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The Historical Fertility Transition:
A Guide for Economists

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Abstract

The historical fertility transition is the process by which much of Europe and North America went from high to low fertility in the nineteenth and early twentieth centuries. This transformation is central to recent accounts of long-run economic growth. Prior to the transition, women bore as many as eight children each, and the elasticity of fertility with respect to incomes was positive. Today, many women have no children at all, and the elasticity of fertility with respect to incomes is zero or even negative. This paper discusses the large literature on the historical fertility transition, focusing on what we do and do not know about the process. I stress some possible misunderstandings of the demographic literature, and discuss an agenda for future work.

Key words: Fertility transition, long-run growth, Malthusian models, quantity-quality trade-off

JEL Codes: N3, O1, O4

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Prior to the historical fertility transition, which took place in most of Europe and North America between the late eighteenth and early twentieth centuries, married women could expect eight or more births. Today many women do not have children at all. For centuries, the elasticity of fertility with respect to incomes was positive. Today it is zero or even negative. The fertility transition forms a major part of the process that brought the European, and later other, economies from slow to rapid and sustained growth. This article discusses the empirical literature on the historical fertility transition: what we know and what we still need to learn.

Current interest in the broad area of demographic behavior and long-run growth reflects several intellectual influences, including Robert E. Lucas's lectures on growth (Lucas (2002)). Early efforts in this area usually embed the microeconomic model of fertility decisions developed by Gary Becker in a framework that allows feedbacks from the economy to fertility decisions. Perhaps the leading paper in this area is Becker et al (1990). A more recent body of research focuses explicitly on how economies transition from a "Malthusian" economy of high fertility and little growth in per-capita incomes to one in which fertility is much lower and per-capita incomes grow rapidly. This "Unified Growth Theory" (hereafter UGT), developed by Oded Galor, David Weil, and others, integrates a microeconomic model of the demand for children with feedbacks from a model of growth. Other, related literature either considers fertility and growth in a different way, or examines related questions such as the role of children in the labor market.

These discussions have provoked renewed interest in the empirics of the historical fertility transition: when and why it took place, and how rapidly it created the low fertility we now see in most wealthy countries. Growth theorists are to be commended for trying to explain historical fact and highlight the importance of issues that were previously of interest primarily to economic historians and to others, such as demographers, outside the economics profession. Unfortunately, some recent discussions misconstrue the demographic literature. The use of certain theoretical ideas has also led some to believe that the relevant propositions have actually been tested in historical contexts, when that is unfortunately often not the case. Fully understanding the fertility transition will require much more empirical research. This paper has two goals. I provide an overview of the historical fertility transition, and then discuss the main hypotheses that are current in the economics and economic history literature. Throughout I set aside three other issues. First, most current economic research stresses the *implications* of demographic change for economic growth and development. That issue lies beyond the scope of this paper. Second, economists typically think of fertility decline as the reduction in the number of children born to a woman or to a couple. Demographers and others stress heterogeneity in the way fertility declines, for example, whether couples reduce the number of surviving offspring by spacing their child-bearing or ending child-bearing before that is biologically necessary. I discuss this issue only where important to understanding the evidence on the fertility transition. Finally, the fertility transition in developing countries since World War II has been studied far more intensively than its historical counterpart. This paper focuses on the earlier, historical episode, which is most relevant to what theorists have in mind when modeling the Industrial Revolution.

1. The basic contours of the historical fertility transition

Figure 1 reports fertility experience for the period 1800-1970 for five major countries: France, England and Wales, Germany, the United States, and Italy. The measure reported in Figure 1 is the Crude Birth Rate (CBR), defined as the number of births per thousand per annum. This paper focuses on the first four countries; Italy is included in Figure 1 only to suggest the heterogeneity of historical experience. Figure 2 focuses on the single case of Germany to highlight the relationship between fertility and mortality decline.[1] Ignoring the heterogeneity in Figure 1 for the moment, we see fertility declining starting in the eighteenth or nineteenth century, and this decline accelerates in the second half of the nineteenth century. The two world

[1] Deaths in Figure 2 are reported as the Crude Death Rate, defined analogously to CBR. The Crude Rate of Natural Increase (CRNI) is defined as CBR – CDR.

wars produced dramatic, temporary reductions in fertility, and the post-World War II period saw a "Baby Boom." By the 1970s most of Western Europe experienced the emergence of "low-low" fertility. Today, some OECD countries have fertility rates too low to sustain population growth through natural increase alone.[2] The relationship between fertility and mortality declines differs across these countries, but the German experience detailed in Figure 2 is fairly typical. For most of the nineteenth century, birth rates exceeded death rates and population grew (even with, as in the German case, extensive emigration). This is no longer true; for much of the late twentieth century, German rates of natural increase were negative.

Most countries outside Europe and North America did not experience fertility declines until after World War II. Timing within Europe and North America is less clear. Some economists have accepted the view that the fertility transition took place all at once across Europe. Most economists would not admire the data and methods upon which that assertion is based.[3] The all-at-once view has important implications for causality. Some scholars invoke the claim of simultaneous fertility transitions to support their view that economics has little to do with the fertility transition:[4] "Clearly the simultaneity and speed of the European transition makes it highly doubtful that any economic force could be found which was powerful enough to offer a reasonable explanation" (Cleland and Wilson (1987, p.18)).

Figures 1 and 2 report national aggregates. Several studies document the existence of fertility control among small groups as early as the seventeenth century. These "forerunners" were

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[2] Kohler, Billari, and Ortega (2002) discuss the emergence of very low fertility in the 1990s; Goldstein, Sobotka, and Jasilione (2009) discuss a recent, partial reversal.

[3] Galor (2005, Footnote 33) accepts the view that the fertility transition began everywhere at once in Europe. He is citing the results of a large project undertaken at Princeton University in the 1960s and 1970s. The Princeton conclusion reflects problems with sources, measures, and econometrics. The Princeton project devised a series of indices of overall fertility, marital fertility, illegitimate fertility, and the contribution of marriage patterns to fertility. The index of marital fertility I_g is scaled such that it would equal one if the population in question had fertility equal to the very high level of the Hutterites in the 1920s. See Appendix B to Coale and Watkins (1986) for definitions. I_g does not perform in Monte Carlo studies as claimed (Guinnane, Okun and Trussell (1994); Brown and Guinnane (2007). This index's performance is crucial to the claim that fertility started to decline everywhere at once.

[4] Thus it is puzzling to find an economic historian claiming, counter to the evidence, that "… the timing of the demographic transition in Europe and the United States places it circa 1890…" Clark (2007, p. 225).

usually urban elites or members of minority groups such as Jews (Livi-Bacci (1986)). More generally, research based on either sub-national aggregates or micro data often find earlier fertility declines than in national data. The Princeton studies report earlier fertility declines in cities, for example, but stress the behavior of national populations. Knodel (1988) reports that couples married 1800-24 in five of the fourteen German villages he studied exhibited significant control of marital fertility.

There are more general reasons for skepticism about simultaneous fertility transitions. Most scholars agree that France's fertility decline started in the early nineteenth century *at the latest*. Weir (1994, Table B3)'s careful construction of the Princeton indices shows that the decline in French fertility began in the late eighteenth century. In the early nineteenth century, U.S. birthrates were higher than elsewhere, but falling rapidly. By the end of the nineteenth century U.S. fertility fell below that of much of Western Europe. France and the United States are not esoteric exceptions one can ignore.[5]

Another concern reflects the CBR so often relied upon in economics research. In many circumstances it is the only measure available, or, as in my Figure 1, the only measure available that is defined consistently across a set of countries for the right period. Yet it has serious weaknesses, especially applied to this period of rapid economic and demographic change. The CBR does not account for age-structure or marriage patterns, both of which changed significantly in some European populations during this period. Consider England and Wales, where from 1871 to 1911 there was a disproportionate increase in the number of women of child-bearing age. The overall population increased by about 60 percent, while the female population aged 15-44 increased by 77 percent. The shift in age-structure in the absence of a fertility reduction would have *increased* the CBR by 11 percent. By failing to take into account the changing population

[5] Hacker (2003) questions whether the U.S. really had an early fertility decline. He is right to stress the weakness of the sources for the early nineteenth century, but the methods he prefers are fragile in their own way, and even he suggests a U.S. fertility transition well before the late nineteenth century.

age-structure, the Crude Birth Rate understates the change in behavior.[6] Some European societies experienced significant changes in marriage patterns during this period that make the CBR a poor guide to marital fertility. For example, between 1871 and 1911, the proportion of English women who had never married by ages 25-29 rose from .37 to .44 (Hajnal 1953, Table 3). Mean age at marriage for English males rose over the same period by 1.2 years (to 27.6), while at the same time in Germany it fell by nearly 1 year (to 27.9). The changes for women are similar but slightly less pronounced (Ehmer 1991, Table 1).[7]

Figure 3 reports a better measure, the Cohort Fertility Rate (CFR) for the five countries in Figure 1. CFR is the average number of children born to women in a given cohort, and thus requires age-specific fertility for a cohort's entire reproductive life. Its cross-section analogue, the Total Fertility Rate (TFR), is the sum of current age-specific fertilities, and thus reports the number of children born to a woman who experiences current age-specific fertility throughout her life. Reliable data needed to compute the CFR do not go back very far into the nineteenth century, and are not available even then for most countries. But Figure 3 suffices to suggest that the experience of specific cohorts born in the nineteenth century is not well-captured by CBR.[8] What looks like constant fertility (as measured by the CBR) may well reflect two offsetting trends. Figure 4 uses the exceptional French data to illustrate just this point: France's precocious marital fertility decline was partially offset by a mid-century marriage boom.

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[6] This precise effect is not present in every population represented in Figure 1. This is the point. The figures in question come from the decennial censuses of England and Wales for 1871 and 1911, and the Registrar-General's reports on births, deaths, and marriages. I have taken them from Mitchell (1980, Series B1, B2, B5, and B6).

[7] Cross-sectional differences in marriage patterns at the time were especially large. In 1900, England and Ireland had about the same Crude Birth Rate, but the latter was achieved by relatively few couples having very large familes (Guinnane 1997).

[8] TFR estimates for the United States start at 7.04 in 1800 and fall to 3.56 by 1900. These figures, just like the CBR in Figure 1, are for the white population only (Haines (2000a, Table 4.3)).

2. From Malthus to Becker

Most of the literature uses Malthusian models to understand the relationship between population and the economy before the fertility transition, and views the fertility transition as an escape from the Malthusian world. Figure 5 shows that escape: until the early nineteenth century, there was a positive relationship between fertility and the real wage in England and Wales. Then the relationship breaks down: higher wages, the product of capital accumulation and technological change, no longer translated into higher fertility.

