Secularization and Long-Run Economic Growth

Holger Strulik[*]

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Abstract. This paper integrates a simple theory of identity choice into a framework of endogenous economic growth to explain how secularization can be both cause and consequence of economic development. A secular identity allows an individual to derive more pleasure from consumption than religious individuals, leading secular individuals to work harder and to save more in order to experience this pleasure from consumption. These activities are conducive to economic growth. Higher income makes consumption more affordable and increases the appeal of a secular identity for the next generation. An extension of the basic model investigates the Protestant Reformation as an intermediate stage during the take-off to growth. Another extension introduces intergenerationally dependent religious preferences and demonstrates how a social multiplier amplifies the speed of secularization.

Keywords: economic growth, religion, identity, productivity, secularization, comparative development.

JEL: N30, O10, O40, Z12, Z13.

In a consumer culture the consumer, not Christ, is king.

(Skye Jethani)

1. Introduction

This paper proposes a novel theory of identity choice and endogenous economic growth in which secularization is both cause and consequence of successful economic development. It contributes to the literature on the fundamentals of economic growth (Acemoglu, 2009) by proposing a theory of how culture, driven by economic change, may change rapidly and where cultural change in turn drives further economic development. The core idea is that through abandoning their religious identity (their strife for salvation from the dire situation on earth), individuals are able to derive more pleasure from material possessions and consumption activities. The prospect of pleasure in this world motivates them to work harder and save more for future consumption. Increasing labor supply and capital accumulation induces technological progress and income growth, which entices further individuals to abandon religion in order to derive more pleasure from material possessions, which motivates them to supply more labor and capital, etc. Through this feedback loop, the economy takes off when religiosity declines and industrialization is observed in conjunction with secularization.

Following the literature, I define 'religious' as believing in a god or a group of gods and following the rules of a religion (Merriam-Webster, 2015). Although the proposed theory is perhaps more general, the paper focuses on economic and religious developments of the Western world, which means it focuses on Christian beliefs. I define as the core creed of Christian religion that through belief in and acceptance of the death and resurrection of Jesus Christ, sinful humans can be reconciled with God and thereby are offered salvation and the promise of eternal life (Metzger and Coogan, 1993). The Christian Church is the agent specialized in promoting the desire for these immaterial (heavenly) values and goals (Ekelund et al., 1996). I define as religious identity the self-identification with Christian religious values. In Section 2, I argue that individuals identify with either immaterial self-transcendence values (religion) or with material self-enhancement values (materialism). I argue that individuals using individual possessions or consumption activities as identity fixers have choosen a secular (materialistic) identity.

I define as secularization, the decline in the social significance of religion manifested by the decline in the number of religious people (individuals identifying with religion), measured by declining

church attendance (Bruce, 2011). Most scholars of religion agree that for Christians, church attendance is a good measure of religiosity (Brierley, 1999; Bruce, 2011; Warner, 2011). Attending the Sunday service was obligatory for Protestants of most denominations as well as for members of the Anglican Church and deliberate failure to attend Sunday mass is still considered to be a grave sin according to Catholic canon law. In the economists' language, church attendance is a revealed preference. Since church is the only place where sins can be forgiven, not attending shows a loss of interest in salvation and eternal life, the main goods offered by the church. Attendance is strongly but not perfectly correlated with adherence. In particular, attendance declines before membership declines (Bruce, 2011). Moreover, there exists a temporary phase of "fuzzy fidelity" in which many individuals claim that while religion is not important in their life they continue to consider themselves Christians and occasionally appear in church (Voas, 2009). This temporary state is not explicitly taken into account in the theory below but considered to be best described by a secular identity.

As industrialization, secularization is a general phenomenon, observed throughout the Western world. The first data point, however, is only observed in 1851 for England when church attendance was about 60 percent (Brierley, 1999). Since "we can be fairly confident that the people of pre-industrial Europe were deeply religious", we can be certain that secularization began before 1851 (Bruce, 2011). In the 20th century, with ongoing take-off to modern growth, secularization also gained momentum: "During the twentieth century in nearly all postindustrial nations – ranging from Canada and Sweden to France, Britain, and Australia – official church records report that where once the public flocked to Sabbath worship services, the pews are now almost deserted." (Norris and Inglehart, 2004). According to the latest Win-Gallup (2012) poll, the global average of the religiosity index declined by 9 percent from 2005 to 2011. Religiosity declined almost everywhere in Europe and in the US (by 13 percent) and also in some developing countries. Iannaccone (2003) and Voas (2009) provide long-run data for a panel of countries over the 20th century and show that for every country, religious activity was higher at the beginning of the period than at end. The onset and pace of secularization, however, appears to be country-specific. Section 4 of this paper suggests one explanation of idiosyncratic economic and religious development based on the denomination of state religion.

Many studies have found a positive association between economic development and secularization. Inglehart and Baker (2000), for example, investigate modernization across countries by

computing a secular value index from the World Value Surveys and find a significant and quantitatively important association of income per capita and the secular value index. In fact, 70 percent of the cross-country variation of secular values can be explained by income, the employment share in the industrial sector, and three dummies (Communist, Catholic, and Confucian). Likewise, McCleary and Barro (2006) find across countries a causal negative effect of income on religious participation and beliefs, which is also quantitatively important. A one standard deviation increase in log GDP per capita decreases church attendance by 17 percent. In a second exercise they take growth of income per capita as the independent variable and find that monthly attendance at church has a significantly negative impact on growth. Paldam and Gundlach (2013) use the World Value Survey to compile a country-specific religiosity index (14 items from "God is very important in life" to "Churches answer spiritual needs") and find a negative impact of income on religiosity. On average, religiosity falls by 50 percent when countries pass through the transition from being underdeveloped to becoming a developed country.

While Paldam and Gundlach (2013) did not establish a causal influence of secularization on economic development, other studies argue in favor of such a feedback mechanism. Lipford and Tollison (2003), for example, document a bi-causal negative association of income and religious participation across US states. Rupasingha and Chilton (2009) use US county-level data on religious adherence and find a causal negative effect of adherence on economic growth. Acknowledging that secularization is usually understood as a dynamic process, Herzer and Strulik (2013) investigate the time series properties of church attendance rates and income per capita for a panel of countries from 1930-1990, based on the Iannaccone (2003) data. They find a cointegration relationship between both variables and that a one percent increase in the log of income per capita is associated with a decline in church attendance by about 9 percentage points. Causality runs in both directions, supporting the view that secularization is cause and consequence of economic development.

The available empirical literature thus provides some supporting evidence that vanishing religiosity (secularization) plays a role for comparative economic development. The negative association between religiosity and income may appear surprising at first sight, since there is also evidence across countries that actively religious persons display several "good" attitudes which are thought to be conducive to growth; in particular, trust and trustworthiness (Guiso et al., 2003). The explanation offered by the present paper is that individuals identifying with religion put more emphasis

on immaterial values and strife less for worldly pleasures and possessions. An individuals identifying with secular or consumerist values can be expected, ceteris paribus, to work harder and to save more in order to enjoy more consumption and engage in more leisure activities now and in the next period.

Sociologists and theology scholars generally regard secularization as a complex, multi-dimensional phenomenon, driven by increasing individualism, rationalism, religious pluralism, liberalism, scientific developments, structural change, and more (Warner, 2010; Bruce, 2011). Rigorously applying Occam's razor, the theory of the present paper focuses on one aspect of secularization in order to generate a feedback loop between secularization and economic growth: consumerism. Pleasure seeking consumption is the most relevant aspect in the context of long-run growth because it is through a consumption-induced increase of labor supply and savings that secularization can be simultaneously cause and consequence of economic development.

The present study is related to a few papers investigating the role of "the spirit of capitalism" in the theory of economic growth, notably Zuo (1994, 1995), Cavalcanti et al. (2007), and Doepke and Zilibotti (2008). The papers by Zuo and Calvacanti et al. investigate the impact of alternative given preferences and character traits on economic growth. The paper by Doepke and Zilibotti is more closely related to the present one in that it also proposes a theory of preference formation. Parents shape their children's preferences for leisure and patience depending on occupational possibilities. The theory is useful in explaining the demise of the aristocracy and the rise of a capitalist middle class during industrialization. Doepke and Zilibotti put less emphasis on explaining the economic take-off of aggregate income per capita and productivity and do not consider the secularization of a society.[1]

In some sense the present paper provides a unified growth theory (Galor, 2011). It explains a long epoch of quasi stagnation as well as a terminal epoch of balanced growth and the endogenous emergence of a take-off period connecting the initial and terminal stages. The mechanism that generates these dynamics, however, is new and non-standard. It is based on the interaction between income and identity choice. In the period of (quasi) stagnation, income and consumption opportunities are limited and religion dominates the daily life. Because people identify predominantly with religious, immaterial values, they supply relatively little labor and save little for future consumption. The economy, nevertheless, grows (at glacial speed) because learning-by-doing improves

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[1] See also Strulik (2012a) who investigates the role of patience for explaining the gradual take-off to growth in a representative agent framework.

factor productivity. As income rises people increasingly identify with secular, material values and start to work more and save more for future consumption. Eventually, the economy takes off, accompanied by a consumer revolution (McKendrick et al., 1982) and an industrious revolution (Voth, 1998). With increasing secularization, savings rates, and productivity the economy finally converges toward a terminal stage of high and constant growth.[2]

The paper is organized as follows. The next section motivates the underlying theory of identity choice. Section 3 introduces the basic model, derives the main propositions, and calibrates the model to reproduce the long-run economic and religious development of England. Section 4 extends the model by allowing for identification with two distinct religions. One of these, Protestantism, promotes deriving utility from wealth accumulation. The extended model explains the endogenous rise and fall of Protestantism. I also investigate the case when there is no individual choice of religious denomination and compare the impact of Catholic vs. Protestant state religions on the speed of secularization and economic development. Section 5 introduces social interaction at church, which, for simplicity, has been neglected in the basic model. The fact that the value of religious identity depends on how many other people identify with religion creates a social multiplier and amplifies the speed of secularization. Section 6 concludes by mentioning limitations of the present study and by providing an outlook for future research. The Appendix discusses an extended version of the basic model, in which parents may make an effort to raise their children religiously (vertical socialization). Conditions are shown under which the model is isomorph to the one in the main text. The Appendix also provides an extension towards increasing variety of consumer goods. The extension preserves all basic results and perhaps better captures the common notion of consumerism as the desire to possess and consume an increasing variety of goods.

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[2] The standard mechanism of unified growth theory is built upon the evolution of demographic variables interaction with education and aggregate productivity growth. See, Galor and Weil (2000), Kögel and Prskawetz (2001), Jones, 2001, Lucas (2002), Boucekkine et al. (2002), Doepke (2004), Galor and Mountford (2008), Strulik and Weisdorf (2008) and many others. Of course, the present paper does not deny the importance of demographic change for long-run economic development. Abstracting from demographics helps to keep the model simple, to disentangle effects, and to establish, in theory, identity choice and its impact on economic behavior as a stand-alone mechanism, which, of course, in practice interacts with demographic forces. In the Appendix I provide an extension towards endogenous fertility. The model predicts that religious individuals, ceteris paribus, have more children while all results from the simple model are preserved. The theory thus also provides a new, complementing explanation of the fertility transition as driven by secularization.

2. Religious vs. Secular Identity

The theory of secularization offered by the present paper is inspired by Akerlof and Kranton's (2000, 2010) economic theory of identity. Akerlof and Kranton argue that preferences and individual utility are identity-specific and that identities are chosen, given certain constraints. In order to facilitate access to the new field of identity economics they carefully explain that people are not necessarily aware that they actively choose the utility-maximizing identity. Referring to Friedman's (1953) general methodology of positive economics, it is important that people behave as if they maximize their utility regardless of whether they are aware of their maximizing behavior. A religious identity is certainly less ascriptive than several other dimension of identity and can be relatively easily abandoned.[3] Abandoning the immaterial and ascetic values propagated by religion in favor of a secular identity allows an individual to experience – without feeling of guilt – the full pleasure provided by consumption activities and material possessions.

While all major religions criticize excessive consumption for being inconsistent with religious fulfillment (Landis, 1957; Belk, 1983), this is particulary true for the Christian church (Abela, 2007). The motivation is clear: the church views the strife for "worldly" possessions and the pleasure derived from consumption activities as being in direct competition to the goods it offers, i.e. salvation from sin, redemption from the dire situation on earth, and a place in heaven with Jesus Christ. According to Weber this strife for salvation generates emotional gratification in the here and now (Weber, 1920; Stolz, 2006), a phenomenon that in the economists' language could be called the present value of the expected rewards from eternal life. Below, I will call it briefly the "value of religion". For a religious individual the purpose of earthly life is salvation and not the pleasure derived from material possessions (Stearns, 2001).

