to accrue sizable financial benefits from these tax-free operations (see Avila (2010) for a historical account).

Church subsidies. Aggregate estimates of public subsidies to churches in Brazil are unavailable. However, according to official estimates, revenues accrued directly from church-related activities summed up to R$24.2 billions in 2013 (US$10.2 billions), which may give a rough idea of the impacts of the churches tax exemption policy on the government budget.[18] On the other hand, this figure likely underestimates the true extent of church tax exemption as it does not include other economic activities controlled by churches that are not directly related to temple activities. For instance, *Igreja Universal do Reino de Deus* (IURD, in portuguese or simply Universal) famously purchased a top 3 national TV broadcaster in 1990 (Rede Record), which by itself registered net operating income of nearly R$ 2.2 billion in 2019.

Subsidies to religion are hardly unique to Brazil. In the United States alone, Cragun et al. (2012) estimated annual government subsidy of religion per year of US$71 billion. 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.

3 Data and Descriptive Analysis

In the previous section we described prominent aspects of our empirical context. Following these descriptions, this section introduces the data we use throughout our analysis and some descriptive regressions. The objective of these regressions is to shed light on how different aspects of the Brazilian market influence the distribution of shares of this market across religious denominations.

[18]Exchange rate of 42.32 USD = 100 BRL in December 2013. Standard for profit firms pay federal taxes including IRPJ (∼5%), PIS (0,65%) COFINS (3%) and local service tax ISS (3-5%) over gross revenue.

Data. Our temple-level dataset comes from the Brazilian Internal Revenue Service (*Receita Federal do Brasil*) 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 1 and structure the data retrospectively as an yearly panel with a total of $3,427,626$ denomination-municipality-year observations from 1991 to 2018. All municipalities in Brazil have at least one establishment across the sample period.[19] Yearly population estimates are from IBGE.

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 5 evangelical establishments at any point in time.[20] After this selection we ended up with 246 markets.

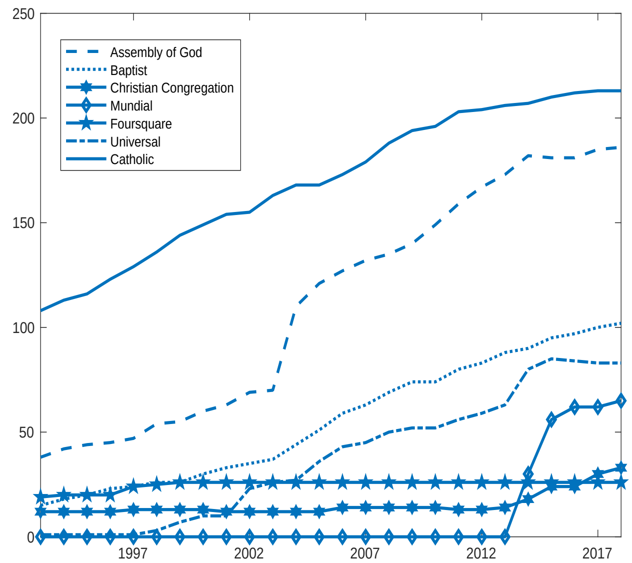
We restricted our analysis to the 1991-2018 period because yearly data on population is available since 1991. We study entry and exit decisions of temples of the six largest Evangelical denominations – according to the observed number of temples of all denominations in 2018 – and the Catholic church. The Evangelical denominations are: Assembly of God, Baptist, Universal, Mundial, Christian Congregation and Foursquare. Together the Catholic church and these six Evangelical denominations had more than 91% of the temples in our sample. The other Evangelical denominations are much smaller and less representative in the Brazilian society.[21] Figure 3 illustrates the evolution of the number of temples in our

[19]Municipality boundaries in Brazil change substantially throughout 1991-2018. 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.

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

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

Figure 3: Number of Temples of the Largest Denominations: 1991-2018



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. The number of temples of Mundial, which was founded only in 1998, and of Universal, which had a very small number of temples in 1991, jumped from zero in 2013 to almost 50 in 2018. Despite the growth of the Catholic church Figure 1 shows that its share decreases continuously over time, from 56% in 1991 to 30% in 2018.

Descriptive Analysis. Before presenting the theoretical model, we examine the relevance of competition and observed and unobserved market characteristics to explain the evolution of the number of active temples of these denominations as illustrated in Figure 3. Our descriptive study for Evangelical churches is based on the following Probit Model:[22]

the state space of the model.

[22]As approximately 80% of the municipalities in our sample have at most 1 temple of the same denomination, we model only entry and exit decisions.

$$P\left(a_{im}^{t}=1|\mathbf{a_m^{t-1}},p_m^t\right)=$$
$$\Phi\left(\rho_0+\rho_1 a_{im}^{t-1}+\sum_{j\neq i,j\in E}\rho_{2j}n_{jim}^{E,t-1}+\rho_3 n_{im}^{C,t-1}+\rho_4 p_m^t+\mu_i+\mu_m^t\right), \tag{1}$$

where, $a_{im}^t \in \{0,1\}$ is church i's action in municipality m, period t, $\mathbf{a_m^{t-1}}$ is a vector containing the action of all churches in the previous period, $n_{jim}^{E,t-1}$ is the number of temples of (other) Evangelical churches, $j \in E = \left\{1,2,...,N^E\right\}$, $j \neq i$, competing with church i in market m, period $t-1$; $n_{jim}^{C,t-1}$ is the number of Catholic temples competing with church i in market m period $t-1$; p_m^t is the population in market m, period t; μ_i is a church fixed effect; μ_m^t is a time varying market fixed effect and $\Phi(\cdot)$ represents the CDF of a standard Normal distribution. 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.[23] To estimate the model we interact the variables $n_{jim}^{E,t-1}$ and $n_{jim}^{C,t-1}$ with denomination dummies; denomination fixed effects were included in all models. For the Catholic Church we estimate an analogous model, excluding the variable $n_{jim}^{C,t-1}$ from the equation.

It is well know – see Heckman (1981) – that nonlinear binary models with fixed effects may be biased due to the incidental parameters problem. To circumvent this problem we estimate the Probit models using a two-step procedure – see Minamihashi (2012), Collard-Wexler (2013), Lin (2015) and Sanches et al. (2016). In the first step 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 $t-1$, p_m^t and interactions of market and year dummies – term μ_m^t in equation (1). In the second step we estimate equation (1) including μ_m^t obtained in the first stage as an additional control variable.

[23]We pooled Evangelical churches because for smaller denominations we do not observe variation in the dependent variable for most markets and periods and, in this case, some coefficients of the model could not be estimated. Either way, estimates of relevant coefficients of individual Probit models are quantitatively and qualitatively close to the coefficients shown in Table 2.

Table 2 shows the results. The first four columns have estimates for the Evangelical churches. The first model does not include any control for unobserved heterogeneity. In this model most of the interactions between denomination dummies and the number of Evangelical and Catholic competitors has a positive sign and is not statistically significant at the usual levels. When we include μ_m^t – column 2 – the signal of the interactions, in general, get negative and statistically significant. This effect is expected as, typically, market/time unobserved heterogeneity tends to generate positive bias in the coefficients capturing competition between firms (Igami and Yang, 2016; Sanches et al., 2016). We also note that the coefficient attached to μ_m^t is positive and statistically significant at 1%. In the third column we also include market dummies. The inclusion of market dummies has little effect on the magnitude and significance of the coefficients. In the the fourth column we exclude μ_m^t but left market type dummies. The patterns in column 4 are similar to the patterns observed in column 1, when we do not have any control for unobserved heterogeneity. The same pattern is observed in the last four columns of the table, where we estimate the same models for the Catholic church. These results suggest that unobserved heterogeneity across markets and periods of time is important in our setup and that the variable μ_m^t captures relatively well variation in churches decisions due to unobserved market/time heterogeneity.

Another interesting fact observed in Table 2 is that strategic interaction between churches seems to be relevant in this market. In particular, the model for the Evangelical churches suggests that competition between Evangelical churches is more intense than between Evangelicals and the Catholic church. For the Catholic church, in turn, and in accordance with the coefficients in columns 6 and 7, entry of Evangelical churches in a given market tends to reduce entry probabilities of the Catholic church in that same market.

