Biodemography and Darwinian theory

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Abstract:

Theory in biodemography must reflect the theoretical underpinnings of biology. Biodemographers therefore need to explain why the reproductive behaviour of most contemporary humans suggests that they do not strive to maximize their "inclusive fitness". Human behavioural ecologists have shown that reproductive behaviour in traditional societies is roughly consistent with Darwinian theory but the cultural changes associated with modernization include a progressive abandonment of norms that encourage efficient conversion of resources into offspring. Our evidence suggests that this is the result of a change in the composition of human communities. Human behaviour is strongly influenced by cultural norms which are generated by social interaction within communities. This unique behaviour evolved in communities in which a high proportion of social interaction was between kin, who have an interest in encouraging each other to make evolutionarily optimal reproductive decisions. In modern communities a smaller proportion of interaction is between kin so encouragement is reduced allowing norms to become increasingly less pro-natal.

Most modern people think it is obvious why people become modern. For them, a more interesting and important puzzle is why some people fail to embrace modern ideas. Why do people in traditional societies often seem unable or unwilling to aspire to a better life for themselves and their children? Why don't they see the benefits of education, equal rights, democracy and a rational approach to decision-making? What is the glue that makes them adhere to superstition, religion, obligations to family and tribe and to just accept a life of poverty?

The "kin influence hypothesis" (Newson et al., 2005) suggests an explanation both for why people become modern and why modern ideas are often slow to be accepted by a population. It is based on the understanding of how cultural norms change that has been gained by social-psychological research. The hypothesis takes a Darwinian approach to explaining human behaviour and recognizes that much of cultural change associated with modernization is a progressive abandonment of values and norms which encourage people to pursue what evolutionary theorists refer to as "reproductive success"[1].

It proposes that the cascade of cultural changes associated with modernization is the result of the dramatic change in the human social environment that occurs early in economic development. For most of human evolutionary history, the norms of all cultures must have prescribed behaviour that, on balance, enhanced the genetic fitness of their members. As Lumsden and Wilson (1981) and Alexander (1979) rightly pointed out, if this were not the case, evolutionary biologists are not able to explain how humans evolved the uniquely human capacity for learning and imitation that makes culture possible.

With economic development, however, people begin to abandon the beliefs and values that encourage fitness-enhancing behaviour. For example, they adopt the idea that smaller families are better even though their increasing wealth makes it easier to raise a large family. Evolutionary biologists, therefore, have the problem of explaining why culture has recently ceased to prescribe fitness-enhancing behaviour. Since this change routinely accompanies economic development, it is reasonable to suspect that it is somehow caused by economic development.

The kin influence hypothesis proposes that economic development disrupts the social mechanism that keeps the culture of pre-modern societies on the track of genetic fitness. In pre-modern societies, virtually all communities and social networks are kin-based so most people acquire most of their beliefs, values and knowledge from their relatives. Individuals have an "inclusive fitness"[2] (Hamilton, 1964) interest in the reproductive success of their sons, daughters, cousins, nephews, and grandchildren. This interest has the effect of supporting norms and values that encourage converting resources into offspring rather than "wasting" time and resources on other life goals. However, if social networks become less dense with kin and social interactions are mostly between people who have no interest in each other's reproductive success, the social support for fitness-enhancing norms disappears. This does not cause a sudden change in culture or behaviour but norms, beliefs and values begin to increasingly diverge from those which would ensure the active pursuit of genetic fitness.

Newson et al. (2005) and Newson et al. (2007) show how this idea can work in theory and present empirical evidence in support of the hypothesis. Here we add to the empirical argument by reviewing evidence that "modernity" is a diachronic process with considerable cross-cultural predictability and that the leading causal variable is a dramatic change in social network structure that is closely followed by the beginning of the demographic transition to small families.

Modernity as a process observed quantitatively

A series of surveys begun in 1981 (European and World Values Surveys, 2006) have produced data that invite social scientists to consider modernity in terms of attitudes and values that can be measured. The findings, based on surveys of over a quarter of a million people in more than 75 countries, suggest that modernization is a rather uniform process (Inglehart and Baker, 2000, Inglehart and Welzel, 2005).

A perception of "multiple modernities"(Eisenstadt, 2002) may arise because the values held by people in a modern or modernizing culture continue to reflect some aspects of the population's cultural heritage. But the data shows economic development to be associated with a rather coherent cultural shift away from a traditional value system. The perception of multiple modernities may also arise because this shift is not a discrete event. Once the cultural shift begins, it continues. In 25 years of World Value Survey monitoring, considerable cultural change was detected in economically developed populations as well as in many developing ones (Welzel, 2006).

This implies that modernity is better understood as a *process of change* rather than a culture or value system that *results from the change*. What's more, this process is better described by what it is moving away from (i.e. "traditional values") than by what it is heading towards. It is unhelpful to perceive becoming modern as the adoption of Western values when Western values are continuing to change. Modern Thailand is not like modern America. But then the modern America of 2008 is not like modern America of 1958 or what modern America will be like in 2058.

The suggestion that there are "traditional values" implies that pre-modern cultures, although very diverse in some respects, share certain values that are different from those of "economically developed" cultures. This is consistent with the view of Inkeles and Smith(1974), who demonstrated over 30 years ago, that individuals within a modernizing population begin to abandon a suite of "traditional attitudes", such as desire for a large family and passivity in the face of obligations to family and elites, and replace them with "modern attitudes", such as political activism, desire to better one's self and a recognition of the need to control family size.

The idea of "traditional values" shared by pre-modern cultures is also consistent with the observations of anthropologists who have concentrated on looking for similarities between cultures rather than differences (e.g., Murdock, 1967, Brown, 1991) and of human behavioural ecologists who have analyzed the norms and practices of a wide range of small-scale cultures from a Darwinian perspective (e.g., Chagnon, 1988, Hill and Hurtado, 1996, Borgerhoff-Mulder, 1988, Cronk, 1989, Irons, 1979, Wang et al., 1995, and reviews by Cronk, 1991, Low, 1993, , 1999, , 2000).

Environmental and evolutionary explanations

Inkeles and Smith(1974) suggested that exposure to modern institutions, such as schools and businesses, causes people to abandon "traditional attitudes" in favour attitudes that are more appropriate in a modern social and economic environment. But the idea that modern attitudes spread by diffusion to new populations does not explain why they emerged in the first place in European populations in the 18th and 19th century. Nor does it explain why the process of cultural change continues in these populations.

Explanations of cultural change can be "environmental" or "evolutionary". Both kinds of explanation have been offered to explain modernization.

Environmental explanations are synchronic, suggesting that cultural changes are adaptations to contemporaneous changes in the environment. Specific modern inventions, for example, have been credited with causing cultural change; birth control technology is often mentioned as a cause of a change in sexual mores. The ecology of an economically developing society is continuously changing through the introduction of new technology, changes in the law, business practices and political systems, increasing wealth, improving health, widening communication, intergroup conflict, migration and many other changing factors. All of these are likely to influence the behaviour of members of a population.

Evolutionary explanations are diachronic, suggesting that while contemporaneous events may be driving marginal changes, a substantial amount of social change is the result of processes set in motion by changes in the distant past. These processes play out over an extended period of time and will continue until a new equilibrium is reached. The process of change and its future trajectory can be better understood, therefore, by using models in which the whole trajectory of past change is represented. The historical trigger of the evolutionary process is not readily linked with the present-day consequences, however, so the cause of change and the mechanism of causation may be obscure. Also, when the change is the result of an evolutionary process, attempts to influence the speed or direction of change are likely to be ineffective if they don't address the underlying instability that is driving the process.

Evolutionary processes behave in this way because inherited elements generate lags in a population's response to change. This has been closely studied in biological ecosystems. When a population of organisms experiences a change in the natural environment, genes are the inherited elements that create lags. Each new generation inherits the genes of its parents and therefore resembles antecedents that were adapted to conditions that existed before the change. But as Darwin (1859) pointed out, A change in the environment generates selective pressures that reshape gene pools over many generations.

In the case we examine here, it is culture, not genes, that creates the lag. During the early part of their lives, humans acquire beliefs, values, skills customs and other cultural information by imitating and learning from members of previous generations. As they grow older and more experienced they may modify cultural information they have acquired to make it more relevant to their current circumstances. Nevertheless, populations tend to maintain many cultural characteristics that were created as an adaptation to earlier circumstances. The cultural change known as "modernization" is a multi-generation diachronic process that is apparently ongoing today even in societies that industrialized several generations ago. To understand an evolutionary process and to predict how it is likely to proceed, we must identify what is driving it.

Most current evolutionary explanations for modernization assume that the change processes were triggered by liberation from constraints that existed in the past. Many components of modernization have been treated as causally independent triggers. The introduction of schools, for example, could have allowed people to see new possibilities. The growth of scientific knowledge encourages people to question religious dogma. Technology and division of labour reduced drudgery. Wage labour alleviated poverty and the tight social control of family, church and community. More humane political systems gave people greater freedom of choice. Better communication gave people information that allowed them to make better choices (e.g., Lesthaeghe, 1983, Inglehart and Welzel, 2005). The plausibility of these proposals notwithstanding, we will try to show that such particulars of modernization are part of a pattern that can be explained more economically in terms of an evolutionary process that generates all of them.

"Liberation from constraints" hypotheses do not define in which directions culture will evolve. Early social theorists noted a gradual secularization and the replacement of superstition with rationality and science (e.g., Weber, 1994, , 1951). But as cultural change progressed, it became clear that the changes could not be attributed to people making rational choices. Even Becker (1960), who has argued that children can be viewed as consumer items, recognizes that rationality and economic circumstances cannot completely account for why a person may prefer a baby to a new car. Research in social psychology has shown that individuals economize on cognitive effort when faced with choices. They sometimes "make up their mind" after rationally evaluating the available evidence but they often form opinions based on rapidly observed cues about the choices available, such as which choice appears to be most popular (e.g., Hovland et al., 1953, Petty and Cacioppo, 1986).

Liberation from constraints *does* explain how modern people have the time and resources to follow a plethora of odd hobbies (1965), but not why they are motivated to do so. It therefore does not provide the basis for an evolutionary approach that can explain cultural change, cultural diversity or predict how culture will change over time. It gives no reason to believe that the direction of cultural change will be anything but random, whereas the data we review below shows that modernity is a fairly tight and predictable pattern of change that has many cross-cultural similarities.

The lack of explanatory power of the evolutionary "liberation from constraints" approach may explain why social scientists have mostly used synchronic approaches when attempting to explain and predict social change. This involves monitoring changes in the environment and considering how human psychology might react to those changes to make adaptations. , These approaches also have weaknesses, however. Modern and modernizing societies experience many environmental and cultural changes. Reasons why one change may cause another readily suggest themselves and correlations between variables provide empirical evidence to support suggestions. But there is often a high degree of collinearity between the variables and the direction of causation is often questionable. For example, as a population modernizes, wealth tends to increase, family size decreases and women become better educated and more likely to work outside the home. This supports the suggestion that the alleviation of poverty causes people to have fewer children. But it also supports the suggestion that educating women and putting them to work outside the home causes wealth to increase.

A great deal of effort has been spent investigating environmental variables such as socio-economic factors and looking at relationships between them and measures of opinion and behaviour. This work has not, however, lead to the development of models that reliably explain cultural differences or accurately predict cultural change.

Adding formal diachronic hypotheses to the candidate explanations offers new causal explanations that may succeed where synchronic explanations have left a muddle. Certainly, if diachronic cultural evolutionary processes are important, attempts at pure synchronic explanation will *inevitably* result in a muddle. If important causal arrows are downwards through time, synchronic explanations will simply fail to detect them. Our argument here is that the evolutionary process has created the collinearity that bedevils purely synchronic explanations of modern behaviour.

