Revival or Extinction?

An Application of Systems Dynamics to Church Attendance and Membership Data

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Abstract

The growth and decline of the Christian church can be modeled using system dynamics, a methodology based on simulation, and mathematics. The primary assumption of these models is that the church's growth is driven by a sub-class of church members called enthusiasts. who recruit to the church through their contacts with unbelievers. However this growth is restricted by reversion from the church and the inability of the enthusiasts to retain their conversion potential indefinitely. The models show that over the long term churches can stabilise to a fixed proportion society provided the conversion potential of the enthusiasts is sufficiently high in comparison to the losses. The models predict two threshold for the conversion potential: one over which fast revival-growth occurs and the other below which a church becomes extinct.

The model is applied to a range of denominational attendance and membership data giving estimates of the conversion potential and numbers of enthusiasts. Thus it is possible to indicate which of the growth and loss mechanisms have the greatest leverage for improvement in the church's potential for growth. Results show that not only are traditional denominations declining, but some have a conversion potential too low to avoid extinction. For others extinction cannot be avoided even if all losses are stemmed. They are simply converting too few people. However many of the newer churches are not only growing but have revival-type growth indicating that the number of enthusiasts in their midst is increasing.

Introduction

Dynamical Systems and Church Growth

A dynamical system is any system, which has quantities that change over time according to the laws of cause and effect. Dynamical systems are found in the areas of physics and engineering where the construction is very precise coming out of the fundamental laws of physics. Such systems are often modeled and analyzed with high-powered mathematics. However there are also many examples of dynamical systems in the social arena: the growth of a population, the spread of a disease, or evolution of political ideas. In social case the laws on which the models are based are less clear than the physical sciences nevertheless much success has been achieved in the application of such models, especially in the areas of ecology and epidemiology.

A church is also an example of a dynamical system. The numbers of people who attend, or are in membership, changes over time, according to the mechanisms of births, deaths conversion etc. As such it is possible to analyze the growth and decline of a church using a dynamical model. Hayward (1999) described a simple model of church growth built using mathematics and the assumption that only some of the church members were involved in the conversion of unbelievers – the enthusiasts. The model showed that in the short term the growth of the church is similar to an epidemic with the result that not all of the population gets converted. Growth depends on the ability of the enthusiasts to reproduce themselves by making more enthusiasts.

Systems Dynamics

However powerful mathematics is as a tool for such modeling it is difficult to relate the equations of the model to the laws of cause and effect. An alternative modeling approach is provided by System Dynamics, invented by JW Forrester and pursued by many practitioners over the world, especially in the areas of Business Dynamics. The Systems Dynamics Society gives information on the background and applications of the methodology.

Models are built in a diagrammatic form with the variables and parameters clearly identified. Variables are quantities like population number. Parameters are quantities like birth rate. As such the model is understood in terms of the real quantities that can be measured in the real world.

There are further advantages in this approach as such models may be investigated by computer simulation and by causal loops. The latter is a very conceptual way of explaining behaviour without having to resort to particular numbers or equations. As such the consequences of the assumptions made can be clearly demonstrated and if the behaviour not seen the assumptions can be dismissed and changed.

Hayward (2000, 2002) re-expressed the model of church growth into the systems format and has applied to a range of revival type behaviour in the Christian church including the Toronto Blessing and the Alpha course. Hayward (2000) extended the model to include the effects of births and deaths. The construction and consequences of this model are outlined again in this report. An extention of this model is given as another talk at the annual meeting of the Religious Research Association 2002.

Data Fitting

The main purpose behind this report is to attempt to estimate the parameters involved in the systems dynamics model from church attendance and membership data. The most important of these parameters is the reproduction potential – how many enthusiasts one enthusiast makes during their enthusiastic period. From this parameter it will be possible to say whether the church is in revival growth, heading for sustainability, or heading for extinction. Estimates will also be possible for the length of the enthusiastic period, the reversion rate from the church and the percentage of the church that are enthusiasts.