Two distinct approaches to the Malthusian world exist in the literature. An older version stresses Malthus's own argument, that is, that the regulation of births reflected the regulation of marriage. In this model marital fertility depends only on age at marriage and the proportions who marry. The lifetime fertility of any given woman is a stochastic function of her age at marriage. Central to this version of the Malthusian model is the "European marriage pattern" in which young adults deferred marriage until well after puberty, often into their middle and late twenties, and as much as ten to twenty percent of some cohorts never married at all. Couples could not marry until they could support themselves and their offspring, implying that marriage decisions depended on the real wage in young adulthood.[9] In this version of the Malthusian model, the fertility transition reflects a shift from controlling *marriage* to controlling *fertility within marriage*. More recently, many economists (and much of the recent growth theory) set aside the marriage issue and thus model fertility without concern for its underlying determinants.[10]

Estimating long-run versions of the Malthusian model poses serious challenges. It has three equations and three endogenous variables, and because of echo effects due to past

[9] Most studies find a substantial proportion of pregnant brides, but children actually born outside of marriage rarely accounted for more than 5 percent of all births. For the European marriage pattern, see Hajnal (1965, 1982). Most scholars accept Hajnal's European Marriage Pattern as a stylized account, but it is not clear which parts of Europe it describes. Wrigley and Schofield (1981)'s book is an extended argument that England's demographic system functioned in a particularly benign way because of the strength of the relationship between the real wage and marriage patterns. Earlier studies had stressed mortality changes as the driving force in English population history. Malthusian models in Chinese population history are more controversial, partly because Chinese marriage patterns appear to have been different. Lee and Feng (1999) provide an overview of the debate and references to the literature.

[10] This vision underlies Galor and Weil (2000), as well as most other UGT models.

population shocks, the demographic fluctuations of today may represent the effects of past shocks. Another literature avoids these problems by estimating the short-run elasticities of births, marriages, and deaths to real-wage shocks. The short-run models confirm the central role of nuptiality in regulating fertility.[11]

The demand for children

Virtually all economic analysis of fertility today starts from Becker's model of the demand for children.[12] Becker's insight was to analyze the demand for children using the tools of consumer choice. The model yields important insights for the fertility transition. Observers have long noted that fertility tends to be negatively correlated with income in the cross-section, and, since the beginnings of the fertility transition, over time. Becker's model implies that this is a standard *substitution* effect, that children are not inferior goods: wealthier couples have higher opportunity costs of time, and time is a major cost of child-rearing. The simple version of Becker's model starts with a household utility function U=U(n,Z), where n is the number of children and Z is a vector of all other commodities. The household maximizes this utility subject to a standard budget constraint. Increases in child costs induce substitution away from children and towards the Zs. A pure increase in income raises the number of children demanded, as we expect. But if that higher income reflects rising wages, then that increased wage may show up as

[11] The age-structure change in England noted above is one such echo effect. Lee and Anderson (2002) rely on a state-space representation to contend with the integration and endogeneity problems implied by the model. This paper presents a clear overview of earlier literature as well as the modeling problems at issue. More recently, Nicolini (2007) relies on a simple VAR model that he identifies by an assumption of "contemporaneous stickiness." Møller and Sharp (2008) are unusual in the recent literature in explicitly modeling marriage rates. There are also data reasons to prefer the short-run model: often for historical situations we know the number of events (births, deaths, marriages) but not the population size, and thus cannot compute demographic rates. Lee (1981, 1985) explains the logic of the short-run models. Weir (1984) used this approach to challenge Wrigley and Schofield's interpretation of their English evidence. Guinnane and Ogilvie (2008) apply this approach to some German villages for the period 1634-1870 and provide references to other efforts of this sort.

[12] The important paper references are Becker (1960) and Becker and Lewis (1973). Becker (1981, Chapter 5) is a more elegant and expansive exposition.

an opportunity cost of having children, and reduce the number of children demanded via the substitution effect.[13]

Later interest in Becker's model focuses on the possible trade-off between the *number* of children and their *quality*, usually called the Quantity/Quality or "Q-Q" model. (Child quality is usually taken to mean child's health or education.) The Q-Q model starts from a household utility function of the form U(n,q,Z), where q is the quality of each child. Becker (1981, pp.107-108) divides child costs into three categories. Some costs depend only on the *number* of children: an example of this, p_n, would be the costs associated with the mother's pregnancy and delivery.[14] Another cost is related to child quality, but does not depend on the number of children, as it goes to purchase household public goods: examples of p_q include books that children could share. A final cost, p_c, is the cost of augmenting the quality of any child. The household's budget constraint is then:

$$p_n n + p_q q + p_c n q + \pi_z Z = I \qquad (1)$$

where I is household income and π_z is the price of the Zs. The marginal rate of substitution between quantity and quality now depends on the ratios of fixed to variable costs for quantity and quality respectively, as well as on the ratio of marginal variable cost to the average variable cost of quality. The substitution effects between quantity and quality are stronger in the Q-Q model than in the original Becker model. Consider an increase in p_n. The household will substitute away from numbers to both child quality and Zs, as one would expect. But because of that interaction term $p_c n q$, the shadow cost of n depends on q, so a reduction in child numbers raises the shadow cost of numbers even more, inducing more substitution of quality for quantity.

This Q-Q model has considerable appeal in historical circumstances. We observe sharp fertility declines that seem to reflect small changes in the economic environment. For example, as

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[13] In a number of articles often called collectively the "Easterlin synthesis," Richard Easterlin integrated Becker's approach with a better appreciation of the costs of fertility control as well as the biological limits on reproduction. See especially Easterlin (1978).

[14] This discussion follows Becker (1981) and uses his notation.

Becker noted himself, within this model a modest reduction in the cost of contraception could induce a shift from n to q, which seems consistent with the historical evidence. Several recent papers use historical data to test the Q-Q model. Becker *et al* (2009) use toughening of compulsory schooling laws in Prussia in the late 1840s to study the fertility effects of a reduction in the price of child quality. In their district-level data, areas with higher enrollment rates had lower fertility. This finding seems consistent with the central tradeoff in the Q-Q model. Bleakley and Lange (2009) take a different approach. They examine a program that largely eradicated intestinal worms among children in the early twentieth-century U.S. South. They find that the reduction in the prevalence of worms, which they interpret as a shock to the cost of child quality, increased school enrollment rates and reduced fertility. This again is consistent with the Q-Q model.[15]

3. Explanations and evidence

We can group the many economic explanations offered for the historical fertility transition under six headings. The first is an exogenous decline in infant and child mortality. The second turns on innovations in the technology of contraception, or more widespread availability of contraceptive devices. The third looks for increases in the direct cost of childbearing. The fourth explanation is based on changes in the opportunity costs of child-bearing. The fifth looks for a net increase in returns to child quality. The sixth argument assumes that children were an important way to ensure against risk and to provide for old age, and that the rise of state social insurance as well as private insurance and savings vehicles led households to substitute out of children. We consider these explanations in *ceteris paribus* fashion.

[15] The Q-Q model may get more attention that it warrants. Rosenzweig and Wolpin (1980) show that Becker's original model (with $p_c nq$ constrained to zero) generates nearly all of the testable implications that are identified with the Q-Q model. See also Schulze (1981, pp.166-169).

"Demographic transition theory" and the role of mortality decline

A long tradition assigned to mortality decline a *causal* role in the fertility transition. Frank Notestein (1945) argued that couples in high-mortality societies have a lot of births to ensure a surviving brood of the desired size. An exogenous mortality decline induces couples to have fewer children because they do not need so many "spares." Notestein's account was motivated by the experience of developing countries after World War II, where public-health interventions first reduced infant and child mortality, and in some places those developments were followed by declines in fertility. Most European countries also experienced a significant mortality decline in the nineteenth century. Historians and others still debate the causes of the historical mortality decline, but most scholars stress some combination of better food supplies, improvements in public health systems (such as clean water supplies and food-safety measures), and modest results from medical interventions (such as vaccines against smallpox).[16] Some of these developments reflect local decisions about public-good investments, but it is plausible to view them as largely exogenous to any couple's decision-making.

This mortality decline was concentrated in the early years of life. A woman born in the United States in 1850 had an expectation of life of 39.4 years. A five-year-old girl in that year had an expectation of life of 50.8 years, and a twenty year-old could expect to live an additional 39.8 years. In 1910 these figures were nearly the same for those who had already survived the dangerous early years. A newborn girl could expect to live 54.7 years, and a five-year-old girl, 57.4 years. A twenty year-old woman could expect a further 40.7 years, not even a full year more than in 1850.[17]

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[16] Thomas McKeown (1976) argued that prior to about 1900, medical science had done little to increase human longevity, and concluded that the observed mortality declines to that point reflected direct and indirect effects of better nutrition brought about by higher incomes and better food supplies. Fogel (2004)'s more nuanced account also stresses the role of nutrition. For an introduction and overview to this issue see Angus Deaton's review of Fogel's book, *Journal of Economic Literature* 44(1): 106-114.

[17] *Historical Statistics of the United States* series Ab657, 659 and 661. Mortality figures for the United States are complicated by the lack of complete death registration statistics, but the basic patterns noted in the text are robust.

The Notestein argument does not fit the timing of the historical declines in fertility and mortality. Fertility in the United States declined for decades before any noticeable decline in mortality. The Total Fertility Rates (TFR) reported by Haines (2000b, Table 8.2) decline from the early nineteenth century; there is no sustained fall in the infant mortality rate, on the other hand, until the 1890s. French experience was similar, with a fertility transition preceding mortality declines. In other places, such as Germany (Figure 2), the fertility and mortality declines took place at roughly the same time. This does not rule out a role for exogenous changes in mortality as a causal force, of course, but it suggests that Notestein-style account explains only part of the change. The total fertility rate in the U.S. in the early nineteenth century was about seven. Even if thirty percent of children then died in infancy or childhood, this implies that households *wanted* a surviving brood of four or five. By the end of the nineteenth century, in contrast, white, urban women in the U.S. were increasingly having just two children (David and Sanderson (1987)).

"Demographic transition theory" also has two theoretical flaws. Part of the decline in infant and child mortality is *endogenous* to the fertility decline. There are several lines of argument here, all of which assume that parents can assert some influence on their children's mortality risks by providing health-enhancing resources. In a historical context these resources include breast-feeding (which costs mother's time, but isolates an infant from possibly contaminated water and food supplies), other nutrition, and protection from danger such as hearth fires.[18] In the Q-Q model, reduced infant and child mortality could also reflect changes in other costs. For example, improved contraceptive technology (discussed next) could allow parents to more tightly control the link between actual and desired fertility. Parents might have a smaller

[18] Historical research has not always taken this issue seriously. Papers that do instrument for infant mortality in econometric analysis generally find that it dramatically reduces the apparent impact of mortality in an OLS framework. See Galloway, Hammel, and Lee (1998b), which also surveys earlier literature; Brown and Guinnane (2002); Murphy (2010a).

number of children and care for them more intensively, in effect not relying on high mortality to cull their brood to its desired size.[19]

The second theoretical problem with the "demographic transition" account is that even a fully exogenous reduction in infant mortality would have two, countervailing effects. An exogenous mortality decline reduces p_n and thus makes child numbers cheaper relative to both child quality and Zs. An exogenous mortality decline could actually *raise* fertility net of child mortality.