An evolutionary explanation informed by Darwinian theory

The kin influence hypothesis suggests an evolutionary explanation for the process of cultural change that accompanies modernity which is more specific than "liberation from constraint"

hypotheses. It specifies a single historic change as the trigger for the evolutionary process and describes a mechanism that would drive culture to change in certain directions. Thus the hypothesis provides the basis of predictions about the direction of cultural change and tests of these predictions provide a way of assessing the importance of the proposed mechanism.

The kin influence hypothesis also suggests an explanation for a pattern of progressive cultural change that is characteristic of modernity – a pattern has not been addressed by other social change theories. Although exceptions are sometimes found (Coale and Watkins, 1986, Edgerton, 1992), the norms and values of characteristic of traditional societies encourage members to behave in ways that are close to optimal for maximizing genetic fitness (Chagnon, 1988, Hill and Hurtado, 1996, Borgerhoff-Mulder, 1988, Cronk, 1989, Irons, 1979, Wang et al., 1995, and reviews by Cronk, 1991, Low, 1993,, 1999,, 2000). It is a general biological maxim that living organisms compete *not for their own survival* but for the survival of the *information in their genes* (Hamilton, 1964). The genetic fitness of an individual is determined by the number of copies of its genes that are present in future generations. We are descended from (and carry the genes of) individuals who managed to survive *and* to raise children … children who themselves managed to raise children … and so on. Deciding *not* to make the sacrifices necessary to raise children would have made our ancestors' *own* survival more likely. But our ancestors *did* make these sacrifices and that is why we exist.

The norms of tradition societies do not encourage people simply to produce babies. They encourage the successful rearing of children in circumstances that are often difficult and they also encourage cooperation between relatives. Close relatives share many of the same genes so helping relatives enhances an individual's "inclusive fitness" (Hamilton, 1964). The marriage, kinship and gender role norms of traditional societies encourage cooperation between relatives and efficient reproduction. They regulate the mate choice of members entering their reproductive life (Apostolou, 2007). Parents and other kin arrange matches to link families in a commitment to cooperate in raising the next generation. Norms also influence the timing of births so that adequate resources are likely to be available to raise the baby, (e.g., Mace, 1998, Bledsoe et al., 1994). Some people in traditional societies may be encouraged to postpone or forgo having children themselves and instead devote their time to caring for their relatives (Low, 1999). Many societies have norms and beliefs that encourage the abandonment of babies that show signs of having birth or genetic defects or who are failing to thrive (Hrdy, 1999). From a biological perspective, therefore, the reproductive norms of traditional societies do not encourage mindless procreation but do encourage the efficient use of resources to produce the maximum number of surviving offspring in each generation.

Traditional norms and values limit people's aspirations by keeping them focused on fundamental biological goals. They do not permit the level of comfort valued and seen as necessary by people in modern societies because excess resources are invested in the production of children. This creates more copies of their genes and also propagates their culture. At the same time it creates more mouths to feed and minds to educate.

Modern cultures have beliefs, values and norms that make it much easier for their members to win the competition to maximize the number of years that they survive. But they do so by encouraging them to retire from the biological competition to maximize the numbers of copies of their genes that survive beyond their death. Put another way, cultural and genetic success become decoupled when societies modernize (Richerson and Boyd, 1984).

Darwinian theory, therefore, suggests that explaining why people begin to abandon traditional values is more difficult than explaining why people are slow to adopt behaviours

likely to increase their comfort and security at the expense of their biological fitness. Economic development brings greater resources, which allows more children to be raised, so unvarnished Darwinian theory predicts that the response will be to produce *more* offspring not fewer (Richerson and Boyd, 1984, Vining, 1986). Indeed, when a society begins to develop, population does rapidly increase. So why do values change so that people begin to want fewer children? Favouring relatives is likely to enhance an individual's fitness by improving their reproductive success. So why does culture change so that nepotism or "amoral familism" begins to be thought of as corrupt? Why do tribal identities begin to weaken with economic development? Tribalism supports long-standing collective strategies that usually enhance the fitness of tribal members (Richerson and Boyd, 1999).

In the populations that were the first to modernize, attitudes to reproduction have continued to evolve and current norms about gender roles, sexual behaviour and parenting in these societies are even more difficult to explain in Darwinian terms. The process of change was most closely monitored in the population of the United States. In the early part of 20th century, marriage became increasingly regarded as the union of two people who love and are attracted to one another, rather than a partnership for the purpose of creating a family (Ogburn and Nimkoff, 1955, Buss, 2001). Since the 1970s, marriage or a marriage-like relationships between people of the same sex have become increasingly accepted (Avery et al., 2007). Meanwhile, families have become less stable, with parents more inclined to divorce or to cohabit without marrying (Bumpass and Lu, 2000, Espenshade, 1979). It has become increasingly common for women to postpone having children and in many cases this results in them having no children or fewer children than she would like (Bongaarts, 2001).

In the latter part of the 20th century, the concept of gender empowerment emerged in the populations that were the first to modernize. It became regarded as virtue for societies to encourage women to do the same work as men and for women to seek that work (Thornton et al., 1983). Yet a sexual division of labour is much more advantageous from the point of view of maximizing fitness. Biology constrains men and women to perform different reproductive roles. Women gestate the young and produce milk to feed them so maternal care is more vital for infant survival than paternal care (Low, 2000). The fitness of both men and women is enhanced if women are able to provide necessary childcare. Studies of a number of traditional foraging cultures have shown that work performed by women is consists largely of tasks that can be done while they care for young children (Brown, 1970, Hurtado et al., 1992, Hill and Kaplan, 1988). Human males' activities are not constrained by carrying infants to term and nursing them. In traditional societies men typically provision women and children by activities like hunting, herding, farming, and wage labour. From the evolutionary biologist's point of view, gender empowerment, which has the effect of most women pursuing the same activities as men, prevents couples obtaining the fitness advantages inherent in the traditional division of labour on the basis of gender.

In summary, many of the cultural changes that occur in modern or modernizing countries reflect a dismantling of the norms, beliefs and values which in traditional societies encourage behaviour consistent with the pursuit of genetic fitness.

An enduring change in the social structure

The kin influence hypothesis suggests that the increasing abandonment of biological goals is a cultural evolutionary process triggered by the profound change in social structure that occurs as economic development begins (Newson et al., 2005). In pre-modern and pre-historic human societies and even in ancestral hominid populations, individuals lived as part of a relatively closed social group in which there was frequent social interaction between kin (Foley, 1996). In traditional communities, children work, play and are educated among their

family. When they leave their natal community, it is usually to live among other families. Some pre-modern societies had traditions of young adults temporarily joining a family as an employee (Hajnal, 1982, Smith, 1981). But a more common tradition was for young adults to leave their natal community to marry and become part of the community to which their spouse's family belonged. Some historians have argued that kinship ties may have been weak in pre-modern northwest Europe, where the nuclear family household has a long history. Historical evidence suggests, however, that even if kin did not live under the same roof, they were in frequent contact and the sentiments and responsibilities of kinship were strong (Cressy, 1986).

When a society begins to undergo economic development, new kinds of social networks begin to form. Economic development creates centres of employment and trade where large numbers of unrelated individuals congregate. Industrial modes of transportation make long-distance migrations relatively cheap and easy. Communication technology, from books and newspapers to the Internet allow information exchange by people who have never met. By taking advantage of the developing opportunities, individuals increasingly interact with people who are not family members and who have been raised in different local traditions.

That economic development brings changes to the structure of society has been observed by many social change theorists and the possible consequences of such a change have been much discussed. Weber, Durkheim and Tönnies and other 19th century social theorists also considered changes in the nature of community to be linked to the social change associated with modernization. Kingsley Davis (1937/1997)suggested the diminishing role of the family to be a cause of fertility decline. Zelinsky(1971) more formally documented the phenomenon, showing that higher rates of social and spatial mobility occur with modernization and closely parallel the demographic transition.

Watkins(1990) suggested that the fertility decline in Europe is linked to the widening of communities and her suggestion is supported by research in populations currently experiencing fertility decline. An association between change in social networks and the adoption of family limitation has been widely reported. In developing countries, women who attend market, live near a bus route, belong to a club, have attended school or have seen a movie have been found to have more modern reproductive behaviour. They have fewer children and are more likely to be using birth control (e.g., Kohler, 2001, Axinn and Barber, 2001, Axinn and Yabiku, 2001, Barber et al., 2002, Valente et al., 1997, Behrman et al., 2002, Watkins and Danzi, 1995).

In most previous analyses, however, this change in the social environment has been treated as a synchronic environmental variable. Scholars have agreed that it is likely to cause cultural change, but they have only considered changes observed at the same time or immediately afterwards. They have not considered that an enduring change in the structure of communities might have an enduring capacity to cause cultural change and thus set in train a process of change that plays out as an evolutionary process, rather than merely causing a set of changes that takes place over a discrete time interval.

The evolution of cultural norms

Durkheim's view (1984/1893) that modern societies lack the solidarity that comes from a "collective conscience" is disputed by both common experience and research into the social processes characteristic of humans. Complete strangers who are socialized into different traditions can perceive themselves to be part of a cohesive group and share a common identity. Through social interaction, members of a group generate and modify norms, values and beliefs that coordinate group behaviour and mediate interaction between its members

(Postmes et al., 2000, Postmes et al., 2001, Turner, 1982, Turner et al., 1987). Evolved human social psychology appears to include a facility for forming cooperative groups (Richerson and Boyd, 2001).

The change in the composition of social networks that occurs when societies modernize does not create societies that have no norms (what Durkheim (1984/1893) called "anomie") but it is likely to cause different norms, values and beliefs to emerge. In traditional societies, a large proportion of the social interaction is between relatives, who have an interest in each other's reproduction. Many of the babies born in the community will be their relatives. A healthy baby promises to be an ally and a companion in furthering family interests, but also a new responsibility for the family. During social interaction between kin, therefore, both parties have an interest in encouraging behaviour consistent with the competent rearing of children and this is likely to influence the information they communicate.

Role-play experiments support this, suggesting that people are more inclined to encourage effective reproduction when talking to their kin than when talking to their friends (Newson et al., 2007). Female participants primed by playing the role of a mother advising her hypothetical daughter prefer behavioural choices that are more consistent with successful reproduction than participants primed by playing the role of a woman advising a younger friend. A change in the proportion of interaction with kin versus interaction with non-kin is, therefore, likely to change social norms. A well-established body of social psychological research has shown that social norms evolve as a result of changes in the information and feedback passing between members of a social network (Sherif, 1935, Festinger et al., 1950, Sherif and Murphy, 1936, Turner, 1991, Turner et al., 1987)

In the role-play experiments, however, the participants' choices and advice largely reflected the reproductive norms of the contemporary Western society to which they belonged. Mother-role participants were more encouraging of successful reproduction than women playing the role of friend, *but only marginally so*. Newson et al. (2007) use a formal mathematical model to show that such a weak kin bias will support norms for high fertility when kin dominate social networks but are not strong enough to prevent their relaxation when non-kin dominate social networks. Thus, the decline in family size and many other signatures of modernity do not follow immediately upon the change from kin dense to kin sparse social networks. The transition to small families transpires diachronically (evolves) over several generations.