Church attendance data alone is not sufficient to determine all parameters. The rate of child loss has to be estimated before the data fitting can take place. However if this is underestimated, or overestimated, the reversion rate will fit to an appropriately adjusted value. For some churches it will only prove possible to give a range of parameter values even for the reproduction potential (e.g. United Methodist). For some churches there is more than one separate set of parameter values that provide an acceptable fit (Southern Baptists). For some churches no fit can be found, as there is too much variation in the data due to events within the population (e.g. Uganda). In this case average values for the period is given.

The data fitting uses a least squares method in conjunction with a heuristical method based on the percentage error at each point. Fitting data to a dynamical model does not yield independent statistics so standard statistical hypothesis testing is ruled out. Generally speaking the errors at the data points are 3% or less – depending on the nature of the growth. For the revival data smaller errors were deemed acceptable at the end of revival when the changes are slower than during its course when changes are sudden. It must also be born in mind that church attendance and membership statistics have variable accuracy. In all cases the data fitted for any church are drawn from one source only, so that like data is compared with like, hopefully minimising the effects of systematic errors in counting people.

Of course fitting the data to this model does not prove the model is correct. All it says is that if the model is true the parameters must be the ones stated. It is likely that some of the parameter values have changed during the timescale over which they are fitted. In that case their value gives an average value for that period. Attempts to fit a simpler model (Hayward 2000) which assumed all the church were involved in recruitment throughout their lives cannot be made to fit any data. Thus to some degree recruitment must be via some form of limited enthusiasm.

Data for the UK churches is obtaining from the three church attendance surveys conducted by Christian Research/Marc Europe, or membership data as given in Religious Trends. Data for the USA and other countries is taken from the World Churches handbook. However the LDS figures are from Stark. Data for the Welsh revival 1904-5 is from Williams and the Nagaland revival from Orr.

Initially the report outlines the limited enthusiasm model of church growth concentrating on the behaviour of the church number for different mechanism of growth and decline. Each one is illustrated for real church data. (See the report on the other talk “A Dynamical Model of Strictness and its Effect on Church Growth” for a discussion of these mechanisms in terms of causal loops.)

The parameters of the model are identified and selected church data for the UK, USA and some other countries are discussed. It is found that certain denominations are heading for extinction, some will sustain themselves and some, even in the UK, are seeing revival growth.

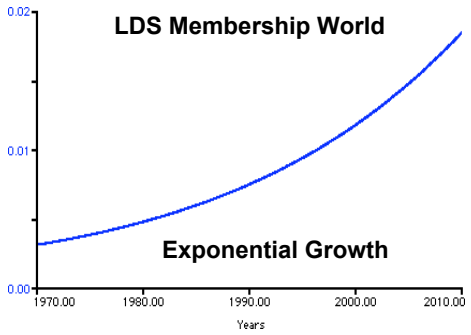
What Causes Church Growth?

- **Conversions**

  Through contact between believers and unbelievers

- **Births**

  Children of believers become believers



Conversion is the main mechanism by which a church grows. It is assumed that conversion occurs because of a contact between a believer and an unbeliever whether this has directly led to the conversion, or brought the unbeliever to some meeting where the conversion occurs. Thus the more believers there are the more conversions will occur. This in turn makes more believers thus reinforcing the growth

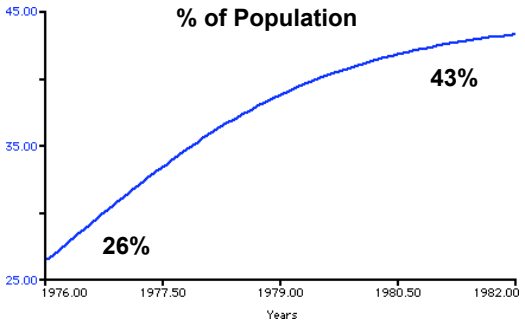
The result is exponential growth. A vibrant church will grow exponentially in its early stages. Using the data from Rodney Stark's paper "So far So Good" it can be shown that the Church of the Latter Day Saints has a worldwide growth of 4% per year. This gives a doubling time of around 18 years.

Exponential growth always has a fixed doubling time. The world population has a doubling time of around 40 years.

The church will also grow without conversion if the children born to believers also go on to be believers. Again the growth is exponential if there are no other mechanisms.

What Limits Church Growth?