Table 2: Probit: Entry/Exit Decisions

	Evangelicals				Catholic			
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
n^E : Assembly	0.085***	-0.154***	-0.188***	0.018	-	-	-	-
	[0.03]	[0.05]	[0.05]	[0.03]	-	-	-	-
n^E : Baptist	0.031	-0.103**	-0.131***	-0.019	-	-	-	-
	[0.03]	[0.04]	[0.04]	[0.03]	-	-	-	-
n^E : Christian Congr	0.055*	-0.020	-0.043	0.014	-	-	-	-
	[0.03]	[0.05]	[0.05]	[0.03]	-	-	-	-
n^E : Mundial	0.152***	0.112***	0.092**	0.112***	-	-	-	-
	[0.02]	[0.04]	[0.04]	[0.02]	-	-	-	-
n^E : Foursquare	-0.038	-0.214***	-0.234***	-0.080*	-	-	-	-
	[0.04]	[0.05]	[0.06]	[0.04]	-	-	-	-
n^E : Universal	0.016	-0.128***	-0.154***	-0.034	-	-	-	-
	[0.03]	[0.04]	[0.04]	[0.03]	-	-	-	-
n^E : Catholic	-	-	-	-	0.028	-0.167***	-0.146***	-0.002
	-	-	-	-	[0.03]	[0.06]	[0.06]	[0.04]
n^C : Assembly	0.072	-0.213	-0.254*	-0.003	-	-	-	-
	[0.09]	[0.13]	[0.13]	[0.09]	-	-	-	-
n^C : Baptist	-0.002	-0.150	-0.187	-0.086	-	-	-	-
	[0.09]	[0.15]	[0.15]	[0.09]	-	-	-	-
n^C : Christian Congr	0.105	-0.050	-0.090	0.040	-	-	-	-
	[0.11]	[0.17]	[0.18]	[0.11]	-	-	-	-
n^C : Mundial	0.153*	0.007	-0.027	0.082	-	-	-	-
	[0.08]	[0.14]	[0.15]	[0.08]	-	-	-	-
n^C : Foursquare	-0.205	-0.499**	-0.541**	-0.290	-	-	-	-
	[0.21]	[0.25]	[0.26]	[0.21]	-	-	-	-
n^C : Universal	-0.014	-0.276*	-0.315**	-0.096	-	-	-	-
	[0.09]	[0.15]	[0.15]	[0.10]	-	-	-	-
μ_m^t	-	15.875***	15.798***	-	-	19.930***	20.317***	-
	-	[0.45]	[0.46]	-	-	[1.27]	[1.53]	-
Observations	38,376	38,376	35,412	35,412	6,396	6,396	6,396	6,396
Market Dummies	No	No	Yes	Yes	No	No	Yes	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.

In summary, the descriptive evidence shown in this section indicates that strategic interactions between churches may be important to explain the expansion of Evangelicals and the Catholic church in Brazil in recent years. Another important aspect that emerges from the descriptive analysis is that unobserved heterogeneity appears to be relevant to explain entry and exit decisions of churches. These two facts will guide the construction and the estimation of our structural model. The structural model is presented in the next section.

4 Dynamic Game of Church Entry

This section develops a dynamic model of strategic interaction between churches. We estimate the primitives of the model using data on entry/exit of temples described in the previous section. This model will serve as the basis for the simulation of the effects of church taxation on the shares of Catholic and Evangelical churches operating in Brazilian municipalities.

4.1 Preliminaries

We consider a general class of dynamic games of incomplete information with features that seem to be important to rationalize the expansion of churches in Brazil. The sequence of events is as follows. At any market churches observe past actions of all players – 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, e.g. costs to operate a temple, sunk costs churches pay to build a temple, etc. 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. Churches collect period payoffs. The transition laws for the state vector determine the distribution of states in the next period. The games restarts.[24]

At a first glance, the objectives of a church are not obvious. One may argue they maximize members, donations, or some ethereal concept of *religiosity* or *spituality* (Hungerman, 2010). Iannaccone (1998) reviews works in the rational choice approach who treat churches as profit-maximizing firms in order to explain church behavior. We take an "agnostic" view concerning the actual objective of the church and follow Walrath (2016) and Rennhoff and Owens (2012)

[24]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).

who assume churches maximize a reduced form profit function (see Subsection 4.2). In contrast to these works, we model churches as forwarding looking entities. Such behavior may be justified by the relatively large sunk costs churches have to pay when deciding to open a temple in a given market. Thus it is reasonable to think that churches weigh sunk investments and the expected streams of payoffs generated by the initial investment. Moreover, we allow for different sunk cost and per period fixed costs across different denominations.[25]

4.2 Elements of the Game

We now formalize churches decision problem. Time is discrete, denoted by $t = 1, \ldots, \infty$. There are $m \in \mathbf{M} = \left\{1, 2, ..., \bar{M}\right\}$ markets. In each market there are $N > 0$ churches. 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. 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 other market m characteristics at period t, which will be denoted by the vector $\mathbf{x^t_m}$. Without loss of generality we assume that $\mathbf{x^t_m}$ is discrete. The vector $\mathbf{s^t_m}$ evolves according to the transition law $H_{im}(\mathbf{s^{t+1}_m}|\mathbf{s^t_m}, \mathbf{a^t_m}) \in [0, 1]$. It characterizes next period probability distribution of observed states conditional on the current state vector and churches action profile.

Church i's decision problem at period t, market m, is to choose an action $a^t_{im} \in \{0, 1\}$ to maximize the expected discounted sum of payoffs. We denote the discounted sum of payoffs by $E_t \sum_{\tau=t}^{\infty} [\beta^{\tau-t}\Pi_{im}(\mathbf{a^\tau_m}, \mathbf{s^\tau_m}, \varepsilon^\tau_{im})]$, 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^τ_{im} 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. We further assume that

[25]Earlier literature motivates the significance of fixed costs and the presence of economies of scale in a church due to (excess) physical capacity and the necessity of trained clergy (Lipford, 1992; Stonebraker, 1993).

$\Pi_{im}(\cdot)$ can be decomposed as:[26]

$$\Pi_{im}(a^t_{im}, \mathbf{a^t_{-im}}, \mathbf{s^t_m}, \varepsilon^t_{im}) = \pi_{im}(a^t_{im}, \mathbf{a^t_{-im}}, \mathbf{x^t_m}) + a^t_{im}\varepsilon^t_{im} + a^t_{im}\left(1 - a^{t-1}_{im}\right) F_i. \tag{2}$$

Here, $\pi_{im}(a^t_{im}, \mathbf{a^t_{-im}}, \mathbf{x^t_m})$ denotes church i's deterministic profits in market m and F_i is an entry cost. Entry costs are paid only at the period churches build a temple at the market.[27] We assume that the deterministic payoffs, $\pi_{im}\left(a^t_{im}, \mathbf{a^t_{-im}}, x^t_m\right)$, can be written as:

$$\pi_{im}\left(a^t_{im}, \mathbf{a^t_{-im}}, \mathbf{x^t_m}\right) = a^t_{im}\left\{\theta_{0i} + \theta_{1i}\left(\sum_{j\neq i, j\in E} a^t_{jm}\right) + \theta_{2i}\left(\sum_{j\neq i, j\in C} a^t_{km}\right) + \theta_{3i}p^t_m\right\} \tag{3}$$

where, $E = \left\{1, 2, ..., N^E\right\}$ is the set of Evangelical churches and C is an unitary set representing the Catholic church; $p^t_m \in \mathbf{x^t_m}$ is the population of market m at period t, and θ_{0i}, θ_{1i}, θ_{2i} and θ_{3i} are parameters. In particular, the parameter θ_{1i} reflects the effects of a temple of (other) Evangelical denominations on the payoffs of church i and the parameter θ_{3i} reflects the effect of a Catholic temple on the profits of (an Evangelical) church i. The parameter θ_{0i} is usually interpreted as firm's fixed operating costs (Sanches et al., 2016). We assume that church i receives the payoff $\theta_{0i} + \theta_{1i}\left(\sum_{j\neq i, j\in E} a^t_{jm}\right) + \theta_{2i}\left(\sum_{j\neq i, j\in C} a^t_{km}\right) + \theta_{3i}p^t_m$ only if it has a temple operating at that market and period of time. Finally we assume that the payoff profitability shock can be written as:

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

where, μ^t_m is a market specific shock that varies over t, γ_{im} is a parameter and ς^t_{im} is an iid shock with standard Normal distribution. Its cdf will be denoted by $Q(\cdot)$.[28] We assume

[26] The structure of this payoff function is, in essence, similar to those adopted by Rennhoff and Owens (2012) and Walrath (2016).

[27] We assume that if a church decides to close a temple in any market it gets a scrap value equal to zero. Aguirregabiria and Suzuki (2014) and Komarova et al. (2018) show that operating costs, entry costs and scrap values cannot be jointly identified. Given this identification restriction, empirical papers typically normalize scrap values to zero – see, for example, Sanches et al. (2016) and Collard-Wexler (2013).

[28] We assume that the effect of μ^t_m on payoffs has an exponential functional form because with this

that the μ_m^ts are observed by all churches, but not by the econometrician. We do not impose any distributional assumption on this shock. In practice we will treat γ_{im} (for all markets and players) as another set of parameters to be estimated. The shock μ_m^t will be an element of the state space, $\mathbf{s_m^t}$. This element captures unobserved heterogeneity affecting churches actions. As we emphasized in the previous section, unobserved heterogeneity appears to be important to explain churches entry/exit decisions. In the next section we show how we obtain estimates of μ_{im}^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:

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

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 $\mathbf{a_{-im}^t}$; $\boldsymbol{\sigma_{im}}$ 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 $V_{im}(\mathbf{s_m^t}, \varepsilon_{im}^t; \boldsymbol{\sigma_{im}})$ 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).

formulation the model captures well the trend of the number of temples – see Section 3.

4.3 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 $V_{im}^1(\mathbf{s_m^t}, \varsigma_{im}^t; \sigma_{\mathbf{im}})$ be church i's value function conditional on $a_{im}^t = 1$ net of the payoff shock ς_{im}^t when the state vector is $\mathbf{s_m^t}$ and the payoff shock is ς_{im}^t and $V_{im}^0(\mathbf{s_m^t}, \varsigma_{im}^t; \sigma_{\mathbf{im}})$ be church i's value function conditional on $a_{im}^t = 0$ when the state vector is $\mathbf{s_m^t}$ and the payoff shock is ς_{im}^t. Then church i chooses to play $a_{im}^t = 1$ with probability:

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

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).[29] This completes the description of our theoretical framework. Next we turn to the estimation of the structural parameters of this model.

[29] Typically, however, dynamic games of incomplete information have multiple equilibria. 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.

5 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.