We argue here that the broader process of modernization is likewise a historical process that is set in motion by the revolution in social network structure. The young Europeans who came together in the 18th and 19th centuries to serve in the armies, work in factories and mines or to emigrate were raised in traditional communities and they brought with them the pro-natal reproductive norms, values and expectations of these communities. Like the contemporary participants in the role play experiments mentioned above, their choices and advice would have reflected their upbringing. But nevertheless, the information passing between non-kin is likely to have been, on balance, slightly less consistent with effective reproduction than information likely to pass between kin.

The effect of this difference on the evolution of cultural norms has been modelled as a "teaching bias" (Boyd and Richerson, 1985, Newson et al., 2007) and as a form of natural selection on cultural variation (Richerson and Boyd, 1984). A relatively weak teaching bias, such that kin depart from prevailing norms in a slightly pro-natalist fashion and non-kin in slightly anti-natalist fashion, will eventually lead to multi-generation demographic transitions such as those experienced by European populations. In countries at the earliest stage of modernization, people will continue to behave largely according to the beliefs and

values of kin-based communities. But the model predicts that once social networks widen, norms will increasingly diverge from those that encourage the pursuit of genetic fitness. Generation-by-generation, individuals will see less value in the efficient production of children.

In countries that began to experience rapid fertility decline in the second half of the 20th century, the slightly less pro-natal influence from non-kin was augmented by exposure to mass media and frank anti-natalist messages from governments and NGOs encouraging family planning (Bongaarts and Watkins, 1996). Not surprisingly, these transitions have occurred at an earlier stage of economic development and have proceeded more swiftly than the earlier transitions of European populations.

Modernization and the erosion of social norms that promote genetic fitness

The onset of the fertility decline is an early and easily detected sign that the dismantling of pro-natalist traditional norms has begun. But there is no reason to believe that the abandonment of the pursuit of fitness will be limited to developing a preference for smaller families. Weakening of the social rewards and sanctions that serve to maintain effective reproduction and cooperation between kin will set in train a number of cultural changes (see Figure 1):

- Decline in social pressure to respect family elders and cooperate with relatives will cause people to increasingly seek social rewards from non-family members and see non-family members as social models.
  - People of all ages will identify with groups that are not based on kinship but whose members share other common interests. Goals linked with these common interests will therefore become increasingly important relative to goals related to the family.
  - Nepotism and tribalism will decline as loyalty to family and long-standing family alliances diminishes and loyalty to other institutions, such as an employer or the state, increases.
  - Increasingly, non-family institutions will be needed to take on responsibilities that were previously assumed by the family, such as educating the young and caring for the sick and elderly.
- Decline in the social rewards associated with getting married and becoming a parent will cause people to replace these goals with those that *do* attract social rewards.
  - Getting married will become increasingly unpopular.
  - The criteria for being considered a "good parent" will become increasingly ill-defined but at the same time more difficult to achieve. Children will become endowed with expensive needs unrelated to their own reproductive success but necessary for their social success in the modernizing world.
  - Women will feel increasingly dissatisfied with a life devoted caring for a home and family and want to do work that they perceive to be more prestigious or rewarding.
- Decline in the social rewards associated with behaviour that supports the family institution will cause the family stability to decline.
  - Young adults will increasingly want and be increasingly allowed to choose a marriage partner whom they find attractive rather one who will be liked by their relatives and who is likely to be an effective partner in the task of producing and raising the next generation.
  - Children will be less willing to cooperate with older family members to achieve goals they believe worthy and increasingly seek the approval of their friends.

  - Couples will be less and less inclined to make personal sacrifices to maintain a stable home for their children.
- Relaxation of the social sanctions against behaviour that disrupts the family will allow the disruption of families to become more common.
  - Sexual promiscuity and adultery will increase, resulting in higher levels of sexually transmitted diseases, accidental pregnancy and family arguments.
  - Divorce will become easier and more common.

These cultural changes have been and continue to be experienced by the populations of European descent that were the first to modernize. Lesthaeghe (1983) has referred to many of the changes in reproductive norms experienced by Europeans in the latter part of the 20th Century as a "second demographic transition". The kin influence hypothesis proposes that the first and second transitions are part of the same evolutionary process.

As the evolution of norms and values continues, some members of the population resist new changes while others argue that they are merely a progression from aspects of culture that are already widely accepted. For example, traditional societies perceive the institution of marriage as a reproductive partnership which involves the family of the marriage partners. With modernization, marriage is increasingly seen as a union of two people who love and are attracted to one another. This view of marriage is now uncontroversial in Western cultures. Nevertheless, many Westerners still feel uncomfortable with the idea that people of the same sex should marry if they love and are attracted to each other.

With respect to all virtually aspects of reproduction (e.g., sexual behaviour, parenting, and gender roles) there are currently large cultural differences between the countries that began to modernize in the 18th and 19th century and the countries that began to modernize in the middle and latter part of the 20th century. But if modernization is an evolutionary process that causes cultural norms, beliefs and values to increasingly diverge from those that encourage behaviour likely to enhance genetic fitness, then similar changes in reproductive norms will eventually be experienced by all populations once economic development has begun. Modernization should be a reasonably tight complex of coevolving cultural changes in which different modernizing societies evolve in a parallel fashion.

The kin influence hypothesis therefore predicts that a substantial part of cross-cultural variation between norms, values and beliefs that affect the pursuit of fitness will be explained by the amount of time that has passed since the social networks in the population began to widen to become less kin-based.

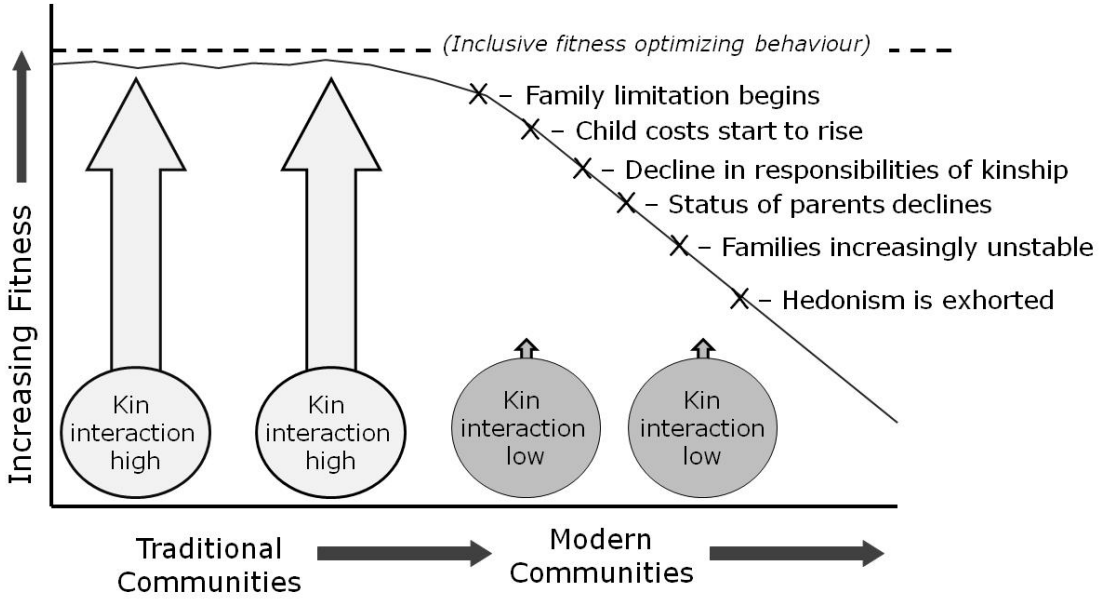


Figure 1. In traditional communities, a high frequency of kin interactions acts as a social "force" that supports cultural norms that prescribing behaviour consistent with achieving genetic fitness. With modernization, people spend more time in non-kin based social networks, the social force is weaker and norms progressively diverge from those necessary to maintain optimal reproductive behaviour.

Modernization and the rise of secularism

The widening of social networks is also a plausible trigger for the evolution of culture away from values and beliefs supported by tradition, religion and superstition in favour of values and beliefs supported by rational discussion and scientific investigation. As Durkheim (1984/1893) pointed out, within small relatively isolated traditional communities, people rely on shared traditions and experiences to negotiate the shared norms, values and beliefs that mediate their social interactions. Once economic development begins, it is increasingly common for people to be within communities whose members have been raised in different local traditions. They therefore need to find other grounds on which to develop social conventions.

In such groups, rational argument and taking account of evidence would have been useful tools for evaluating novel circumstances and contributing to social negotiations. Also, when people work with industrial technology and trade, prestige is afforded to those adept in science and rational discourse. As formal schooling spreads, children are exposed to teachers schooled in science and rationality. At work, ordinary people are exposed to engineers and managers with more advanced education and a strong commitment to rationality and science. In contrast, prestige figures in pre-modern Europe are more likely to be experienced older men and women who headed large families or religious figures who would have had an interest in maintaining traditional local values.

If the spread of rationalism and secularism is also the result of the widening of social networks, changes in the religious beliefs of a population, such as a belief in God and life after death, will parallel the change in norms and beliefs that affect the pursuit of fitness. Religiosity and the prevalence of traditional superstitious beliefs will begin to become less prevalent once social networks widen and the more time that passes since the widening occurs, the more these beliefs will be replaced with more secular and rationally-based beliefs.

Thus, the kin influence also predicts that a substantial part of the cross-cultural variation in the extent to which people belief are influenced by religious faith will also be largely explained by the amount of time that has passed since the social networks in the population began to widen to become less kin-based.

Explaining anomalies of modernization

A successful explanation for the patterns of modernity must explain not only the main trends in cultural change but also the exceptions, the behaviour of people in societies that have taken a different cultural path.

The Anabaptist communities in rural parts of the United States and Canada are demographic anomalies. The Amish, Hutterites and some Mennonite sects maintain the attitudes and behaviours characteristic of pre-modern societies. They are not unthinking rigid traditionalists, however. They partake of modern ideas and products that do not threaten their way of life, such as modern medicine. Members of the community participate heavily in the modern economy, typically as commercial farmers, and this allows them to enjoy the financial security and health experienced by people living in a modern society. They keep socially separate from people outside their communities, however. Their religious principles advise that they live in closed kin-based communities (Greksa, 2002, Kraybill and Olshan, 1994).

If environmental variables such as financial and health security cause people to choose to have fewer children, the people in these communities should have small families like people in other communities in North America. The kin influence hypothesis, however, predicts that their closed kin-based communities will maintain the pro-natal norms characteristic of traditional communities. The prediction of the kin influence better fits the observed behaviour of people in these communities, where families of nine children are common, children leave school in their early teens to help their parents and the work of men and woman conforms to traditional gender roles.

Note that pronatalist beliefs by themselves are not reliably associated with high fertility. In the US, Catholics and Conservative Protestants espouse pro-natal, pro-family, and anti-abortion values. But their fertility actually converged to the US mean several decades ago (Hout et al., 2001). The cultural isolation and kin rich social networks of the strict Anabaptists seems to be necessary to retain high fertility in a modern context.

Another apparent anomaly is the low fertility of large parts of the French population in the early 19th century. If one considers environmental variables associated with economic development to be the trigger for the adoption of family limitation fertility should have declined first in England. England industrialized earlier than France and by the early 19th century much more of its population was employed in industry. Yet fertility remained high in the English population until the end of the 19th century and the fertility of France's rural agricultural population began to decline in the 1820s. The kin influence hypothesis explains this apparent anomaly by providing another explanation for the early fertility decline in France.