- **Lack of Unbelievers**
- **Enthusiasts**
  - **Only some in the church involved in converting others**
  - **The enthusiastic period is limited**



Revival among Baptists Nagaland India 1976 - 1982

Growth cannot continue exponential for ever. There are limits to growth. The most obvious limit is size of the population. Indeed the growth of the church will slow down due to the shrinking pool of unbelievers. It becomes harder for believers to find unbelievers to make contact with.

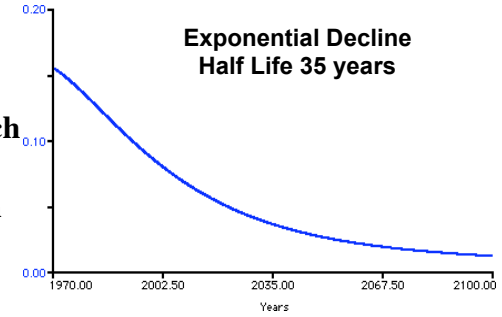
However growth will burn out much sooner if only a subset of the church are involved in conversions - the enthusiasts. If it is assumed the main enthusiasts in recruitment are new converts, because they have a network of unbelieving friends and often the highest zeal, then growth is further restricted. Such enthusiasts have a limited enthusiastic period after which they become the more subdued members of the church. The growth of the church runs out before all unbelievers are converted in the same way as an epidemic ceases before all have caught the disease

Such behaviour often happens in revivals A revival occurred among the Baptist churches in Nagaland, a largely Christian state in India. Membership statistics show the revival lasted 6 years, which took the membership of the Baptist churches from 26-43% of the Christian community. According to the systems dynamics model the growth was expected to run out as the enthusiasts were not recruiting at a rate to sustain themselves beyond this level. The revival would have ended because of a lack of enthusiasts.

What Causes Church Decline?

- **Reversion**
- **Deaths**

Net loss to the church if some children of believers do not join church to replace those who die



Church in Wales (Episcopal) 1970-2100

Reversion of adults is one of the main causes of decline. For most churches this is a similar percentage each year, often around 6%, some of whom may well go to a different denomination. If there were no gains this would lead to an exponential decline in the church.

The church may also decline through deaths, but only if the deaths are greater than the retention of the children of believers mentioned on the previous page. If life expectancy is about 70 years then, even if none of the children of believers become believers themselves, deaths would be the equivalent of a reversion rate of 1.4% per year. If the birth rate and the death rates are equal and all the children are retained then deaths will cause no loss to the church as those who die are replaced by those who are brought into the faith. Such a church would survive without any conversions.

The Church in Wales, the disestablished Anglican church in Wales, is declining exponentially with a half life of 35 years. This trend was based on Easter communicant figures over a 30 year period. Although higher than the attendance of the church it is a statistic which has been measured the same way over that period. In 1979 the church had 150,000, which dropped to 83,000 in 2000. Using the model this could be a mere 11,000 by 2100. Surprisingly the losses from this church are the same as many others. It is just not converting enough people to make up for the losses.

Parameters

- **Reproduction Potential**
  How many new enthusiasts one enthusiast makes
- **Fraction of Converts "Enthusiastic"**
- **Duration of Enthusiastic Period**
- **Adult Reversion Rate**
- **Fraction of Children who Leave**

If all the preceding effects are built into a systems model a number parameters emerge that determine the future dynamics of the church's numbers.

Reproduction Potential

This is the key parameter for determining extinction, sustainability or revival-type growth. It is defined as the number of new enthusiasts one enthusiast makes before their enthusiastic period has elapsed. Values vary from 0.8 to 1.3. E.g. a value of 0.8 means it takes 10 such enthusiasts to make 8 new ones, although they may convert others who do not become enthusiasts. The reproduction potential must be at least 1 if enthusiasts are not going to do decline.

Fraction of Converts "Enthusiastic"

If only half of the new converts are enthusiasts, and the reproduction potential was 1, then each enthusiast is responsible for making 2 converts.