5.1 Identification and Estimation

The identification of the vector of structural parameters, $\Theta = \left\{ (\theta_{0i}, \theta_{1i}, \theta_{2i}, \theta_{3i}, F_i, \gamma_{im})_{\forall(i,m)}, \beta \right\}$, 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, $H_{im}(\mathbf{s^{t+1}_m}|\mathbf{s^t_m}, \mathbf{a^t_m})$, directly from the data.[30] Having obtained these two objects and fixing the discount factor, identification of the payoff parameters in this model follows directly from Pesendorfer and Schmidt-Dengler (2008). Next we characterize 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

[30] 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 – see Aguirregabiria and Nevo (2013). This assumption is common in applied papers using this framework (Collard-Wexler, 2013; Sanches et al., 2016).

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.

As explained, the first step requires the estimation of beliefs, $\sigma_{im}(\mathbf{a^t_{-im}}|\mathbf{s^t_m})$, and transitions, $H_{im}(\mathbf{s^{t+1}_m}|\mathbf{s^t_m}, \mathbf{a^t_m})$. 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 $\mathbf{s^t_m}$ – see, for example, Ryan (2012) and Sanches et al. (2016). In this paper, the challenge to estimate beliefs is that the state vector contains the shock μ^t_{im} that is observed by all churches but not by the econometrician. We obtain estimates for this object using the same two-step procedure discussed in Section 3. The estimation of the first step is exactly the same as we described in Section 3. In the second stage we estimated the same Probit model shown in columns 2 (for the Evangelical denominations) and 6 (for the Catholic church) of Table 2, but included interactions of past actions with μ^t_m (for the Evangelical churches) and of past actions and population (for the Catholic church).[31] The parameters of the CCPs are in the Appendix.

Having estimated μ^t_m we can estimate its transition. We discretized μ^t_m 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. $a^t_{im} = a^{t-1}_{im}$. With beliefs and transitions we can estimate the parameters of the structural model.[32]

5.2 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 high but it is consistent with interest rates

[31]The inclusion of these variables in the CCPs improve the fit of the structural model to the data.

[32]The shock μ^t_m 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^t_{im} but the estimates of the structural model are robust to the number of bins we use to discretize μ^t_{im} (and also the population). We considered here the model with five bins for μ^t_{im} because the state space of the model is already large, which complicates substantially the numerical solution of the model.

Table 3: Structural Parameters

	Assembly	Baptist	Congregation	Mundial	Foursquare	Universal	Catholic
Constant (θ_0)	-6.37	-6.14	-6.23	-5.95	-6.93	-6.19	-1.87
	[0.413]	[0.418]	[0.413]	[0.425]	[0.42]	[0.395]	[0.411]
Evang Comp (θ_1)	-0.04	-0.03	**-0.01**	0.03	-0.08	-0.04	-0.02
	[0.011]	[0.013]	**[0.019]**	[0.008]	[0.018]	[0.011]	[0.009]
Cat Comp (θ_2)	-0.06	**-0.04**	**-0.03**	**0.01**	-0.14	-0.07	-
	[0.029]	**[0.034]**	**[0.056]**	**[0.034]**	[0.049]	[0.042]	-
Population (θ_3)	-0.06	-0.05	-0.04	-0.04	-0.03	-0.05	-0.14
	[0.007]	[0.007]	[0.006]	[0.007]	[0.007]	[0.007]	[0.013]
Shock (γ)	6.93	6.56	6.4	6.17	7.16	6.61	3.37
	[0.449]	[0.45]	[0.442]	[0.456]	[0.427]	[0.427]	[0.38]
Entry Costs (F)	-6.12	-6.18	-6.27	-6.22	-6.33	-6.19	-9.45
	[0.298]	[0.302]	[0.301]	[0.297]	[0.312]	[0.297]	[0.602]

Note: Robust standard errors estimated from 50 bootstrap repetitions in brackets. Coefficients in bold are not significant at 10%.

in Brazil during most part of this period.[33] 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-error 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. Four aspects of these estimates deserve special attention. First, as expected and in consonance with the descriptive regressions showed in the Section 3, 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 10% 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 for Assembly of God, Foursquare and Universal. Third, entry costs are negative, significant and

[33]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.

relatively large. This indicates that entry costs are substantial in this market. Entry costs of the Catholic church seems to be considerably higher than entry costs of Evangelical churches. In line with the discussion in Subsection 2.1 this is reasonable as, on average, Catholic temples are more elaborate than Evangelical temples, which, typically, appear to be more functional. Finally, the coefficient θ_0, which is interpreted as fixed operating costs has roughly the same magnitudes for Evangelical churches but is much smaller for the Catholic church. These differences are also expected because, while Evangelical churches usually operate in rented spaces, Catholic temples operate in Church owned properties. Overall, the estimates shown in Table 3 seem to reflect important differences in the technologies to open and operate religious temples of Catholic and Evangelical churches.

6 Counterfactual Analysis

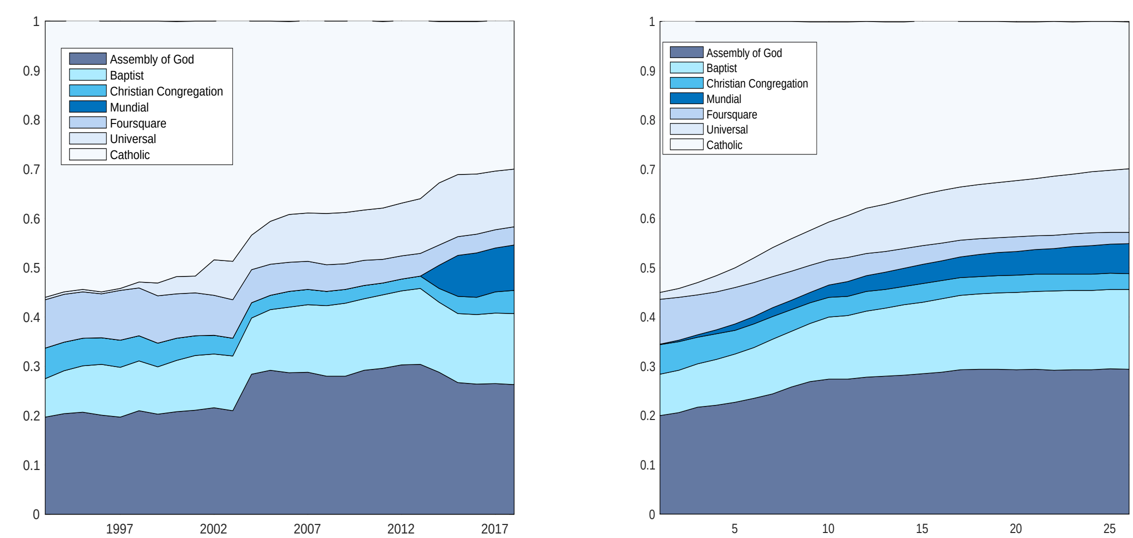
Now we use the estimated model to study how tax exemption to churches affected the share of Catholic temples in Brazilian municipalities. To compute tax counterfactuals we scale down churches payoffs using different factors, solve the model for the counterfactual configuration of payoffs and simulate the evolution of the number of temples in Brazilian municipalities from 1992 until 2018. We compare the counterfactual paths with the path we obtain after solving the model using the original set of parameters – see Table 3. Before showing the results of our counterfactual experiments, we analyze the fitting of the model to the data.

6.1 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.

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 each group for the equilibrium vector of beliefs. We describe the algorithm we use to solve the model in the Appendix. Having computed the vector of equilibrium beliefs we forward simulate the model starting from the state vector observed by each church in 1991 in each municipality 27 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 4 shows the shares of each denomination as observed in the data – same figure as shown in Section 3 – 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 4: Predicted Shares – Data and Model



(a) Data

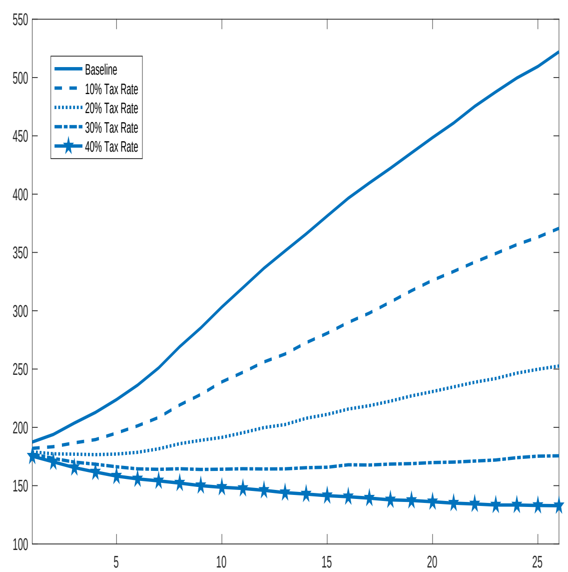
(b) Model

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. Next we use this model to construct counterfactual experiments.

6.2 Counterfactuals

Now we employ the structural model to evaluate how churches tax exemption affected the share of evangelical temples operating in Brazilian municipalities. We begin by recalculating the equilibrium of the model, assuming that churches pay a proportional tax on their variable payoffs – payoffs net of entry costs –, i.e. multiplying their variable payoffs by $1-\varrho$, where $\varrho \in [0, 1]$ is the tax rate.[34] Under each scenario, 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. We compute yearly averages of the total number of active temples and the tax revenues collected from these temples across the 100 paths.