When religion is abandoned such that an individual obtains no utility from salvation goods, we return to the standard economic model of the consumer. Consumption (in this period and the next) and leisure are the only elements of the utility function. With consumption being the only goal, individuals, according to Akerlof and Kranton (2000), now use possessions (the house, the BMW, the stamp collection) and consumption activities (shopping at Ikea, attending a Sunday football match) as identity fixers (as home owner, 'BMW-man', stamp collector, football club supporter, etc). A secular identity could also be called a materialistic identity and the act of seeking pleasure through consumption could be called materialism. I prefer to use 'secular' instead of 'material'

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[3] See Caselli and Coleman (2013) for a paper on ethnic identity choice, which seems to be much harder to accomplish.

because it illustrates that one has to abandon religious identity in order to derive the full pleasure from consumption.

The literature in sociology and marketing provides ample evidence that possessions and consumption activities are used for self-identification (Prelinger, 1959; Baudrillard, 1998; Belk, 1983, 1985; Micken and Roberts, 1999; Mittal, 2006). From the perspective of psychology, this identification with "self-enhancement values" through consumption has been found to conflict with the identification with "self-transcendence" values as manifested in religious values (Schwartz, 1994; Kilbourne et al., 2005). Some scholars argue that consumption provides meaning that had previously been provided by religion (Belk et al., 1989; Twitchell, 1999), a view to which also religious scholars concur. As summarized by Hugh Whelchel, director of the Institute of Faith, Work, and Economics, "Consumerism has become for many the de facto religion of the 21st century" (Whelchel, 2013). From the long-run perspective of Christianity, the emphasis of consumption is indeed observed as a relatively new phenomenon: "Several essential features of today's capitalism were either unimaginable or positively condemned throughout most of Christian history. We suffer no crisis of conscience, nor even a second thought, about consuming goods or experiences solely for relaxation and amusement. Yet Puritans and our Christian forebears of other strains understood consumption principally for pleasure as sinful indulgence." (Clapp, 1996)

Although consumerism is a relatively new phenomenon, the Christian church has always acknowledged its potential threat to religious faith and demand for salvation. The teaching of the Bible diminishes wealth ("It is easier for a camel to go through a needle's eye than for a rich man to enter the kingdom of God."; Luke 18:25) as well as consumption ("Do not love the world or the things in the world. If anyone loves the world, the love of the Father is not in him. For all that is in the world – the desires of the flesh and the desires of the eyes and pride in possessions – is not from the Father but is from the world."; 1 John 2:15-16). Similar advise is given by the Old Testament: "The heart of the wise is in the house of mourning, but the heart of fools is in the house of pleasure."(Ecclesiastes 7:4). In the Middle Ages, Thomas of Aquinas warned that the desire for material possessions is disordered and conflicting with the desire for God (Thomas Aquinas, 1947). In the 19th century, Pope Leo warned against the desire for wealth and the strife for pleasure in the encyclical "Rerum Novarum" (Leo XIII, 1891), which is commonly considered as the foundation of modern Catholic social teaching. In the 20th century the encyclical "Solicitudo Rei Socialis" of Pope John Paul II (1987) expands on these issues by strongly condemning

consumerism and by developing the notion of "super-development" as a state that "makes people slaves of possession and of immediate gratification, with no other horizon than the multiplication or continual replacement of the things already owned with others still better." The view of the Catholic church was largely taken over and amplified to different degrees by the Protestant denominations. As noted by Weber (1904), Protestantism aimed to make every Christian a monk. In particular, ascetic Protestantism introduced the strife for wealth accumulation (Weber, 1904) but kept condemning consumerism, as summarized in Wesley's sermon: "Gain all you can by honest industry"...[but]... "Do not waste any part of so precious a talent merely in gratifying the desire of the eye by superfluous or expensive apparel, or by needless ornaments. Waste no part of it in curiously adorning your houses; in superfluous or expensive furniture; in costly pictures, painting, gilding, books; in elegant rather than useful gardens." (Wesley, 1744).

The present paper thus argues that it is no coincidence that the timing of industrialization, consumerism, and secularization roughly coincides.[4] Consumerism, defined as a society in which individuals formulate their goals partly or largely through acquiring goods beyond essential needs, began in Western Europe in the 18th century. This led to increasing demand for sugar, tea, and other colonial goods, and the emergence of the shopkeeper and advertisement (McKendrick et al., 1982, Stearns, 2001). Historians debate whether it was initiated predominantly by (mildly) declining poverty or whether consumerism was spurred by "exogenous" events. The theory proposed below allows for both explanations. The literature suggests that the Enlightenment and its focus on the material world rather than religious values as well Romanticism and its praise of emotion and individualism served as exogenous impulses of consumerism (Campbell, 1987; Stearns, 2001). Like industrialization, consumerism experienced an onset and a take-off phase. The latter was reached in the mid-19th century, propelled by the inventions of the department store (Zola, 1883), the amusement park, tourism, and spectators sports (Benson, 1994; Stearns, 2001).

The hypothesis that increasing consumption activity rather than increasing income supplants religious activity is supported by Hirschle (2011) who investigates church attendance rates across 82 European regions. Hirschle begins by confirming the negative association between attendance and income found in other studies. He then compiles an index of "consumption-related cultural activities" (number of visits to cinemas, concerts, sports events, etc.) and shows that consumption wins the "horse race" against income. When both are taken into account in the regression,

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[4]In fact, the observation of long periods of secularization in a stagnating economy would falsify the present theory.

income turns insignificant and a significantly negative correlation between church attendance and consumption activities emerges. Additionally, Hirschle shows that at the micro level, individual income is an insignificant explanation of church attendance in regressions in which consumption activities are represented (with a significantly negative sign).[5] These observations are consistent with a study by Gruber and Hungerman (2008) showing how religious participation across US states declined when laws prohibiting retail activity on Sunday were repealed. Stillman et al. (2012) provide corroborating experimental evidence by showing that a higher level of spirituality of test persons corresponds with a decreased desire to consume material goods.

3. The Basic Model

3.1. **Preferences.** Consider an economy populated by two overlapping generations, each consisting of a measure $(0, 1]$ of individuals. As usual, individuals experience utility from consumption and leisure. Furthermore, they experience utility from identifying themselves with a social group. A social group shares a common perspective from which to view the world and a set of basic principles to live out. For simplicity, there are only two identities available, a religious identity and a secular identity. In line with psychological evidence and recent modeling in economics we understand identity as an individual control variable (Akerlof and Kranton, 2000). Formally, identity is a bivariate indicator variable, $\sigma_t \in \{0, \ 1\}$, with $\sigma_t = 1$ if individuals identify with secular, "consumerist" values and $\sigma_t = 0$ if they identify with religious, immaterial values.

Individuals are assumed to be heterogenous in the value that they attach to religiosity but are otherwise, as common in growth theory, assumed to be homogenous. Specifically, let ρ be a measure of the general value of religion in society and let $\rho R(i)$ denote the utility that individual i experiences from being religious if he or she shares a religious identity. The general value of religion ρ is taken as given by individuals but it may be subject to parametrical shifts (the Enlightenment). Later, in an extension of the basic model, we allow the value attached to religion to depend on the number of religious persons in society. For the basic model, we abstract from social interaction and treat it parametrically. In order to get analytical results we assume that the individual value of religion is uniformly distributed in the society such that $R(i) \in [0, 1]$. Later, we also investigate

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[5] Hirschle (2010) presents corroborating evidence from Ireland's recent growth and secularization history.

a Pareto distribution, which captures, perhaps more realistically, the feature that some individuals never abandon religion.[6]

Religious individuals place less value on utility experienced from consumption than individuals identifying with secular values. In economic terms, less utility gained from consumption is the "opportunity cost" of a religious identity. Only persons who abandon their religious identity are capable of enjoying the full pleasure from consumption. This is the minimum setup of an identity-driven growth model. Extensions are conceivable. For example, identifying with religion could also involve a time cost (for prayer and churchgoing; Azzi and Ehrenberg, 1975) or a monetary cost (tithe). Identification with religion may furthermore imply the forgoing of interest on savings. For the sake of simplicity, we refrain from these extensions, which could be integrated without loss of generality.

Summarizing and assuming log functional forms, an individual born at time t experiences utility

$$u_t = (\alpha + \sigma_t) \log c_t + \beta (\alpha + \sigma_t) \log c_{t+1} + \gamma \log (1 - \ell_t) + (1 - \sigma_t) \rho R, \qquad (1)$$

in which c_t and c_{t+1} denote consumption when young and when old, respectively, and ℓ_t denotes labor supply when young. Old age is defined as the period of retirement. If an individual identifies with secular values, $\sigma_t = 1$, and the utility function reduces to the one of a standard OLG model with endogenous labor supply. If an individual identifies with religious values $\sigma_t = 0$, and the individual experiences utility from being religious at the expense of reduced utility from consumption. The parameter α is potentially dependent on the specific religion. Some denominations recommend or require an ascetic life style (small α) while others require less sacrifice (high α).

Notice that all economically relevant decisions are made in the first period of life. The model is thus robust against conversion at the end of the second period of life, "in the face of death". Such a move would be driven by expectations about the impact of religiosity on the *afterlife*. It incurs no opportunity costs and has no impact on savings and work effort, since these decisions

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[6] The analysis should be conceptualized as starting somewhere in the Middle Ages with a given distribution of religious value. This paper does not answer the interesting question of where the given distribution of religious value originated from. See Wright (2005) for an introduction to the long-run evolution of religion and religiosity. As it will become evident below, the specific distribution is not decisive for the result of gradual secularization and economic take-off. Only a homogenous society would spontaneously secularize or not at all. But even there, the central mechanism would be preserved. Only the dynamic system would be piece-wise linear with a bang-bang solution.

have already been made. The variable $R(i)$, in contrast, measures the value of a religious identity for the *here and now*, where it incurs opportunity costs in terms of pleasure from consumption.[7]

Young individuals take wages as given and earn a labor income $w_t \ell_t$. Furthermore, they operate a home production technology which generates b units of goods. With s_t denoting savings, the budget constraint is given by

$$w_t \ell_t + b - c_t - s_t = 0. \tag{2}$$

Assuming a (small) contribution of home production to total income is unnecessary for the main results. It adds more realism by ensuring that an equilibrium of stagnation, if it exists, is associated with a positive capital stock and positive aggregate output. Without home production, the equilibrium of stagnation would coincide with the origin.

3.2. **Identity-Specific Labor Supply and Saving.** Maximizing the utility function (1) with respect to the budget constraint (2) and the savings constraint $c_{t+1} = (1 + r_t)s_t$, in which r_t is the interest rate net of depreciation, provides the following solution.

$$c_t = \frac{(\alpha + \sigma_t)(w_t + b)}{(\alpha + \sigma_t)(1 + \beta) + \gamma} \tag{3}$$

$$s_t = \frac{\beta(\alpha + \sigma_t)(w_t + b)}{(\alpha + \sigma_t)(1 + \beta) + \gamma} \tag{4}$$

$$\ell_t = \frac{(\alpha + \sigma_t)(1 + \beta)w_t - \gamma b}{[(\alpha + \sigma_t)(1 + \beta) + \gamma]\, w_t}. \tag{5}$$

In order to avoid distracting case differentiation, we assume that the return from home production b is low enough to allow for an interior solution of labor supply ℓ_t, that is $w_t > \gamma b / [(\alpha(1 + \beta)]$. Religious individuals, that is individuals who set $\sigma_t = 0$, derive less pleasure from consumption and consequently supply less labor and save less for future consumption.

PROPOSITION 1. *For given wage rate, individuals identifying with secular values supply more labor and save more.*

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[7] It can be shown that the model is isomorph to one in which the negative consequences of a hedonistic life style are borne exclusively in the (potentially infinite) afterlife, i.e. in which household maximize

$$u_t = \tilde{\alpha} \log c_t + \tilde{\beta} \log c_{t+1} + \tilde{\gamma} \log (1 - \ell_t) + (1 - \sigma_t) \left\{ \tilde{\rho} R - \sum_{i=t+2}^{\infty} \beta^i \left[\log(c_t) + \log(c_{t+1}) \right] \right\}.$$

At first sight, the latter case appears to be non-robust against conversion at the end of life on earth. In principle, individuals could behave hypocritically and try to "outsmart god" by living a hedonic life in anticipation of conversion and forgiveness of sins shortly before death. This approach, however, becomes again consistent with the one of the main text by defining that hypocritical behavior means no (true) identification with religious values.

This is proven by inspecting the derivative of (3)-(5) with respect to σ_t and observing that $\partial \ell_t / \partial \sigma_t > 0$ and $\partial s_t / \partial \sigma_t > 0$.

A religious transition during which a majority of the population changes identity will thus be characterized by increasing labor supply (an industrious revolution) as well as increasing savings (capital accumulation) and increasing consumption (consumer revolution). The aggregate savings rate increases along the religious transition although individual savings rates $s_t / (w_t + b)$ stay constant because secular individuals have a higher incentive to save in order to experience more pleasure from consumption in old age. This result will be qualified in Section 4 when we consider a religious motive for saving.