Duration of Enthusiastic Period

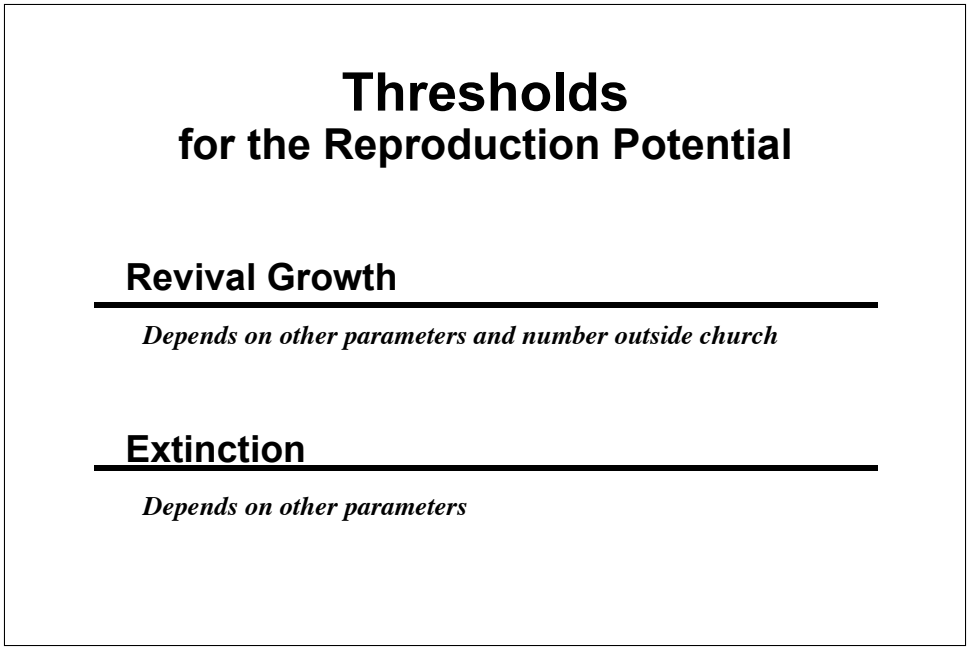
Around 2 years under normal circumstances. This is close to the time it takes for a new convert to lose their network of unbelieving friends.

Adult Reversion Rate

6% per year is typical

Fraction of Believer's Children who Leave Before Becoming Members

In the late eighties this was measured at around one third in the UK. Generally reckoned to be higher now.



The systems dynamics model shows that there are two thresholds the reproduction potential can be compared with.

Extinction Threshold

If the reproduction potential of the enthusiasts is below this threshold the church numbers tend to zero. The church ultimately becomes extinct. The threshold depends on the reversion rate, child loss, fraction of converts who become enthusiasts and the duration of the enthusiastic period. The actual combination is quite complex. Under some circumstances some parameters have little leverage on the extinction threshold. However it will rise if the loss rates go up. The Church then needs more reproduction potential to survive.

If the birth rate is greater then the death rate a church may not become extinct but its proportion of society could still tend to zero. It survives but its "market share" keeps falling.

Revival Growth Threshold

If the reproduction potential is above this threshold the number of enthusiasts will increase. As well as depending on the other parameters in the same way as the extinction threshold it also depends on the size of the unbelieving pool. As the church grows the revival threshold rises until it is above the reproduction potential**.** Growth now slows as conversions become harder. The church numbers tend to a limit determined by reproduction potential being equal to the revival growth threshold.

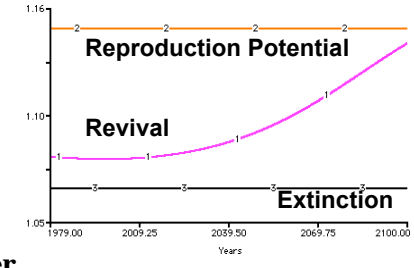
Thresholds - Revival

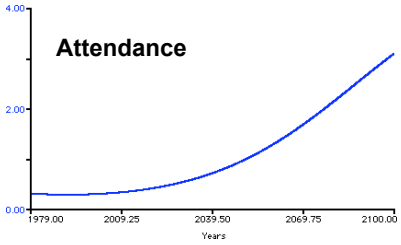
Baptist Church England 1979 - 2100

Fit 1979-1998 Attendance

Reproduction Potential over Revival Threshold

Revival Threshold Rises as Church Gains people





An example of a church whose reproduction potential is over the revival growth threshold are the Baptist churches of England. The parameters were determined from the three church attendance surveys conducted by Christian Research (formerly MARC Europe) in 1979, 1989 and 1998. The model shows the churches in the early stages of revival growth which will continue, assuming the parameters keep the same values, for the rest of the 21st century.