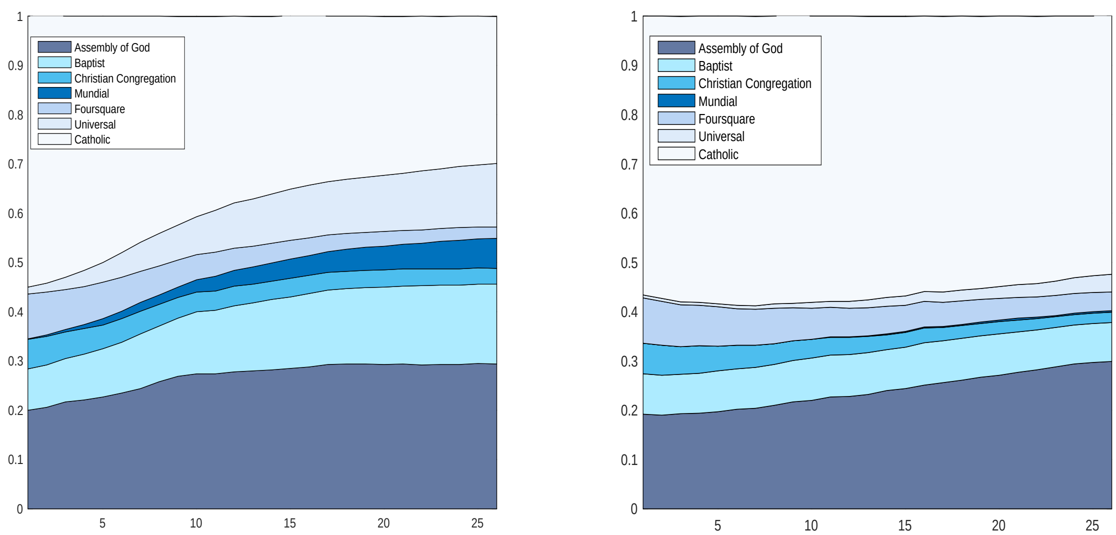
Figure 5: Evolution of the Number of Temples at Different Tax Levels



[34]Variable payoffs are total payoffs excluding the fixed entry cost. When variable payoffs for some state is smaller than zero we set the tax rate to zero.

Figure 5 shows the number of temples for the period 1992-2018 for $\varrho = 0$, $\varrho = 0.10$, $\varrho = 0.20$, $\varrho = 0.30$ and $\varrho = 0.40$. The impact of the tax on the number of churches operating in 2018 would be substantial: if the government had charged a tax rate of 30% – close to the average corporate tax payed in Brazil (34%) – over churches profits the stock of temples operating in 2018 would have fallen approximately 65% – compared to the baseline scenario.

Figure 6: Predicted Shares – Baseline and $\varrho = 0.30$



(a) Baseline

(b) $\varrho = 0.30$

We now examine how the aggregate fall in the number of temples was distributed across churches. Figure 6 illustrates this point. It shows, from 1992 to 2018, the share of each denomination in the baseline scenario – panel (a) – and in the scenario where churches pay a tax rate of 30% on their variable profits – panel (b). According to the figure, the share of the Assembly of God would have grown from approximately 20% in 1992 to 30% in 2018 – and the stock of temples of this denomination would have grown from 34 in 2012 to 52.5 in 2018; the share of the Baptist Church would stay stable at around 8% (14 temples) during the whole period; the share of the Catholic church would also remain relatively the same (56% in 1992 and 53% in 2018) – and its stock of temples would fall slightly from 100 in 1992 to 92 in

2018; the share of all other Evangelical churches, on the other hand, would have fallen from 16% in 1992 to 9% in 2018 and the joint stock of temples of these group would have fallen from 28 (1992) to 17 (2018). Figure 6 suggests that church subsides benefited relatively more smaller Evangelical churches than the Catholic and lager Evangelical denominations.

We now investigate more closely the factors behind the asymmetric effects of the subsidies. To do this, we take the simulated paths of (i) actions, (ii) population and (iii) market/time unobserved heterogeneity measure, μ_m^t, averaged across 100 simulations and run the following linear regression:

$$a_{im}^t\left(\varrho=0\right)-a_{im}^t\left(\varrho=0.3\right)=\alpha_0+\alpha_1 a_{im}^0+\alpha_2 n_{im}^t+\alpha_3 p_m^t+\alpha_4 \mu_m^t+\mu_i+\xi_{im}^t, \tag{7}$$

where $a_{im}^t\left(\varrho=0\right)$ is the action of player i at market m and period t when the tax rate is equal to zero, $a_{im}^t\left(\varrho=0.3\right)$ is the same variable when $\varrho=0.3$, a_{im}^0 is action of the same player and municipality in 1992, $n_{im}^t=\sum_{j\neq i}a_{jm}^t$ is the number of competitors of player i at municipality m and period t when $\varrho=0$ and μ_i is a player fixed effect. All the other variables in this regression were already defined in Section 4. All variables are averaged across simulated paths.

The OLS estimates for different specifications of this equation are in Table 4. Column (1) does not include neither church dummies nor the control for market heterogeneity, μ_m^t; column (2) includes market dummies; column (3) includes also μ_m^t. We interpret the results of this regression as follows. First, in all specifications, the effects of subsidies on entry are stronger in municipalities where churches did not have a temple in 1992. Second, the effect of the subsidy is stronger when churches face a higher number of competitors or, alternatively, the effect of the tax was stronger in markets where competition between churches is more intense. These two effects may explain why late entrants such as Mundial and Universal benefited more from church subsidies than larger incumbents. Third, church dummies are very important to explain variation in the dependent variable: when we include this set of dummies in the model (columns 2 and 3), the R-squared of the regressions jump from 0.06 to 0.33-0.36. We may interpret these dummies as the effect of churches business model on the number of temples opened as a consequence of subsides. Assembly of God (base category) is the church that has the better technology to open and operate temples. The dummy for the Catholic church is negative but relatively small compared to the other Evangelical denominations.

Table 4: Linear Regression to Explain How Subsidies Affects Entry of New Temples

	[1]	[2]	[3]
a^0_{im}	-0.018*	-0.093***	-0.098***
	[0.01]	[0.02]	[0.02]
n^t_{im}	0.042***	0.062***	0.045***
	[0.00]	[0.00]	[0.00]
p^t_m	0.002	-0.000	0.002
	[0.00]	[0.00]	[0.00]
Dummy Baptist		-0.109***	-0.106***
		[0.01]	[0.01]
Dummy Congregation		-0.233***	-0.228***
		[0.01]	[0.01]
Dummy Mundial		-0.214***	-0.209***
		[0.01]	[0.01]
Dummy Foursquare		-0.243***	-0.237***
		[0.01]	[0.01]
Dummy Universal		-0.136***	-0.133***
		[0.01]	[0.01]
Dummy Catholic		-0.056***	-0.057***
		[0.01]	[0.01]
Observations	44,772	44,772	44,772
R-squared	0.059	0.330	0.358
μ^t_{im}	No	No	Yes

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

This last result seems interesting for two reasons: on the one hand, it indicates that the relative decline of the Catholic church in the last decades in Brazil does not appear to be related to the lack of competitiveness of the Catholic church; on the other hand, coupled with the first two results, it suggests that the growth of Evangelical denominations that started to work more recently did not happen because they have a superior technology to open and operate temples but because subsidies to variable profits particularly benefited churches that had initially a smaller stock of temples.

Finally, we use our model to compute the optimal tax rate or, in other words, the tax rate that would maximize government revenue. Figure 7 shows the result of this exercise. The horizontal axis shows the tax rate. The dashed line shows the average number of active temples in all municipalities across 1992-2018. As expected, as the tax rate increases, the number of temples reduces. The solid line illustrates the Laffer Curve of the tax on churches variable profits. More specifically, it shows the present value of total revenues collected by the government from taxes on churches variable profits for different tax rates. The Laffer Curve peaks at $\varrho = 0.68$, indicating that the tax rate that maximizes tax revenue is large.[35]

Figure 7: Evolution of the Number of Temples at Different Tax Levels

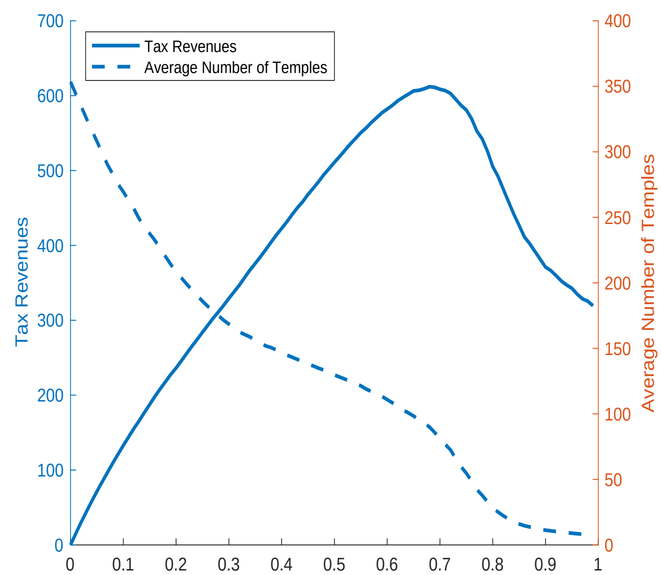
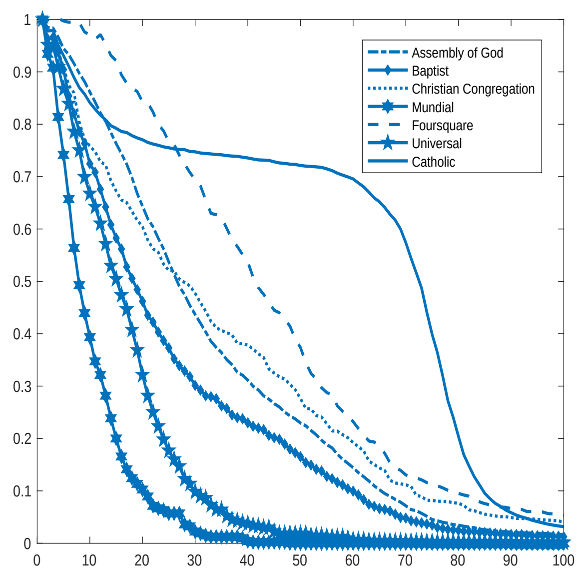