3.3. Identity Choice. Inserting (3)-(5) into (1) we obtain identity-dependent maximized utility.

$$u_t(\sigma_t) = [(\alpha + \sigma_t) + \gamma] \log(w + b) - \gamma \log w - [(\alpha + \sigma_t) + \gamma] \log [(\alpha + \sigma_t) + \gamma] \tag{6}$$

$$+ (\alpha + \sigma_t) \log(\alpha + \sigma_t) + \beta \log \beta + \gamma \log \gamma + \beta(\alpha + \sigma_t) \log(1 + r) + (1 - \sigma_t)\rho R.$$
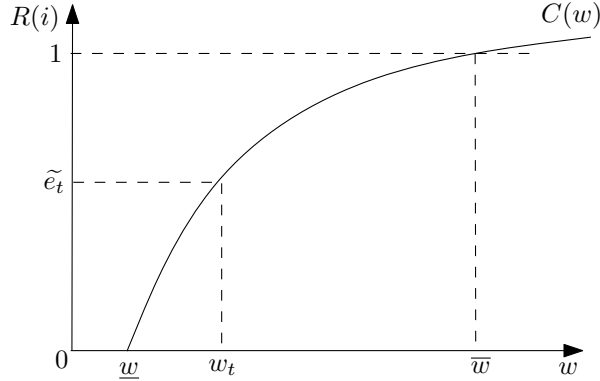
Following the economic theory of identity choice, an individual identifies with religion if it provides more utility than identifying with secular values. This means that individual i, who attaches the value $R(i)$ to religion, identifies with religion if $u_t(0) > u_t(1)$. Calculating the utility difference, we obtain that individual i identifies with religion if

$$R(i) > \frac{1}{\rho} [(1 + \beta) \log(w_t + b) + \phi] \equiv C(w_t), \tag{7}$$

with $\phi \equiv [\alpha(1 + \beta) + \gamma] \log [\alpha(1 + \beta) + \gamma] - [(\alpha + 1)(1 + \beta) + \gamma] \log [(\alpha + 1)(1 + \beta) + \gamma] + (\alpha + 1)(1 + \beta) \log(\alpha + 1) - \alpha(1 + \beta) \log \alpha + \beta \log(1 + r)$. As shown below, the interest rate is constant, $r_t = r$, such that ϕ is constant.

Figure 1 illustrates the result. Individual i chooses a religious identity if $R(i)$ lies above the concave secularization threshold $C(w)$. If $R(i)$ lies below the curve, he or she chooses worldly pleasures. Since $R(i) \in [0, 1]$, we read off that there are $\tilde{e}_t$ persons in society not identifying with religion when the wage per unit of labor is w_t. Generally, however, $C(w_t)$ may be smaller than zero or larger than unity. For $w < \underline{w}$ everybody identifies with religion and for $w > \overline{w}$ nobody identifies with religion. Taking the corner solutions into account, the number of persons in society

FIGURE 1. The Secularization Threshold

who do not identify with religion, denoted by e_t is given by

$$e_t = \max\left\{0 \ , \min\{\tilde{e}_t \ , 1\}\right\}, \qquad \tilde{e}_t \equiv \frac{1}{\rho}\left[(1+\beta)\log(w_t + b) + \phi\right] \ . \tag{8}$$

As wages grow and the society gets richer, fewer individuals are induced to identify with religion, a result that explains the phenomenon of secularization. Notice also that a general devaluation of religion, captured by declining ρ, shifts the $C(w)$–curve upwards and leads to fewer religious individuals in society.

3.4. **Aggregate Savings and Capital Accumulation.** As usual in OLG modeling, we assume that savings of the currently young generation constitutes the capital stock with which the next young generation works. For simplicity, we assume that capital depreciates completely within one generation such that $k_{t+1} = \tilde{s}_t$, in which k_{t+1} is aggregate capital of the next generation and $\tilde{s}_t = \int_0^1 s_t(i)di$. Inserting the savings of secular individuals $s_t^S \equiv s_t(\sigma_t = 1)$ and savings of religions individuals $s_t^R \equiv s_t(\sigma_t = 0)$, we get aggregate savings $\tilde{s}_t = s_t^S \cdot e_t + s_t^R \cdot (1 - e_t)$ of the current young generation. Using (4) to determine identity-dependent savings, we obtain the equation of motion of aggregate capital

$$k_{t+1} = \frac{(\alpha+1)\beta(w_t + b)}{(\alpha+1)(1+\beta)+\gamma} \cdot e_t + \frac{\alpha\beta(w_t + b)}{\alpha(1+\beta)+\gamma} \cdot (1 - e_t). \tag{9}$$

Inspect (9) and recall that secular individuals save at a higher rate to see that the make-up of society has a unique impact on capital accumulation.

PROPOSITION 2. *The larger the population share identifying with secular values e_t, the larger next period's capital stock k_{t+1}.*

This is verified by observing that $\partial k_{t+1}/\partial e_t > 0$ and that secular individuals save at a higher rate, i.e. $\partial s_t/\partial \sigma_t > 0$.

3.5. **Production.** There exists a continuum of size one of competitive firms producing a homogenous output using a Cobb-Douglas production function. In order to establish an analogy to the Romer (1986) model, we measure firm size such that a firm employs one unit of labor. In period t a firm j produces output $y_t(j) = A_t(j)k_t(j)^\theta$. Factor productivity $A_t(i)$ is exogenous to the single firm. The interest rate on competitive markets is thus obtained as $r_t = \theta A_t(j)k_t(j)^{\theta-1} - 1$ and wages are given by $w_t = (1-\theta)A_t(j)k_t(j)^\theta$. Aggregate employment is denoted by k_t and $L_t = \int_0^1 \ell_t(i)\mathrm{d}i$.

Following Arrow (1962) and Romer (1986), we take into account that learning-by-doing (or learning-by-producing) increases productive knowledge and enhances factor productivity. In order to generate long-run growth, knowledge is assumed to be given by $A_t(j) = \bar{A}k_t^{1-\theta}$. On the aggregate level, because of symmetry, $k_t(j) = k_t$, such that output becomes a linear function of capital per worker. This implies $w_t = (1-\theta)\bar{A}k_t$ and $r = \theta\bar{A} - 1$. The parameter $\bar{A}$ controls the diffusion of knowledge independently from the current state of the economy. It can be thought of capturing the effect of persistent determinants of access to knowledge as, for example, institutional barriers to travel and trade.

3.6. **Dynamics.** A linear aggregate production technology is necessary but not sufficient for long-run growth. In order to see this explicitly, insert wages into (8) to obtain the equation of motion for aggregate capital:

$$k_{t+1} = f(k_t) = \frac{(\alpha+1)\beta\left[(1-\theta)\bar{A}k_t + b\right]}{(\alpha+1)(1+\beta)+\gamma} \cdot e_t + \frac{\alpha\beta\left[(1-\theta)\bar{A}k_t + b\right]}{\alpha(1+\beta)+\gamma} \cdot (1-e_t). \qquad (10)$$

For long-run growth to be feasible, $k_{t+1}/k_t > 1$ for $k_t \to \infty$. For high k_t the home production term (b) becomes negligible and the feasibility of long-run growth depends solely on the slope, i.e. on whether $\partial k_{t+1}/\partial k_t > 1$.

In order to focus on the most interesting problem, we make the following assumption.

ASSUMPTION 1.

$$s^S(k_t)' \equiv \frac{(\alpha+1)\beta(1-\theta)\bar{A}}{(\alpha+1)(1+\beta)+\gamma} > 1 > \frac{\alpha\beta(1-\theta)\bar{A}}{\alpha(1+\beta)+\gamma} \equiv s^R(k_t)' \ .$$

This means that long-run growth is feasible if all members of society choose a secular identity, that is for $e_t = 1$, because $s^S(k_t)' > 1$. On the other hand, there is no long-run growth if everybody chooses a religious identity, that is for $e_t = 0$, because $s^R(k_t)' < 1$. In the context of the present paper, Assumption 1 provides the most interesting case because it allows us to capture both growth and stagnation. Notice, however, that the core result of a positive feedback between secularization and economic growth is independent from Assumption 1. If s^R would exceed unity as well, there would also be growth in a completely religious society, albeit at a low rate. It would remain to be true that secularization is cause and consequence of economic take-off since this conclusion relies only on the derived result that s^S exceeds s^R. Likewise, we could assume that $s^S < 1$. In that case, there would never be long-run growth. The model would converge to the Solow model instead of the Ak-growth model but it would remain to be true that secularization is cause and consequence of economic take-off. The take-off of growth rates would be non-permanent and it would only lift the economy to a higher level of income per capita.

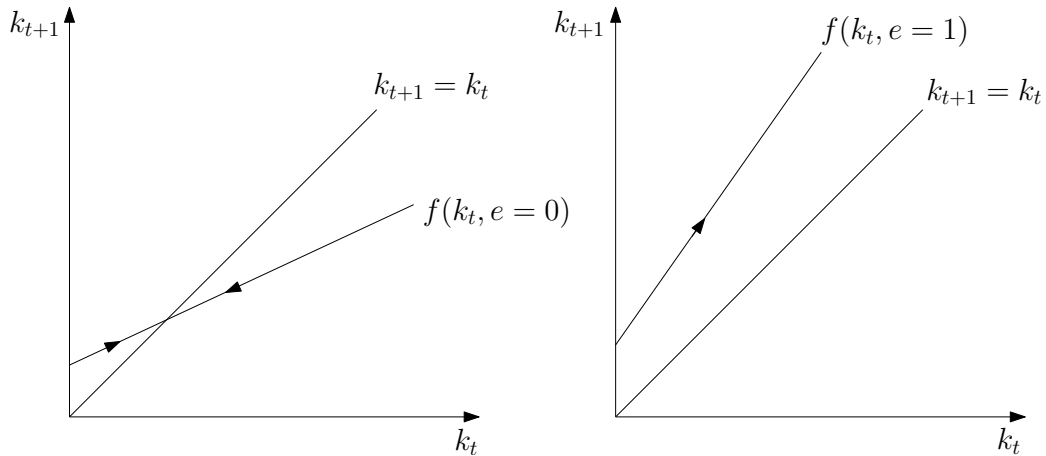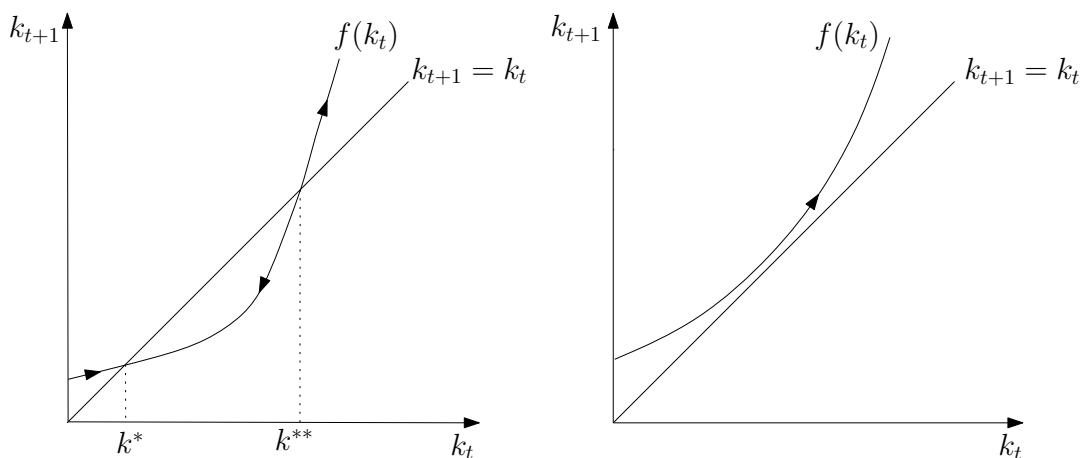FIGURE 2. Phase Diagram: Religious Identity (Left) – Secular Identity (Right)

Figure 2 illustrates Assumption 1. On the left-hand side we see the case when everybody chooses a religious identity. Since $s^R(k)' < 1$, there exists a unique intersection with the identity line, which determines a globally stable equilibrium of stagnation. The right-hand side shows the case when everybody identifies with secular values. There is no intersection with the identity line and $s^S(k)' > 1$ such that there is always economic growth. The long-run growth rate is given by $g \equiv (1 + \alpha)\beta(1 - \theta)\bar{A}/[(1 + \alpha)(1 + \beta) + \gamma] - 1$.