Industrialization or socioeconomic development is one cause of the widening of social networks. But other kinds of social change will also disrupt the family-based social structure characteristic of pre-modern societies. In the late 18th century, France experienced a decade of revolution that caused a restructuring of rural as well as more urban communities. On the other hand, during the early stages of the Industrial Revolution in England the village social structure may have remained relatively intact. In the Severn Gorge region where the English industrial boom was underway in the early 18th Century, mines and factories sprang up in the countryside near natural resources and attracted local labour. Families would often work as teams, developing the skills that allowed them to specialize in a particular kind of industrial work and teach those skills to their children (Trinder, 2000). Early English economic modernization seems to have allowed kin-based social network to exist for a generation or two longer than the French social revolution did. The kin influence hypothesis suggests that this may be why fertility declined first in France.

The kin influence hypothesis also provides an explanation for the fertility decline experienced by many urban populations (Livi-bacci, 1986). Cities attract migrants and visitors from many regions so wide social networks are often inevitable even in pre-modern times. There is evidence that fertility was low even in classical cities like Rome and the population of pre-modern cities was only maintained by immigration from the surrounding countryside where fertility was higher (Knauft, 1987).

Thus, the kin influence hypothesis explains demographic behaviour that is not explained by hypotheses which ascribe causation to environmental variables.

Testing predictions of the kin influence hypothesis

Two predictions of the kin influence hypothesis were mentioned above:

- A substantial part of cross-cultural variation between norms, values and beliefs that affect the pursuit of fitness can be explained by the amount of time that has passed since the social networks in the population began to widen to become less kin-based.
- A substantial part of the cross-cultural variation in the extent to which people's beliefs are influenced by religious faith can also be largely explained by the amount of time that has passed since the social networks in the population began to widen to become less kin-based.

These predictions could be tested if we knew the time when the social networks began to widen in a variety of populations. But, although the evidence cited above strongly suggests that a dramatic widening of social networks occurs at the inception of the modernizing process (e.g., Zelinsky, 1971, Watkins, 1990, Davis, 1937, Kohler, 2001), the timing of the social network change has not been systematically monitored.

We do, however, know the timing of a common point in what we suggest is a cultural evolutionary continuum that begins with the widening of social networks and the reduction of influence from kin. All populations begin to adopt family limitation as they begin to develop economically and, as we have argued above, this is a likely indicator that the influence of kin has begun to decline. The birth rate of most populations has been recorded for many years and this allows us to detect when members of a population began to limit family size. Knowing the year fertility began to decline (YFBD) in a country therefore allows us to assign countries to a position on this cultural continuum.

If position on this cultural continuum does substantially explain cultural differences, then the timing of the onset of the fertility decline (YFBD) should be highly correlated with measures that reflect the attitudes and behaviour of different populations.

The YFBD could be estimated for 174 countries (see Table 1)[3]. There has been no substantial fertility decline detected in 13 countries but the date of their fertility decline has been projected by the United Nations(Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2006). Countries whose fertility is projected to decline in 2010 or earlier were included in the analysis.

Afghanistan	2008*	Comoros	1991	India	1973	Mongolia	1978	Somalia	2010*
Albania	1968	Congo	2005	Indonesia	1972	Morocco	1975	South Africa	1965
Algeria	1982	Congo, Dem Rep	2020*	Iran, Islamic Rep	1985	Mozambique	1995	Spain	1920
Angola	2010*	Costa Rica	1963	Iraq	1980	Myanmar	1976	Sri Lanka	1962
Argentina	1920	Côte d'Ivoire	1991	Ireland	1922	Namibia	1990	St. Lucia	1970
Armenia	1968	Croatia	1908	Italy	1913	Nepal	1988	St. Vincent & Grenadines	1965
Australia	1891	Cuba	1920	Jamaica	1971	Netherlands	1897	Sudan	1985
Austria	1907	Czech Rep	1905	Japan	1945	New Zealand	1900	Suriname	1970
Azerbaijan	1969	Denmark	1898	Jordan	1980	Nicaragua	1974	Swaziland	1987
Bahamas	1968	Djibouti	1995	Kazakhstan	1965	Niger	2008*	Sweden	1902
Bahrain	1973	Dominican Rep	1968	Kenya	1984	Nigeria	2000	Switzerland	1887
Bangladesh	1981	Ecuador	1971	Korea, (North)	1972	Norway	1903	Syrian Arab Rep	1985
Barbados	1966	Egypt	1968	Korea, (South)	1962	Oman	1990	Tajikistan	1980
Belarus	1920	El Salvador	1972	Kuwait	1975	Pakistan	1991	Tanzania	1990
Belgium	1881	Equatorial Guinea	2020*	Kyrgyzstan	1970	Panama	1970	Thailand	1966
Belize	1982	Eritrea	1989	Lao PDR	1992	Papua New Guinea	1981	Togo	1990
Benin	1998	Estonia	1885	Latvia	1890	Paraguay	1969	Tonga	1967
Bhutan	1995	Ethiopia	2001	Lebanon	1970	Peru	1971	Trinidad and Tobago	1966
Bolivia	1978	Fiji	1960	Lesotho	1985	Philippines	1963	Tunisia	1971
Bosnia & Herzegovina	1908	Finland	1912	Liberia	2018*	Poland	1910	Turkey	1962
Botswana	1984	France	1827	Libya	1985	Portugal	1916	Turkmenistan	1975
Brazil	1966	Gabon	1996	Lithuania	1910	Qatar	1978	Uganda	2012*
Brunei Darussalam	1965	Gambia	1991	Luxembourg	1881	Romania	1905	Ukraine	1910
Bulgaria	1915	Georgia	1935	Macedonia, FYR	1935	Russian Federation	1925	United Arab Emirates	1975
Burkina Faso	2000	Germany	1888	Madagascar	1994	Rwanda	1990	United Kingdom	1893
Burundi	2020*	Ghana	1990	Malawi	1995	Samoa	1970	United States	1890
Cambodia	1972	Greece	1913	Malaysia	1965	Sao Tome & Principe	1985	Uruguay	1920
Cameroon	1993	Guatemala	1978	Maldives	1991	Saudi Arabia	1985	Uzbekistan	1975
Canada	1890	Guinea	1998	Mali	2008*	Senegal	1990	Vanuatu	1965
Cape Verde	1986	Guinea-Bissau	2020*	Malta	1940	Serbia & Montenegro	1915	Venezuela	1970
Central African Rep	1997	Guyana	1970	Mauritania	1998	Sierra Leone	2020*	Viet Nam	1975
Chad	2015*	Haiti	1974	Mauritius	1963	Singapore	1959	Yemen	1990
Chile	1966	Honduras	1977	Mexico	1974	Slovakia	1905	Zambia	1985
China	1969	Hungary	1900	Micronesia, Fed States	1980	Slovenia	1905	Zimbabwe	1976
Colombia	1968	Iceland	1903	Moldova, Rep	1925	Solomon Islands	1984		

Table 1. Year that fertility is estimated to have began to decline or is * projected to decline in 174 countries (Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2006, Secretariat, 2007, Coale and Watkins, 1986, Caldwell and Ruzicka, 1978, Palloni, 2000, Tomasson, 1977, Milne and Wright, 1997, Coale and Treadway, 1986, UNPD, 2007, Ogawa and Retherford, 1993).

Cross-national differences in attitudes

To compare the extent to which members of a population are directed toward fitness-enhancement or adhere to beliefs arising from shared tradition rather than rational argument, we used two publically available cross-national measures of attitudes and behaviour.

1. The World Values Survey (WVS) (European and World Values Surveys, 2006) has conducted a series of surveys beginning in 1981, with over a quarter of a million respondents in more than 75 countries. (See http://www.worldvaluessurvey.org)
2. The Pew Global Attitudes Project (Pew Global Attitudes Project, 2003) surveyed over 38,000 people in 44 countries in 2002. (See http://pewglobal.org)

These surveys included questions designed to determine attitudes to reproductive behaviour and religious beliefs. Scholars have used the mean responses of survey participants in each country to compare the cultural values of each country's population (Inglehart and Welzel, 2005, Inglehart and Baker, 2000, Pew Research Center, 2003).

To see how well YFBD explained the variance in attitude between countries, we calculated the correlation coefficient (Pearson's *r*) between the year fertility began to decline in a country and the country mean of responses to relevant survey questions. For comparison, we also calculated the correlation coefficient between these means and an environmental variable that indicates the current economic development of a country (per capita GDP).

Cross-national differences in behaviour

A number of cross-national measures and indices have been produced that indicate the prominence members of the population give to the pursuit of genetic fitness:

- Total Fertility Rate (TFR)(Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2006) is the average number of children that would be born to a woman if she experienced the current age-specific fertility rates through her lifetime. This measure reflects the extent to which members of the population want to have children or grandchildren.
- Per capita gross domestic product (GDP)(Development Data Group The World Bank, 2006) is the total market value of all final goods and services produced in a country during a year, divided by the mid-year population. This reflects the extent to which members of the population are contributing to the national economy rather than enhancing their inclusive fitness by producing and raising children.
- "Corruption perception index" (cpi) (Transparency International, 2006) is a measure of perception of corruption in a country based on 16 polls and surveys from 10 institutions. High levels of corruption (low cpi) suggest that people in a country are more inclined to behave in ways likely to improve their inclusive fitness such as helping their relatives and friends. Low levels of corruption (high cpi) suggest people are more likely to be loyal to non-family institutions such as the state, an employer or trading partner.
- The "Gender Empowerment Measure" (GEM)(United Nations Development Programme (UNDP), 2006) is a measure of the extent to which the power and influence of women in a country is the same as that of men. The United Nations Human Development Program creates this measure by combining inequalities in three areas: political participation and decision making, economic participation and

decision making, and power over economic resources. A high GEM suggests that in this country the social rewards associated with being a mother and housewife compare unfavourably with those associated with work outside the home. When social rewards for motherhood are low, women pursue the same goals as men rather than devoting their effort to increasing their genetic fitness.

- Average number of years spent in education (UNESCO, 2006). The more years children spend in education, the longer they remain dependent on their parents, the more expensive they are and the less efficient the conversion of resources to offspring. Children who attend school longer also have less opportunity to learn skills of housekeeping and childcare and will be more likely to postpone childbearing.
- Mean national IQ. Lynn and Vanhanen (2002) estimated what they argued was the mean IQ for the populations of 81 countries based results of tests that had been administered in the countries. From this they inferred the mean IQ for the populations of another 104 countries based on their proximity to countries where IQ had been measured. They reported correlations of between .5 and .7 between mean IQ of a population and its wealth as measured by per capita GDP. Lynn and Vanhanen's methods have been criticized and their conclusion (that the wealth of a population can be largely explained by the intelligence of its members) has been disputed (e.g., Volken, 2003). However their results and conclusions have been widely cited so it worthwhile to consider other explanations for the correlation between wealth and IQ that they observed.
  A rise in IQ of between three and five points per decade has been observed in industrialized countries (Flynn and J.R, 1987, Flynn, 1984, Flynn, 1987). This may be partly the result of the parents no longer attempting to maximize reproduction success. Children from smaller families have been found to have higher IQs, as are first-born children and children who spend more time with their parents and other adults (Zajonc and Zajonc, 1976, Steelman et al., 2002). A high average IQ suggests that a high proportion of the population have been raised by parents who invest highly in a small number of children rather than produce a larger family and expect older children to look after younger ones. This effect will act as a synchronic environmental factor. Another explanation of IQ variation between countries is that IQ increases as people deal with ever more complex artefacts and social environments, one of the diachronic, historically cumulative products of modernization (Schooler, 1998).
- "Sociosexual Orientation Inventory" (SOI) index", a questionnaire-derived measure of willingness to have casual sex, which was obtained from samples of mostly university undergraduates in 38 countries (Schmitt, 2005). A higher average SOI Index in a country indicates that social sanctions discouraging casual sex are more relaxed. The population is more tolerant of behaviour that might result in unwanted pregnancy, family disruption or the spread of infection. This change is likely to be greater in female sexual behaviour than males. Females suffer fitness costs when pregnancy results from mating with an uncommitted partner. Males gain in fitness. In a traditional society, therefore, the sanctions against female promiscuity are likely to be stronger than sanctions against males.