Figure 8 explains why the optimal tax rate is relatively high. In panel (a) we normalize the average (across years) number of temples of each denomination to 1 when $\varrho = 0$ and computed the average number of temples for ϱ varying from 0 to 1. The figure shows that when we increase ϱ the number of temples of all denominations falls monotonically. The

[35]To calculate the present value of tax revenues collected by the government, we assumed that the government discount rate is 0.80. If instead we assume that government discount rate is 0.9, the optimal tax rate would be $\varrho = 0.65$.

decline in the number of temples of Mundial and Universal, the two newest denominations that benefited relatively more from subsidies, is particularly intense. The main point here is that the reduction in the number of temples of the Catholic church is more pronounced when ϱ is small but the stock of temples of this church is relatively constant for moderate values of ϱ. When ϱ is around the optimal tax rate the stock of temples of the Catholic church shrinks very quickly. Precisely, it is the "resilience" of the Catholic temples to increases in tax rates that explains why the optimal tax rate is relatively high in this market. In the next section we analyze further consequences of the rise of Evangelical churches in Brazil.

Figure 8: Variation in the Number of Temples for Different Tax Rates



7 Further Consequences of Subsidies to Religion

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). Motivated by this fact, we now turn our attention to the role of religious competition and subsidies in determining political representation in Congress.

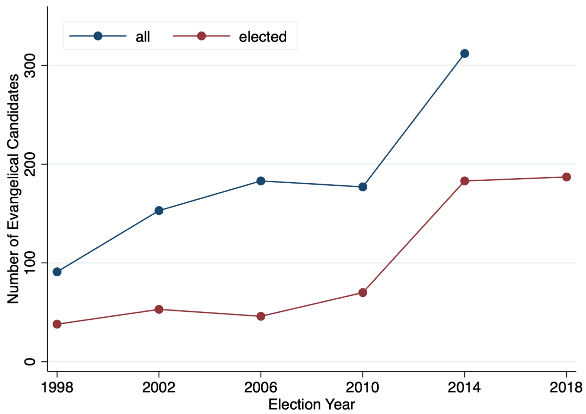
We begin by presenting a brief historical account of the increase in the presence of Evangelical groups in Brazilian Politics. Then we explore the timing of church entry decisions across municipalities within an event-study framework to investigate the role of the growth of Evangelical churches on voting decisions. Finally we combine these estimates with the counterfactual scenarios estimated in Subsection 6.2 to calculate the effects of subsidies to religion on the composition of the Brazilian Congress.

7.1 Evangelicals and Politics in Brazil

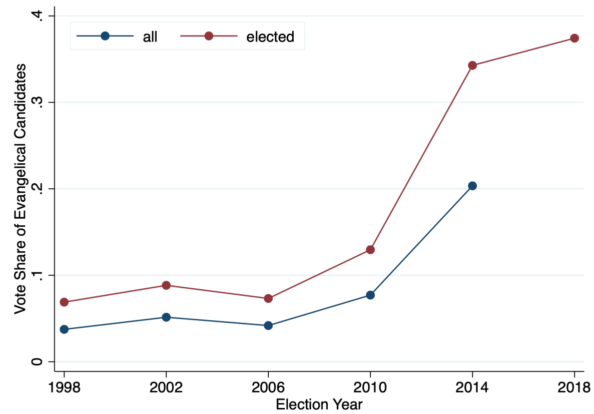
The rise of Evangelicals has been marked by an increase in their presence in Brazilian politics. In the post-junta elections of 1986, a Constituent Assembly was elected to draft the new constitution, including 36 Protestants (20 Pentecostals) out of 559 members (Freston 2001: 21-23). Evangelical churches took this opportunity to abandon their non-political stance to successfully seek legal equality with the Catholic Church, including equal rights to state subsidies (see Section 2.3).

In Congress, evangelical members of Parliament form an 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. They initially receive property and funds from president José Sarney's government to secure its support for government stances, having seen its influence in Brazilian politics grow in the last 30 years. Figure 9 illustrates the evolution of evangelical participation in politics in the last 6 elections. The number of total candidates and elected candidates associated with evangelical denominations increased by three and fourfold, respectively. The corresponding rise in evangelical vote share are even more dramatic, with the evangelical caucus (FPE) having received less than 7% of the vote share among all elected congressmen in 1998 to more than 37% in 2018. Most of these seats are held by members of the main Pentecostal denominations such as Assembly of God, Christian Congregation and Universal Church, as well as by late Protestant

Figure 9: Evangelical Participation in Politics, 1998-2018



(a) Number of Candidates



(b) Vote share

denominations such as Presbyterians. Catholic politicians do not take part.[36]

Even though it is known for its heterogeneity, the FPE has shown substantial influence in policy-making regarding issues related to morality politics. It positions itself as socially conservative, typically voting *en masse* against issues such as gender equality, abortion, euthanasia and same-sex marriage. It also opposes the criminalizing of discrimination against LGBT, as well as physical punishment imposed by parents on their children.

7.2 Election Outcomes and Church Entry

Now we explore the staggered timing of temple entry by comparing changes in voting patterns for municipalities that have year of temple entry between 1992 and 2018 within an event-study framework. Our key identification assumption is that the timing of temple establishment is uncorrelated with other determinants of changes in evangelical vote share. Our approach is capable of testing for differential pre-trends in the outcome variable and recovering any dynamics of the impact of church entry. In particular, we specify the following regression model for FPE vote share:

[36]The growing participation of Evangelicals in Brazilian politics is likely not only due to their increasing share of the population. They go to church more often than Catholics, and are two times more likely to vote for a clergyman and three times more likely to follow political recommendation from the church.See Datafolha survey at http://arte.folha.uol.com.br/poder/2016/12/25/evangelicos-catolicos-costumes/.

$$Y_{mt} = \sum_{\tau=-T}^{T} \beta_\tau D^\tau_{mt} + \omega W_{m,1991} \times d_t + \gamma_m + \alpha_{st} + u_{mt} \quad (8)$$

where m and t index municipality and time in years, 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_{st} are region-year fixed effects. We also control for a set of pre-determined socio-demographics that significantly correlate with the timing of implementation interacted with year fixed effects d_t in order to account for potential differential deterministic trends that might correlate with time of entry and evangelical vote share.[37]

Treatment assignment is denoted by D^τ_{mt} that is set to 1 if temple entry occurs τ years away from the current year t in municipality m, with $\tau < 0$ referring to years before entry and $\tau > 0$ after entry.[38] Thus, for a municipality that receives a temple in year e_m we have:

$$D^\tau_{mt} = \mathbb{1}_{[t-e_m=\tau]}$$

The β_τ coefficients represent the time path of FPE voteshare relative to the date of entry conditional on the three unobserved variance components d_t, γ_m and an error term u_{mt} which may exhibit arbitrary dependence within municipality but is uncorrelated with the other right hand side variables.[39] Our main results in this paper are obtained by estimating equation (8) by ordinary least squares, including a set of event-time dummies along with time and municipality dummies. For ease of exposition, in our main set of estimates we define τ

[37]In Appendix E we discuss the importance of factors that determine the time of entry of Evangelical temples in our sample.

[38]More specifically, treatment is defined according to entry of the first temple of a given church group - Pentecostal, non-Pentecostal ou Catholic. As discussed in Section 3, the municipalities in our sample are relatively small and have on average 1.5 evangelical temples and 5 at the most.