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But Figure 2 illustrates only the two limiting cases. The actual curvature of $f(k)$, as shown in (10), is a linear combination of the limiting cases. When society predominantly identifies with religion, the left-hand side of Figure 2 dominates the aggregate picture and the slope of $f(k)$ is relatively flat. When society predominantly identifies with secular values, the right hand side dominates, and $f(k)$ is steep. Because identity choice is itself a function of wages (8), and wages are a linear function of capital, the share of secular individuals in society is itself a positive function of aggregate capital $e(k)$. The reduced form of the economy consists of one equation of motion for capital per capita. At an earlier stage of development the aggregate capital stock is small, wages are low, most people identify with religion, and labor supply and savings are low. Consequently, the $f(k)$ curve is relatively flat. With rising capital stock, wages increase, more people identify with secular values and the $f(k)$ curve becomes steeper. In short, the $f(k)$ curve is convex, converging asymptotically against a straight line as k goes to infinity.

FIGURE 3. Poverty Trap (Left) – Transition to Long-Run Growth (Right)

There are thus two different cases conceivable, as illustrated in Figure 3. The panel on the left-hand side shows a case in which the $f(k)$–curve intersects the identity line twice. We observe two equilibria, a locally stable one at k^* and an unstable one at k^{**}. This means that social identity is simultaneously cause and consequence of successful economic development. If a medieval society is conceived as stagnating at an equilibrium k^*, at which most individuals identify with religious values and aggregate savings and thus capital and productivity are too low for long-run growth, then an exogenous event is needed to release society from the poverty trap. This would be a

parametric change that shifts the $f(k)$–curve upwards such that the equilibrium of stagnation ceases to exist and the picture looks like the one on the right-hand side of Figure 3.

An upward shift of the $f(k)$–curve could be realized by an exogenous shift of $\bar{A}$, allowing for an easier diffusion of knowledge, as discussed in Strulik (2014). Another possibility could be an event that diminishes the general value of religion ρ. This would shift the secularization threshold $C(w)$ upwards in Figure 1. Ceteris paribus less people identify with religion and as a consequence, the *aggregate* savings rate rises and the $f(k)$–curve shifts upwards. As discussed in Section 2, Enlightenment or Romanticism could be considered as such events.[8]

However, economic take-off and secularization need not be initiated by an exogenous loss of value in religion. Alternatively, both medieval times and the modern era could be captured by the picture on the right hand side of Figure 3. To see this, note that the ratio between the $f(k)$–curve and the identity line provides the gross growth rate of capital k_{t+1}/k_t. The middle ages are then identified as a period in which the $f(k)$–curve comes close to the identity line. In fact, as demonstrated below, the distance between the two curves can be so small that growth becomes unobservable over centuries to the naked eye. Since stagnation does not exist, there is actually always growth of knowledge and productivity but during some "dark period", growth occurs at glacial speed. As the funnel between the two curves widens, the economy takes off and society secularizes endogenously. These insights are summarized by the following proposition.

PROPOSITION 3. *(a) If the value of religion ρ is sufficiently high or autonomous factor productivity $\bar{A}$ is sufficiently low then there exist two equilibria of stagnation, one locally stable (k^*) and one unstable (k^{**}). An economy starting at $k_0 < k^*$ converges to stagnation at k^*. Take off to growth and secularization requires an exogenous event.*

(b) If the value of religion ρ is sufficiently low or productivity $\bar{A}$ is sufficiently high, there exists no equilibrium of stagnation and take-off to growth and secularization are initiated endogenously.

The proof is obvious from the phase diagram analysis performed above.

The case of endogenous secularization, without value loss of religion, helps to rationalize the frequently observed phenomenon that in a secularized society many people still believe in God. These beliefs, however, no longer dominate their daily life. Notwithstanding their beliefs, they

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[8]In the case of Enlightenment, the curve shift could also be conceptualized as being endogenously brought forward. In the simplest case it could be a function of time. After people have contemplated metaphysical issues for a sufficiently long period of time, Enlightenment emerges.
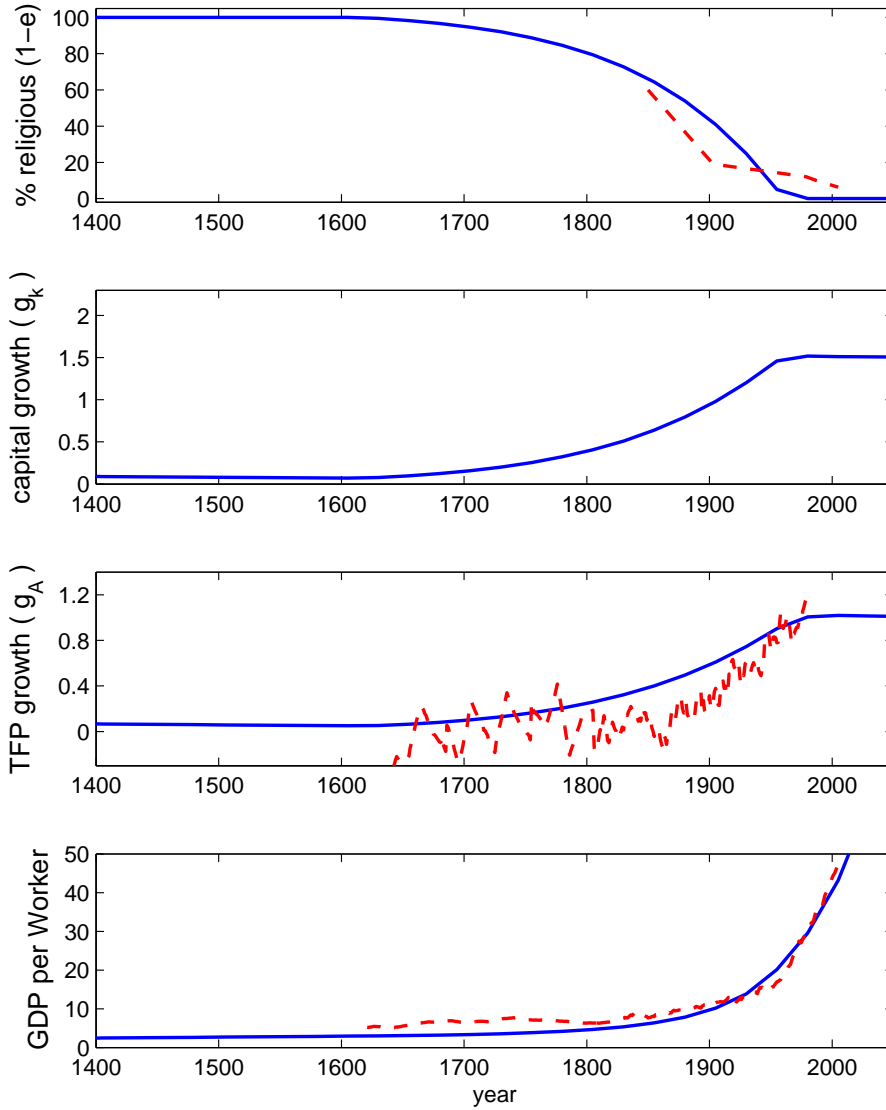
identify with secular, material values because rising income has provided access to worldly plea-sures and has aroused the desire for material possessions. Watching a football game or visiting an amusement park provides higher utility than attending Sunday service at church. Moreover, Sunday service reminds the congregation that true believers would not seek worldly pleasures. Only by abandoning religious identity can individuals experience the full pleasure of consumption. It thus seems reasonable that during secularization, some religious beliefs are kept or changed very slowly while the self-identification with religious values and religious activity (church attendance) recedes, such that a temporary state of "fuzzy fidelity" (Voas, 2009) emerges.

As a corollary, the theory also offers an alternative and complementing view on the Kuznets curve (Kuznets, 1955; Williamson, 1985). During secularization, income inequality first increases with rising average income as more people identify with secular values and work harder and safe more. Inequality reaches a maximum when the population is equally divided between religious and secular identities and then declines with further ongoing secularization.

3.7. **A Calibration Study.** In this section I calibrate the model and investigate how well it can explain the economic take-off and secularization of England. England is a natural choice because of its rich historical data, because it is the pioneer of the Industrial Revolution, and because it has been already investigated by several other calibration studies of growth over the very long run. However, even for England, historical data on religiosity and religious behavior is scarce. While there exists no hard data for the Middle Ages and the early modern period, we know that "most British social scientists, historians, and church leaders think that Britain is now not very religious and was once markedly so." (Bruce, 1995, see also Bruce, 2011). Brierley (1999) provides data from the census in 1851 and then again from after WWII. I augment the data from Brierley with two data points from Warner (2010) for 1902 (19 percent attendance) and 1947 (15 percent). As argued in the Introduction, attending church (instead of shopping or attending a football game) is a clear signal that religion is an important determinant in an individuals's life. It is only in church where religious individuals experience salvation and forgiveness of sins. It is also in church where people are exposed to sermons caution against placing too much value on possessions, an exhortation that secular individuals presumably prefer not to hear but which religious individuals would like to be reminded of.

For GDP per worker and TFP, I use the data compiled by Madsen at al. (2010) for the years 1620-2000. TFP is computed by Madsen et al. as the Solow residual, implying huge fluctuation

FIGURE 4. Secularization and Economic Growth in the Long-Run

Blue (solid) lines: model prediction. Red (dashed) lines: Data for church attendance in England from Brierley (1999) and Warner (2010); economic data from Madsen et al. (2010). Growth rates in percent. GDP per worker in thousands. Parameters and steady-state values: $\theta = 0.33$; $\alpha = 1.5$; $\rho = 3$; $b = 0.1$; $g_y^* = 0.015$; $L^* = 0.3$; $(s/w)^* = 0.15$. Implied: $\beta = 1$; $\gamma = 11.6$; $\bar{A} = 14.4$.

in annual growth of TFP. In order to identify a TFP trend I use 50-year moving averages. After calculating adjustment dynamics, the generational data is converted into annual data by assuming that a generation takes 25 years. As common practice in these exercises, I set the capital share θ to $1/3$. I set $\bar{A}$, β, and γ such that the steady-state growth rate is 1.5 percent annually, the savings rate is 15 percent, and such that people work 30 percent of their time. These values try to capture England (or the UK) at the end of the 20th century. We are thus left with three parameters to

calibrate adjustment dynamics from the high middle ages (year 1000) to today and beyond (year 2050): home production b, the value of religion ρ, and the weight attached to consumption α. It turns out that the best fit of the historical time series is obtained for $b = 0.1$, $\rho = 3$, and $\alpha = 1.5$. For these parameters values there exists no steady state of stagnation and secularization and the take-off to growth are endogenously initiated.

Figure 4 shows the resulting adjustment dynamics (solid blue lines) together with the historical time paths (dashed red lines). The upper panel shows identity choice, i.e. the share of the population identifying with religion. During the High Middle Ages almost everybody identifies with religion.[9] From the 17th century on some secular identities become visible, initiating a process of secularization that continues with increasing speed. In 1851, about 60 percent of the population still identifies with religion, a figure which corresponds with the historical attendance data. From then on, the model predicts a somewhat "too slow" secularization for the late 19th century and a "too fast" secularization during the 20th century. For the year 2000, the model predicts that nobody is attending church while in fact 7.5 percent were attending.

The next panel shows the predicted trajectory for growth of aggregate capital. Since secular individuals work and save more, secularization is accompanied by an increase in the average savings rate and an increase of aggregate labor supply. These predictions accord well with historical observations. In England, aggregate savings rates have been estimated at about 4% in 1688 (Dean and Cole, 1969) and then rising during industrialization from around 7% in 1760 to 14% in 1800 (Crafts, 1985). Maddison (1992) provides savings rates for 11 developed countries from 1870 to 1981 and shows that they were generally on the rise during industrialization. He also documents a decline of savings rates in many countries during the most recent decades. Such a decline would be consistent with the model if it were explained by receding Protestantism and receding "spirit of capitalism" (see Section 4). Weil (2005) documents across 142 contemporaneous countries that the savings rate is about 5 percent on average for countries in the lowest income decile (i.e. those most similar to England and other European countries in the Middle Ages). The savings rate then gradually increases with income. It is about 10 percent for countries in the second decile, about 20 percent for the seventh decile and somewhat above 30 percent for the tenth decile.