To see how well YFBD explained the variance between countries in these behavioural indices, we calculated the correlation coefficient (Pearson's *r*) between the year fertility began to decline in a country and the measure.

Comparing correlated factors

Modernization involves many cultural and environmental changes occurring simultaneously, influencing each other and potentially masking each other's effects. Environmental factors such as wealth and health and cultural variables such as religiosity are often discussed as contributing to cross-national differences in behaviour. We carried out regression analyses to compare the effectiveness of these predictors of behaviour with the historical variable YFBD.

Four variables reflecting behaviour were used as dependent variables:

- Corruption Perception Index
- Gender Empowerment Measure
- Average years spent in education
- Female Sociosexual Orientation Index

Independent variables compared were:

- Per capita GDP (as an indicator of the wealth of the society)
- Health adjusted life expectancy (as an indicator of the health of the society)
- Mean national response to the WVS question "How important is religion in your life?" (as an indicator of the religiosity of the society)
- YFBD (as an indicator of the society's historical social structure)

The correlation between mean national IQ and the per capita GDP of the country has been used to support the proposal that some countries are wealthier because their population is more intelligent(Lynn and Vanhanen, 2002). We carried out regression analyses to compare the effectiveness of YFBD, health adjusted life expectancy and mean national IQ as "predictors" of per capita GDP

Results

Cross-national differences in attitudes

Consistent with the first prediction of the kin influence hypothesis, the year that fertility began to decline in a country is highly correlated with the national mean of attitude measures relating to sexual behaviour, parenting behaviour and religious belief (Table 2). The more recently fertility began to decline in a country, the more inclined its population is to believe that parenting should be a rewarding experience. They are more likely to believe that children should be obedient, unconditionally love and respect their parents and want to make them proud. At the same time, they are less likely to approve of activities inconsistent with adults attending to the biologically essential job of producing and raising children. Divorce, prostitution, abortion and homosexuality are less justifiable in the view of members of populations that have more recently begun to limit family size.

The correlation between ideal family size and YFBD is among the weakest. This is consistent with the kin influence hypothesis prediction about the process of cultural change with modernization (see Figure 1). The desire for a large family is abandoned relatively early in the modernization process. Thus, in this sample of countries which are developed or have begun to develop, there is little variation between countries that where fertility began to decline 30 years ago and those that began to modernize 130 years ago. Interestingly, in the countries where fertility began to decline earliest, the

TFR is lower than the mean of what people say is the ideal family size, whereas in countries where fertility began to decline recently, the TFR is greater than the mean ideal family size.

Consistent with the second prediction of the hypothesis, members of populations with a recent demographic transition are also more likely to subscribe to religious beliefs and want children to be raised with religious faith. There is a less strong correlation between YFBD and belief in God and other responses related to religion. This is probably because many Eastern religions do not include a belief in God or belief in a god is less explicit than in the Abrahamic faiths.

There are also significant correlations between the wealth of a country (GDP per capita) and the mean responses to many of the questions. This supports the argument that attitudes some aspects of parenting and sexual behaviour are influenced by poverty and wealth. But, with only two exceptions, the correlations between the attitude measure and GDP per capita are weaker than those between attitude measure and YFBD.

Cross-national differences in behaviour

Consistent with the first prediction of the kin influence hypothesis, indices that reflect behaviour influencing reproductive success are highly correlated with the year of onset of the fertility decline (Table 3). As predicted, this includes female but not male willingness to have casual sex (SOI). Some of the variables are also highly correlated with each other. This is consistent with the prediction. If the behaviours are co-evolving, the variables that reflect them will be correlated.

Although correlations between YFBD and attitude and behaviour variables are strong, YFBD does not explain more than 60 per cent of the variance between countries and less of the individual-level variance. A closer look at the relationship between the variables suggests explanations for more of the variance. We plotted the index of each county against the year fertility began to decline (or is projected to decline) in that country (Figures 2 – 8).

The decline in TFR appears to be close to linear for a generation or so after it begins and then it ceases to decline at around European levels, with TFR is slightly below that necessary to maintain the size of the population. (Figure2). This suggests that all countries that have begun to develop embark on the same cultural shift from a regime consistent with maximizing inclusive fitness to a regime that encourages the birth of some children but does not encourage reproduction at biologically competitive levels. In European countries, TFR stabilized at between two and three and then declined further after modern birth control technology became widely available. Since the development modern birth control, TFR has tended to stabilize at below replacement level fertility.

The countries which first experienced fertility decline appear to be approaching an upper limit on the number of years that young people spend in school (Figure 6), with young people in some countries typically staying in full time education until they are over 20.

We used only mean national IQ values that were based on measurement and so calculated the correlation with only 71 countries. The correlation between IQ and YFBD (.785) was stronger than the correlation between IQ and per capita GDP. The countries

that experienced the fertility decline first may be approaching an upper limit (Figure 7). Indeed some recent evidence suggests that the rise in IQ that has been observed in a number of countries for most of the 20th century (Flynn, 1987, Flynn, 1984), may now be stabilizing (Sundet et al., 2004) or starting to decline (Teasdale and Owen, 2005). In countries which are strongly influence by Confucian culture (China, Japan, Korea and Singapore), mean IQ is higher than predicted by YFBD (Figure 7). Genetic explanations have been proposed for this small difference in IQ (Lynn and Vanhanen, 2002), but these countries also share a Confucian cultural heritage that includes high respect for schooling (Dandy and Nettelbeck, 2002) and ideographic written language, the learning of which might favour aptitudes estimated by I.Q.

The pattern of variation between countries gives information about other factors that play a role in explaining the differences between countries. For example, as predicted by the kin influence hypothesis, per capita GDP does rise with time that has passed since fertility began to decline but an examination of the outliers (Figure 3) shows that many of the countries that are wealthier than would be predicted by YFBD are oil rich. In such countries, GDP per capita is substantially a windfall based on resource endowment that other countries value. In the standard development trajectory, GDP per capita is largely a result of social modernization (e.g. higher female participation in the paid labour force and fewer dependent children). Among those that are poorer than expected are European states (apart from Austria and Finland) that used part of the Warsaw Pact. In these countries, traditional communities eroded as industrial means of production developed, but their GDP per capita advanced slowly compared to more capitalist economies because of the inefficiencies of centrally planned economies.

Attitude measure	*Number of respondents*	*Number of countries surveyed*	*Correlation (r) with:*	
			YFDB	*Per capita GDP(2002)*
Per cent of the sample in a country that choose the following as important for children to learn				
obedience	258,854	79	.643	-.379
religious faith	256,703	79	.694	-.384
Per cent of the sample in a country agreeing or saying "yes" to following questions:				
Regardless of what the qualities and faults of one's parent are, one must always love and respect them.	243,000	78	.710	-.747
Do you believe in God?	222,733	78	.519	-.292
Do you believe in life after death?	237,817	78	.608	-.168
Do you believe in hell?	237,642	78	.755	-.425
It is necessary to believe in God in order to be moral and have good values[†].	31,473	39	.815	-.598
Homosexuality is a way of life that should be accepted by society[†].	33,323	41	-.736	.575
Mean response of sample in a country to the following questions:				
Extent of agreement with: When jobs are scarce, men should have more right to a job than women	227,226	79	.649	-.554
What do you think is the ideal family size – how many children, if any?	204,629	77	.421	-.096
Extent of agreement with: One of my main goals in life has been to make my parents proud.	124,819	66	.772	-.578
How important is religion in your life?	230,621	79	.710	-.419
How important is religion in your life? [†]	32,020	40	.699	-.515
How important in work in your life?	232,413	79	.652	-.432
Extent to which the following are justifiable				
homosexuality	235,071	77	-.688	.724
prostitution	222,343	77	-.687	.532
abortion	243,617	79	-.785	.416
divorce	244,136	79	-.733	.468

Table 2. Correlations between a number of attitude measures from surveys conducted in up to 79 countries during the late 20th and early 21st century and the year fertility began to decline (YFBD) in that country and the country's per capita GDP in 2002. All correlations are highly significant, as is expected from the very large sample sizes and robust correlations.
[†] from Pew Global Attitudes Survey(Pew, 2003). Other values are from The World Values Survey(European and World Values Surveys, 2006).

	1	2	3	4	5	6	7	8
1. Year fertility began to decline								
2. Total fertility rate (2000-05)	.771*** (165)							
3. GDP per capita (2002)	-.639*** (156)	-.444*** (157)						
4. Corruption Perception Index (2005-06)	-.671*** (148)	-.500*** (149)	.860*** (142)					
5. Gender empowerment measure (2000-04)	-.706*** (73)	-.508*** (73)	.722*** (73)	.756*** (72)				
6. Average years in education (2002-04)	-.799*** (134)	-.816*** (135)	.600*** (131)	.704*** (121)	.817*** (65)			
7. Mean national IQ (measured)	-.790*** (71)	-.814*** (72)	.668*** (68)	.683*** (68)	.583*** (45)	.813*** (63)		
8. Socio-sexual orientation index: men	-.225(ns) (43)	-.101(ns) (44)	-.082(ns) (44)	.069(ns) (43)	.210(ns) (37)	.258(ns) (41)	.046(ns) (35)	
9. women	-.673*** (43)	-.449** (44)	.383* (44)	.613*** (43)	.636*** (37)	.618*** (41)	.490** (35)	.520*** (44)

*** p < .001 ** p < .01 * p < .05 (ns) non-significant

Table 3. Correlations between the Year Fertility Began to Decline (YFBD) in a country and national indices that reflect behaviour related to the pursuit of fitness. Numbers in parentheses indicate the number of countries for which each measure is available.