Note the revival growth threshold is rising throughout the century until it almost reaches the reproduction potential in 2100. After this the increase in enthusiasts will slow down, eventually leading to their reduction in number. They will not, however disappear. Their numbers, along with the church's will tend to a limit. But only after a few hundred years. Changes in these sort of dynamical systems take a long time to work through!

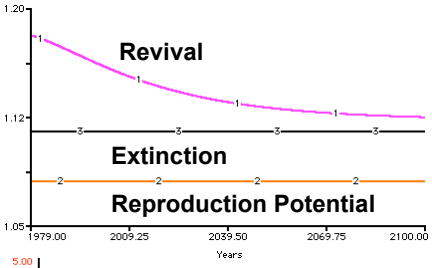
Thresholds - Extinction

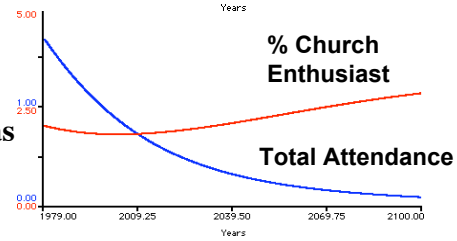
Church of England
1979 - 2100

Fit 1979-1998 Attendance

Reproduction Potential under extinction threshold

Revival threshold drops as church loses people





An example of a church headed for extinction is the Church of England. Again this is based on the Attendance survey data of 1979-1998. Its reproduction potential is below extinction threshold. However it would be a long time before it becomes extinct. As of 2002 its numbers are just below a million, by 2100 they will be around 81,000. It has a half life of about 25 years.

Interestingly the proportion of enthusiasts in the church is increasing, but not their number. This is because of population growth and the reversion from the church. As the reproduction potential is below the extinction threshold it is not possible for the number of enthusiasts to increase.

If the church could keep all the children of believers in the faith it would just stay above the extinction threshold. If it stemmed half its losses it would continue to decline but would still have over half a million attending in 2100. Stem all its losses and it and would see revival-type growth!

One of the advantages of the systems dynamics method is that it can examine alternative scenarios by considering the effect the parameters have on the behaviour of the system.

English Churches

Church	Rep. Potential	Enth. Period	Reversion	Enthusiasts	Status
England	1.03	3.5	4%	9%	Extinct
Methodist	0.75	2.4	3.5%	6%	Extinct
C of E	1.08	2.4	4%	2%	Extinct
Baptist	1.15	2.05	2.5%	1.6%	Early Revival
New	1.275	2.6	4%	11%	Revival

A comparison of a number of English denominations shows a wide variation in parameters. The Wesleyan Methodists are in serious decline with a reproduction potential well under one, and thus under the extinction threshold. Even if they stemmed all their losses they would not survive. They are not making enough enthusiasts and as a result not converting enough people.

By comparison the Church of England although under the extinction threshold is in a better position, with a reproduction potential slightly above the average for England. Apart from the reduction in losses, discussed on the previous page, a moderate change in reproduction potential would mean it would avoid extinction and even go into revival growth. This is probably because there are a number of congregations in the church already seeing this type of growth, but as yet their numbers are small in comparison to the relatively inactive and aging ones.

Although the Baptists are undergoing revival growth it is the independent New Paradigm churches and charismatic streams that are seeing the most growth and the highest reproduction potential. Note they also have a larger percentage of enthusiasts. Data for this church was based on membership data for the 1990's as they were not a well defined group at the time of the 1979 attendance survey. However as most do not have a formal membership system their "membership" is measured by regular attendance. Thus this data reflect their attendance through 1990's

If growth continues in the same way the new churches will be larger than Methodists by 2010, larger than the Church of England by 2025, having passed the growing Baptists in 2020.