Hours worked were not recorded in any country in the pre-industrial period. Using indirect methods, economic historians have, however, compiled evidence for an "industrious revolution"

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[9] The years 1000 to 1400 are not shown in Figure 4 because they closely resemble 1400. This saves space to show in more detail the years in which there is actually movement in the data.

preceding and accompanying the industrial revolution. According to de Vries (1994), who coined the term "industrious revolution", increasing labor supply was motivated by increasing desire for consumption goods. According to Thompson (1967), "Saint Monday" (the practice of taking Monday off to recover from the weekend) was universally observed until the beginning of the nineteenth century. Koyama (2012) notes that in the fifteenth century there were 46 official holidays, of which between 38 and 43 fell on days other than Sundays. According to Voth (2001) the annual days worked per person increased from 258 in 1760 to 336 in 1830. Clark and van der Werf (1998) find a more gradual increase of the annual days worked from 266 in 1600 to 318 in 1870.[10]
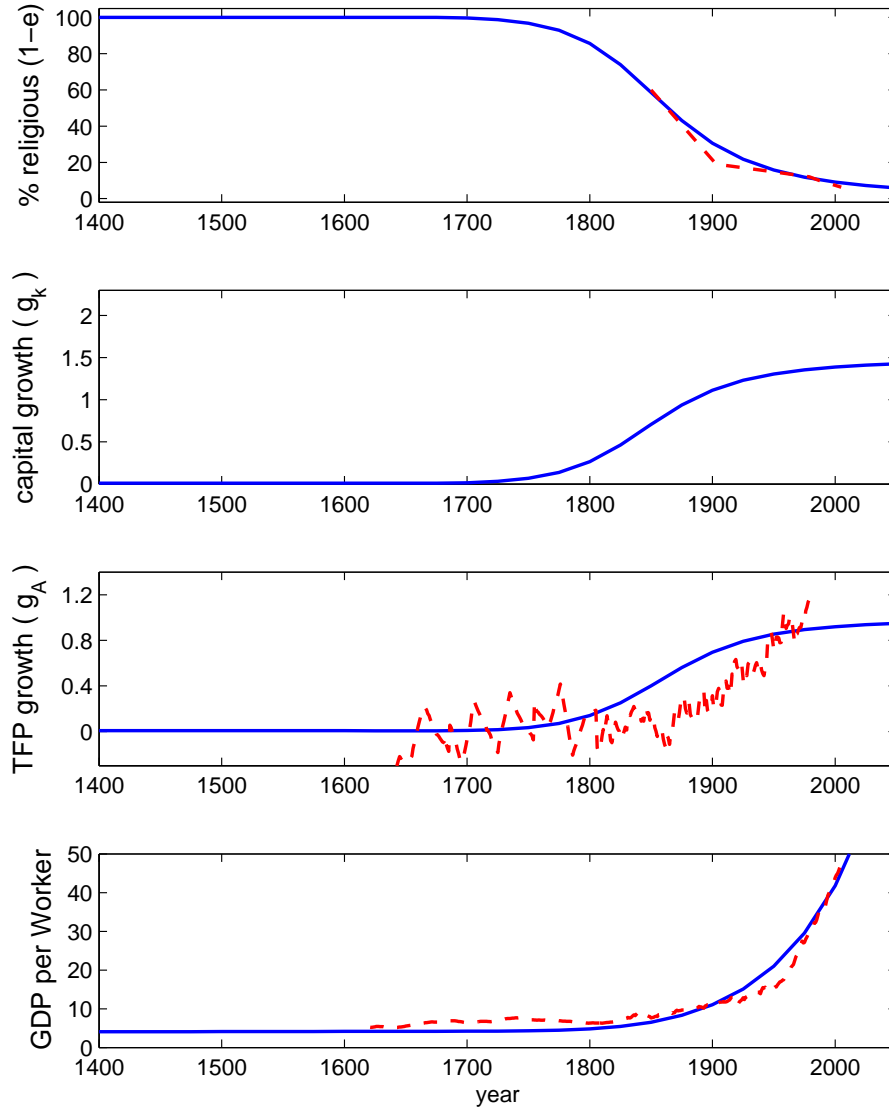
Increasing capital accumulation leads to a higher scale of production and more learning-by-doing. It thus promotes TFP growth, as shown in the third panel. The model roughly fits the gradual take-off of TFP but somewhat overestimates TFP growth in the early modern period with a "too early" increase of TFP for the time before the second Industrial Revolution (before 1860). The lower panel in Figure 4 shows the predicted evolution of GDP per worker. For better comparison I have normalized income at the 1980 value of the actual data. The model underestimates GDP somewhat during the early modern period.

3.8. **Alternative Distribution of R.** Overall, the theory of secularization and growth explains the actual economic and religious evolution reasonably well. The outcome that religiosity hits rock bottom in the late 20th century, however, is counterfactual and not entirely satisfying. The result follows directly from the simplifying assumption that R is uniformly distributed in $[0, 1]$. This assumption was necessary in order to obtain a closed-form solution but it is not very realistic. It seems to be more reasonable to assume that the support of the distribution of religious value is unbounded from above. This notion takes into account that there are some individuals who will never abandon religion, regardless of their income level. The simplest way to capture this idea is to assume that R is Pareto-distributed. The shape-parameter (Pareto-index) λ provides a simple control of the fatness of the tail of the distribution.

Specifically, assume that the density function is given by $f(R) = \lambda/R^{\lambda+1}$ such that the cumulative distribution function is $F(R) = 1 - 1/R^{\lambda}$, implying that the value of religion is now

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[10]The theory predicts that, as the economy approaches the steady state, labor supply should stabilize. This prediction is only seemingly contradicted by the observation that during the 20th century hours worked per worker declined markedly. The reason is that hours worked per household remained stable because of increasing female labor market participation. As Francis and Ramey (2009, p. 189) observe: "We find that hours of work for prime age individuals are essentially unchanged, with the rise in women's hours fully compensating for the decline in mens hours."

FIGURE 5. Secularization and Long-Run Growth: Pareto-Distribution of Religious Value

Parameters and steady-state values as for Figure 4 except $\rho = 1.5$ and $\lambda = 1.9$. Data as for Figure 4.

distributed in $[1, \infty]$. The religiosity threshold $C(w_t)$ is maintained from the basic model. However, it no longer translates one-to-one into the population share of secular individuals. Instead we obtain the population share of secular individuals as

$$
e_t = \begin{cases} 0 & \text{for } C(w_t) < 1 \\ 1 - \frac{1}{[C(w_t)]^{\lambda}} & \text{otherwise.} \end{cases}
$$

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Since the lower bound of the distribution moves up from 0 to 1, we need an adjustment of ρ to 1.5 in order to match the secularization trajectory. All other parameter values are kept as calibrated for the basic model (Figure 4). Figure 5 shows the predicted long-run development for $\lambda = 1.9$. Allowing for an unbounded support of R and a fat tail of the distribution significantly improves predicted religiosity for the late 20th century. As a consequence, TFP growth adjusts somewhat slower to the steady state but otherwise the economic times series look very similar to the basic scenario from Figure 3. The feature that religiosity stays significantly positive during the 21st century does not change the main results. Secularization remains cause and consequence of economic development.

4. The Protestant Reformation as an Intermediate Stage

4.1. **Setup.** This section extends the basic model by introducing a second religious identity. One religious identity, called Catholic, provides the same utility as the unique religious identity in the basic model. The second religious identity, called Protestant, allows one to derive utility from wealth accumulation. Specifically, utility (1) is rewritten as

$$u_t = (\alpha + \sigma_t) \log c_t + \beta (\alpha + \sigma_t) \log c_{t+1} + (1 - \sigma_t)\pi_t \eta \log s_t + \gamma \log (1 - \ell_t)$$

$$+ (1 - \sigma_t) [\rho(1 - \pi_t) + \rho_p \pi_t] R \tag{11}$$

and $\pi_t \in \{0, 1\}$. This means that for individuals who identify with religion ($\sigma_t = 1$) and choose $\pi_t = 0$, everything remains the same as in the basic model. If religious individuals choose $\pi_t = 1$, however, they assume a Protestant identity. The general value of Protestant religion is denoted by ρ_p and it may be higher, lower, or equal to the value of Catholic religion ρ. The Protestant work ethic or "spirit of Capitalism" (Weber, 1904) is captured by $\eta > 0$. As discussed in the Introduction, the modeling of the spirit of capitalism is not new in the literature. The earlier literature, however, did not investigate the role of identity choice and secularization for economic growth.[11]

Maximizing utility with respect to (2) and $c_{t+1} = (1 + r_t)s_t$ provides the solution (12)-(14).

$$c_t = \frac{(\alpha + \sigma_t)(w_t + b)}{(\alpha + \sigma_t)(1 + \beta) + \gamma + (1 - \sigma_t)\pi_t \eta} \tag{12}$$

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[11] Protestants may also experience less utility from leisure than Catholics and secular individuals. This would amplify the effect of the savings channel and lead to the prediction of a phase of particularly high labor supply before secularization and economic growth accelerate.

$$s_t = \frac{[\beta(\alpha + \sigma_t + (1 - \sigma_t)\pi_t\eta]\,(w_t + b)}{(\alpha + \sigma_t)(1 + \beta) + \gamma(1 - \sigma_t)\pi_t\eta} \tag{13}$$

$$\ell_t = \frac{[(\alpha + \sigma_t)(1 + \beta) + (1 - \sigma_t)\pi_t\eta]\,w_t - \gamma b}{[(\alpha + \sigma_t)(1 + \beta) + \gamma(1 - \sigma_t)\pi_t\eta]\,w_t}. \tag{14}$$

Comparing the influence of identity on economic behavior, we find that Catholics are unambiguously "outperformed" by secular individuals as well as by Protestants but the ranking between Protestants and secular individuals is ambiguous.

PROPOSITION 4. *For given wage rate, individuals identifying with secular values as well as individuals identifying with Protestant values supply more labor and save more than individuals identifying with Catholic values.*

PROPOSITION 5. *For given wage rate, individuals identifying with Protestant values save more than individuals identifying with secular values if $\eta > \beta\gamma/(1 + \alpha + \gamma)$. They supply more labor if $\eta > 1 + \beta$.*

For the proof of Proposition 4, compute the derivatives of (12)–(14) and observe $\partial\ell_t/\partial\sigma_t > 0$, $\partial s_t/\partial\sigma_t > 0$, $\partial\ell_t/\partial\pi_t > 0$, and $\partial s_t/\partial\pi_t > 0$. For the proof of Proposition 5, inspect differential economic behavior $s_t(\sigma_t = 1, \pi_t = 0) - s_t(\sigma_t = 0, \pi_t = 1)$ and $\ell_t(\sigma_t = 1, \pi_t = 0) - \ell_t(\sigma_t = 0, \pi_t = 1)$.
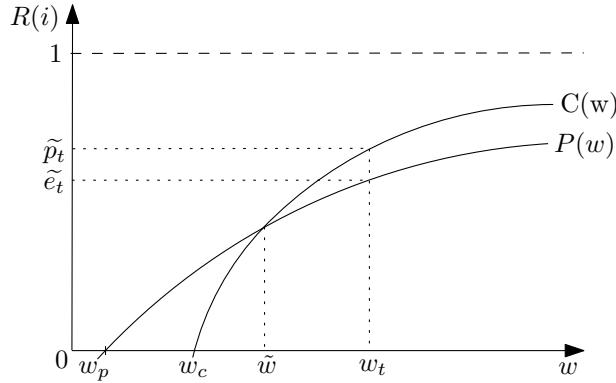
The intuition for Proposition 4 is similar to Proposition 1. Because Protestants experience utility from savings, they work harder and save more than Catholics. If Protestants put sufficient weight on wealth accumulation, they supply more labor and save more than secular individuals. The condition for savings of Protestants to exceed that of secular individuals is relatively easily fulfilled. A sufficient yet not necessary condition is, for example, $\eta > \beta$. The condition for more labor supply of Protestants is harder to fulfil because secular individuals have an incentive to work hard for material pleasures. Protestants lack this incentive. If the condition for savings is fulfilled, the transition from a Catholic religious society to a secular society is accompanied by a non-monotonous behavior of the savings rate where growth of capital and productivity first increases and then decreases. Growth is highest at an intermediate state of development. Adjustment to the secular steady state of balanced growth entails a decline of growth when the "spirit of capitalism" recedes (Sombart, 1915; Wiener, 1982). In the following, we consider two cases. In the first case, Protestantism emerges endogenously and coexists with Catholicism. In the second case, either Protestantism or Catholicism is ruled out by the government (state religion).

4.2. **Identity Choice.** Proceeding as in Section 3 and comparing utilities, we obtain the same threshold $C(w)$ between (Catholic) religious identities and secular identities, as shown in equation (7) and displayed in Figure 3. Comparing utilities for $\sigma_t = 1$ and $(\sigma_t = 0, \pi_t = 1)$ we find that an individual prefers a Protestant religious identity over a secular identity if

$$R(i) > \frac{1}{\rho_p}\left[(1 + \beta - \eta)\log(w_t + b) + \phi_p\right] \equiv P(w_t),\tag{15}$$

with $\phi_p \equiv [\alpha(1 + \beta) + \gamma + \eta]\log[\alpha(1 + \beta) + \gamma + \eta] - [(\alpha + 1)(1 + \beta) + \gamma]\log[(\alpha + 1)(1 + \beta) + \gamma] + (\alpha + 1)(1 + \beta)\log(\alpha + 1) - \alpha\log\alpha - (\alpha\beta + \eta)\log(\alpha + \eta) + \beta\log(1 + r)$.