[39]An appealing feature of the event-study research design proposed here is that it provides an explicit way of testing the issue of reverse causality. In other words, we can directly examine whether municipality-specific trends in outcomes determine church entry. More formally, if entry dates are randomly assigned the following restriction should hold:

$$\beta_\tau = 0 \quad \forall \tau < 0$$

.

as a period of 2 years, in practice forcing the treatment effect to be the same within a 2-year period. As usual, not all β's can be identified as D^{τ}_{mt} are perfect collinear in the presence of municipal fixed effects. For this reason, we follow common practice and normalize $\beta_{-1} = 0$, so that all post-implementation coefficients can be thought of as treatment effects. We also impose the following endpoint restrictions:

$$\beta_\tau = \begin{cases} \overline{\beta} & \text{if } \tau \geq 4 \\ \underline{\beta} & \text{if } \tau \leq -4 \end{cases}$$

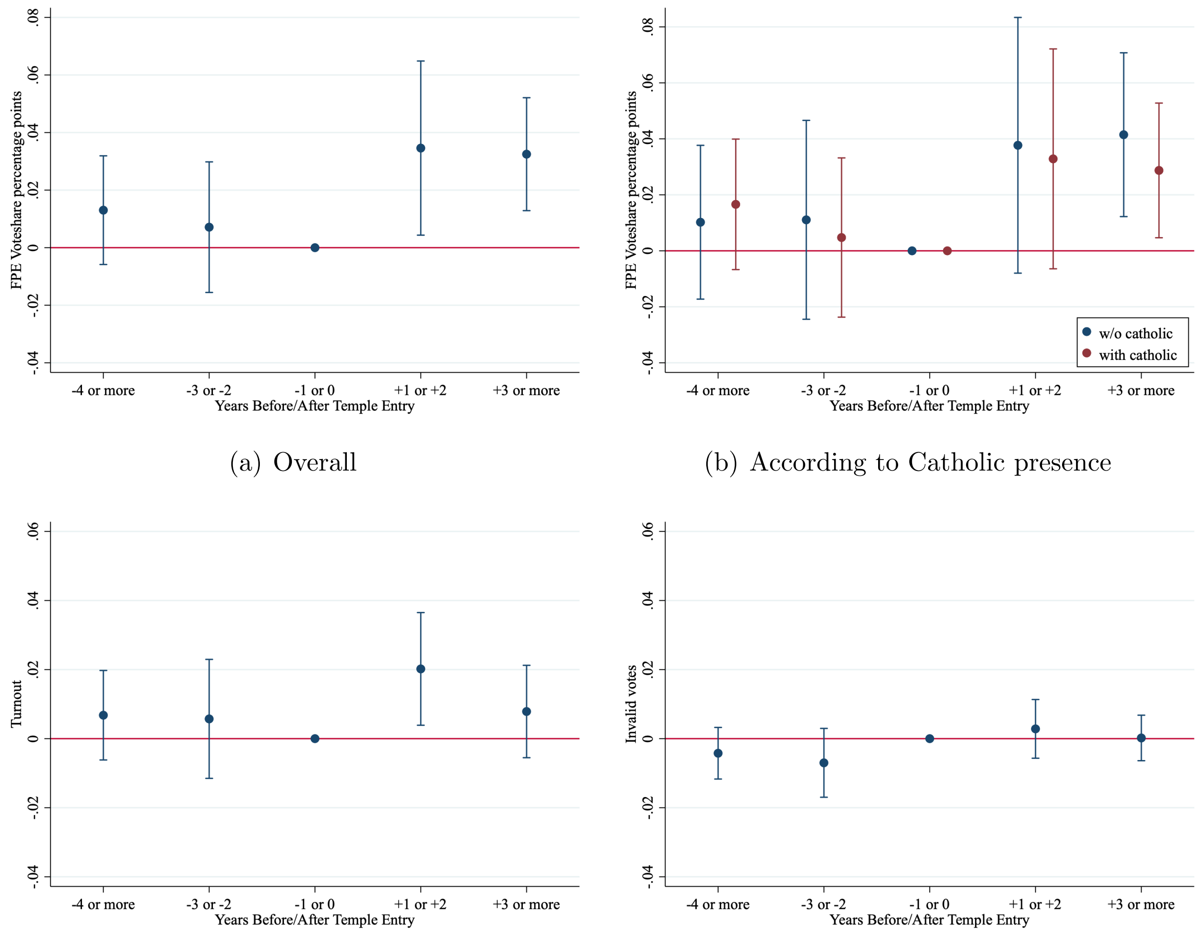
which simply state that any dynamics wear off after four years.[40] This restriction helps to reduce some of the collinearity between the year and event-time dummies. By limiting the analysis to a four-year window pre/post treatment, we ensure that the event-time coefficients are identified off of a nearly balanced panel of municipalities. We report robust standard errors clustered at the municipal level.

Main Estimates. We begin by examining the impact of Evangelical temple entry on the Evangelical bloc (FPE) vote share in elections for the lower house of Congress. Figure 10(a) plots the estimated β_τ coefficients from a regression of the form given in equation (8). 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. We find an increase in evangelical vote share of 3.5 percentage points in the first 2-year period after entry, which continues in the 3 or more years after entry.[41] The estimated magnitude translates into a 75% increase in FPE vote share once an evangelical temple is built, from a baseline of 4.5 percentage points (see Table 7 in the Appendix). This is consistent with evidence from Corbi and

[40] For another example of such endpoint restrictions, see Kline (2011). Nearly identical results ensue if we fully saturate the model in event time.

[41] Column (1) of Table 7 in the Appendix gives estimates corresponding to Figure 10. Column (2) add controls for socio-demographics characteristics interacted with time dummies, $W_{mt,1991}$, and region-year fixed effects, α_{st}. The pattern observed in Figure 10 is virtually unchanged.

Figure 10: Evangelical Temple Entry and Election Outcomes



(a) Overall

(b) According to Catholic presence

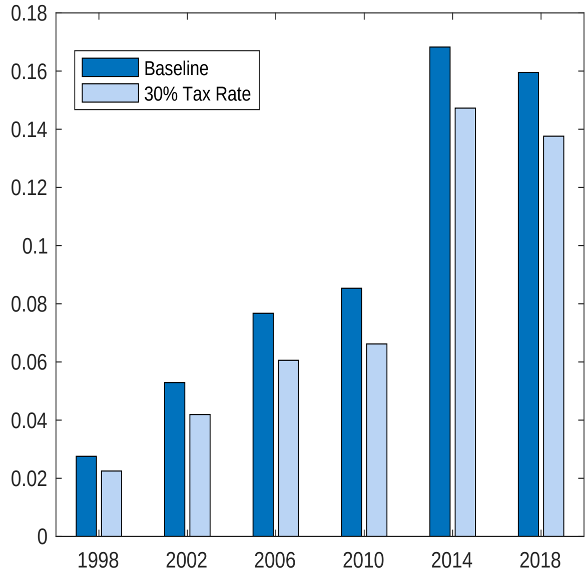
(c) Turnout

(d) Invalid votes

Komatsu (2019) who show that religious media enhanced the effect of temples in increasing membership and evangelical political participation. Figure 10(b) shows that the effect of evangelical temple entry slightly larger when the catholic church is not present.

Figures 10(c)-(d) reports the effects of temple entry by church on turnout and invalid (blank/null) vote rates, respectively. As before, no systematic correlations is detected between temple entry and these other electoral outcome pre-trends. The effect of Evangelical temples on FPE vote share shown in Figure 10(a) may be partially driven by an increase in turnout, albeit short-lived. This kind of mobilization effect is consistent with the media persuasion literature that finds variation in vote shares due partially to changes in who shows

Figure 11: Evangelical Vote Share under Alternative Tax Rates, 1998-20



up to vote (DellaVigna and Kaplan, 2007; Barone et al., 2015). Invalid votes are not affected by temple entry.[42]

7.3 Evangelical Vote Share under Alternative Tax Scenarios

The results above imply that the impact of different tax rates on the evolution of the number of temples over time is sizable. Figure 11 displays the evangelical vote share in election years 1998-2018 that FPE members would have received if the level of taxation was 0 (baseline) and 30%. We calculate vote share under alternative tax scenarios as $\widetilde{Y}_{mt}(\varrho) = Y_{mt} + \left(\tilde{d}_{mt}(\varrho) - d_{mt}\right)\hat{\beta}_1$ where Y_{mt} and d_{mt} are observed FPE vote share and an indicator of whether an actual evangelical temple exists in municipality m in election year t; $\tilde{d}_{mt}(\varrho)$ is a counterfactual indicator for temple given tax rates ϱ and $\widehat{\beta}_1$ is the estimate of the short-term effect of temple entry on vote share from column 1 of Table 7.

The effect of taxation on vote share is monotonic and substantial, as expected. For

[42]Columns 3 and 5 of Table 7 give estimates corresponding to Figures 10(c)-(d).

instance, in 2018 the vote share of Evangelicals would be 14% under a variable profit tax rate of 30% against 16% in the Baseline model. The fall in the share of votes caused by the 30% tax rate is around 18.2% on average, across the 1998-2018 elections.

8 Conclusion

The rapid spread of Evangelical Churches and the decline of the Catholic Church in religious markets during the last century is a social phenomenon observed in many parts of the world. This paper examined the role of tax-exemption policies for churches – a practice observed in various countries – in explaining these patterns using the Brazilian experience in the last decades as a showcase.

Using administrative data on the timing of church entry per municipality we formulate and estimate a dynamic game of church entry. We recovered the payoffs of the main Evangelical and Catholic churches in Brazil. In line with the descriptive evidence, our structural estimates show that the entry of a new church in a given market reduces payoffs of incumbents, indicating that competition between churches is relevant to explain the structure of religious markets. More importantly, estimates indicate that Catholics and Evangelicals adopt different technologies to open and operate temples. Catholics technology is characterized by lower operating costs and higher sunk entry costs; Evangelicals, on the other hand, have lower entry costs and higher operating costs. These patterns are in line with observed differences in the business models adopted by these two groups of churches.

We solve the model and simulate the number of temples for each year in the 1992-2018 period imposing different tax levels on variable payoffs. We show that subsidies spurred the opening of temples of all denominations, but benefited more Evangelical churches. This is because subsidies in the form of tax exemption on variable payoffs seem to benefit churches that had a smaller stock of temples in the initial years in our sample and not because the technology adopted by Evangelicals is more efficient. We also computed the Laffer curve associated to this tax, taking into account the fact that market structure is an endogenous object, i.e. that the number of firms operating in a market also depends on tax levels. We find an optimal tax rate of 68% and argue that its large magnitude comes from the fact that when the tax rate increases the stock of Evangelical temples plummet but the stock of Catholic temples stays relatively constant for moderate tax rates. The latter effect, in turn, sustains the growth of government tax revenues.