Figure 2. Total fertility rate

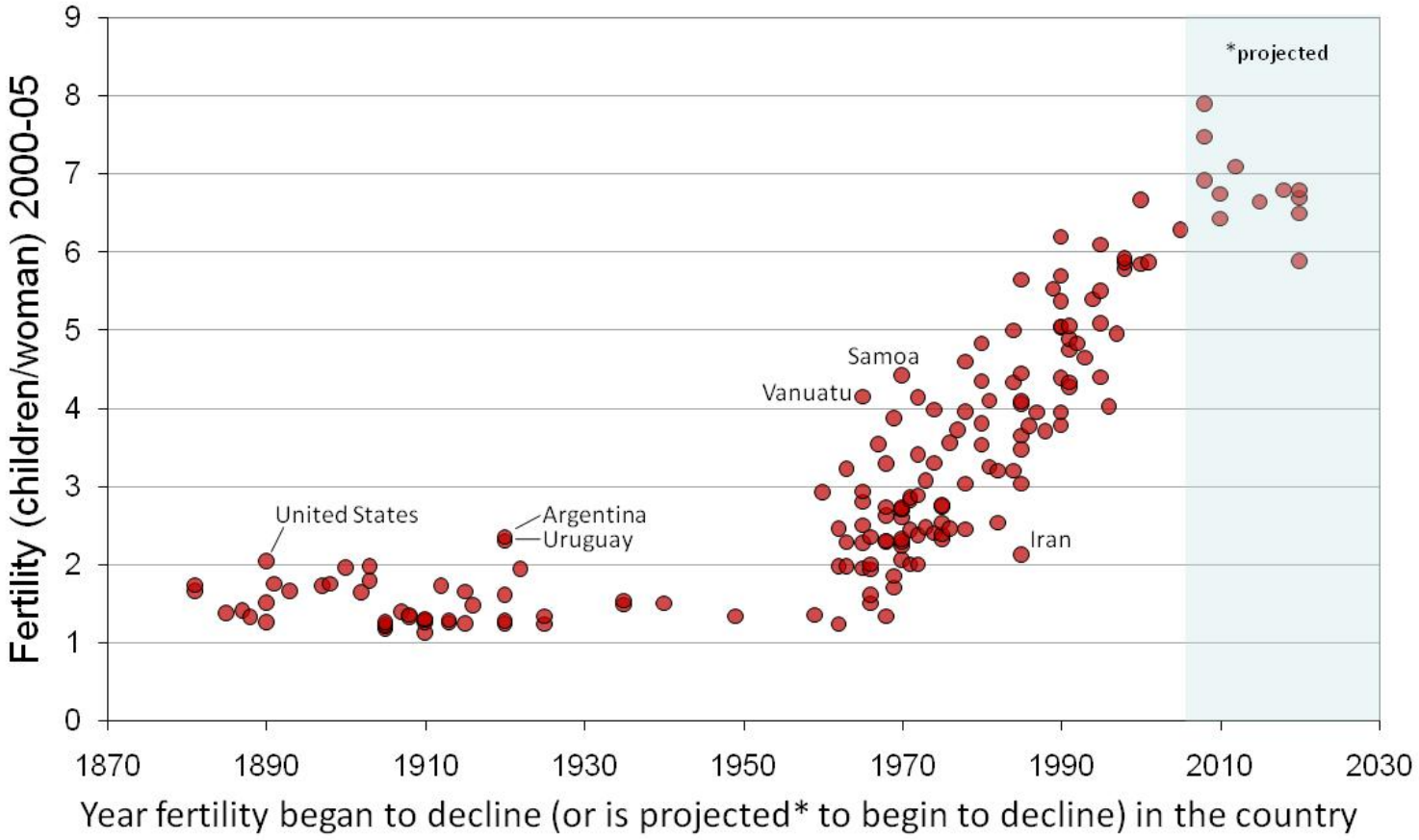


Figure 3. Per capita GDP. Countries that had centrally planned economies are marked with red circles.