FIGURE 6. Thresholds: Protestant Reformation and Secularization

I assume that movers to Protestantism are dissatisfied with the Catholic church but would prefer a Protestant identity, if available, vis a vis a secular one. Graphically, this means that for Protestantism to emerge, the $C(w)$ threshold has to intersect the $P(w)$ threshold from below, as shown in Figure 6. In this case, all religious individuals identify with Catholic values as long as income lies below $\tilde{w}$. For income larger than $\tilde{w}$, a region emerges between the $P(w)$-curve and $C(w)$-curve in which individuals prefer a secular identity over Catholicism and a Protestant identity over a secular one, implying that they identify with Protestantism. For Protestantism to emerge, the following condition has to be fulfilled.

PROPOSITION 6. *The $C(w)$ threshold intersects the $P(w)$ threshold from below if (i)*

$$\frac{1 + \beta - \eta}{1 + \beta} < \frac{\rho_p}{\rho}.\tag{16}$$

and (ii) $\phi_p/(1 + \beta - \eta) > \phi/(1 + \beta)$.

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For the proof, notice that $P(w)$ is flatter everywhere than $C(w)$ if (16) holds. Then $C(w)$ cuts $P(w)$ from below if the zeroes fulfil $w_p < w_c$, that is, if the second condition holds. This condition is hard to interpret because the ϕ's are large compound parameters. In numerical experiments, it turns out that condition (ii) is always fulfilled for plausible parameters, given that (16) holds. This means that the easily interpretable condition (16) is crucial. It states that Protestantism always emerges if $\rho_p \geq \rho$, i.e. if the general value of Protestant religion is not smaller than the general value of Catholicism. Interestingly, there also exists a range of values for η for which Protestantism emerges even if it provides less religious value ($\rho_p < \rho$), for example, because Protestants compared to Catholics experience a less magical and spectacular divine service in a plain church with less saints to adore and less mystical explanations for the tide of events, or because the Protestant Church exercises more control over its adherents (Weber, 1904). For this to be true, η has to be large enough, allowing Protestants to trade off lower inherent value of religion in exchange for utility derived from wealth accumulation. Comparing denominations, this means that if a Protestant religion puts little weight on wealth, the religious experience at church is likely to be not too different from Catholicism (Lutheran Protestantism, the Anglican Church). However, if a Protestant religion puts strong emphasis on wealth accumulation and hard work, Protestantism may emerge even if it offers a much plainer liturgy and exercises more control over its adherents than the Catholic competitor (Calvinistic Protestantism).

If an interior intersection of the $C(w)$-curve and $P(w)$ curve exists, the population shares of identities can be once again be read off the ordinate. For example, take the wage w_t in Figure 5. There, a share $\tilde{e}_t$ of the population identifies with secular values, a share $1 - \tilde{p}_t$ identifies with Catholicism and a share $\tilde{p}_t - \tilde{e}_t$ identifies with Protestantism. Taking corner solutions into account as well, the complete description of population shares is given by $1 - p_t$ Catholics, $p_t - e_t$ Protestants, and e_t secular individuals with $p_t = \max\{0, \min\{C(w_t), 1\}\}$ and $e_t = \max\{0, \min\{P(w_t), 1\}\}$ for $C(w_t) > P(w_t)$ and $e_t = p_t$ otherwise.

4.3. **Dynamics.** The production side of the economy is taken from the basic model. Computing aggregate savings, i.e. aggregate identity-specific savings over the population shares of identities, provides the equation of motion

$$k_{t+1} = \tilde{f}(k_t) = \frac{(\alpha+1)\beta\left[(1-\theta)\bar{A}k_t + b\right]}{(\alpha+1)(1+\beta)+\gamma} \cdot e_t + \frac{\alpha\beta\left[(1-\theta)\bar{A}k_t + b\right]}{\alpha(1+\beta)+\gamma} \cdot (1-p_t)$$
$$+ \frac{(\alpha\beta+\eta)\left[(1-\theta)\bar{A}k_t + b\right]}{\alpha(1+\beta)+\gamma+\eta}(p_t - e_t), \tag{17}$$
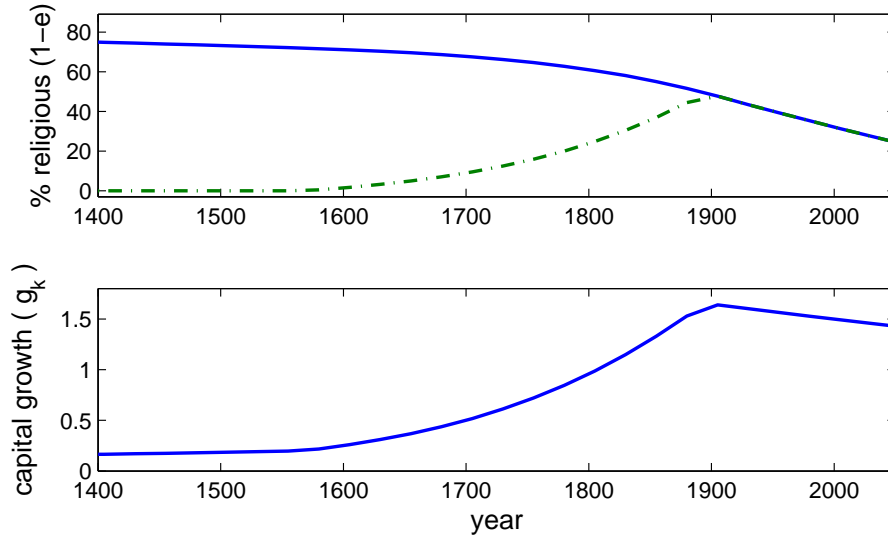
which replaces (10). Because the population shares are a unique function of the wage rate according to (7) and (15) and wages are a unique function of aggregate capital, the reduced form of the model is again a unique, piece-wise defined, and concave difference equation for k. The remainder of the analysis proceeds as described in Section 3. Because Protestantism appears and flourishes, if at all, only when wages are high enough, there again exists two qualitatively different cases: either the $\tilde{f}(k)$ curve intersects the identity line (exogenous initiation of secularization and growth) or not (endogenous initiation). The only difference is that there may be an intermediate phase during which the population share of Protestants first rises and then falls.

4.4. **The Rise and Fall of Protestantism.** The possibility of Protestantism does not affect the main conclusion that secularization is both cause and consequence of economic development. But it is helpful to explain non-monotonous adjustment behavior of macro-aggregates. If savings rates of Protestants exceeds those of secular individuals, we observe overshooting behavior of capital stock growth and TFP growth. Growth increases when Protestantism is on the rise (and replaces Catholicism) and growth declines when Protestantism declines (and gets replaced by secular identities).

Figure 7 shows a case of endogenous rise and fall of Protestantism. For that purpose we set $\rho = 6$, and $\bar{A}$ such that $g_y^* = 1.2$ percent and keep the other parameters from the benchmark model. For the Protestants, we set $\eta = 1.5$ and $\rho_p = 0.8\rho$. These values imply that Protestants save more than secular individuals. The lower panel in Figure 7 shows the (mildly) overshooting behavior of the growth rate of aggregate capital. The rise and fall of Protestantism explains a steeply rising rate of accumulation during the second Industrial Revolution, which subsequently declines with ongoing secularization.

4.5. **State Religion.** It could be argued that in pre-modern Western Europe, religious denomination was hardly an individual choice. Specifically after the Peace of Westphalia in 1648, there was an extended period during which religious denomination was largely determined by the local ruler ("cuius regio, eius religio"). The decision to believe in the decreed state religion, however, likely remained an individual choice, in particular, after Enlightenment. In England, for example, the "Act of Uniformity" from 1558 formally required church attendance until it was was repealed in 1969. As shown above, according to the earliest available data, attendance was already only 60 percent in 1851, indicating the problem of enforcing religiosity.

FIGURE 7. Protestant Reformation and Overshooting Savings Rates

Upper panel: Blue line: population share of religious identities. Green line: share of Protestant religious identities. Parameters: $\rho = 6$, $\rho_p = 4.8$; $g_y^* = 0.012$; $\eta = 1.5$; other as for Figure 4.

Enforcement of denomination can conveniently be discussed using Figure 5. It means the withdrawal of either the $P(w)$- or $C(w)$-curve from the figure. The main insight is that the enforcement of state religion does not change the result of secularization being cause and consequence of economic development. If Catholicism is no longer available, utility of the former Catholics declines but secularization unfolds nevertheless. If Protestantism is no longer available, some additional individuals prefer a secular identity; for example, at wage $\tilde{w}$ a share $\tilde{p}_t - \tilde{e}_t$ of the population.

The feature that thrift and hard work is rewarded in Protestantism enhances economic growth. Economic growth, in turn, eventually speeds up secularization. The model thus predicts that, ceteris paribus, Protestant states experience an earlier take-off to growth and are more secular today. In order to verify this claim, I run a couple of numerical experiments. Keeping all economic parameter values as specified above, I set up alternative state religions and start all economies in the year 1650 (after the Peace of Westphalia). I then observe the percentage of religious individuals in 1925 and 2000 and the GDP in 1925 relative to 1700. I choose 1925 because this is the earliest year for which church attendance is available for several European countries. I choose 1700 because GDP per capita estimates are available from Maddison (2001). This allows us to confront the model's predictions with actual developments in Europe.

TABLE 1. State Religion: Secularization and Industrialization

Case	Denomination	% reli.(1925)	% reli.(2000)	$\frac{GDP(1925)}{GDP(1700)}$
1	cath. $\rho = 6$	75	71	1.3
2	prot. $\rho_p = 6, \eta = 0.15$	40	21	3.8
3	prot. $\rho_p = 6, \eta = 0.3$	24	0.1	6.8
4	prot. $\rho_p = 8, \eta = 0.3$	64	54	2.5
5	cath. $\rho = 4$	55	39	2.0

Predictions from model with parameters as specified below Fig. 1. All simulations start in the year 1650 with the same initial values. $\rho_p = 0$ when $\rho > 0$ and vice versa. reli(i) is the predicted percent of religious people in year i. $GDP(1925)/GDP(1700)$ is the predicted change of income from 1700 to 1925; see text for further explanations.

Table 1 summarizes the results. Case 1 considers Catholic state religion and $\rho = 0.6$. This country is predominantly populated by religious individuals in 1925 as well as in the year 2000. In 1925, it had just experienced the onset of the take-off to growth and GDP is 1.3 times its value in 1700. Case 2 shows a Protestant state religion of equal general value ($\rho_p = 0.6$) and a modest utility gain from savings ($\eta = 0.15$), conceptualized as Lutherian protestantism. Here, the model predicts that in 1925 already a minority (40%) is religious, a value that declines to 21% by the year 2000. In 1925 the country has already experienced industrialization and GDP is 3.8 fold its value in 1700. Case 3 shows results for a significant weight of savings in Protestantism. This country is already largely populated by secular individuals in 1925 and is basically completely secular by the year 2000. It has grown almost 7 fold since 1700. Secularization and economic development happen at a slower pace when a higher general value is assigned to Protestant religion, as shown in case 4. Religiosity is now not too far away from the Catholic country of case 1, but the GDP ratio is about twice as large. In 1925, GDP is 2.5 its 1700 value. Finally, we consider case 5, in which a low value is assigned to Catholic state religion. Development is faster than for case 1 but inferior compared with Protestantism. Although the country is more secular in 1925 than the Protestant country from case 4, the GDP ratio is smaller. In short, a few changes of parameter values are sufficient to generate a multitude of country-specific paths of religious and economic development. In any case, however, secularization is cause and consequence of economic development and, ceteris paribus, Protestant countries are predicted to experience faster secularization and take-off to growth.

Table 2 shows the economic and religious development for a set of European countries (I considered all countries for which data was available from Bentzen et al., 2013; Tomka, 2003; and

Table 2. Industrialization – Denomination - Secularization

country	YIT	Rank YIT	Rank Non-C.	Catholic	Protest.	Att. 1925	Att. 1990	GDP 1925	GDP 1925/1700
UK	1801	1	3	12	$11.8/66.6^b$	43	17	5144	4.1
Switzerland	1891	2	6	45.5	52.7^c	32	23	5388	6.1
Germany	1896	3	5	44.1	50.5	64	24	3532	3.9
Netherlands	1897	4	4	40.4	37.6^c	61	54	5031	2.4
Sweden	1933	5	1	-	98.3	14	11	3414	4.6
Denmark	1938	6	1	-	95	18	6	4378	4.2
Norway	1939	7	2	0.2	96.2	27	11	2863	4.0
Austria	1946	8	8	89	6.6	62	41	3367	3.4
France	1950	9	9	90	1.6	46	23	4166	4.6
Italy	1961	10	10	93		70	53	2921	2.7
Hungary	1962	11	7	56^a	26	64	16		
Ireland	1967	12	11	94.9	3.7	96	92	2573	3.6
Poland	1969	13	12	95^a	-	85	68		
Spain	1969	13	13	99.9	-	70	37	2451	2.9

YIT is the year of industrial transition from Bentzen et al. (2013). Catholic and Protestant is the declared religious adherence by the adult population in 1960 (except ^{a}: 1983), data from Tomka (2013). Protestants are Lutheran and others, except ^{c}: Calvinists. ^{b} UK: 66.6 Anglican, 4.4. Calvinist, remainder other Protestant. Rank Non-C. is the country ranking with respect to non-Catholic adherence. Att. 1925 and Att. 1990 is church attendance rate from Iannaccone (2003), see text for further explanations. Spearman's rank correlation coefficient: 0.77 (p-value 0.0013).