Fast Revivals

Revival	Rep. Potential	Enth. Period	Change in church	Duration Of Revival	No of Converts
Wales 1904 Whole Church	2	1 - 2 weeks	48.9% 53.4%	15 months	100,000
Calvinist Methodist	2.25		12.1% 13.2%		15,854
Baptists Nagaland	1.43	4 months	26% 43%	6 years	85, 935

For short term revivals the reproduction potential is much larger, and the duration of the enthusiastic period shorter. The raising of the reproduction potential is something that only happens for a short time in an enthusiasts life during a such a revival. It is too short for people to be running out of unbelieving friends. It should be born in mind that these are average figures and some people may be enthusiastic for much longer than others.

For the 1904-5 revival in Wales the reproduction potential is much higher than for Nagaland. This reflects the fact that the Christian church was a much higher proportion of the population than the Baptists in Nagaland. It is harder to have revival-type growth when the church is more dominant unless enthusiasts target unbelievers in preference to their believing friends.

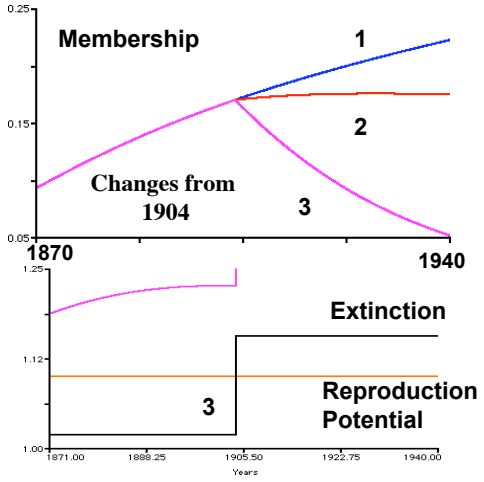
A similar result is obtained for individual denominations in the Welsh revival. The Calvinistic Methodists, at the forefront of the revival have a higher reproduction potential than the average for the whole church.

Faster revivals tend to have a shorter enthusiastic period. For Wales it was barely a few weeks. Contrast also with the New churches on the previous page, whose in enthusiastic period is over 2 years even though they also have revival growth.

Low Reproduction
Cause of Future Decline

Welsh C. Methodists

- Late 19th Century
  - Small Losses
  - Low Reproduction Potential
  - Sustaining itself 1.
- Losses at current levels
  - Child Losses 2.
  - & Reversion 3.



The Welsh Calvinistic Methodists make an interesting study from the point of view of the church growth systems dynamics model. As a denomination they were involved in all revivals in Wales from 1735 onwards (about 16) although they did not finally leave the established church until the early 1800's. Sadly the only reliable data is available from after the 1859 revival.

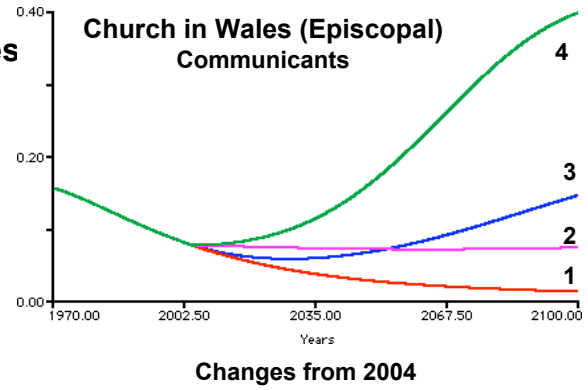
Fitting their communicant data from 1871 to 1904, before the last revival took place, shows they were sustaining themselves in line with population growth, falling behind towards the end. They had a moderately low reproduction potential (1.1) for a church of this size but with very few losses (around 0.5% reversion) Had the revival not happened, and these trends continued they would have continued to fall behind the population (1).

Alternatively if child losses at the current levels of about 50% had started in 1904 the church would have stopped growing and its proportion of society would be falling quite fast (2). If the current reversion levels had also started at that time it would have gone into serious decline with the reproduction potential below the extinction threshold (3).