Innovations in contraceptive methods

A second explanation for the fertility transition implies that couples long wanted smaller families, and improvements in contraceptive methods made that goal easier to achieve. Assessing this explanation is frustrated by lack of direct evidence on contraceptive practice for most of the period. The best we can do is to provide a broad characterization of those technologies and the constraints they put on couples. Indirect evidence shows that until the second half of the nineteenth century, most fertility control relied on a combination of withdrawal (*coitus interruptus*) and abstinence from sexual relations.[20] The first "modern" methods appeared in the second half of the nineteenth century. These techniques relied partly on advances in medical

[19] If this claim seems extreme, consider the practice of wet-nursing, which was extensive in France into the late nineteenth century. In many cases, one woman would take several urban babies soon after their birth, and travel with them by train to the location where they would be cared for. Some babies would die *en route*, from cold or hunger, and others would die from neglect at their destination. The practice was widespread and not limited to urban middle and upper classes. Rollet (1982, Table 1) estimates that about ten percent of all French newborns, and about thirty percent of those born in the Paris region, were sent to a wet nurse in the late nineteenth century. Martin-Fugier (1978, pp. 26-27) quotes a thirty percent mortality rate for wet-nursed infants in the Paris region earlier in the century. This is roughly twice the infant mortality rate for France as a whole at the time.

[20] McLaren (1978, pp.25-27) among others notes that frequent condemnations of withdrawal in the eighteenth century suggest that the practice was already used as a form of contraception. Woycke (1988, p.11) concludes that throughout the nineteenth century, "…it was *coitus interruptus* that remained the most common contraceptive practice." Santow (1995) provides the best recent account of this issue. The nineteenth century also witnessed the spread of "marriage manuals," a euphemism for guides to sexuality, sexual health, and contraception. These guides appeared as early as the eighteenth century, although their circulation was at first limited (McLaren 1978, pp.26-30). The usefulness of such guides in limiting fertility of course depends on their information being more accurate than what couples already knew from other sources.

understanding, but also on the invention of vulcanized rubber (in 1844). Applied to the production of condoms (in 1855), this new industrial process allowed couples to replace expensive and relatively unreliable condoms made from natural materials. (Most studies, in fact, conclude that prior to vulcanization, condoms were intended to prevent the spread of disease, not pregnancy). Depending on the place, condoms were widely available in barber shops, drug stores and other retail outlets. Vulcanized rubber was also the basis for the introduction of the diaphragm and similar barrier methods in the later nineteenth century.

Thus we have a new set of technologies, which would make contraception easier and more reliable, introduced not long before we observe the actual fertility decline in some countries (but well after France and the U.S.). Michael and Willis (1976) first integrated the costs of averting unwanted births into the microeconomic model. Their model assumes that couples can affect births, which is a random variable, using methods that imply various utility and money costs. The couple's optimization takes into account both the costs of contraception and the utility costs of having "too few" or "too many" children. (Thus the Q-Q tradeoff enters their thinking indirectly; a couple with too many children may, because of the budget constraint, be forced to choose a lower level of quality than preferred). Any contraceptive method implies both fixed costs (which must be "paid" to use the method at all) and a marginal cost (which depends on the number of births averted). A couple that wanted to avert three of an expected eight births would be happier with a relatively high marginal cost approach than would a couple that wanted to avert all but two of eight expected births.

The U.S. and many European countries at first made concerted efforts to limit the spread of contraceptive knowledge and technologies. In the United States, the "Comstock Laws," a collection of state and federal statutes, made it illegal to disseminate both marriage manuals and contraceptive devices such as condoms. Similar measures were enacted in England, Germany, and many other European countries. The focus and practical enforcement of such laws were uneven, and in some cases, celebrated court cases probably advanced public knowledge of contraceptive methods. The policies could also be self-contradictory.[21]

The effects of these restrictions on the fertility transition are not really known. Demographers today tend to argue that the availability of contraceptives and contraceptive information is the most important barrier to fertility decline in developing countries.[22] Economists are more skeptical, stressing the incentives to reduce family sizes. In any case, three sets of useful surveys confirm that throughout the nineteenth and early twentieth century, withdrawal and abstinence remained the primary approaches used by married couples.[23] Since these technologies had been available, essentially, throughout human history, it is unlikely that the condom and similar new methods played a strong role in the fertility transition. Legal restrictions probably mattered less than cost. Rubber condoms were at first expensive. Brown (2009, p.15) estimates that in the early twentieth century, a year's supply of condoms cost a Berlin worker the equivalent of ten to fifteen days of work. Other barrier methods such as the diaphragm required the attention of a trained medical professional.[24] Cost may account in part for Santow (1993)'s finding that *coitus interruptus* remained widely-used well into the twentieth

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[21] Germany's *Lex Heinze* (1900) illustrates the point nicely. This Act made illegal any public display or advertisement of objects intended for "obscene" use. But retailers could still *sell* condoms and other devices. At the same time, two other important German institutions, the Army and the Sickness Funds, were doing their best to *encourage* the use of condoms to stop the spread of venereal disease. Bailey (2010) is one of the few careful empirical studies of the Comstock Laws, but deals with a period, the 1960s and later, that is well after the U.S. fertility transition. She concludes (p.122) that in 1965, without the bans in place, marital fertility in the affected states would have been eight percent lower.

[22] This view underlies the literature on the so-called KAP-gap. In many surveys in developing countries, a significant number of women report that they do not want any more children but are not using contraception, or that they had more children than they actually wanted. The precise reasons for this are debated, but many demographers think this fact reflects lack of access to contraceptives. Westoff (1988) is an early, somewhat skeptical view. See also Bongaarts (1991). The publications of the Alan Guttmacher Institute, on the other hand, argue that there is considerable "unmet need for contraception" today. See, for example, "Facts on Satisfying the Need for Contraception in Developing Countries," April 2010.

[23] Three sets of surveys, some of doctors and some of women or couples directly, all conclude that the primary techniques used by married couples were withdrawal and abstinence. See Brown (2009, Table 1) for a summary of three German surveys from the early twentieth century; David and Sanderson (1986, pp. 317-328) discuss the Mosher survey of American women born in the 1850s and 1860s, as well as later U.S. surveys; Jütte (2003, p.220) discusses a survey of French doctors from the 1890s.

[24] The contraceptive pill used today dates from the 1950s, with its first widespread use taking place in the 1960s. Historical sources also refer to efforts to induce abortion. Given social and later legal views of this practice, we cannot hope to know how common abortion really was during the period of the transition.

century, even in countries where alternatives were available. The methods available even prior to the fertility transition were sufficient to produce voluntary reductions of the magnitude we observe in the nineteenth and early twentieth centuries. David and Sanderson (1986) develop a model of a couple's lifetime fertility as a renewal process, and use it to derive estimates of the number of live births a couple would experience in a twenty-year marriage under various assumptions about coital frequency and contraceptive failure rates. Their baseline couple (no contraception) would have about nine births if they had sexual intercourse, on average, five times per 24-day cycle. If this couple used a method with a 12.5 percent failure rate, and failed to use it about 10 percent of the time, they would have only three births in twenty years. This "method" approximates what we know about the use of *coitus interruptus* in modern populations. Conscientious use of condoms would get the couple below *one* birth.[25]

Increases in the direct costs of children

In the Q-Q model, increases in p_n induce substitution towards both child quality and the Z goods directly, and towards quality through the interaction term in the budget constraint. One logical possibility to explain the fertility transition is that the direct costs of child-bearing changed in ways that induced couples to have smaller families. The problem is that most costs did not

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[25] Their model is based on Sheps and Menken (1973) and assumes that couples follow the same strategy over their entire lifetime. Michael and Willis (1976, Table 2) report a similar exercise using different parameter values. The unwary economist may fall into a trap created by the way most demographers think of fertility control. To most demographers, the term "family limitation" does not mean a reduction in family size, it means *a reduction in family size achieved in a particular way*. A couple seeking to have only N children can adopt a "stopping" strategy (have N children before initiating any effort to restrict fertility) or a "spacing" strategy (reduce the probability of a birth right from the start of marriage, and thus spread out births throughout the fertility years of the marriage). Most studies in historical demography assume that only stopping is legitimate evidence of fertility control; evidence of smaller families achieved via spacing is attributed to motivations unrelated to family size. The reasons for this assumption lie beyond the scope of this paper, but amount to a concern about identification (see Henry (1961)). Many historical demographers also view rudimentary fertility control techniques as unsuited to a spacing strategy; dynamic models of family-building, one the other hand, imply that risk-averse couples using unreliable contraceptive methods will prefer spacing to stopping (David, Mroz, and Wachter (1987)). Several empirical studies show that spacing was actually widespread in the early stages of the fertility transition (see Bean, Mineau, and Anderton (1990) and Mroz and Weir (1990)). The development of more reliable fertility control techniques in the nineteenth century could well have caused stopping to replace spacing. Works relying on the demographer's definition would identify a *shift to stopping* as the onset of the fertility transition.

change, over the relevant period, in ways that would produce the observed fertility decline. Most households in this period devoted the bulk of their expenditure to food, clothing, and housing. The real price of clothing dropped dramatically following the technological innovations of the Industrial Revolution, many of which were in textiles. Food prices varied over time and place, and protective tariffs on agricultural goods could raise the price of food in one country above its counterpart in others. But in general, food prices declined, which at a crude level would imply a reduction in p_n.

The only significant increases in direct costs took place because of urbanization. Most European countries as well as the United States experienced rapid urbanization during the nineteenth century. About six percent of the U.S. population lived in an urban place in 1800; in 1900 that was nearly forty percent (Haines 2000, Table 4.2). England was already very urban in 1801 (34 percent), and became even more so over the nineteenth century. By 1911, 79 percent of the English population lived in an urban center (Woods 1996, (Table 3)). France started out the period less urban, and while its cities did grow, it remained less urban than England or Germany. Urbanization in Germany was especially rapid in late nineteenth century. Germans living in places with fewer than 2000 people fell from 64 to 40 percent of the population between 1871 and 1910 (Wehler 1995, Table 71). In urban areas, housing costs exceeded costs in rural areas, but of course the decision to live in a city was up to a couple. Most studies find that urban fertility was lower than rural fertility in the nineteenth century, although the precise causation has not been established. Knodel (1974, Table 3.2) reports that marital fertility in Berlin in 1867-68 was about 87 percent of that in rural Prussia; by 1905-06, Berlin’s fertility was half of rural Prussia’s and Prussian cities overall had fertility about 75 percent of rural Prussia’s. Haines (1989, Table 2) estimates TFR in the urban U.S. in 1905-1910 at about 2.7, with rural nonfarm TFR at 4.0 and rural farm TFR at 6.0. Once the fertility transition began, fertility usually fell first in urban areas, with rural areas then catching up.[26]

A second type of direct costs underlies a literature that started with the U.S. fertility transition. Richard Easterlin's (1976) famous explanation for the fertility decline in rural America rests on the rising costs of farmland as an area was settled. Suppose a farm couple wanted to establish each child on a farm similar to their own. As the price of local farmland rose, parents either had to send their children further west, where land was cheaper, or had to have fewer children. Easterlin argues that parents preferred to have fewer children and be able to settle them locally. He dates the beginning of the decline in New York State to 1805 and even Iowa, much further west, to 1835.[27] Later research focuses on Easterlin's assumption that parents wanted to give each child a fixed bequest. Sundstrom and David (1988), for example, motivate their regression analysis using a bargaining model that presumes that a primary motivation for child-rearing is support in old age. In equilibrium, children can drive a harder bargain with their parents if they can point to better, off-farm opportunities. Cross-sectional regressions for U.S. states in 1840 show that fertility is negatively correlated with measures of non-farm labor-market opportunities. Once such proxies are introduced, land prices have no influence on fertility.[28]

Child labor raises another source of variation in direct costs. In many societies children offset some of the direct costs to their parents by working either in parental income-generation activities (such as a farm) or by working in the labor market. Any change in children's earnings would clearly alter the net costs to their parents. Two important trends affected children's earnings opportunities during the period in question. Most accounts imply that industrialization at first increased income-earning opportunities for children, because new technologies did not

[26] Sharlin (1986) surveys urban-rural differences in European fertility, using the Princeton project's data.
[27] His fertility measure is the child-woman ratio, or the number of children age 0-9 per thousand women 16-44. This measure is sensitive to in- and outmigration of both children and adults, as well as to variations in infant and child mortality.
[28] Carter et al (1994) provide additional evidence on this debate. This type of argument illustrates the problems with defining child quality. One could argue that Easterlin's explanation is one where parents reduce child numbers when the costs of quality increased.

require physical strength. By the 1830s large minorities of English children were working. Nardinelli (1990, Table 4.2) reports that in most English counties, at least one-quarter of children aged 10-14 were reported in the workforce. Some parts of the textile sector depended heavily on children. One Parliamentary inquiry reported that in cotton textiles, half of all workers were under 18, and 6.8 percent were under 10 (Nardinelli 1990, Table 5.3). Wehler (1996, p. 254) notes that in German factories in this period, children could be fifteen percent of the workforce. Estimates for industrializing New England run even higher.