Iannaccone, 2003). The countries are ranked according to the year they experienced the industrial transition (YIT), defined as the first year in which employment in the manufacturing sector exceeded employment in agriculture, according to Bentzen et al. (2013). The columns 'Catholic' and 'Protestant' show the distribution of denominations in percentage in these countries, available for the year 1960 from Thomka (2003). The column 'Rank Non-C.' shows the rank of the countries when ordered according to the share of the population that is not Catholic. Comparing the ranks with YIT, we see that, on average, Protestant (i.e. non-Catholic countries) experienced the industrial transition earlier. Spearman's coefficient of rank correlation is 0.77. The last two columns provide alternative indicators of economic development, GDP in 1925 and the 1925-1700 GDP-ratio (from Maddison, 2001). They confirm that the Protestant countries grew, on average, faster than the Catholic countries. In particular, countries with a high share of Calvinist Protestantism grew very fast (Switzerland) or were already remarkably developed in 1700 (the Netherlands). The two 'Att.' columns show church attendance according to Iannaccone (2003). On average, Protestant countries display lower church attendance in 1925 and in 1990. Despite the large variety of country-specific developments, the results from Table 2 are largely consistent

with the model's prediction from Table 1. Protestantism is a motor of economic development and a catalyst of secularization.[12]

5. Social Interaction

This section returns to the basic model and introduces a so far neglected mechanism, the interdependence of religious preferences. It seems plausible that the individual choice of identity depends on the identity choice of other members in society. For once, as has been vividly illustrated by Iannaccone (1992), religious activities are of a collective nature. The edification derived from Sunday service, for example, depends on how many others are attending. Moreover, the presence of many secular people may raise doubt about the general value of religion.

The simplest way to take these considerations into account is to augment the individual value of religion $R(i)$ with a social multiplier (Glaeser, et al., 2003) such that it becomes $(1 - \delta e_{t-1})R(i)$. The idea here is that the current youth observe the identity choice of their parent's generation and assign a lower value to religion if many of their parent's generation identified with secular values, i.e. if e_{t-1} is large. The parameter δ measures the strength of social interdependence, $0 < \delta \leq 1$. The assumption that δ is bounded from above by unity seems to be natural. It implies that religion has zero value if the whole society consists of secular individuals.

Introducing the modification into the basic model, we find that individual i prefers a religious identity if

$$R(i) > \frac{(1+\beta)\log(w_t + b) + \phi}{(1 - \delta e_{t-1})\rho} \equiv g(e_{t-1}, w_t), \tag{18}$$

which replaces (7). Proceeding as in Section 3, we see that there are $e_t = g(e_{t-1}, w_t)$ secular individuals in society (at an interior equilibrium). A dynamic equilibrium furthermore requires that $e_t = e_{t-1}$. Inserting this condition into (18) we find that the solution $e(w_t)$ – if it exists – reads

$$\begin{aligned} e_{low} &= \frac{1}{2\delta} - q_t \\ e_{high} &= \frac{1}{2\delta} + q_t \end{aligned} \qquad q_t \equiv \sqrt{\frac{1}{4\delta^2} - \frac{(1+\beta)\log(w_t + b) + \phi}{\delta\rho}}. \tag{19}$$
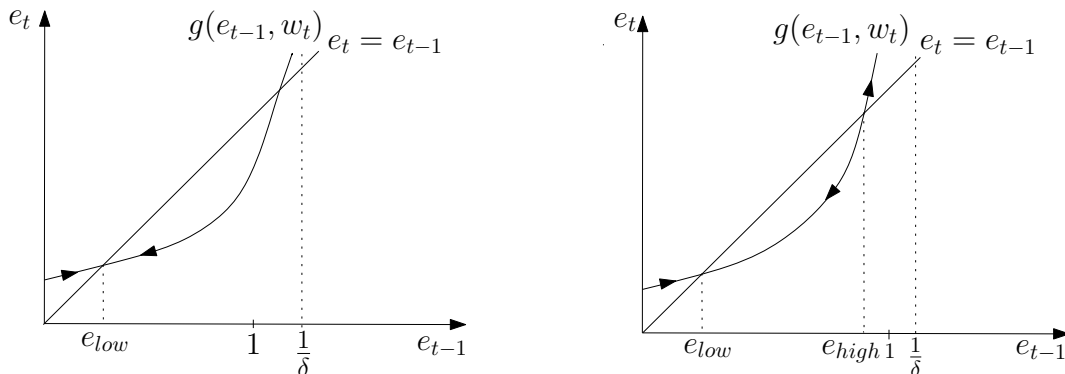
For a diagrammatic exposition of the solution, note that $g(e_{t-1}, w_t)$ is increasing in e_{t-1} and w_t and convex in e_{t-1} with a pole at $1/\delta$. Figure 8 shows the possible solutions with interior

[12]In a related study, Becker and Woessman (2009) found an income effect of Protestantism in Prussia through education. Cantoni (2015), using city data for the Holy Roman Empire for the period 1300–1900, could not find an effect of Protestantism on economic growth. In an earlier version of this paper (Strulik, 2012b) I provided an explanation for this non-finding, using the model described above and arguing that a significant difference in economic performance may be discernable only in the 20th century.

equilibria. As before, e_t is bounded from below by zero and from above by unity. From (19) we see that the lower bound (all religious) is assumed when the root exceeds $1/(2\delta)$ and the upper bound (all secular) is assumed when the radicand becomes negative.

Figure 8 shows two situations for a given wage w_t. Actually, however, wages are endogenous and rising with economic development. Economic and religious evolution can then be illustrated as follows. At the beginning, there was an epoch during which everybody identified with religion. As wages grew, and $g(e_{t-1}, w_t)$ moved upwards, an interior equilibrium e_{low} emerged. This equilibrium is stable for given w_t, implying that if the associated $f(k)$-curve intersects the identity line (recall Figure 3), there exists a unique equilibrium of stagnation. This is so because at low e_t, the social multiplier is small and almost everybody prefers a religious identity. Diagrammatically the intersection at the upper branch of the $g(e_{t-1}, w_t)$ curve exceeds unity and cannot be attained (as shown in the left panel of Figure 8).
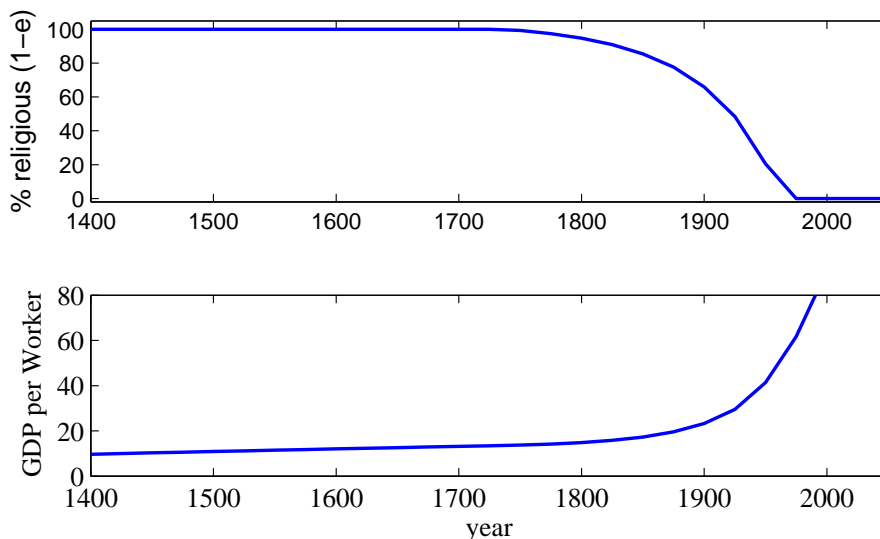
FIGURE 8. Multiple Social Equilibria

With further rising wages and thus further upward shifting of the $g(e_{t-1}, w_t)$-curve, a second equilibrium e_{high} emerges. Now, there exist two equally valued equilibria. It seems natural to assume that society continues to converge to the locally stable e_{low}. Fathers and grandfathers had supported a similar solution. An authoritarian ruler, however, may be capable to move society to e_{high} by verdict. Notice that the equilibrium e_{high} is unstable. This means that as wages continue to rise, dynamics follow the upper branch of the $g(e_{t-1}, w_t)$-curve and society secularizes very quickly. The equilibrium at e_{low}, in contrast, is locally stable and moves slowly upwards with economic development. It may even be possible that the associated $f(k)$-curve intersects the identity line and the economy stagnates.

Yet eventually, the presence of socially-dependent preferences promotes a fast secularization of society even without coordination on e_{high}. To see this, notice that an interior equilibrium ceases to exists when $q > 1/(2\delta)$. Diagrammatically, the identity line becomes tangent to the $g(e_{t-1}, w_t)$-curve where $q = 1/(2\delta)$. Any further upward shift initiates a spontaneous complete secularization of society within one generation. People stop going to church because others are also no longer going. The higher the power of social interaction on preferences, the earlier spontaneous secularization happens. At the extreme, for $\delta = 1$, the critical mass is reached at $1/2$, i.e. when half of society identifies with secular values. On the other hand, if $\delta < 1/2$, spontaneous secularization needs a higher critical mass of secular individuals. It occurs when $q < 0$.

FIGURE 9. Secularization and Growth with Social Interaction

Parameters as for Figure 4 and $\delta = 0.3$.

Figure 9 illustrates the impact of the social multiplier. For that purpose, I have set $\delta = 0.3$ and kept everything else from the basic model. Compared to the basic model (Figure 4), secularization happens very fast, basically within one century. Consequently, the take-off to growth (the rise in GDP) is also steeper. Increasing or reducing the importance of social interaction would speed up or slow down the pace of secularization and industrialization. Based on the simple univariate distribution of R, the model predicts an overly drastic fall of religiosity to zero, a feature that could be avoided by introducing an unbounded distribution of R, as shown for the Pareto-case in Section 3.

6. Conclusion

This paper has proposed a theory of identity choice and economic growth that explains a long epoch of (quasi) stagnation in which individuals predominantly identify with religion and an epoch of high growth in which individuals predominantly identify with secular, material values. Between these states lies a transition period during which the economy takes off and the society secularizes. The theory offers a rationalization of the observed bi-causal relationship between religious adherence and economic development. An extension of the basic model has investigated Protestantism as a third option of identity choice. The extension has been helpful in explaining the rise and fall of Protestantism and overshooting behavior of capital accumulation along the way to balanced growth. A second extension has introduced socially-dependent religious preferences and has shown how a social multiplier amplifies the speed of economic development and secularization.

Numerical experiments have compared the predictions of the model with the historical time series for England. The model has explained the historical evolution of England reasonably well, an assessment that could presumably be derived from an application of the model to the growth and secularization process of other European societies as well. An interesting question is how the generally high church attendance in the U.S. can be reconciled with the model, given that the U.S. is among the richest countries in the world. One explanation within the present framework could be based on the less regulated market for religion and the higher competition of denominations in the U.S. (Finke and Stark, 2005). This has allowed the entry of new churches, which are no longer depreciating consumerism and may in fact encourage it by allowing its adherents to pray for a more fulfilled life on earth, for a better job, or a larger car. This renunciation of "old time religion" fits into the present framework once it is considered as "secularization within the Church" (Wilson, 1982).[13] Based on state churches, such a movement was hardly possible in many European countries; or market liberalization came "too late" when society was already largely secularized.

In the Appendix, it is shown that the theory is robust against extensions that allow individuals to raise their children religiously (vertical socialization), to decide about their fertility, and to experience greater utility from consumption through an increasing variety of available goods. Several other extensions of the model are conceivable. It would be interesting to consider a society stratified not only by the value attached to religion but also by income. It can be expected that

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[13]According to the Pew Forum (2008), comparing childhood and current denomination of U.S. citizens, the "old time" denominations lost (Baptists -3.7%, Methodist -2.1%, Lutheran -0.9%, Presbytarian -0.7%, Catholic −7.5%) while the new churches (Pentecostal and non-denonominational) and the unaffiliated (agnostic, atheist) gained.

this would relax the strong implications of income at the individual level without fundamentally changing the aggregate conclusions. In a two-dimensional society, we would observe that some rich individuals identify with religion while some poor ones identify with secular values. But on average, society would continue to become less religious as average income rises. Secularization would remain both cause consequence of economic growth.