However the church's real problem was its inability to reproduce enthusiasts. The higher losses only exposed the weakness of the church's reproduction potential. In fact this sort of decline started in the 1940's, helped by the population of Wales not increasing much beyond 1920. However the problem can be traced back to the late 1800's. They had lost the potential for conversion growth.

Prospects for a Declining Church

1. Predicted Decline
2. Half losses
3. Rep. Pot 1.1 to 1.2
4. Both Effects



Changes from 2004

Returning to the Church in Wales a fit to the model gives it a reproduction potential of 1.1 and around 4% reversion. What is the best strategy to improve its situation?

If the church could half its reversion and child losses (2) it would survive but not recover. However an increase in reproduction potential from 1.1 to 1.2, higher than the Baptists of England would just be enough to bring it back to 1970 levels by 2100 (3).

The real change in circumstances comes if both strategies could be applied together (4). The church enters revival growth coming back to its 1970 levels by 2040 with much more growth to come.

How easy it is to raise the reproduction potential by this amount is not clear, but it involves change in only a small number of people within the church. Around 5% based on the fits to data so far.

USA Churches

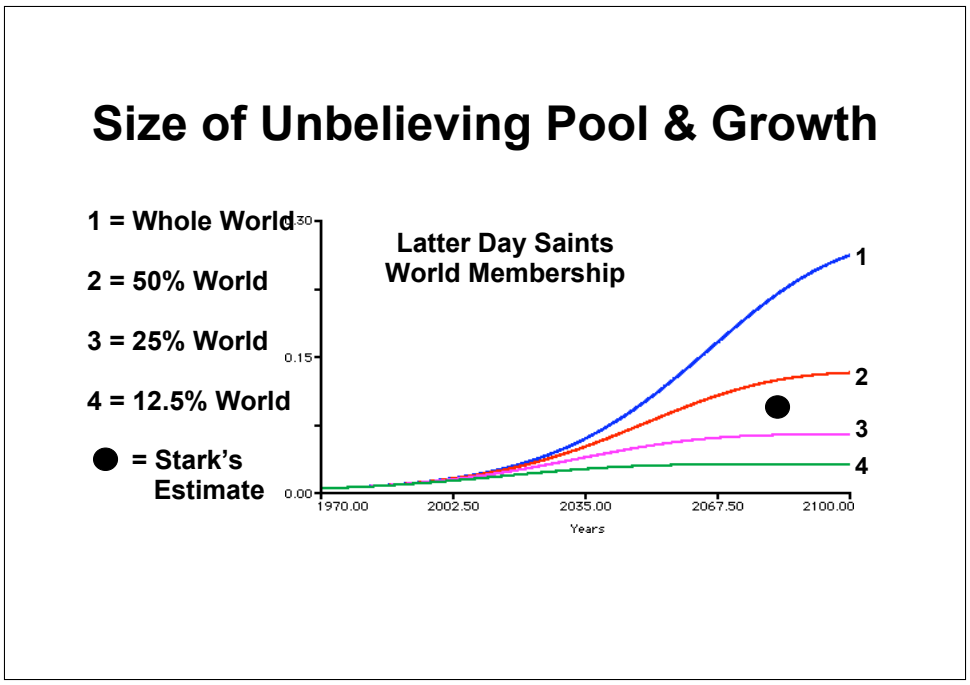
Church	Rep. Potential	Enth. Period	Reversion	Enthusiasts	Status
United Methodist	0.8-1.3	2 - 4	1-8%	1-9%	Extinct (just)
Episcopal	1.1	1.8	6%	7%	Extinct (just)
S. Baptist	1.25 0.9	3.1 1.5	5% 0%	8% 1%	Revival (ending) Extinct
Pentecostal	1.2-1.3	2	2-6%	3-6%	Revival

The main difference in fitting data for the USA churches is that the population of that country is growing much faster than the UK. Thus it is much easier to have revival growth, or sustainability, as the extinction and revival thresholds are correspondingly lower. Of course it is still equally hard for a church in a growing population to increase its *proportion* of society. Data was based on figures up to 1990.

The United Methodist provided a huge range of parameter fits. It would not be possible to distinguish between them without other sources of data, e.g. adult reversion. Nevertheless in all case the church is just under the extinction threshold, although not as seriously as the English Methodists. Likewise the Episcopal church is just under the extinction threshold.