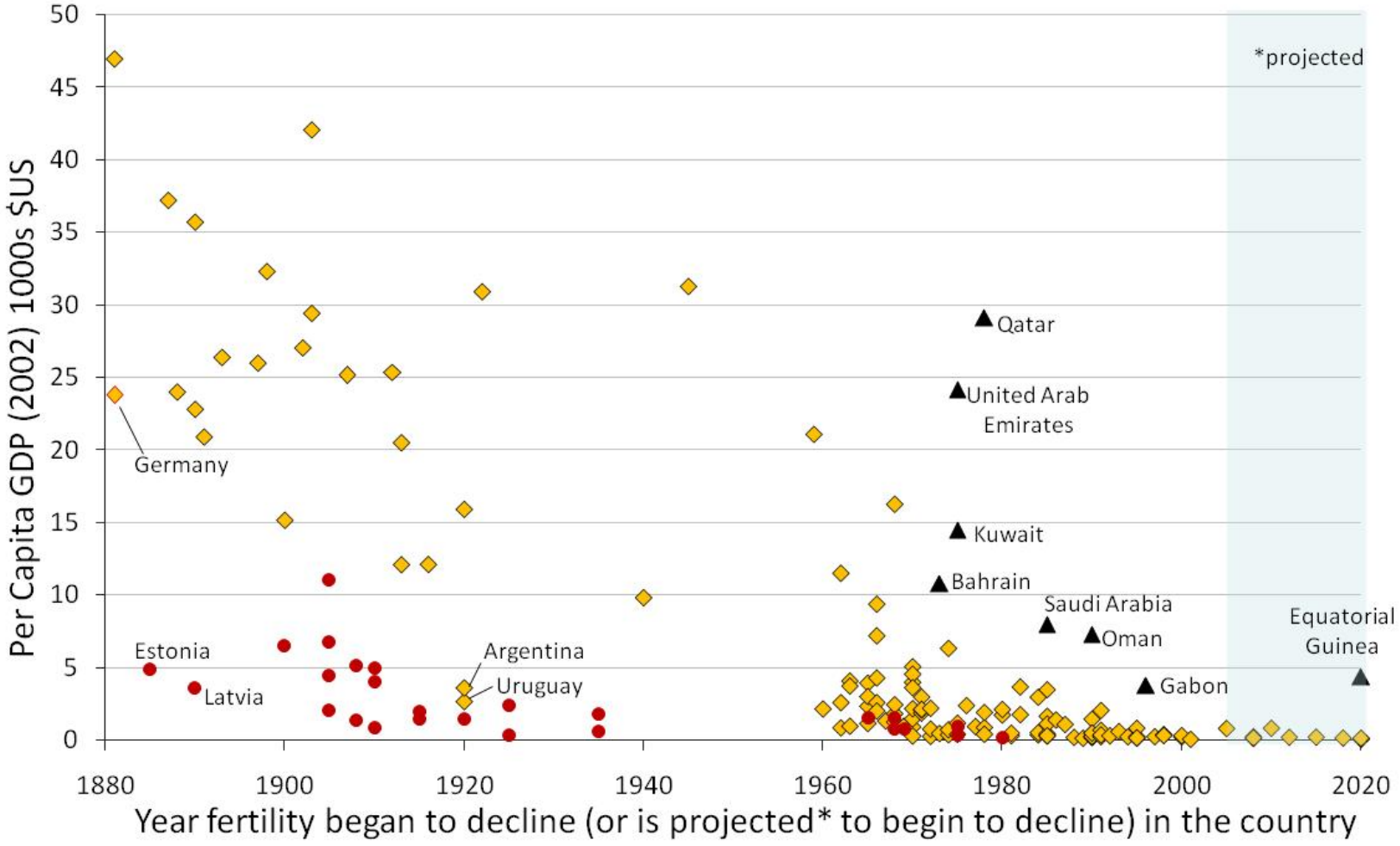


Figure 4. Corruption Perception Index

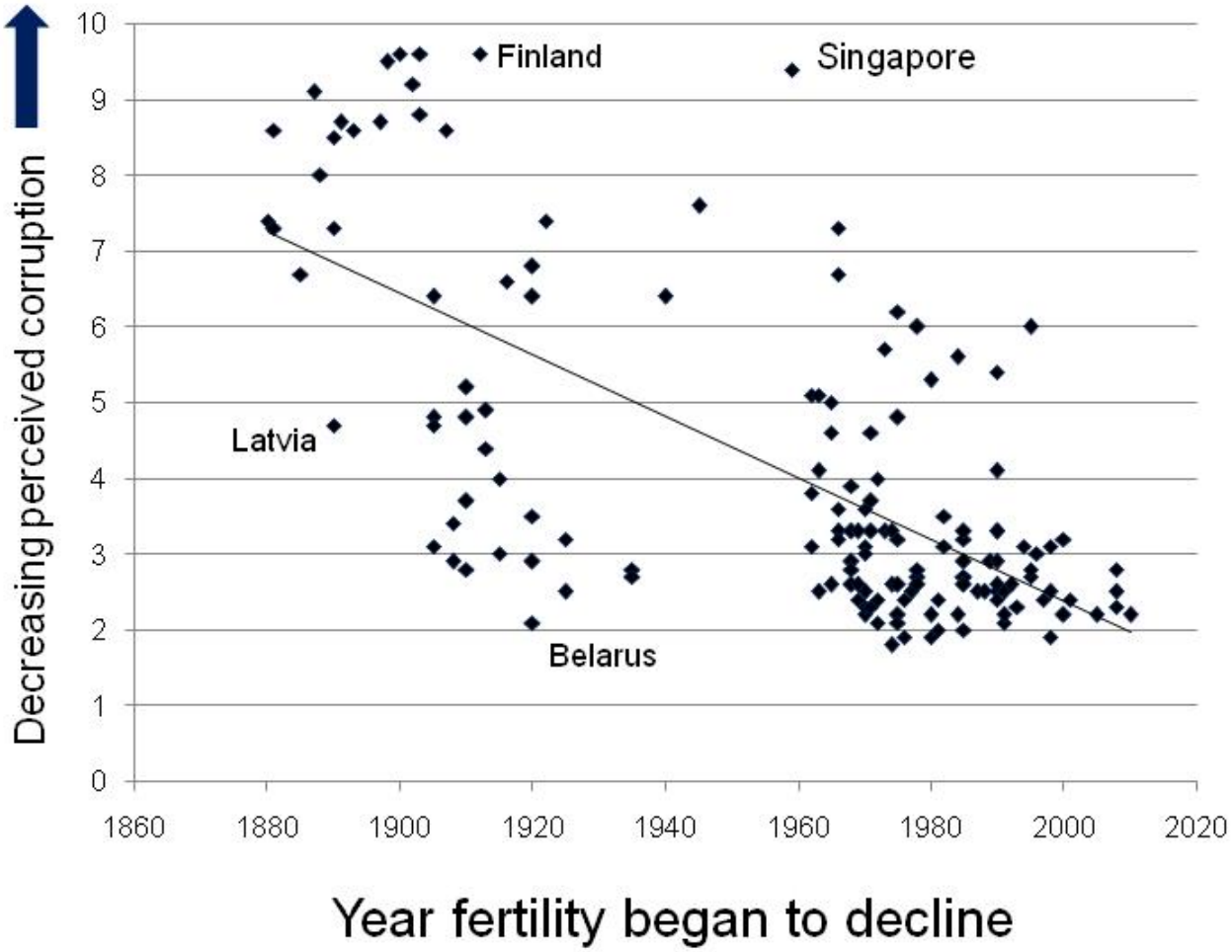


Figure 5. Gender empowerment measure

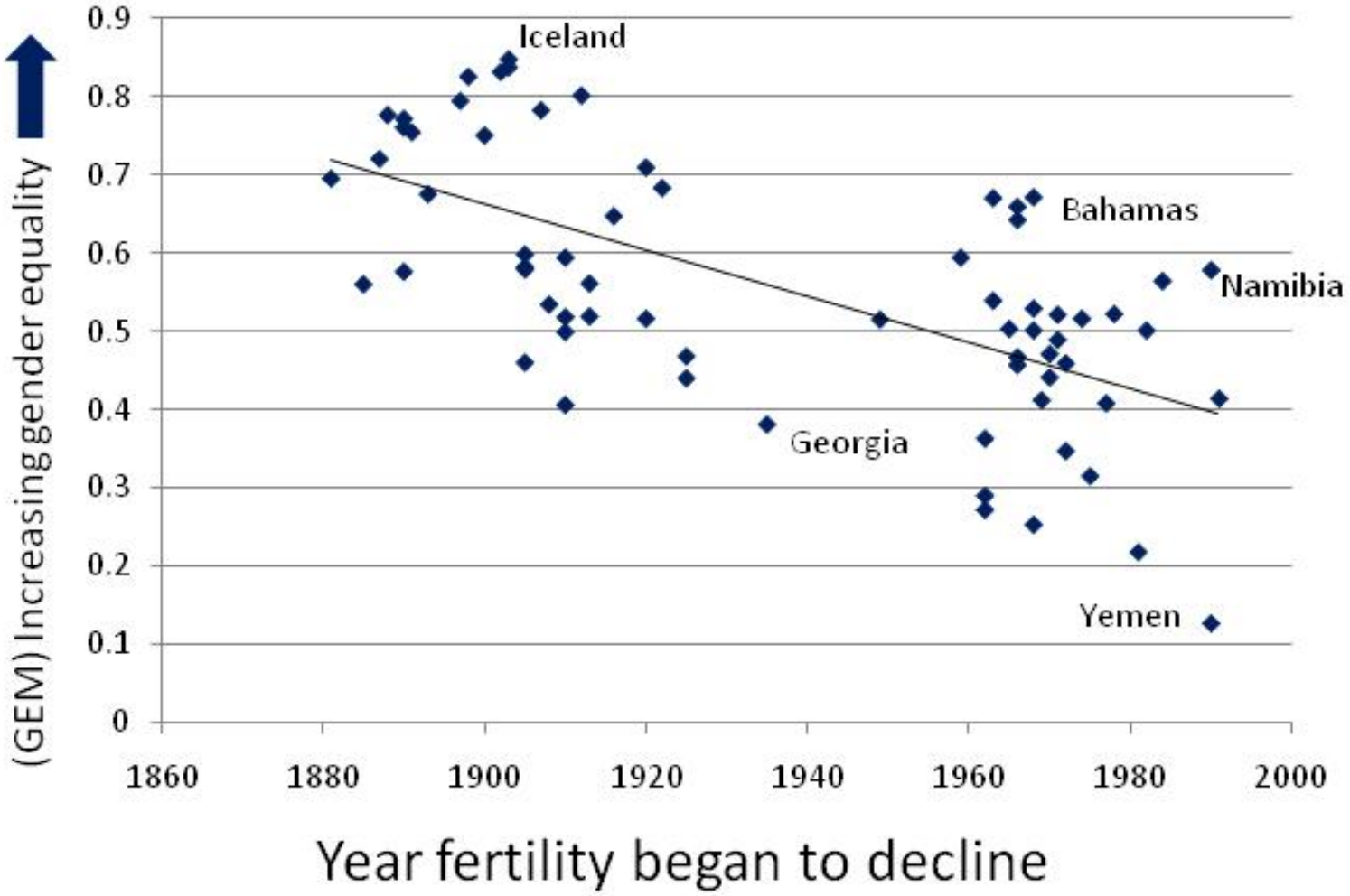


Figure 6. Average years in education

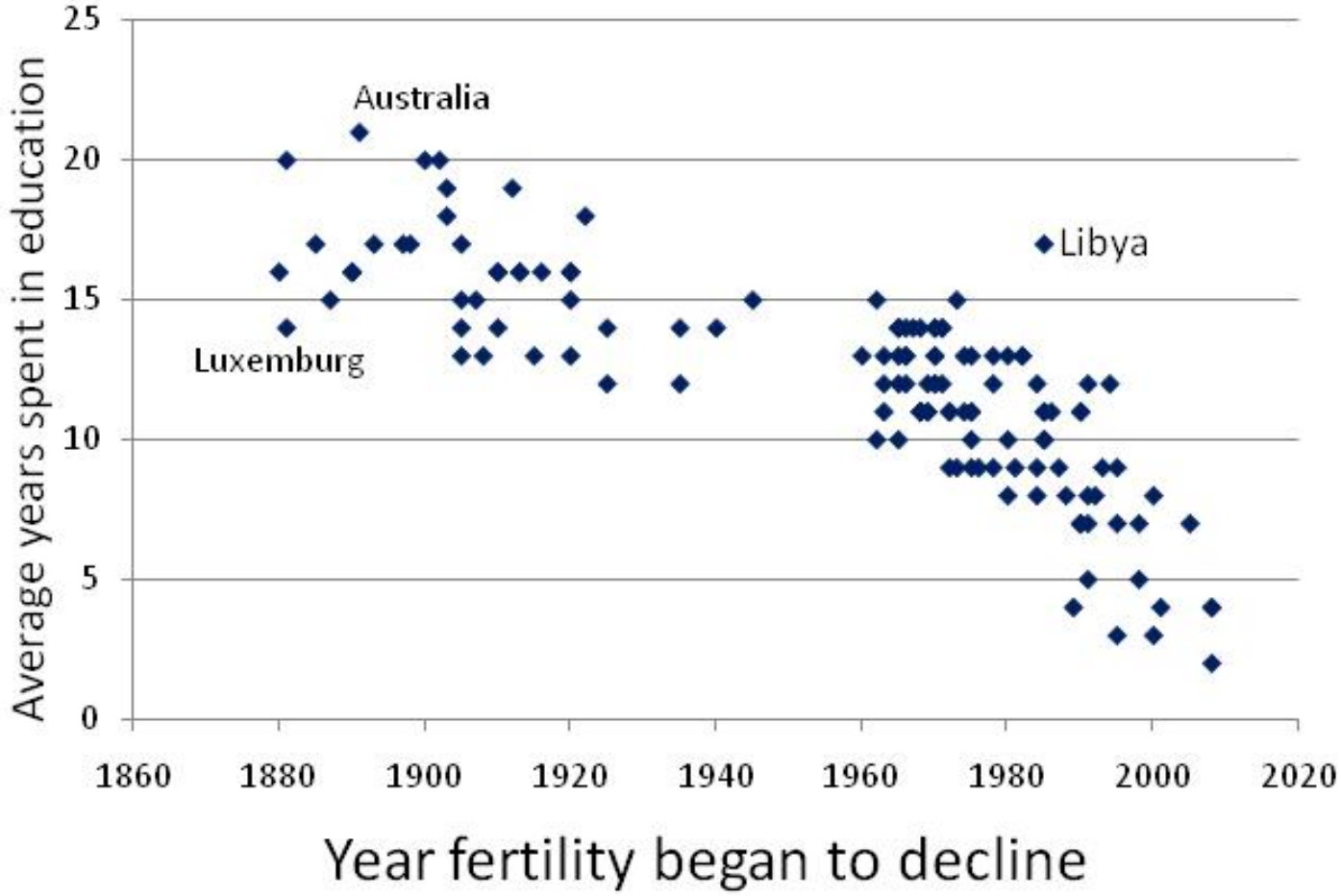


Figure 7. Average IQ

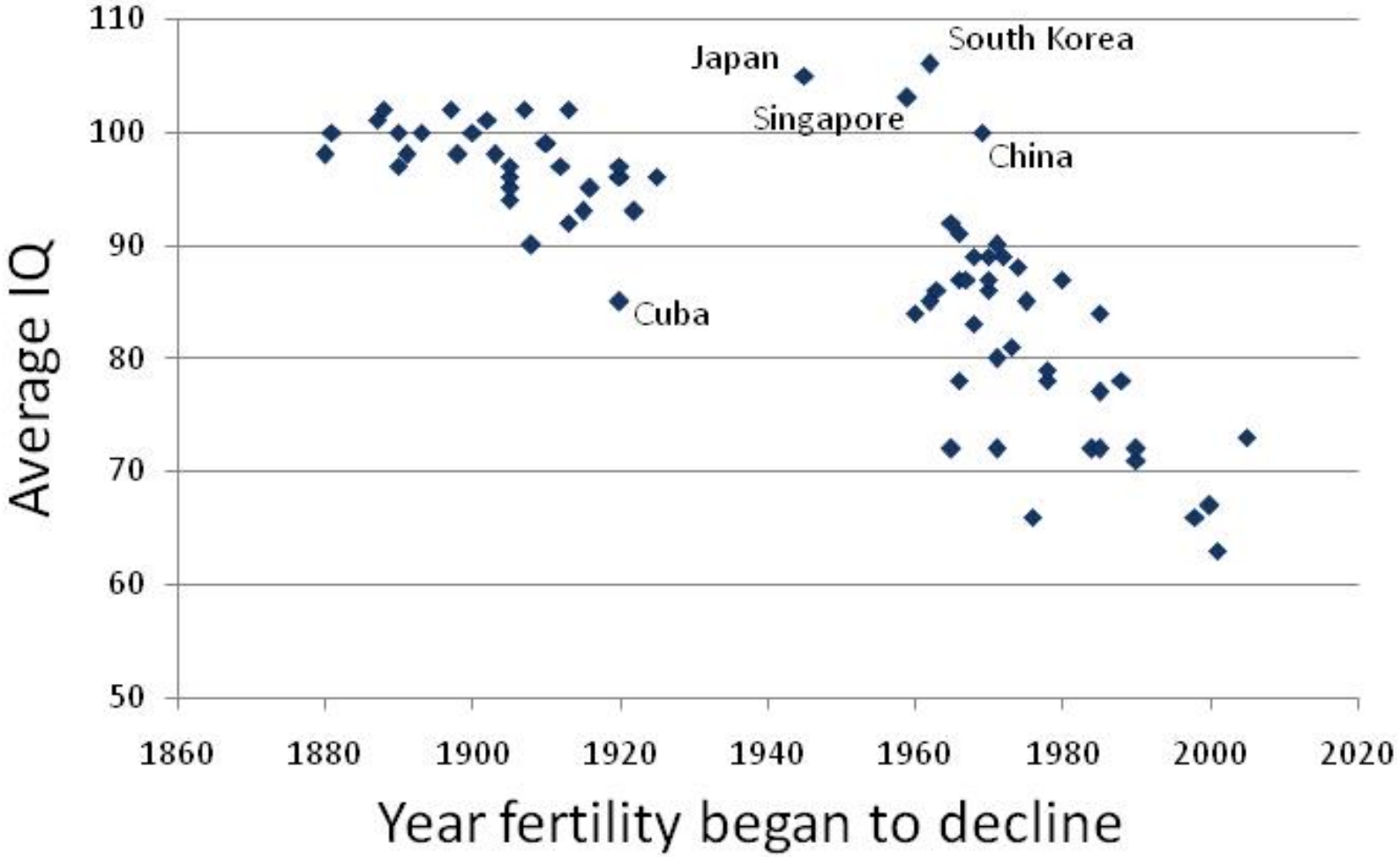
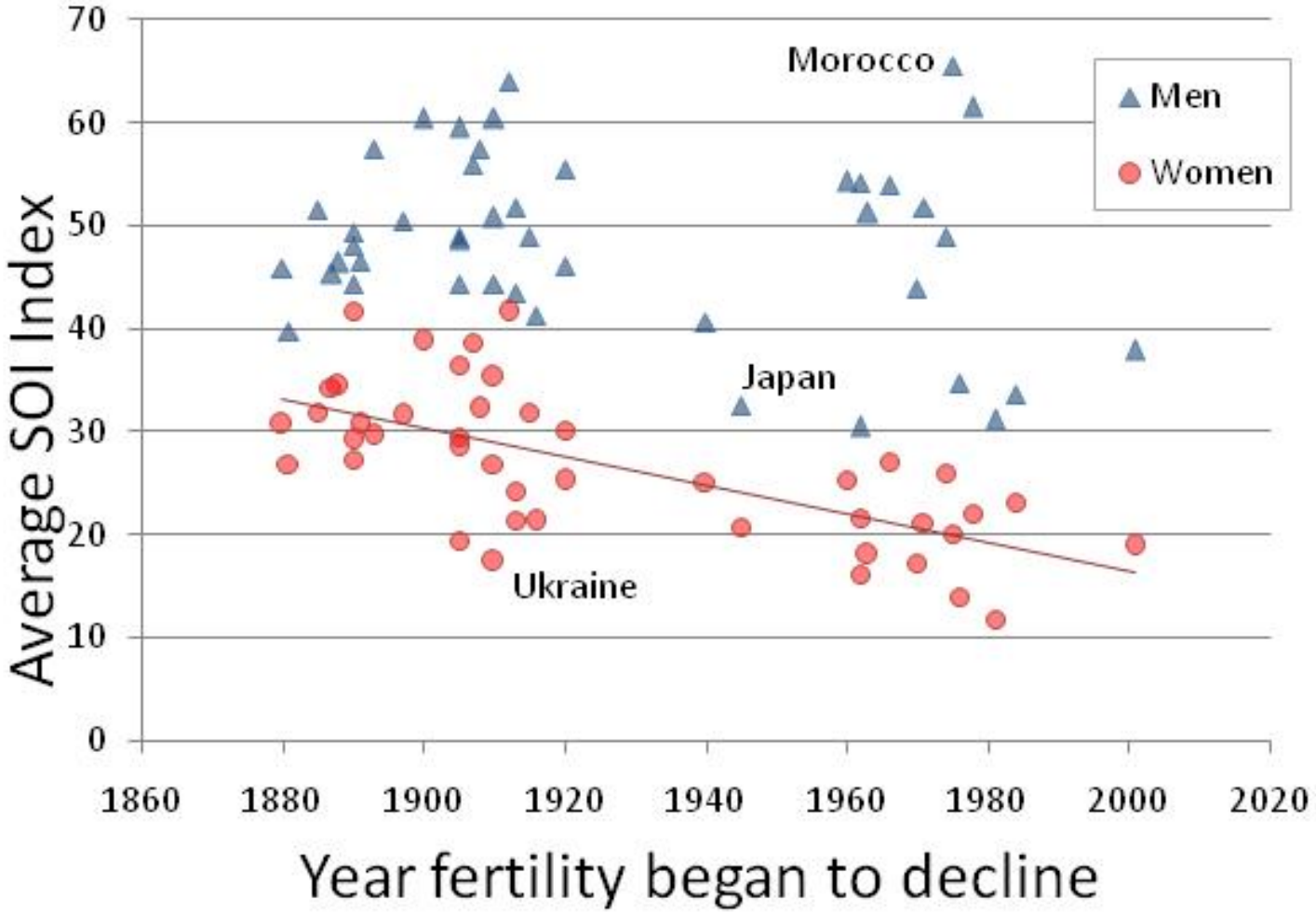