It would also be interesting to integrate other important factors of long-run growth like, for example, science and market R&D. The focus of the present study on learning-by-doing seems to be justified for most of human history because before the mid 19th century technological advances were not largely brought forward by formally trained scientists. Since then, however, knowledge production has increasingly become a market activity, rendering the learning-by-doing approach less appropriate. With an extension towards endogenously emerging R&D, it could be possible to conceptualize secularization as cause and consequence not only of economic development but also of the scientific exploration of the world.

Endogenous Fertility. Suppose, that – additionally to the setup of the basic model – individuals derive utility from the number of children they have. Let n_t denote fertility, δ the associated weight in the utility function, and let child costs be measured in τ units of income. Then utility function (1) and budget constraint (2) of the basic model are restated as:

$$u_t = (\alpha + \sigma_t) \log c_t + \beta (\alpha + \sigma_t) \log c_{t+1} + \gamma \log (1 - \ell_t) + \delta \log n_t + (1 - \sigma_t) \rho R$$

$$0 = w_t \ell_t + b - c_t - s_t - \tau n_t.$$

Maximizing utility subject to the budget constraint and $s_t = (1 + r_t)s_t$ provides the following solution:

$$c_t = \frac{(\alpha + \sigma_t)(w_t + b)}{(\alpha + \sigma_t)(1 + \beta) + \gamma + \delta}, \qquad s_t = \frac{\beta(\alpha + \sigma_t)(w_t + b)}{(\alpha + \sigma_t)(1 + \beta) + \gamma + \delta}$$

$$\ell_t = \frac{[(\alpha + \sigma_t)(1 + \beta) + \delta] w_t - \gamma b}{[(\alpha + \sigma_t)(1 + \beta) + \gamma + \delta] w_t}, \qquad n_t = \frac{\delta(w_t + b)}{[(\alpha + \sigma_t)(1 + \beta) + \gamma + \delta] \tau}.$$

The solutions for consumption, savings, and labor supply are structurally equivalent to the solution (4)-(5) in the paper. The introduction of endogenous fertility thus preserves the distinguished behavior of secular and religious individuals from the basic model (Proposition 1). The derivative of n_t with respect to σ_t is:

$$\frac{\partial n_t}{\partial \sigma} = -\frac{(1 + \beta)\delta(w_t + b)}{[(\alpha + \sigma_t)(1 + \beta) + \gamma + \delta]^2 \tau} < 0.$$

Ceteris paribus, religious individuals have more children than secular individuals. Notice furthermore that $\partial n_t / \partial \delta > 0$ and $\partial n_t / \partial \alpha < 0$. A church, interested in maximizing the number of adherents through fertility, might thus be not only interested in encouraging high fertility (pushing δ) but also in propagating ascetic values and in devaluating pleasure from consumption (diminishing α). Inserting the optimal solution for $\sigma_t \in \{0, 1\}$ into the utility function and computing the utility differential we find that person i identifies with religion if

$$R(i) > \frac{1}{\rho} \left[(1 + \beta) \log(w_t + b) + \tilde{\phi} \right] \equiv C(w_t),$$

with

$$\tilde{\phi} \equiv [\alpha(1 + \beta) + \gamma + \delta] \log [\alpha(1 + \beta) + \gamma + \delta] - [(\alpha + 1)(1 + \beta) + \gamma + \delta] \log [(\alpha + 1)(1 + \beta) + \gamma + \delta]$$

$$+ (\alpha + 1)(1 + \beta) \log(\alpha + 1) - \alpha(1 + \beta) \log \alpha + \beta \log(1 + r)$$

The solution is isomorph to (7) in the paper. Thus, all results from the basic model are preserved. Furthermore the model predicts that secularization and economic growth are accompanied by a fertility transition. Secularization thus provides a complementing driver of the fertility transition.

Expanding Variety of Consumption Goods. Let the utility function (1) be generalized towards

$$u_t = (\alpha + \sigma_t) \log c_t^M + \beta (\alpha + \sigma_t) \log c_{t+1}^M + \gamma \log (1 - \ell_t) + (1 - \sigma_t) \rho R, \tag{A.1}$$

in which, following Krugman (1980) and many others, c_t^M denotes aggregate consumption, i.e. a consumption basket. Sub-utility from the consumption basket is given by $c_t^M = \sum_{i=1}^{n_t} c_{i,t}^\epsilon$, in which i indexes the consumption varieties and n_t is the number of available consumption varieties at time t. The elasticity of substitution between varieties is given by $1/(1 - \epsilon)$ and $0 < \epsilon < 1$. Household optimization can then be subdivided in two steps. In the first step, households decide about labor supply and savings. The solution of this step coincides exactly with the solution of the simple model (the price index of the consumption basket is unity, as shown below.) In the second step, households decide about how to allocate their spending on the available goods, i.e. they maximize utility $\sum_{i=1}^{n_t} c_{i,t}^\epsilon$, given the constraint $c_t = p_{i,t} c_{i,t}$, in which $p_{i,t}$ is the price of variety i. From the first order conditions, we obtain:

$$c_{i,t} = \left(\frac{\lambda_t p_{it}}{\epsilon}\right)^{1/(\epsilon-1)}, \qquad \lambda_t = \epsilon \left[\frac{\left(\sum_{i=1}^{n_t} p_{i,t}\right)^{\epsilon/(\epsilon-1)}}{c_t}\right]^{1-\epsilon}, \tag{A.2}$$

in which $c_{i,t}$ is the downward sloping demand function for variety i and λ_t is the shadow price of aggregate consumption expenditure.

Suppose good i is produced by competitive firms in sector i using the production function $y_{t,i}(z) = A_t k_{t,i}(z)^\theta$. Aggregate productivity is determined by the aggregate capital stock through learning-by-doing as in the simple model. This means that wages and interest rates are the same as in the simple model. Perfect competition implies that the price of good i and all other goods is unity (since one unit of output $y_{t,i}$ is transformed into one unit of variety $c_{t,i}$). With prices pinned down to unity, we obtain $\lambda_t = \epsilon(n_t/c_t)^{1-\epsilon}$ and consumption

$$c_{it} = \left[\frac{\epsilon(n_t/c_t)^{1-\epsilon}}{\epsilon}\right]^{1/(1-\epsilon)} = \frac{c_t}{n_t}, \tag{A.3}$$

i.e. an equal division of expenditure over goods. The price index is obtained as $\left(\sum_{i=1}^{n_t} p_{it}^{\epsilon/(\epsilon-1)}\right)^{(\epsilon-1)/\epsilon}$, which equals unity, confirming the initial supposition.

Finally, inserting (A.2) into the sub-utility function for varieties, we get $c_t^M = n_t(c_t/n_t)^\epsilon$, implying that utility is increasing in the number of available varieties, even holding aggregate expenditure c_t constant. Inserting this result into the utility function we obtain

$$u_t = (\alpha + \sigma_t) \log\left[n_t(c_t/n_t)^\epsilon\right] + \beta(\alpha + \sigma_t) \log\left[n_{t+1}(c_{t+1}/E(n_{t+1}))^\epsilon\right] + \gamma \log(1 - \ell_t) + (1 - \sigma_t)\rho R.$$

One problem with the solution is that individuals have to form expectations about how many varieties will be available in their second period of life. Suppose, for simplicity, that individuals expect the same number of products available as in the first period, $E(n_{t+1}) = n_t$. Then, the solution is straightforward. Proceeding in the same manner as for the simple model, we find that individual i prefers a religious identity if

$$R(i) > \frac{1}{\rho}\left[(1 + \beta)\log(w_t + b) + \phi_{n_t}\right] \equiv C(w_t) \qquad \phi_{nt} \equiv \phi + (1 - \epsilon)(1 + \beta)\log n_t, \qquad \text{(A.4)}$$

and ϕ as defined in the main text. This means that the number of available consumption varieties operates as another upward-shifter of the $C(w_t)$-threshold. As more consumption opportunities become available, individuals are increasingly tempted to abandon the religious identity in favor of consumption indulgence. Suppose, for example, that technological progress increases also the number of available varieties such that $n_t = \nu(A_t)$, with ν being a positive function. Economic growth would then provide another catalyst for secularization through the number of available consumer goods and the temptation they exert to abandon the self-identification with religious values.

Vertical Socialization. Suppose that parents are allowed to spend d_t units of time in order to raise their child religiously. Suppose the original variable $R(i)$ denotes now the "unconditional" value of religion for individual i. If an individual has been raised religiously, it evaluates being religious higher by factor $(1 + d_{t-1})$. This means that adult i experiences utility $(1 + d_{t-1}(i))R(i)$ from religion if he or she identifies with the religion. In other words, religiously raised individuals find it harder to abandon religion for material pleasures.

Following the economic literature on vertical socialization (Bisin and Verdier, 2000), we assume paternalistic preferences, i.e. parents evaluate the gain from their children being religious according

to their own preferences. The simplest way to incorporate this idea is to assume that religious adults experience utility $\log(d_t)$ from raising their child religiously. We assume that secular parents do not make any socializing effort in order to prevent their children from taking up a religious identity. This laissez-faire attitude is consistent with the notion of a secular identity in the main text. Secular individuals are conceptualized as individuals for whom religion does not play a role in daily life, now including also the ideological formation of children. The main difference to the standard economic theory of vertical socialization is that we allow adults to re-optimize and to abandon their religious identity. For individuals raised religiously it is harder to identify with secular values. How hard it is, is determined by their parents socialization effort.

To keep things simple, we set $b = 0$. Individuals maximize utility

$$u_t = (\alpha + \sigma_t) \log c_t + \beta(\alpha + \sigma_t) \log c_{t+1} + \gamma \log(1 - \ell_t) + (1 - \sigma_t) \log d_t + (1 - \sigma_t)(1 + d_{t-1})\rho R$$

subject to $w_t \ell_t - c_t - s_t$ and $c_{t+1} = (1 + r)s_t$. The solution in case of $\sigma_t = 1$ is

$$s_t = \frac{(1+\alpha)\beta w_t}{(1+\alpha)(1+\beta) + \gamma}, \qquad \ell_t = \frac{(1+\alpha)(1+\beta)}{(1+\alpha)(1+\beta) + \gamma},$$

which coincides with the solution from the main text for $b = 0$. Naturally secular individuals make no effort raising their children religiously.

The solution in case of $\sigma_t = 0$ is

$$s_t = \frac{\alpha\beta w_t}{1 + \alpha(1+\beta) + \gamma}, \qquad \ell_t = \frac{\alpha(1+\beta)}{1 + \alpha(1+\beta) + \gamma}, \qquad d_t = \frac{1}{1 + \alpha(1+\beta) + \gamma}.$$

Religious parents always spend a constant share of their time raising their children religiously.[14]

Comparing both solutions, we find that individuals identifying with secular values supply more and save more (which confirms Proposition 1 for the extended model). As a proof, compute

$$s_{t|\sigma=1} - s_{t|\sigma=0} = \frac{\beta(1 + \alpha + \gamma)w_t}{[1 + \alpha(1+\beta) + \gamma]\,[(1+\alpha)(1+\beta) + \gamma]} > 0,$$

$$\ell_{t|\sigma=1} - \ell_{t|\sigma=0} = \frac{(1+\alpha)(1+\beta) + \gamma(1+\beta)}{[1 + \alpha(1+\beta) + \gamma]\,[(1+\alpha)(1+\beta) + \gamma]} > 0.$$

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[14] The solution would be structurally similar if utility from religious children were linear in d_t. Other forms of the utility function do not yield explicit solutions.

To solve for identity choice we plug the identity-specific solutions into the utility function. Comparing utilities, we find that individual i identifies with religion if

$$R(i) > \frac{1}{\tilde{\rho}}\left[(1+\beta)\log w_t + \tilde{\phi}\right] \equiv \tilde{C}(w_t)$$

where

$$\tilde{\rho} = \begin{cases} \left(1 + \frac{1}{\alpha(1+\beta)+\gamma}\right)\rho & \text{if raised religiously} \\ \\ \rho & \text{if not raised religiously} \end{cases}$$

and $\tilde{\phi} = \alpha\beta\log\beta + (1+\alpha)(1+\beta)\log(1+\alpha) - [(1+\alpha)(1+\beta)+\gamma]\log[(1+\alpha)(1+\beta)+\gamma] - \alpha(1+\beta)\log\alpha + -[1+\alpha(1+\beta)+\gamma]\log[1+\alpha(1+\beta)+\gamma] + \beta\log(1+r)$. The solution is structurally similar to the threshold (7) from the main text. The solutions do not precisely coincide because there are potentially more individuals in the extended model. In particular, we may observe that secular parents have religious children. While this complicates the macro analysis, it is straightforward to see that it does not influence the general dynamics stemming from the evolution of wages and the feedback of savings and work effort on the next period's wages. If we furthermore assume that the $R(i)$ are "genetically" transmitted from parent to child, we find that for non-decreasing wages, the children of secular parents never prefer a religious identity. In this case the extended model is isomorph to the model from the main text.

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