

The Historical Fertility Transition and Theories of Long-Run Growth: A Guide for Economists

Timothy W. Guinnane
Department of Economics
Yale University

Revised May 2010

13,000 words

Note: This paper is under review at the *Journal of Economic Literature*. My research on this and related topics has been generously funded by the National Institutes of Health (US) and the Leverhulme Trust (UK) and the Economic and Social Research Council (UK). This paper has been presented in seminars at Brown University, the University of Colorado (Boulder), and the Autonomous University of Barcelona. I have learned much about these issues from working with and talking to John Brown, Christoph Buchheim, Oded Galor, Carolyn Moehling, Thomas Mroz, Sheilagh Ogilvie, Barbara Okun, Cormac Ó Gráda, Jean-Laurent Rosenthal, Mark Rosenzweig, Paul Schultz, William Sundstrom, Nathan Sussman, James Trussell, Christopher Udry, and David R. Weir. For comments and suggestions I thank the editor and three referees, as well as David Mitch. My interest in this subject is due to Paul David, and any (good) ideas here probably reflect his influence more than is reflected in the citations.

Abstract

Recent developments in growth theory place the historical fertility transition at the center of models that explain the transition from high-fertility, low-growth economies to the low-fertility, high-growth experience that characterizes most of the world today. This body of work marks an important advance in making demographic and economic behavior endogenous to each other. This literature also takes the historical record seriously, and is motivated by an attempt to explain actual experience. This paper discusses the larger literature on the historical fertility transitions and what it means for economic explanations of the historical fertility transition. I discuss several possible traps for the unwary economist and as well as where both the theoretical and empirical literatures need to go if we are to understand this important change in human history.

The neoclassical model of economic growth attributed to Robert Solow treats population as exogenous to the economy. Early models of population (such as Malthus) treated economic change as exogenous to the demographic system. Thus neither model was equipped to elucidate one of the most important transformations in human history, the transition from high to low fertility. Prior to the fertility transition, which took place in most of Europe and North America between the late eighteenth and early twentieth centuries, fertility was regulated only indirectly, via marriage. Married women could expect to have eight or more births. After the fertility transition, the link between marriage behavior and fertility became weak, if not non-existent. Economists have recently developed enhanced models to study the interaction between economic and demographic change, focusing on long-run growth. An important focus of the newer research has been to make fertility decisions endogenous to the economy, and thus to construct models in which economic change induces couples to have smaller families, and those smaller families in turn affect economic behavior in ways that shape growth.

Current interest in the broad area of demographic behavior and long-run growth reflects several intellectual influences, including Robert E. Lucas's now-famous lectures on growth (Lucas (2002)). Early efforts in this area usually embed the microeconomic model of fertility decisions due to Gary Becker in a framework that allows feedbacks from the economy to fertility decisions. These models have either a single equilibrium, or possibly multiple equilibria without explicit focus on how an economy would transition from one to another. 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) due to Oded Galor, David Weil, and others, integrates a microeconomic model of the demand for children with feedbacks from a model of growth, and as such accounts in a coherent way for a central issue in our understanding of long-run 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 facts, and to 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 misunderstand 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 often not the case. Getting a better grip on the facts requires both more empirical research and more care in consuming the fruits of 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 economics work naturally 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. This paper only discusses this second issue where it becomes 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 in 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. 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 show the relationship between fertility and mortality decline. Ignoring the heterogeneity in Figure 1 for the moment, we see a single, broad pattern of fertility declining starting in the eighteenth or nineteenth century, and in most cases accelerating in the second half of the nineteenth century. The two world wars produced dramatic, temporary reductions in fertility, and the post-World War II period saw some type of “Baby Boom.” By the 1970s most of western Europe saw the emergence of “low-low” fertility. Today, few OECD countries have fertility rates high enough to sustain population growth through natural increase alone.¹ 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 the 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.²

The timing of the fertility transition

Fertility fell first in western Europe and North America, and began to decline later in eastern Europe. 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. Economists accepting this conclusion probably would not admire the data and methods

¹ 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.

² The measures reported in Figures 1 and 2 are the Crude Birth Rate (CBI) which is the number of births per thousand population. The Crude Death Rate (CDR) is defined analogously. The Crude Rate of Natural Increase (CNRI) equals CBR- CDR.

upon which it is based. In addition, 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:³ “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).

The evidence reported in Figure 1, which is similar to the stylized facts considered in most theoretical works, relies on national aggregates. Studies based on micro-level evidence often conclude that the fertility transition started earlier than implied by the aggregate data such as reported in Figures 1 and 2. Knodel (1988) reports that couples married 1800-24 in five of the fourteen German villages he studied exhibited significant control of marital fertility. This type of result raises the importance of heterogeneity in the incentives to control fertility. One could worry that Knodel’s villages were exceptional in some way. They are: they were poorer and less developed than most of Germany. If anything, we would expect *later* transitions there.

There are more general reasons to use caution in talking about simultaneous fertility transitions. Figure 1 reminds us that there were two important exceptions. Most scholars agree that France’s fertility decline started in the early nineteenth century *at the latest*. France’s CBR was already lower than anywhere else, and declining, in the early nineteenth century (Figure 1). Using more refined approaches Weir (1994, Table B3) shows that the decline in French marital fertility began in the late eighteenth century. Mroz and Weir (1990) use econometric models of family-building to show that in northern France this decline was especially pronounced.