Figure 8. Average Sociosexual orientation index score



Comparing correlated factors

In three of the four indices of behaviour, those reflecting corruption, female equality and education, over 60 percent of the variation between countries could be explained by one other variable and YFBD (Table 4a to c). YFDB on its own predicted over 40 per cent of the variance in mean female Sociosexual Orientation Index (Table 4d).

These regression models show that evidence of an association between an environmental variable, such as per capita GDP, or a cultural variable, such as religiosity, can appear to be an important predictor of behaviour. But the amount of the variance that they explain is much reduced when the year fertility began to decline is included in the model. The per capita GDP of a country remains a strong predictor of the corruption perception index (Table 4a) and gender empowerment measure (Table 4b) of the country but this does not confirm wealth to be a *cause* of low corruption or high female equality. In fact, the direction of causation is more likely to be the other way. Countries are likely to be wealthier *because* they are less corrupt and more of their women are educated and contributing to the economy. By contrast, it cannot be argued that the year fertility began to decline was influenced by the corruption or gender equality being experience in a country many years later.

A strong correlation exists between mean national IQ and per capita GDP of the 67 countries where IQ tests had been performed that allowed Lynn and Vanhanen (2002) to estimate mean national IQ (Table 5). Over 40 per cent of the variance is "explained" by IQ. But health adjusted life expectancy "explains" nearly as much of the variance on a much larger sample of countries. When both are included in a regression model, the variable reflecting health proves to be more important than IQ. But the year fertility declined in the country is found to explain more of the variance than the other two, considered separately or together. This is consistent with the proposal of the kin influence hypothesis that populations that have begun to modernize are proceeding along a cultural evolutionary process and that many of the differences between countries can be partly explained by the amount of time that has passed since they began the process.

(a) Corruption Perception Index

Model	*1*	*2*	*3*	*4*	*5*	*6*
Per capita GDP (2002)	.858***			.683***	.664***	.711***
Health adjusted life expectancy		.639***		.206*	.177	
Religiosity			-.468***	-.076(ns)	-.031	
Year fertility began to decline					-1.01	-.230***
N (number of countries)	141	148	76	75	76	142
Adjusted r^2	.734	.404	.219	.754	.754	.764

(b) Gender Empowerment Measure

Model	*1*	*2*	*3*	*4*	*5*	*6*
Per capita GDP (2002)	.722***			.596***	.589***	.475***
Health adjusted life expectancy		.614***		.021(ns)	-.092(ns)	
Religiosity			-.602***	-.328**	-.070(ns)	
Year fertility began to decline					-.419**	-.441***
N (number of countries)	73	73	56	56	56	73
Adjusted r^2	.514	.368	.351	.642	.698	.644

(c) Average years spent in education

Model	*1*	*2*	*3*	*4*	*5*	*6*
Per capita GDP (2002)	.596***			.211(ns)	.091(ns)	
Health adjusted life expectancy		.790***		.428***	.282*	.455***
Religiosity			-.593***	-.272**	-.054(ns)	
Year fertility began to decline					-.516***	-.478***
N (number of countries)	130	134	71	71	71	134
Adjusted r^2	.350	.621	.343	.582	.684	.730

(d) Mean Female Sociosexual Orientation Index Score

Model	*1*	*2*	*3*	*4*	*5*	*6*
Per capita GDP (2002)	.376*			-.055(ns)	-.087(ns)	
Health adjusted life expectancy		.484**		.240(ns)	.142(ns)	
Religiosity			-.600***	-.492**	-.247(ns)	.020(ns)
Year fertility began to decline					-.442*	-.662***
N (number of countries)	43	43	38	38	38	38
Adjusted r^2	.120	.234	.342	.337	.414	.426

Table 4. Linear regressions of four variables, comparing models using wealth, health and religiosity along with year fertility began to decline. Standardized coefficients (betas) reported.

Per capital GDP (2002)

Model	*1*	*2*	*3*	*4*	*5*	*6*
Mean national IQ	.665***		.256	.296*		.065(ns)
Health adjusted life expectancy		.594***	.456*		.272**	.312(ns)
Year fertility began to decline				-.463**	-.439***	-.402**
N (number of countries)	67	156	67	67	156	67
Adjusted r^2	.433	.353	.467	.505	.435	.516

Table 5. Linear regression of per capital GDP.

Discussion

Data reflecting a range of cross-national differences is consistent with the view that modernization is a process of cultural evolution triggered by the widening of social networks that occurs with economic development. A considerable number of variables across many cultures change in concert in ways that the theory predicts. In countries that began to undergo economic development later than populations of European decent, cultural change appears to be following the same course as Europeans experienced. The timing of the beginning of the fertility decline (YFBD), an event which occurs in all countries that develop economically, is frequently the best single predictor of the current value of measures of attitude and behaviour. And it also frequently plays a large role in multiple models.

Social scientists have invested a great deal of effort in performing research that has provided evidence to support synchronic or environmental explanations of cultural change and cultural differences. It makes sense that norms, values and behaviour should be sensitive to contemporaneous environmental factors. Correlations between combinations of variables that represent these factors have provided support to a variety of plausible models. We can therefore understand that many social scientists may question whether they need to consider the possibility that a culture change is a diachronic process that was set in motion by an historical event.

On the other hand, it must be noted that extensive investigations and much discussion over many decades has not allowed social scientists to develop a consensus about the mechanisms of cultural change. Nor have social scientists developed models of cultural in which the values of environmental variables generate reliable predictions about the course of future cultural change or advice on how it might be managed. Coupling an environmental approach with an evolutionary explanation based on vague ideas about people being liberated from constraints has been equally unfruitful.

We therefore believe that the evolutionary approach is worthy of consideration. The kin influence hypothesis suggests that the cultural evolutionary process is triggered by a widening of social networks. The findings reported here cannot prove this to be the trigger but they are consistent with the trigger being an event that occurs early in economic development. The formal model presented elsewhere along with evidence of the way the content of social influence is likely to change as networks widen (Newson et al., 2007), provide a strong argument that the widening of social networks will initiate the kind of cultural evolutionary process that we have observed. If the change in the structure of communities in the past is responsible for cultural change years later, information about the social history of a population will help to predict future social change and may suggest ways that policy makers can influence its course.

In a statistical sense, the historical variable, YFBD, "explained" substantial amounts of the variance between countries and it is possible to point to specific reasons for some of the unexplained variation. The explanatory power of the variable is reduced because of variations in the degree of heterogeneity within the country. The indices and measures used in the analysis, including the YFBD, are observed at the national level. A country in which some groups live in modern communities while others live in isolated small-scale communities will appear to abandon traditional values more slowly than ones in which the switch to wider social networks occurs at roughly the same pace throughout the

country. For a country like India where a large diverse population inhabits a large diverse sub-continent, the change in social structure occurred more slowly than in a smaller, more homogeneous country like Thailand. We would expect, therefore than the cultural changes characteristic of modernization will also occur more slowly. The United States also covers a large area and has a heterogeneous population and, although the American population is unquestionably modern, there is a considerable divergence within the population between the "social conservatives" and those whose values are closer to those of Europeans (Pew Global Attitudes Project, 2003). However, fertility rates of Catholics and Conservative Protestants in the United States only converged with mainstream Protestants in about 1960 (Hout et al. 2001).

The amount of immigration a country has experienced also introduces variation in the speed of social change measured at the national level and may also help to account for cultural differences between the United States and Europe. The source of many immigrants to developed countries is countries with high fertility or fertility that was high until recently. The immigrants therefore bring less modern attitudes with them. It is notable that Japan, which modernized very rapidly, has had virtually no immigration. And the large number of recent immigrants to the United States from Latin American countries may help to explain not only the higher fertility of the United States compared to Europe, but also a number of cultural differences.

If the cultural change associated with modernization is a process characterized by new less family-orientated cultural norms emerging from new less family orientated social networks, it is not surprising that foreign aid, investment or military intervention fail to modernize the attitudes of a population largely made up of people who were raised in villages. Forces from outside a population can't make its members adopt modern ideas by installing a democratic government or by buying the country's natural resources. Providing schools and health centres may help because they provide venues for social interaction between non-kin.

But cultural change progresses gradually. For example, in Iran, fertility began to decline in about 1985, 23 years ago. Records of births and deaths in Britain suggest that it began to decline there in about 1893. Twenty-three years after this, in 1916, young British men were sacrificing their lives fighting other Europeans in the First World War. Every country's army was receiving much encouragement from its Christian church. Meanwhile, British women were expected to dress modestly. Those who were over 30 would be allowed to vote for the first time in 1918. It would not be extended to 21-year-old women until 1928. If countries are progressing along the same cultural continuum, we should perhaps feel relieved that the people of the Middle East appear to be doing so more rapidly and with less bloodshed than the people of Europe.

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[1] Some readers may see terms like "reproductive success" and "modernization" as value laden. We want to be clear that we mean to imply no value judgements about reproduction, modernity or the lack thereof. In the first instance, we think it important to understand what is happening to human culture and behaviour. Enlightened value judgements and policy choices depend upon understanding how the world works.

[2] If the fitness of and individual is determined by the number of copies of its genes that are present in future generations, the term "inclusive fitness" acknowledges that an individual's fitness is also enhanced by actions that promote the survival and reproduction of its close relatives with whom it shares many genes.

[3] Israel, Palestine and Cyprus were excluded because the population of these countries includes a high proportion of recent immigrants or refugees. France was also excluded. Fertility began to decline in some parts of France in the first half of the 19th century. If this date were used, France would be a considerable outlier in any analysis. Suggestions for why France experienced a fertility decline so early are discussed in the introduction.