By the mid-nineteenth century, the use of children, especially in industry, became controversial. Governments imposed age restrictions and other measures that reduced children's earning opportunities. The British "Factory Acts," starting in 1833, imposed restrictions on the ages of children who could work, and how many hours they could work. But they started at a modest level; the 1833 Act restricted children aged 9-12 to *forty-eight* hour weeks. Prussia introduced similar measures in 1839, with other German states soon following (Wehler (1996, p. 257)). Many governments tied restrictions on child labor to an education requirement. The English Factory Acts required that child workers also be in school. In some cases, the factory had to set up its own school to continue employing children (Nardinelli 1990, pp. 106-7). The Prussian 1839 Act established a minimum work age of nine years, and sixteen years for children who had not yet had at least three years of schooling. In Massachusetts as of 1837, manufacturers could not employ anyone under the age of 15 who had not attended school at least three months in the previous year (Moehling 1999, p. 74).

There are two styles of explanation for the new child-labor laws. One is that a combination of social-welfare concerns, along with representatives of labor concerned about competition with adult males, overwhelmed industrialists' opposition to child-labor restrictions. The other explanation is that these measures were enacted when industry no longer opposed them; either it had become easy to substitute capital and other sorts of labor for child labor, or the workforce had already changed in ways that the new laws were not a binding constraint when passed.[29]

Child-labor restrictions potentially reduce the incentive to have a large family, but we have to bear in mind their limitations. Most such measures either did not apply to agricultural work, or did so in a more relaxed way. Wehler (1996) emphasizes that the German restrictions did not successfully limit the role of children in production at home, which remained important throughout the nineteenth century. And in every case, the restrictions' impact would depend both on enforcement measures and parents' desire to evade them. Finally, if child-labor restrictions were introduced when they were mostly irrelevant, then they could not be a strong causal force in the fertility transition.

Increases in the opportunity costs of child-bearing

Industrialization usually changed the role of women in the workforce, although economic historians do not agree on just how. Several studies show that women played important roles in factory work early in the industrialization process, but became a less important part of that labor force as time went on. In a few industries such as textiles, women were certainly quite numerous into the twentieth century. Horrell and Humphries (1995, Table I) estimate *wive*s' labor-force participation rates of about 65 percent for England in the period 1787-1815, which corresponds to the height of the Industrial Revolution. This figure appears to fall in the late nineteenth century. Most other accounts report women as a proportion of the workforce in particular industries.[30] In Britain in 1851, women constituted about thirty percent of the country's measured labor force, and about forty percent of all employed women worked in textiles and clothing (Bythell 1993, p. 35). Goldin and Sokoloff (1982, Table 3) estimate that women comprised 20-30 percent of the workforce in New England textile factories in 1820, and about twice that in 1832. Saxonhouse

[29] Moehling (1999) argues the latter for the United States and gives references to the debate.
[30] Historical censuses do a poor job of reporting women's occupations, especially married women's occupations. Horrell and Humphries (1995) base their study on family budgets.

and Wright (1984, Table 1) report that 57.6 percent of the workforce in cotton textiles in the American South in 1880 were female. Wehler (1996, p. 254) reports that women could be half the workforce in some German factories in the 1830s and 1840s; in 1875, according to the census, women constituted nearly half of the workforce in textile and clothing factories in Germany, and about twenty percent of industrial workers overall.[31]

Married women certainly worked prior to the industrial revolution, but industrial work created new opportunities and trade-offs for women. It offered better-paying work that could not be combined with child-minding; a woman spinning yarn at home could also care for children, while a woman working in a textile factory could not. Some industries refused to hire married women at all, thus giving women an incentive to delay marriage.[32] Industrialization thus raised the opportunity cost of children in two ways.

Several studies find that local employment opportunities for women lowered fertility. Crafts (1989) relies on the fertility and occupational information in the 1911 census of England and Wales. He finds a consistent, negative correlation between women's local labor-force opportunities and marital fertility, with elasticities ranging from -.13 to -.34. Studies such as Brown and Guinnane (2002), which uses both textile mills and the structure of local agriculture to proxy for women's earnings opportunities, find small, statistically significant effects with the expected signs. Schultz (1985) uses a different approach that links women's earnings opportunities to the fertility transition per se. Using time series-cross section data on Swedish counties for the period 1860-1910, he shows that the ratio of women's to men's wages explains about a quarter of the decline in Swedish fertility. He treats women's earnings as endogenous, and instruments for them using demand-side shocks to agricultural prices. Women's earnings

[31] Kocka (1990, Table 16). This figure refers only to establishments with five or more employees.

[32] The "Lowell system" used by some textile mills in New England before the Civil War recruited young women to work in the mill and live in a special company boardinghouse under the supervision of a "housemother." The point was to recruit farmers' daughters who would otherwise be unwilling to undertake factory work (Saxonhouse and Wright (1984, pp.4-5)).

depress fertility at virtually all ages, so this effect seems to work through more than delayed marriage.[33]

Changes in the costs of and returns to child quality

Another appealing idea is that fertility decline reflects increases in the net return to child quality. There are two different questions to ask. First, did the cost of child quality, in the form of education, decline? Second, did the return to child quality increase? A positive answer to either question implies a substitution away from numbers towards child quality. Unfortunately we can say more about the former than the latter.

Economic historians of education stress important distinctions in the types of economically useful education. One could acquire basic literacy and numeracy at home (if the parents were literate) or in primary school. More advanced education or training required secondary schools, formal apprenticeship, or on-the-job training. Tertiary education during the relevant period was restricted to a small elite, and while perhaps important for overall TFP growth, would not figure heavily in demographic decisions.

The growth of literacy and its primary cause, public elementary education, differs dramatically across the countries on which we focus. There are two broad classes of important decisions: First, to make primary schooling universally available, and second, to make it compulsory.. Prussia led the way with the 1763 requirement that all children aged five to thirteen attend primary schools. The schools were not free, but there was tuition assistance for the poor. Like many grand educational reforms, this measure's implementation was resisted by various interests, and in any case Prussia lacked sufficient teachers for all the children in the territory

[33] Wanamaker (2010) uses the introduction of textile mills in South Carolina in the period 1880-1900 to study the impact of changes in opportunity costs on family sizes. The introduction of a textile mill reduced fertility in the surrounding area by about 11 percent c. 1900. The effect reflects differential migration of low-fertility couples and so does not reflect a shift in the opportunity cost of childbearing in the sense of Becker's model.

(Melton 1988, pp.174-177).[34] In 1816, about 60 percent of students required to attend school actually did so, a figure rising to 82 percent by 1846. Some German states, such as Saxony, did better (Nipperdey (1994, p.463). Several U.S. states introduced free public elementary education starting in the 1840s, and for most of the nineteenth century the U.S was an outlier in the proportion of young people in school. Free, compulsory education came later to Germany (1872), France (1882), and England and Wales (1893) (Bruland 2003, pp. 160-161). Easterlin (1981, Appendix Table 1) estimates that in 1850, there were 1800 children in primary schools per 10,000 total population in the U.S., compared to 1600 in Germany, 930 in France, and 1045 in the United Kingdom.

Literacy is both a broadly comparable measure of educational outcomes and the most economically useful output of primary schools. Mitch (2004, Tables 12.5A and 12.5B) reports that, in the time around 1860, adult male illiteracy rates were about 35 percent in France, 30 percent in England, 30 percent in the United States (whites only), and 5 percent in Prussia. Female illiteracy rates in these countries were higher: 45 percent for France, 37 percent for England, 10 percent for U.S. (whites only) and 5 percent for Prussia. The rapid development of schools in both Britain and France dramatically increased literacy rates by the end of the nineteenth century (Furet and Ozouf (1977, p.293)).

The creation of schools certainly reduced the cost of elementary education. But the opportunity cost of the time spent in school remained, even when schools were free. Mitch (1992, p.156) quotes Horace Mann's comment in the British 1851 census of education: "It is not for sake of saving a penny per week, but for the sake of gaining a shilling or eighteenpence a week that a child is transferred from the school to the factory." Child-labor laws might have been more important for encouraging schooling than the schools themselves.

[34] Economic historians of schooling stress that the quality of schools varied dramatically across time and place. The celebrated Prussian schools, for example, stressed the formation of Prussian citizens; thus instruction was weighted toward subjects such as religion. Primary school students learned to read and write, and some basic arithmetic, but more advanced skills were acquired in other ways (Nipperdey (1994, p.462)).

What were the returns to education? Historical sources usually report only literacy status, not years of education, and occupation rather than income or wage. So we cannot estimate returns to education as is in the modern literature on the economics of education. Goldin and Katz (2000) exploit the unique Iowa census of 1915 to provide one of the only historical estimates available. They find that the return to an additional year of high school or college then was, for males, on the order of 11-12 percent (Goldin and Katz (2000)). Mitch (1992, pp. 230-235) estimates the present value of acquiring literacy in Victorian Britain for a representative child. The present value of the cost of acquiring literacy would be about £4. At a wage premium of 5 shillings per week for literacy, the present value of the higher wages for a 35-year work life would be over £200.

Efforts to examine the relationship between children's education and their parents' fertility also confront data problems. Sources usually do not include both *parental* fertility and *children's* educational attainment, which is what we need for direct tests of the Q-Q tradeoff. It would be tempting to interpret parental education as a proxy for children's education. But this kind of effect can be interpreted in many different ways. The paper on Prussia discussed earlier (Becker et al (2009)) takes the preferred approach, which is to estimate the impact of school enrollment rates on fertility. Presumably this approach could be replicated in other contexts, using changes in schooling and child-labor rules to measure the net returns to education.