Finally, we estimate that Evangelical temple entry increases the vote share received by the evangelical caucus in Congress by 3.5 percentage points in a given municipality within an event-study framework. By combining these estimates with the counterfactual scenarios from the dynamic entry model, we show that the evangelical vote share in Congressional elections would have been 20% lower if churches were taxed as regular firms. Overall, our results suggest that tax subsidies have asymmetric effects on the spread of different religious denominations as well as a consequential role in the growing political representation of Evangelical groups.

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Online Appendix (Not for Publication)

This appendix (i) brings more details about the growth of Evangelical churches in Brazil (Appendix A); (ii) describes the estimator we use to compute the structural parameters of our model (Appendix B); (iii) describes the algorithms we use to solve the model and to compute our simulations (Appendix C); (iv) shows the Conditional Choice Probabilities (CCPs) that correspond to the first stage of the structural estimation of the model (Appendix D); and (v) additional results of our event-study (Appendices E and F).

Appendix A: Three Waves of Pentecostalism in Brazil

In this appendix we briefly describe the three successive waves of Pentecostal denominations that started to threat Catholic hegemony as discussed in Section 2 (Mariano, 2014).[43]

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*.[44] 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.[45] 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.[46] 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 of 1988, and obtain radio and TV concessions later used a 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).

[43] See Table 1 for a classification of all religious denominations in Brazil used in this paper.

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

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

[46] 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).

Appendix B: Estimators

This appendix describes the estimator we used to estimate the parameters of the structural model.

Miessi Sanches et al. (2016) shows that if the payoff of dynamic discrete choice models takes a linear-in-parameters form, then, for a given discount rate, payoff parameters can be estimated by OLS. Specifically, from equation (5) define the ex-ante expected value function value as – see, for example, Pesendorfer and Schmidt-Dengler (2008):

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

where, $E_\varsigma\left[V_{im}\left(\mathbf{s_m^t},\varsigma_{im}^t;\sigma_{\mathbf{im}}\right)\right]$ denotes the expectation of the unconditional value function over the distribution of ς_{im}^t, $\Pi_{im}\left(\mathbf{a_m^t},\mathbf{s_m^t}\right)$ 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 $\mathbf{s_m^t}$:

$$\mathbf{V_{im}}=\mathbf{\Pi_{im}}+\mathbf{D_{im}}+\beta\mathbf{G_{im}}\mathbf{V_{im}}. \tag{9}$$

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 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 (9) for $\mathbf{V_{im}}$ we have that:

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

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, $\tilde{\mathbf{\Theta}}_{\mathbf{im}}=(\theta_{0i},\theta_{1i},\theta_{2i},F_i,\gamma_{im})'$, we can write $\mathbf{\Pi_{im}}=\mathbf{X_{im}}\tilde{\mathbf{\Theta}}_{\mathbf{im}}$, 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:

$$\mathbf{V_{im}}=\tilde{\mathbf{X}}_{\mathbf{im}}(\beta)\,\tilde{\mathbf{\Theta}}_{\mathbf{im}}+\tilde{\mathbf{D}}_{\mathbf{im}}(\beta), \tag{10}$$

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

$$\int V_{im}\left(\mathbf{s_m^{t+1}},\varsigma_{im}^{t+1};\sigma_{\mathbf{im}}\right)dQ\left(\varsigma_{im}^{t+1}\right)=\tilde{\mathbf{X}}_{\mathbf{im}}\left(\mathbf{s_m^{t+1}},\beta\right)\tilde{\mathbf{\Theta}}_{\mathbf{im}}+\tilde{\mathbf{D}}_{\mathbf{im}}\left(\mathbf{s_m^{t+1}},\beta\right). \tag{11}$$

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

$$V^1_{im}\left(\mathbf{s^t_m}, \varsigma^t_{im}; \boldsymbol{\sigma_{im}}\right) =$$
$$\theta_{0i} + \theta_{1i}\sum_{\mathbf{a^t_{-im}}} \sigma_{im}\left(\mathbf{a^t_{-im}}|\mathbf{s^t_m}\right)\left(\sum_{j\neq i} a^t_{-im}\right) + \theta_{2i}p^t_m + \gamma_{im}\mu^t_{im} + a^{t-1}_{im}F_i +$$
$$\beta\sum_{\mathbf{a^t_{-im}}} \sigma_{im}\left(\mathbf{a^t_{-im}}|\mathbf{s^t_m}\right)\left\{\sum_{\mathbf{s^{t+1}_m}} H_m\left(\mathbf{s^{t+1}_m}|\mathbf{s^t_m}, \mathbf{a^t_{-im}}, a^t_{im} = 1\right)\int V_{im}\left(\mathbf{s^{t+1}_m}, \varsigma^{t+1}_{im}; \boldsymbol{\sigma_{im}}\right) dQ\left(\varsigma^{t+1}_{im}\right)\right\} \tag{12}$$

Substituting equation (11) into equation (12):

$$V^1_{im}\left(\mathbf{s^t_m}, \varsigma^t_{im}; \boldsymbol{\sigma_{im}}\right) =$$
$$\left(\mathbf{X^1_{im}}\left(\mathbf{s^t_m}\right) + \beta E_{\mathbf{s^{t+1}_m}}\left[\tilde{\mathbf{X}}_{\mathbf{im}}\left(\mathbf{s^{t+1}_m}, \boldsymbol{\sigma_{im}}, \beta\right)|\mathbf{s^t_m}, a^t_{im} = 1\right]\right)\tilde{\boldsymbol{\Theta}}_{\mathbf{im}} + \tag{13}$$
$$\beta E_{\mathbf{s^{t+1}_m}}\left[\tilde{\mathbf{D}}_{\mathbf{im}}\left(\mathbf{s^{t+1}_m}, \beta\right)|\mathbf{s^t_m}, a^t_{im} = 1\right],$$

where,

$$\mathbf{X^1_{im}}\left(\mathbf{s^t_m}\right) = [1 \quad \sum_{\mathbf{a^t_{-im}}} \sigma_{im}\left(\mathbf{a^t_{-im}}|\mathbf{s^t_m}\right)\left(\sum_{j\neq i} a^t_{-im}\right) \quad p^t_m \quad \mu^t_{im} \quad a^{t-1}_{im}],$$

and,

$$E_{\mathbf{s^{t+1}_m}}\left[\tilde{\mathbf{X}}_{\mathbf{im}}\left(\mathbf{s^{t+1}_m}, \boldsymbol{\sigma_{im}}, \beta\right)\tilde{\boldsymbol{\Theta}}_{\mathbf{im}} + \tilde{\mathbf{D}}_{\mathbf{im}}\left(\mathbf{s^{t+1}_m}, \beta\right)|\mathbf{s^t_m}, a^t_{im} = 1\right] =$$
$$\sum_{\mathbf{a^t_{-im}}} \sigma_{im}\left(\mathbf{a^t_{-im}}|\mathbf{s^t_m}\right)\left\{\sum_{\mathbf{s^{t+1}_m}} H_m\left(\mathbf{s^{t+1}_m}|\mathbf{s^t_m}, \mathbf{a^t_{-im}}, a^t_{im} = 1\right)\int V_{im}\left(\mathbf{s^{t+1}_m}, \varsigma^{t+1}_{im}; \boldsymbol{\sigma_{im}}\right) dQ\left(\varsigma^{t+1}_{im}\right)\right\}.$$

Simplifying the notation:

$$V^1_{im}\left(\mathbf{s^t_m}, \varsigma^t_{im}; \boldsymbol{\sigma_{im}}\right) = \mathbf{X^1_{im}}\left(\mathbf{s^t_m}\right)\tilde{\boldsymbol{\Theta}}_{\mathbf{im}} + \beta E_{\mathbf{s^{t+1}_m}}\left[\tilde{\mathbf{D}}_{\mathbf{im}}\left(\mathbf{s^{t+1}_m}, \beta\right)|\mathbf{s^t_m}, a^t_{im} = 1\right],$$

with $\tilde{\mathbf{X}}^{\mathbf{1}}_{\mathbf{im}}\left(\mathbf{s^t_m}, \beta\right)$ representing the term inside brackets in equation (13). Using the same reasoning we can write the value function conditional on $a^t_{im} = 1$ as $V^0_{im}\left(\mathbf{s^t_m}, \varsigma^t_{im}; \boldsymbol{\sigma_{im}}\right) = \tilde{\mathbf{X}}^{\mathbf{0}}_{\mathbf{im}}\left(\mathbf{s^t_m}, \beta\right)\tilde{\boldsymbol{\Theta}}_{\mathbf{im}}$. Now, plugging $V^0_{im}\left(\mathbf{s^t_m}, \varsigma^t_{im}; \boldsymbol{\sigma_{im}}\right)$ and $V^1_{im}\left(\mathbf{s^t_m}, \varsigma^t_{im}; \boldsymbol{\sigma_{im}}\right)$ into equation (6) we have that:

$$Q^{-1}\left(P\left(a^t_{im} = 1|\mathbf{s^t_m}; \boldsymbol{\sigma_{im}}\right)\right) = \left(\tilde{\mathbf{X}}^{\mathbf{1}}_{\mathbf{im}}\left(\mathbf{s^t_m}; \beta\right) - \tilde{\mathbf{X}}^{\mathbf{0}}_{\mathbf{im}}\left(\mathbf{s^t_m}; \beta\right)\right)\tilde{\boldsymbol{\Theta}}_{\mathbf{im}} + \tilde{\mathbf{D}}^{\mathbf{10}}_{\mathbf{im}}\left(\mathbf{s^t_m}, \beta\right),$$

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

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

Stacking this equation for all states and market types:

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

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

$$\tilde{\mathbf{\Theta}}_{\mathbf{i}}\left(\beta\right)=\left[\left(\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{1}}\left(\beta\right)-\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{0}}\left(\beta\right)\right)'\left(\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{1}}\left(\beta\right)-\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{0}}\left(\beta\right)\right)\right]^{-1}\left[\left(\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{1}}\left(\beta\right)-\tilde{\mathbf{X}}_{\mathbf{i}}^{\mathbf{0}}\left(\beta\right)\right)'\mathbf{Y_i}\right]. \quad (14)$$

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

Differently from popular estimators in this literature – see Aguirregabiria and Mira (2007), Bajari et al. (2007) and Pesendorfer and Schmidt-Dengler (2008), among others – this estimator does not require the utilization of complex optimization methods and has a global maximum. Conveniently, because the estimator has a closed form it speeds up considerably the estimation algorithm.