The Southern Baptists provided at least two separate minima in the least squares fit. The most optimistic sees them coming to the end of revival growth with their proportion of US society falling slightly around 1990. However the same data would fit a church with a much lower reproduction potential and no reversion rate. In that case it is below the extinction threshold. Although this latter fit is unrealistic due to the lack of reversion, it shows that a church can appear healthy by still growing but could be highly vulnerable to increased reversion losses - like the Welsh Calvinistic methodists in the late 19th century.

The USA Pentecostals are seeing significant revival growth, even allowing for the increase in population.



One crucial parameter not discussed so far is the size of the unbelieving pool. Because denominations have transfer growth from other denominations, then the unbelieving pool has been taken to be all the people not in that denomination.

The size of this pool makes a huge difference to predicted growth. Consider the world numbers for the Latter Day Saints (LDS) mentioned under conversion growth. At present their growth is exponential. However if it is assumed they have similar losses to the Christian churches then estimates of the parameters of the model can be obtained.

Whatever the size of the unbelieving pool the results are the same up to 2025. After that, if it is assumed the whole population of the world is in contact with the church through this century, then by 2080 the church membership would be slowing down but still reach 210 million. This is much higher than Stark's estimate of 85 m for that year, but similar to Anderson's based on the data up to 1994.

If only half the population is contactable that value falls to 120 m. If the pool is a quarter of the world the 2080 estimate is now 60 m, less than Stark's value. Thus the LDS may be headed for substantial revival growth this century, or slowing down. On the basis of this data it is not possible to say which scenario will prevail. However if Anderson's most recent data fitting is correct the LDS may only be contacting a small fraction of the available world pool, and face a significant slow down in their growth.

Even in the most optimistic case the LDS level out at 4.5% of the world population. With a reproduction potential of around 1.2 their growth potential is no different from the USA Pentecostals or the English new churches. The difference is the size of the unbelieving pool they may have contact with.

Other Countries

Church	Rep. Potential	Enth. Period	Reversion	Enthusiasts	Status
Australia	1.1-1.3	1.5-3	1%-4%	1.5-5%	Sustain
Uganda	1.2	0.8	9%	9%	Revival
Argentina	1.3	3.1	5%	13%	Revival

The protestant churches in Australia are in a healthier state than those in England. Taken as a whole they are sustaining themselves after weak revival growth. That is the number of enthusiasts were undergoing revival growth but not their proportion. If these parameters stay the same the churches will continue to grow in line with the population.

Uganda has a very high birth rate and an increasing death rate due to Aids. Also the population and especially the church underwent persecution at various times in the period 1960-1990. As such it is difficult to fit the model to the church data. An average value gives the church in significant revival growth reflected in the much shorter duration of the enthusiastic period than other churches. The reversion rate appears unduly high.

Argentina's protestant churches provided a good fit with revival growth. The high percentage of enthusiasts suggest the revival has been going sometime.

Data Needed

- How many enthusiasts in a church?
  - How many do they convert?
  - How many converts are enthusiasts?
  - How long are they enthusiastic?
- Reversion rates?
  - How long before a revert is open to conversion again?
- Child retention rates?

Conclusion

Data fitting has indicated a number of churches such as the English Baptists, English new churches and USA Pentecostals, with revival-type growth, whereas the Anglican churches in England Wales and the USA, together with the Methodists in England and the USA are heading for extinction. The main difference between the growing and declining churches is the reproduction potential rather than the losses. The declining churches are not converting enough people.

Other churches such as the LDS, or national churches such as Uganda and Argentina, also have revival-type growth. However the growth of fast revivals has a much larger reproduction potential and much shorter duration for the enthusiastic period.

Further data fitting would be enhanced if estimates of parameters were available from sources other than church numbers. Answers to the following questions would greatly enhance the application of this and any other models:

- How many enthusiasts are there in a church at any one time?
- How many people does each enthusiast convert?
- How many converts become enthusiasts?
- How long do enthusiasts remain active in recruitment?
- What are the churches reversion rates?
- How long before a revert is open to conversion again?
- What are a churches child retention rates?

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