Social insurance and old-age support

One particular return to child-rearing that receives considerable attention in the literature is children's role in insuring parents against the consequences of accidents, ill-health, and old age. The most common argument is that children are a form of life-cycle savings; parents invest when they are young and healthy, and then expect their children to care for them in infirmity or old age. (The Sundstrom-David criticism of Easterlin's model, noted above, is one version of this argument.) We should also consider insurance against accidents and ill-health. Two versions of this argument have been advanced to explain the fertility transition. One is that industrialization and the increased mobility it entails, especially rural-to-urban migration, made it harder for parents to hold children to the intergenerational bargain. This "child default" argument implies that the developing industrial economy made children a less desirable vehicle for savings.[35] A second version of the argument points to the development of substitute means of providing for old age, especially social insurance and the welfare state.

Both versions of the argument suffer from the problem that we know that economic ties between parents and children varied dramatically across the societies in question before the fertility transition. In some European regions, peasant households would draft formal documents that turned a farmstead over to the heir, and carefully specified the heir's obligations to his parents (as well as to siblings to who had not yet received an inheritance). This *Altenteil* guaranteed specific transfers to the retired couple, who often lived on the farm in a special house reserved for that purpose.[36] At the other extreme, rural laborers' children in England would, from at least the early-modern period, leave home for good in their early to mid teens. The best evidence suggests these children had no further economic relationship with their parents (Macfarlane (1986, pp. 83-84)). Thus the extent to which parent-child ties changed during the nineteenth century varies a great deal. We should also note that the "child default" version of the argument resembles arguments about mortality (although in reverse): from the parents' viewpoint, rising child default is like increased infant and child mortality. Parents' might actually invest in more, lower-quality children to ensure that at least some children remained faithful.

This argument faces a different kind of challenge, which is that the social-insurance systems introduced at the end of the nineteenth and early twentieth century were usually replacing earlier schemes. Thus there is no clear "before." Prior to the introduction of social insurance,

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[35] This would also be consistent with Caldwell's changes in "net intergenerational wealth flows." Carter et al (1994) invoke the child default argument in discussing the U.S. fertility transition.

[36] The practice goes by many names. There are clear references to it in Scandinavia and Ireland, but most would associate it with German-speaking Central Europe. See Guinnane (1997, pp. 149-151) for Ireland, Gjerde (1985) for Norway, and Gaunt (1983) for a survey of Northern and Central Europe.

every society in question here had some form of provision for the poor and those unable to provide for themselves because of illness or age. These "poor relief" systems were locally-financed and organized, and were rarely as generous as the social-insurance schemes that eventually replaced them. Another important difference was their logic: poor relief systems were intended to relieve "need," and so imposed asset tests. The numbers receiving relief at any one time were small, as one would expect. Hennock (2007, p.46-47) estimates that 6.6 percent of the English population and about 3.4 percent of the German population received poor relief in 1885. Social insurance, on the other hand, generally operated on insurance principles: covered individuals received specified payments triggered by specified events or conditions.[37]

The literature divides social insurance into four categories: sickness insurance, (workplace) accident insurance, old age and disability insurance, and unemployment insurance. The first broad social-insurance system dates to 1883, when the German government introduced compulsory sickness insurance (1883) and then accident insurance (1884). Disability and old-age insurance were added in 1889, while unemployment insurance came later. The system's introduction was less discrete than these dates imply. Some German workers were already covered by schemes that were compulsory for their industry, and that became the model for the system for which Bismarck is always credited. The sickness and accident-insurance programs covered only workers in selected industries at first, although coverage broadened rapidly.[38] Participation in the disability and old-age insurance program were limited by income. The United Kingdom's Old Age Pensions Act (1908) illustrates a different approach. This non-contributory scheme was introduced for all persons who met a (mild) means test and had reached the age of 70

[37] Many workers in the late nineteenth century were also covered by voluntary, private schemes that provided assistance in case of sickness, accident, or infirmity. Some individual employers and labor groups also created insurance programs that covered parts of the workforce. In Germany, some workers were obliged to join a particular insurance organization long before the introduction of formal social insurance. Guinnane and Streb (2010) discusses Friendly Societies and the German organizations. Murray (2007) discusses these organizations more broadly and provides references to the broader literature.

[38] Khoudor-Castéras (2008) reports that the health insurance law covered 21 percent of workers in 1885, rising to 44 percent in 1913. The accident insurance system at first covered 18 percent of workers, but by 1913 covered 94 percent (Appendix Tables 1 and 2).

years. France and other Continental countries tended to emulate the German approach to social insurance, introducing first sickness and accident insurance, usually in the 1890s or later. There were earlier old-age pension systems, but they were voluntary and did not receive state subsidies, and were not widely used. The United States was an outlier: before the Social Security Act of 1935, the U.S. had no social insurance *per se*. Local poor relief systems, war pensions, and mother's pensions filled some of the role met by poor relief and social insurance in Europe. The "workman's compensation" system introduced in the U.S. in the early twentieth century filled the role of German-style accident insurance (Fishback and Kantor (2000)).

The timing of social insurance's rise in Europe hints that it is part of the story of the fertility transition. We cannot identify a single date at which social insurance first appeared, however. On the other hand, with care one might track the extension of such programs to different parts of a national population, and look for the impact on fertility of changes in social insurance over time. The broad patterns also do not make it likely that social insurance alone is central to the story. The two forerunners, France and the United States, were laggards in developing social insurance

4. Conclusions

The historical fertility transition played a central role in the making of modern economies. This paper outlines the central empirical patterns in a selection of important, wealthy countries, and then provides an overview of the major economic explanations for the fertility transition. I caution at several points that apparently minor differences in demographic measures can make an important different to the patterns economists seek to explain. More generally, much of the relevant literature in this area was produced by demographers and others who sometimes use definitions that to economists are unfamiliar and perhaps surprising. These differences reward care in consuming that literature.

There are several different economic explanations for the historical fertility transition. Two doubtless played a role, but are easy to exaggerate. During the late nineteenth century technological change introduced the first widespread use of "modern" contraceptives such as condoms. Yet the imperfect evidence available suggests these methods were still expensive, and that most couples continued to rely on "traditional" methods such as abstinence and withdrawal. Furthermore, simulation models show that traditional methods were sufficiently effective to account for the fertility decline we observe. Another often-stressed explanation for fertility decline is the decline of mortality, especially infant and child mortality. Mortality decline probably played a role in the historical fertility decline, but I have stressed two caveats.In some countries fertility declined significantly before any real mortality decline. In addition, infant and child mortality are at least partially endogenous to fertility.

The other explanations discussed here all work off relative price changes, as implied by Becker's demand-for-children model. Several significant changes in the relevant period plausibly altered the costs of and returns to children in ways that would reduce fertility. These include housing costs due to urbanization, changes in child-labor law, increases in the opportunity costs of child-bearing because of better labor-force opportunities for women, the introduction of free or compulsory primary education, and the development of social-insurance systems.

Despite at least one hundred years of academic and official interest in the decline of fertility, this question is not one for which economists have a clear, empirically well-founded explanation. (This is not to say there are not many partial answers based on particular times or places, or many theoretical efforts that capture some important part of the process.) There are several reasons for the current state of the literature. The most important is extensive simultaneity: the relevant period saw many significant economic changes, and some of these changes were tied to other changes such as the introduction of social insurance. Economists are well aware (and more recently, working hard on) the interrelations between fertility and the economy. But there remains the problem of understanding the role of any given change in a period when many other important forces changed at the same time. This is of course partly a standard identification problem, and partly an issue of being able to invoke *ceteris paribus* reasoning. Both require much more careful empirical work than we presently have.

Much more empirical work is both necessary and possible. The recent literature typically relies on national aggregates, or, in some cases, sub-national aggregate data. This approach sometimes reflects a reasonable trade-off between the costs and benefits of data collection. But for many historical economies there remain significant possibilities for using data much better-suited to testing the hypotheses described. The most important unexploited sources are individual-level data, especially individual-level data that include wealth and income, or reasonable proxies for wealth and income (such as occupation). The latter point is crucial: we know relatively little about the historical fertility transition because much of the earlier research relied on sources that do not contain useful economic information. Individual-level information is important for several different reasons. Sometimes data of this sort allows the researcher to follow life-cycle fertility, which permits use of a broader range of shocks to identify behavioral responses. Even when the sources are cross-sectional, individual-level data supports tests of multivariate hypotheses. (With aggregate data, on the other hand, there are usually ecological inference problems with any multivariate hypothesis.) These empirical approaches require significant investment of researcher time and other resources, but hold out the promise of really understanding, for example, the effect of women's labor-force opportunities on the demand for children during the fertility transition. The recent upsurge in theoretical interest in the historical fertility transition will pay an even greater dividend if it motivates renewed interest in using the available data to understand the economics of the historical fertility transition.

References

Bailey, Martha J., 2010. "'Momma's Got the Pill:' How Anthony Comstock and Griswold v. Connecticut Shaped U.S. Childbearing." *American Economic Review* 100(1): 98-129.

Barro, Robert J., and Gary S. Becker, 1989, "Fertility Choice in a Model of Economic Growth." *Econometrica* 57(2): 481-501

Bean, Lee, Geraldine Mineau, and Douglas Anderton. 1990. *Fertility Change on the American Frontier: Adaptation and Innovation*. Berkeley: University of California Press.

Becker, Gary S., 1976. *The economic approach to human behavior* Chicago: University of Chicago Press.

Becker, Gary S., 1981. *A Treatise on the Family*. Cambridge, MA: Harvard University Press.

Becker , Gary S. and H. Gregg Lewis, 1973. "On the Interaction between the Quantity and Quality of Children." Journal of Political Economy 81(2): S279-288.

Becker, Gary S., 1960. "An Economic Analysis of Fertility." In Demographic and Economic Change in Developed Countries, Princeton.

Becker, Gary S. and Robert J. Barro, 1988. "A Reformulation of the Economic Theory of Fertility." *Quarterly Journal of Economics* 103(1): 1-25.

Becker, Gary S., Kevin M. Murphy and Robert Tamura, 1990. "Human Capital, Fertility, and Economic Growth." *Journal of Political Economy* 98(5): s12-s37.

Becker, Sascha O., Francesco Cinnirella, and Ludger Wössman, 2009. "The Trade-off between Fertility and Education: Evidence from before the Demographic Transition." CESIfo Working Paper No. 2775.

Bleakley, Hoyt, and Fabian Lange, 2009. „Chronic Disese Burden and the Interaction of Education, Fertility, and Growth." *The Review of Economics and Statistics* 91(1): 52-65.

Bongaarts, John, 1991. „The KAP-Gap and the Unmet Need for Contraception." *Population and Development Review* 17(2):293-313.

Brown, John C., 1988. "Coping with Crisis: The Diffusion of Waterworks in Late Nineteenth-Century German Towns." *Journal of Economic History* 48:307-18.

Brown, John C., 2009a. "Fertility Control with Imperfect Methods: Strategies of Family Building and the Choice of Technique during the German Fertility Transition, 1885-1915." Working paper

Brown John C., 2009b. "Household Choice of Technique in the Fog of Uncertainty: Strategies of Family Building and Patterns of Choice during the German Fertility Transition, 1885-1915" Working paper

Brown, John C., and Timothy W. Guinnane, 2002. "Fertility Transition in a rural, Catholic population: Bavaria 1880-1910." *Population Studies* 56(1):35-49.