Appendix C: Model Solution and Simulations

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 (14), in step h we compute the vector of equilibrium probabilities implied by the model for all states, market types and players using equation (6):

$$P^h\left(a_{im}^t = 1|\mathbf{s_m^t}; \sigma_{\mathbf{im}}\right) = Q\left(V_{im}^1\left(\mathbf{s_m^t}, \varsigma_{im}^t; \tilde{\mathbf{P}}_{\mathbf{im}}^{\mathbf{h-1}}\right) - V_{im}^0\left(\mathbf{s_m^t}, \varsigma_{im}^t; \tilde{\mathbf{P}}_{\mathbf{im}}^{\mathbf{h-1}}\right)\right), \tag{15}$$

   where, $\tilde{\mathbf{P}}_{\mathbf{im}}^{\mathbf{h-1}}$ 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 (15) by $\mathbf{P_m^h}$.

2. If $||\mathbf{P_m^h} - \mathbf{P_m^{h-1}}|| < \lambda$ the algorithm stops; otherwise we set $\tilde{\mathbf{P}}_{\mathbf{m}}^{\mathbf{h}} = \mathbf{P_m^h}\psi + \mathbf{P_m^0}(1-\psi)$, where $\psi \in [0,1]$ is a parameter and $\mathbf{P_m^0}$ is the initial guess for beliefs, and go back to (1) substituting $\tilde{\mathbf{P}}_{\mathbf{m}}^{\mathbf{h}}$ on the right hand side of equation (15).

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. To examine the plausibility of the estimates we compare the equilibrium probabilities produced by this algorithm with the equilibrium probabilities obtained from the solution of the following problem:

$$\underset{\mathbf{P}}{min}\ \mathbf{\Phi}(\mathbf{P})'\mathbf{\Phi}(\mathbf{P}),$$

where, $\mathbf{\Phi}(\mathbf{P})$ is the vector with the difference between the left and the right hand side of equation (6) stacked for all states, markets and churches. The solutions obtained from both algorithms were very close. We opted for the first algorithm because it is considerably faster than the second. 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 vector of states observed in 1991 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, $\hat{n}_i^{1991} = \sum_{m=1}^{M} \mathbb{I}\left(a_{im}^t = 1\right)$, 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 1992.

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.

In practice, we repeat this process $S = 100$ times. We also analyzed the performance of the algorithm using larger values for S. Results were quite close to those obtained when we used $S = 100$. The computational costs of increases in S. To keep the estimation time within reasonable limits we fixed $S = 100$.

Appendix D: Conditional Choice Probabilities and State Transitions

This Appendix shows estimates for the CCPs. CCP estimates are based on the following Probit model:

$$P\left(a_{im}^{t}=1|\mathbf{a_m^{t-1}},p_m^t\right)=$$
$$\Phi\left(\rho_0+\rho_1 a_{im}^{t-1}+\sum_{j\neq i,j\in E}\rho_{2j}n_{jim}^{E,t-1}+\rho_3 n_{im}^{C,t-1}+\rho_4 p_m^t+\rho_5 a_{im}^{t-1}\mu_m^t+\rho_6 p_m^t\mu_m^t+\rho_7\mu_m^t+\mu_i\right) \tag{16}$$

where, $a_{im}^t\in\{0,1\}$ is church i's action in municipality m, period t, $\mathbf{a_m^{t-1}}$ is a vector containing the actions of all churches in the previous period, $n_{jim}^{E,t-1}$ is the number of temples of (other) Evangelical churches, $j\in E=\left\{1,2,...,N^E\right\}$, $j\neq i$, competing with church i in market m, period $t-1$; $n_{jim}^{C,t-1}$ is the number of Catholic temples competing with church i in market m period $t-1$; p_m^t is the population in market m, period t; μ_i is a church fixed effect; 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 3 – and $\Phi\left(\cdot\right)$ represents the CDF of a standard Normal distribution. 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. To estimate the model we interact the variables $n_{jim}^{E,t-1}$ and $n_{jim}^{C,t-1}$ with denomination dummies; denomination fixed effects were included in all models. For the catholic church we estimate an analogous model, excluding the variable $n_{jim}^{C,t-1}$ from the equation. Estimates of the coefficients are in Table 5.

Table 5: 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]	-
$\mu_m^t \cdot p_m^t$	-	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.

Appendix E: The Timing of Temple Entry

The decision to enter a municipality is likely influenced by population size and other regional socioeconomic features. While the relative characteristics of different localities do not represent an identification challenge *per se*, the effect of church entry would be confounded if implementation timing was determined as a response to municipality-specific trends in FPE vote share.

In this Appendix we examine whether pre-determined socio-demographic characteristics of municipalities predict the timing of temple entry. Table 6 presents estimates for η in the following equation

$$Year_{ms} = \eta \mathbf{X}_{ms,1991} + \lambda_s + \epsilon_{sm} \tag{17}$$

where $Year_{ms}$ is the year of temple entry in municipality m of state s, $\mathbf{X}_{ms,1991}$ is a vector of pre-determined socio-demographic characteristics and λ_s are region fixed effects.

Table 6: Determinants of timing of temple entry

	(1) Evangelical	(2) Evangelical	(3) Catholic	(4) Catholic
Household income (in 1000's)	-2.528	0.656	1.105	2.215
	[2.097]	[2.200]	[2.288]	[2.432]
1992 Population (in 1000's)	-0.187	-0.190	-0.150	-0.144
	[0.072]***	[0.071]***	[0.075]**	[0.076]*
% Male	-6.791	45.605	-49.522	-42.057
	[40.454]	[42.689]	[41.147]	[44.413]
% White	-1.097	-5.136	-7.462	-9.803
	[2.988]	[3.267]	[3.259]**	[3.605]***
% Evangelicals	-38.620	-25.669	-4.844	3.091
	[8.988]***	[9.573]***	[10.158]	[11.440]
% No schooling	55.612	65.398	36.816	47.951
	[48.422]	[47.759]	[50.403]	[51.250]
% Elementary	50.387	59.562	48.170	54.539
	[52.292]	[51.271]	[54.318]	[55.001]
% High School	40.188	36.543	-54.935	-38.987
	[77.581]	[76.516]	[80.953]	[82.139]
Observations	236	236	214	214
R-squared	0.17	0.22	0.11	0.13
Region FE	No	Yes	No	Yes

Table 6 presents estimates for equation 17 for Evangelical and Catholic churches. Overall, earlier temple entry took place in more populous localities across denominations. Evangelical churches also enter earlier in places with larger pre-existing share of evangelicals, and Catholics enter earlier in municipalities with greater share of white population. These estimates are unchanged when we include region fixed effects. To account for these entry patterns, in the main analysis described below we control for municipality fixed effects to account for pre-existing differences in levels across areas as well as including region dummies and the relevant socio-demographic characteristics interacted with year dummies.

Appendix F: Event-Study Results

In this Appendix we show the coefficients of the event-study for different specifications of equation 8. Column (1) of Table 7 in the Appendix gives estimates corresponding to Figure 10. Column (2) add controls for socio-demographics characteristics interacted with time dummies, $W_{mt,1991}$, and region-year fixed effects, α_{st}

Table 7: Evangelical temple entry and election outcomes

	(1) FPE votes	(2) FPE votes	(3) Turnout	(4) Turnout	(5) Invalid	(6) Invalid
-3 or -2 years	0.013	0.016	0.007	0.005	-0.004	-0.002
	[0.010]	[0.010]	[0.008]	[0.007]	[0.005]	[0.004]
-1 or 0 years	0.007	0.007	0.006	0.004	-0.007	-0.007
	[0.012]	[0.012]	[0.010]	[0.009]	[0.006]	[0.004]
+1 or +2 years	0.035	0.031	0.020	0.017	0.003	0.002
	[0.015]**	[0.015]**	[0.010]**	[0.009]*	[0.005]	[0.005]
+3 or more years	0.032	0.031	0.008	0.002	0.000	-0.001
	[0.010]***	[0.010]***	[0.008]	[0.007]	[0.004]	[0.004]
constant	0.046	0.030	0.737	0.729	0.071	0.073
	[0.008]***	[0.015]*	[0.007]***	[0.009]***	[0.003]***	[0.004]***
Observations	1462	1462	1462	1462	1462	1462
R-squared	0.45	0.51	0.69	0.75	0.85	0.87
Socio-demographics X Year FE	No	Yes	No	Yes	No	Yes
Region-year FE	No	Yes	No	Yes	No	Yes