Brown, John C., and Timothy W. Guinnane, 2007. “Regions and Time in the European Fertility Transition: Problems in the Princeton Project’s Statistical Methodology.” *Economic History Review*

Bythell, Duncan, 1993. “Women in the workforce.” In Patrick K. O’Brien and Roland Quinalt, editors, *The Industrial Revolution and British Society*. Cambridge.

Carter, Susan B., Roger Ransom, and Richard Sutch, 2004. “Family Matters: The Life-Cycle Transition and the Antebellum American Fertility Transition.” In Timothy W. Guinnane, William A. Sundstrom, and Warren Whatley, editors, *History Matters: Essays on Economic Growth, Technology, and Demographic Change*. Stanford.

Clark, Gregory, 2007. *A Farewell to Alms: A Brief Economic History of the World*. Princeton.

Cleland, John, and Christopher Wilson. 1987. "Demand theories of the fertility transition: An iconoclastic view." *Population Studies* 41:5-30.

Coale, Ansley J.; Watkins, Susan Cotts [editors], 1986. *The Decline of Fertility in Europe: the Revised Proceedings of a Conference on the Princeton European Fertility Project*. Princeton, NJ: Princeton University Press.

Crafts, N.F.R, 1989. “Duration of Marriage, Fertility and Women's Employment Opportunities in England and Wales in 1911” P*opulation Studies*, Vol. 43, No. 2. pp. 325-335.

David, Paul A. and Warren C. Sanderson, 1986. “Rudimentary Contraceptive Methods and the American Transition to Marital Fertility Control, 1855-1915.” In Stanley L. Engerman and Robert E. Gallman, editors, *Long-Term Factors in American Economic Growth*. Chicago.

David, Paul A. and Warren C. Sanderson, 1987. “The Emergence of a Two-Child Norm among American Birth-Controllers.” *Population and Development Review* 13(1): 1-41.

David, Paul A., Thomas A. Mroz, and Kenneth W. Wachter, 1987. „Rational Strategies of Birth-spacing and Fertility Regulation in Rural France During the Ancien Regime.“ Stanford Project on the History of Fertility Control Working Paper No. 14-R.

Easterlin, Richard A., 1975. “An Economic Framework for Fertility Analysis.” *Studies in Family Planning* 6(3): 54-63.

Easterlin, Richard A., 1976. “Population Change and Farm Settlement in the Northern United States.” *Journal of Economic History* 36(1): 45-75.

Easterlin, Richard A., 1978. “The Economics and Sociology of Fertility: A Synthesis.” In Charles Tilly, editor, *Historical Studies of Changing Fertility*. Princeton: Princeton University Press.

Ehmer, Josef, 1991.*Heiratsverhalten, Sozialstruktur, ökonomischer Wandel*. Göttingen: Vandenhoeck & Ruprecht.

Festy, Patrick, 1979. *La fécondité des pays occidentaux de 1870 à 1970*. Paris.

Fishback, Price V. and Shawn Everett Kantor, 2000. *A Prelude to the Welfare State: The Origins of Worker’s Compensation*. Chicago.

Fogel, Robert, 2004. *Escape from hunger and premature death, 1700-2100*: Europe, America and the Third World. New York.

Furet, François and Jacques Ozouf, 1977. *Lire et écrire: l'alphabétisation des français de Calvin à Jules Ferry*. Paris.

Galloway, Patrick R., Eugene A. Hammel and Ronald D. Lee, 1994. "Fertility Decline in Prussia, 1875-1910: A Pooled Cross-Section Time Series Analysis." *Population Studies* 48(1): 135-158.

Galloway, Patrick R., Eugene A. Hammel, and Ronald D. Lee, 1998a. "Urban versus Rural: Fertility Decline in the Cities and Rural Districts of Prussa, 1875 to 1910." *European Journal of Population* 14:209-264.

Galloway, Patrick R., Eugene A. Hammel, and Ronald D. Lee, 1998b. "Infant Mortality and the Fertility Transition: Macro Evidence from Europe and New Findings from Prussia." In Mark R. Montgomery and Barney Cohen, editors. *From Death to Birth: Mortality Decline and Reproductive Change*. Washington, DC.

Galor, Oded and David N. Weil, 2000. "Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond." *American Economic Review* 90(4): 806-828

Galor, Oded, 2005a. "From Stagnation to Growth: Unified Growth Theory." *Handbook of Economic Growth*.

Galor, Oded, 2005b. "The Demographic Transition and the Emergence of Sustained Economic Growth." *Journal of the European Economic Association* 3(2-3): 494-504.

Gaunt, David, 1983. "The property and kin relationships of retired farmers in northern and central Europe." in Wall, Richard, Jean Robin, and Peter Laslett, editors. *Family Forms in Historic Europe*. Cambridge: Cambridge University Press, pp. 249-280.

Gjerde, Jon, 1985. *From Peasants to Farmers: the Migration from Balestrand, Norway, to the Upper Middle West*. New York: Cambridge University Press.

Goldin, Claudia and Kenneth Sokoloff, 1982. "Women, Children, and Industrialization in the Early Republic: Evidence from the Manufacturing Censuses." *Journal of Economic History* 42(4): 741-774.

Goldin, Claudia and Lawrence Katz, 2000. "Education and Income in the Early Twentieth Century: Evidence from the Prairies." Journal of Economic History 60(3): 782-818.

Goldin, Claudia and Lawrence Katz, 2002. "The Power of the Pill: Oral Contraceptives and Women's Career and Marriage Decisions." *Journal of Political Economy* 110(4): 730-70

Goldstein, Joshua R., Tomáš Sobotka and Aiva Jaslioniene, 2009. "The End of 'Lowest-Low' Fertility? *Population and Development Review* 35(4):663-699.

Guinnane, Timothy W., 1997. *The Vanishing Irish: Households, Migration, and the Rural Economy in Ireland, 1850-1914*. Princeton: Princeton University Press.

Guinnane, Timothy W., Barbara S. Okun and James Trussell, 1994. "What Do We Know about the Timing of Fertility Transitions in Europe?" *Demography* 31(1): 1-20.

Guinnane, Timothy W., and Sheilagh Ogilvie, 2008. "Institutions and Demographic Responses to Shocks: Württemberg, 1634-1870." SSRN No. 1109058

Guinnane, Timothy W. and Jochen Streb, In Press. "Moral hazard in a mutual health-insurance system: German *Knappschaften*, 1867-1914. *Journal of Economic History*, Forthcoming.

Hacker, J. David, 2003. "Rethinking the 'Early' Decline of Marital Fertility in the United States." *Demography* 49(4): 605-620.

Haines, Michael R., 1989. "American Fertility in Transition: New Estimates of Birth Rates in the United States, 1900-1940." *Demography* 26(1): 137-148.

Haines, Michael R., 2000a. "The Population of the United States, 1790-1920." In Stanley L. Engerman and Robert E. Gallman, *The Cambridge Economic History of the United States*, Volume II. New York.

Haines, Michael R., 2000b. "The White Population of the United States, 1790-1920." In Michael R. Haines and Richard H. Steckel, editors, *A Population History of North America*. New York.

Hajnal, John, 1953. "The Marriage Boom." *Population Index* 19(2): 80-101.

Hajnal, John, 1965. "European Marriage Patterns in Perspective." *Population in History: Essays in Historical Demography*. Eds. D. V. Glass and D. E. C. Eversley. London: 101-143.

Hajnal, John, 1982. "Two Kinds of Preindustrial Household Formation System." *Population and Development Review* 8(3): 449-494

Hennock, E.P., 2007. *The Origin of the Welfare State in England and Germany, 1850-1914*. New York.

Henry, Louis, 1961. "Some Data on Natural Fertility." *Eugenics Quarterly* 81(1): 81-91.

Horrell, Sara, and Jane Humphries, 1995. "Women's Labour Force Participation and the Transition to the Male-Breadwinner Family, 1790-1865." *Economic History Review* 48(1): 89-117.

Jütte, Robert, 2003. *Lust ohne Last: Geschichte der Empfängnisverhütung*. Munich: Beck.

Khoudour-Castéras, David, 2008. "Welfare State and Labor Mobility: The Impact of Bismarck's Social Insurance Legislation on German Emigration before World War I." Journal of Economic History 68(1): 211-243.

Knodel, John, 1974. *The Decline of Fertility in Germany, 1871-1939*. Princeton: Princeton University Press.

Knodel, John, 1988. *Demographic behavior in the past: A study of fourteen German village populations in the eighteenth and nineteenth centuries*. New York: Cambridge University Press.

Knodel, John and Etienne van de Walle. 1986. "Lessons from the past: Policy implications of historical fertility studies." in Ansley J. Coale and Susan C. Watkins, eds. *The Decline of Fertility in Europe*. Princeton: Princeton University Press.

Kohler, Hans-Peter, Francesco C. Billari, and José Antonio Ortega, 2002. "The Emergence of Lowest-Low Fertility in Europe During the 1990s." *Population and Development Review* 28(4): 641-680

Lee, James Z., and Wang Feng, 1999. *One quarter of humanity: Malthusian mythology and Chinese realities, 1700-2000*. Cambridge, Mass. : Harvard University Press.

Lee, Ronald D., 1981. "Short-term Variation: Vital Rates, Prices, and Weather." In Wrigley and Schofield (1981).

Lee, Ronald D., 1985. "Population Homeostasis and English Demographic History." *Journal of Interdisciplinary History* 15(4):635-660.

Lee, Ronald, and Michael Anderson, 2002. "Malthus in state space: Macro economic-demographic relations in English history, 1540-1870." *Journal of Population Economics* 15:195-220.

Livi-Bacci, Massimo, 1986. "Social-Group Forerunners of Fertility Control in Europe." In Coale and Watkins (1986).

Lucas, Robert E, 2002. *Lectures on economic growth*. Cambridge, MA.

Marschalck, Peter, 1984. *Bevölkerungsgeschichte Deutschlands im 19. und 20. Jahrhundert*. Frankfurt.

Macfarlane, Alan, 1986. *Marriage and Love in England 1300-1840.* New York: Basil Blackwell.

McKeown, Thomas. 1976. *The Modern Rise of Population*. New York.

McLaren, Angus, 1978. *Birth Control in Nineteenth Century England*. New York: Holmes and Meier.

Martin-Fugier, Anne, 1978. "La fin des nourrices." *Le Mouvement social* 105:11-32.

Michael, Robert T. and Robert J. Willis, 1976. "Contraception and Fertility: Household Production under Uncertainty." In Nestor E. Terleckyi, editor, *Houehold Production and Consumption*. Chicago.

Mitch, David, 1992. *The Rise of Popular Literacy in Victorian England: The Influence of Private Choice and Public Policy*. Philadelphia.

Mitchell, B.R., 1980. *European Historical Statistics 1750-1975*. New York.

Moehling, Carolyn M., 1999. “State Child Labor Laws and the Decline of Child Labor.” *Explorations in Economic History* 36(1): 72-106.

Møller, Niels Framroze and Paul Sharp, 2008. “Malthus in Cointegration Space: A new look at living standards and population in pre-industrial England.” University of Copenhagen Department of Economics Discussion Papers No. 08-16.

Murphy, Tommy, 2010a. “Old Habits Die Hard (Sometimes): What can Département Heterogeneity Tell us about the French Fertility Decline?” Working paper, Bocconi University.

Murphy, Tommy, 2010b. Peristence of Malthus or Persistence in Malthus? Mortality, Income, and Marriage in the French Fertility Decline of the Long Nineteenth Century. Working paper, Bocconi University.

Murray, John E., 2007. *Origins of American Health Insurance: A History of Industrial Sickness Fund*s. New Haven.

Nicolini, Esteban A., 2007. “Was Malthus right? A VAR analysis of economic and demographic interactions in pre-industrial England.” *European Review of Economic History* 11:99-121

Nipperdey, Thomas, 1994. *Deutsche Geschichte 1800-1866: Bürgerwelt and starker Staat.* Munich.

Notestein, Frank, 1945. "Population–The Long View," In *Food for the World,* ed. Theodore W. Schultz. Chicago: University of Chicago Press.

Rollet, Catherine, 1982. “Nourrices et nourrisons dans le department de la Seine et en France 1880-1940.” *Population* 37(3): 573-604

Rosenzweig, Mark R. and Kenneth I. Wolpin, 1980. “Testing the Quantity-Quality Fertility Model: the Use of Twins as a Natural Experiment.” *Econometrica* 48(1): 227-240.

Santow, Gigi, 1993. “*Coitus Interruptus* in the Twentieth Century.” *Population and Development Review* 19(4): 767-792.

Saxonhouse, Gary and Gavin Wright, 1984. “Two Forms of Cheap Labor in Textile History.” *Research in Economic History* Supplement 3, pp.3-31.

Schultz, T. Paul, 1981. *Economics of Population*. Reading, MA.

Schultz, T. Paul, 1985. “Changing World Prices, Women’s Wages, and the Fertility Transition in Sweden, 1860-1910.” *Journal of Political Economy* 93(6): 1126-1154.

Sheps, Mindel C. and Jane A. Menken, 1973. *Mathematical models of conception and birth*. Chicago.

Sharlin, Alan, 1986. “Urban-Rural Differences in Fertility in Europe during the Demographic Transition.” In Coale and Watkins (1986).

Sundstrom, William A. and Paul A. David, 1988. "Old-Security Motives, Labor Markets, and Farm Family Fertility in Antebellum America." *Explorations in Economic History* 25: 164-197

Wanamaker, Marianne H., 2010. "Did Industrialization Cause the American Fertility Decline? Evidence from South Carolina." Working paper, University of Tennessee.

Wehler, Hans-Ulrich, 1995. *Deutsche Gesellschaftsgeschichte 1849-1914*. Dritter Band. Munich.

Wehler, Hans-Ulrich, 1996. Deutsche *Gesellschaftsgeschichte 1815-1845/4*. Zweiter Band (Dritte Auflage).

Weir, David R., 1984. "Life Under Pressure: France and England, 1670-1870." *Journal of Economic History* 44(1): 27-47.

Weir, David R., 1994. "New Estimates of Nuptiality and Marital Fertility in France, 1740-1911," *Population Studies.*

Westoff, Charles G., 1988. "Is the KAP-Gap Real?" *Population and Development Review* 14(2): 225-232.

Woods, Robert, 1996. "The population of Britain in the nineteenth century." Reprinted in Michael Anderson, editor, *British Population History: From the Black Death to the present day*. New York.

Woycke, James, 1988. *Birth Control in Germany 1871-1933*. London.

Wrigley, E. A, and Roger Schofield, 1981. *The Population History of England, 1541-1871: A Reconstruction*. Cambridge.

Wrigley, E. A, R. S. Davies, J. E. Oeppen, and R. S. Schofield, 1997. *English Population History from Family Reconstitution 1580–1837*. Cambridge.

Figure 1

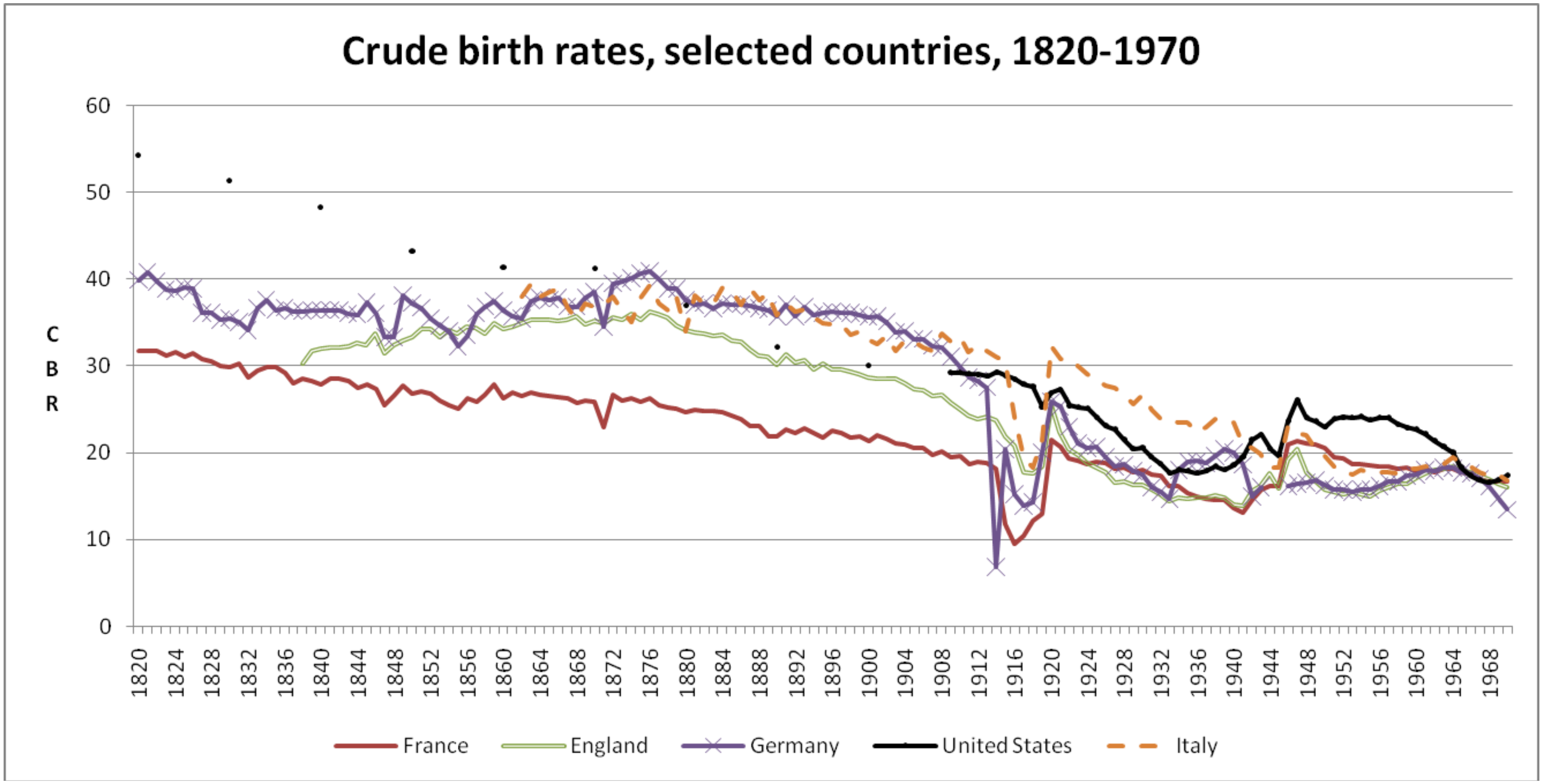

Crude birth rates, selected countries, 1820-1970
60
50
40
30
20
10
0
C
B
R
1820
1824
1828
1832
1836
1840
1844
1848
1852
1856
1860
1864
1868
1872
1876
1880
1884
1888
1892
1896
1900
1904
1908
1912
1916
1920
1924
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
France
England
Germany
United States
Italy

Figure 2

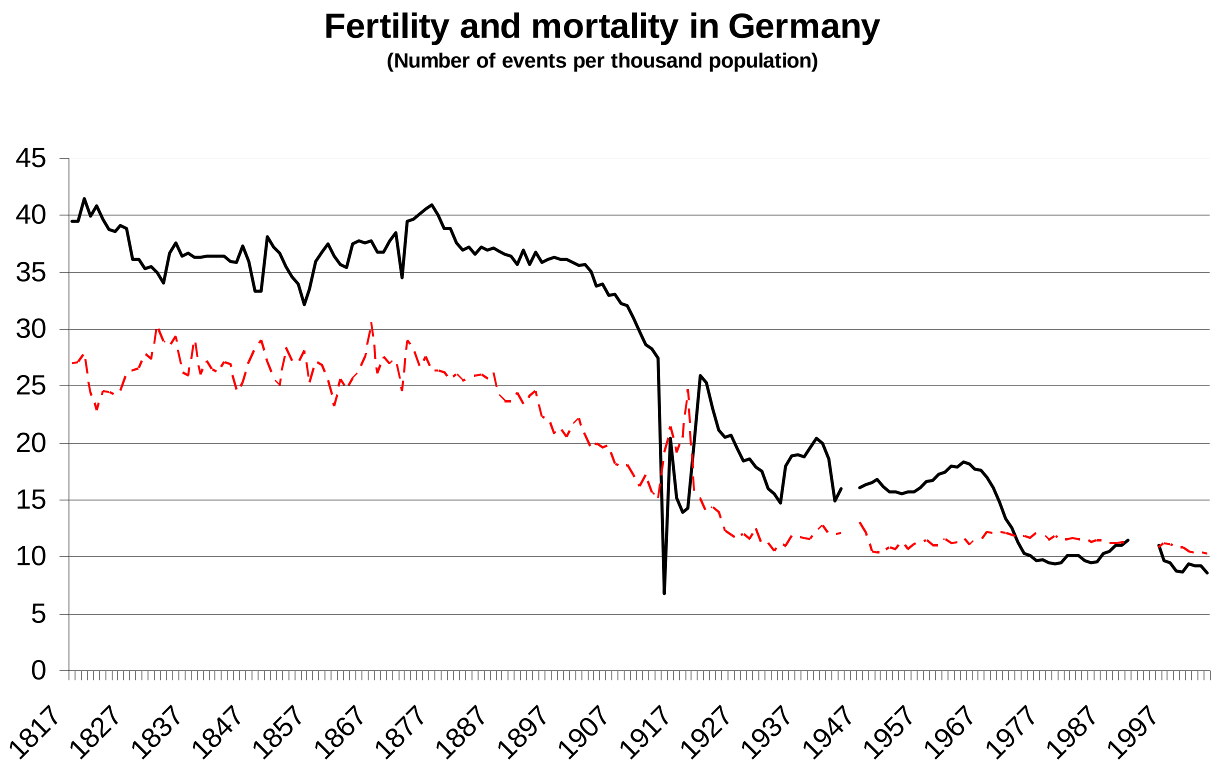
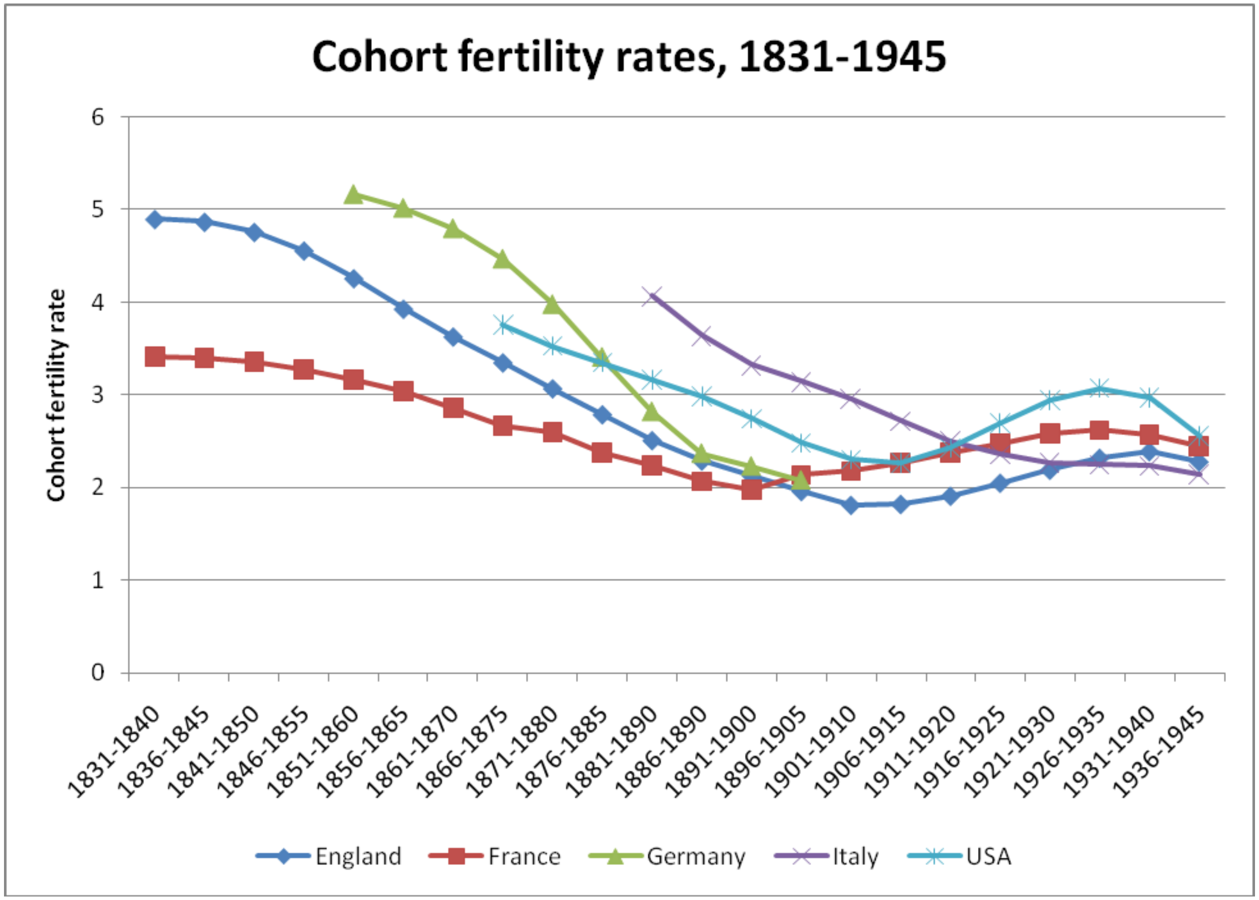
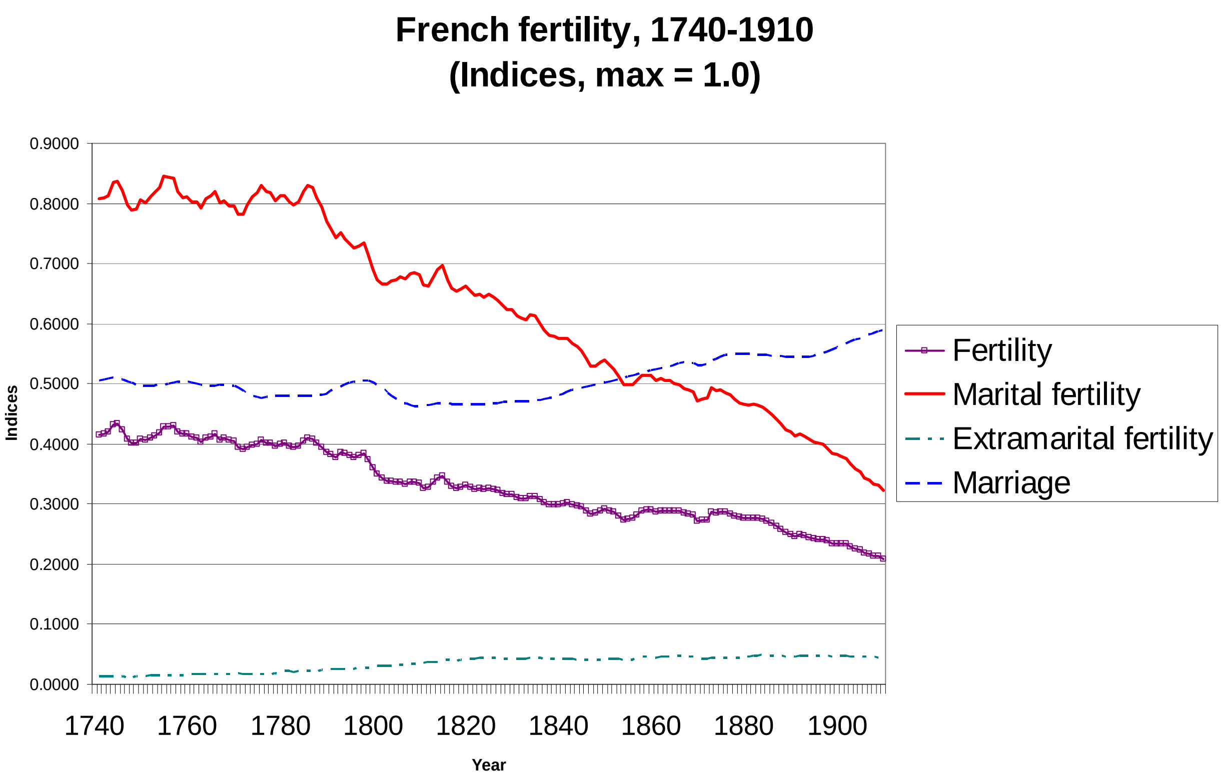

Fertility and mortality in Germany
(Number of events per thousand population)
45
40
35
30
25
20
15
10
5
0
1817
1827
1837
1847
1857
1867
1877
1887
1897
1907
1917
1927
1937
1947
1957
1967
1977
1987
1997

Figure 3: Cohort fertility rates



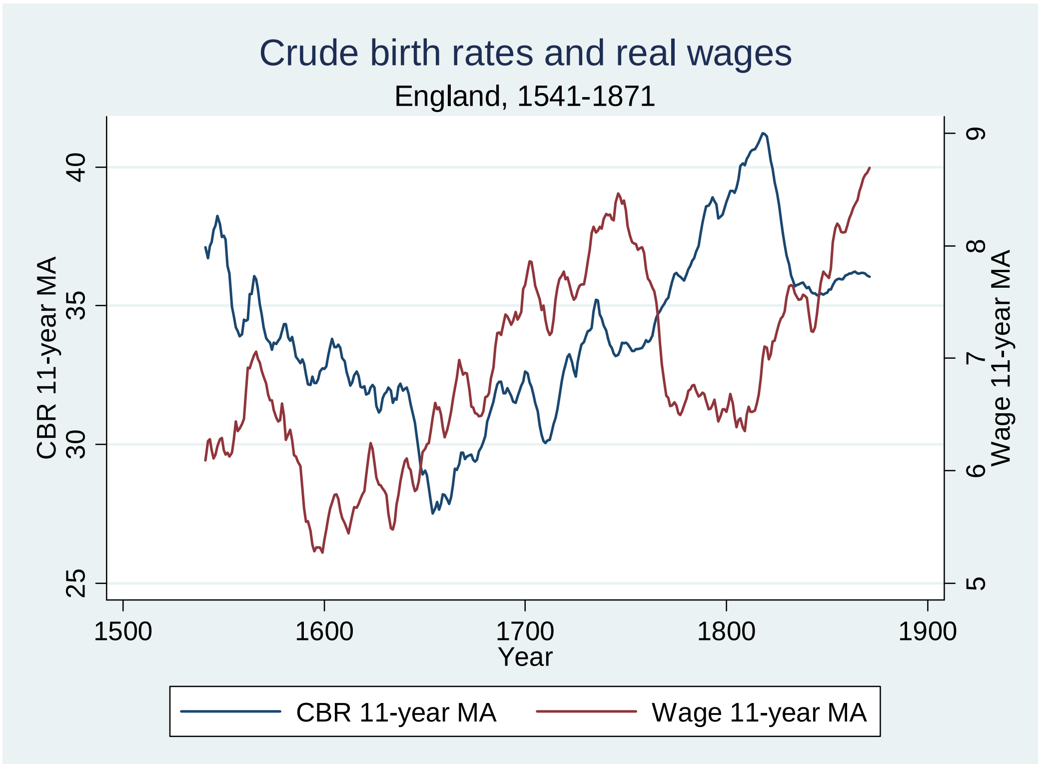
See "Sources and notes for figures"

Figure 4



French fertility, 1740-1910
(Indices, max = 1.0)
0.9000
0.8000
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
Indices
1740
1760
1780
1800
1820
1840
1860
1880
1900
Year
Fertility
Marital fertility
Extramarital fertility
Marriage

Figure 5: Fertility and the real wage in England



Source: “Sources and notes for figures”

Sources and notes for figures

Figure 1

The figures are crude birth rates as reported in Mitchell (1980)

Figure 2

Same as Figure 1

Figure 3

Source: Festy (1979; For England, p. 262, for France, pp. 266-7, for Italy, p. 283, for the US, p. 290, and for Germany, p.222.)

Note: The cohort fertility rate is the mean number of children born to women belonging to the birth cohorts on the horizontal axis. The overlapping years are in the source. The precise birth cohorts vary slightly across countries.

Figure 4

Source: Weir (1994).

Note: "Fertility" is the Princeton index of overall fertility I_f ; marital fertility is the Princeton index I_g; extramarital fertility is the Princeton index I_h; and "marriage" is the Princeton index I_m, which measures the contribution of changing marriage patterns to overall fertility,

Figure 5

Based on Wrigley and Schofield (1981, Figure 10.6)

Note: This figure differs from Wrigley and Schofield (1981, Figure 10.1) in two ways. I plot the CBR, not the Gross Rate of Reproduction. The real wage index here is Robert Allen's "labourers" index, rather than the Phelps Brown-Hopkins index. The series plotted are centered 11-year moving averages. Allen's index can be found at: http://www.economics.ox.ac.uk/members/robert.allen/WagesPrices.htm