Birthrates in the United States were higher than elsewhere, but already falling rapidly in the early nineteenth century. By the end of the nineteenth century U.S. fertility (measured this way) was

³ 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). 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 index of marital fertility I_g in particular does not perform as desired in Monte Carlo studies (Guinnane, Okun and Trussell (1994); Brown and Guinnane (2007).

lower than much of western Europe. At the beginning of the nineteenth century France was one of the largest countries in Europe, and a cultural and intellectual leader. The U.S. had the world's largest economy by the end of the nineteenth century. These are not esoteric exceptions one can ignore.⁴

The other concern reflects the CBR so often used in economics research. Not accounting for changes in either age-structure or marriage patterns, the CBR can *increase* when couples are having smaller families (if, for example, age-structure shifts so that the denominator includes fewer people of child-bearing age), or *decline* when couples are having more children (if, for example, the proportion married declines).⁵ Figure 3 reports the available CFR for the five countries in Figure 1. The data needed to compute the CFR do not go back very far into the nineteenth century. But Figure 3 suffices to suggest that the experience of specific cohorts born in the nineteenth century is not well-captured by CBR.⁶ Variations in marriage rates are another problem. During the period of the fertility transition in many societies more Europeans were getting married, and doing so earlier. Thus what looks like constant fertility (as measured by the CBR) reflects two offsetting trends, an increase in marriage and a decrease in fertility within marriage. Taking this concern into account, for example, the precocious fertility declines in France is even sharper than the CBR would suggest. Figure 4 illustrates the effect of changes in marriage patterns for France, where the proportions married rose by about twenty percent through the nineteenth century. This marriage boom masked to some extent the sharpness of the decline in marital fertility.

⁴ Hacker (2003) calls into question 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 I think he over-states his case. The methods he prefers are fragile in their own way, and even his conclusions suggest a U.S. fertility transition well before the late nineteenth century.

⁵ Weir's estimate of I_g , a measure of marital fertility, falls by nearly half from 1820 to 1900.

⁶ For the United States we have estimates of the Total Fertility Rate (the cross-section analogue of CFR) back to 1800. These start at 7.04 in 1800 and fall to 3.56 by 1900. These figures, like the CBR in Figure 1, are for the white population only (Haines (2000a, Table 4.3)).

One could quibble about the relevance of measures defined over nation-states as the basis for a study of the causes of the fertility transition. The more general issue is heterogeneity: what kind of couples reacted to changing the economic environment by having fewer children. The representative-agent models most common in the growth literature abstract from such heterogeneity, but it is central to testing any claim about the causes of the historical transition. In the concluding remarks I come back to the importance of some kinds of heterogeneity.

2. Theories of fertility and the economy

Economists tend to use the term “Malthusian” as a synonym for poverty or low growth rates. In the literature at stake here, in contrast, the term refers to a specific model of economic-demographic interactions before the fertility transition. In a Malthusian model, 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 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. Thus economic conditions regulated fertility, but indirectly, through marriage. In Malthus’s model the elasticity of fertility with respect to the real wage is *positive*.⁷ Mortality in the Malthusian model depends negatively on the real wage, as higher incomes reduce the incidence of malnutrition and disease. With some simple assumptions there is only one real wage at which the number of births equals the number of deaths. Standard classical assumptions on production close the model; with a given

⁷ The Malthusian model implicitly assumes away illegitimacy. 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. The exceptions, such as in southern Germany, reflect, at least in part, legal restrictions on the right to marry. These restrictions were unusual and do not account for the role of marriage in European demographic patterns. 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, outside of the very northwest corner.

stock of land, capital, and technology, the marginal product of labor is a negative function of population size.

The Malthusian model's pessimistic reputation reflects its implication that demographic behavior determines the long-run equilibrium real wage. Increases in labor productivity brought about by capital investment, new land, or even technological improvement affect, in the long run, only population *size*. Figure 5 illustrates a comparative static exercise. A shift in the marginal product of labor schedule initially generates a higher real wage and thus increases in fertility and decreases in mortality. Eventually however, natural increase (births minus deaths) increases the population size, bringing the system to a new equilibrium at the same real wage but with a larger population.

A large empirical literature tries to test various aspects of the Malthusian model. Figure 6 reproduces Wrigley and Schofield (1981)'s graphical illustration of the relationship between the fertility and the real wage in England. A sympathetic observer can agree with Wrigley and Schofield, on the basis of this figure, that changes in wages drove changes in marriage and thus fertility. Others have their doubts. In the long run, the Malthusian model has three equations and three endogenous variables. In addition, populations can exhibit "echoes" of past population shocks.⁸ A different estimation strategy relies on the fact that in the short run population size is approximately fixed. Short-run versions of the Malthusian model yield estimates of the elasticity of fertility and mortality with respect to shocks to the marginal product schedule. These papers often employ variation in grain prices as proxies for real-wage shocks. This approach is attractive given the wide availability of grain price series, and is justified by the dominance of agricultural output in the pre-industrial economy. Estimates of the price elasticity of marriages and deaths

⁸ Figure 1 reflects such an echo effect: population growth rates increased in the early nineteenth century, creating a large cohort of women of child-bearing years in the mid nineteenth century. Lee and Anderson (2002) is only one of many recent papers proposing methods to estimate long-run versions of the model. They provide references to much of the earlier long-run literature. See also Nicolini (2007) and Møller and Sharp (2008).

vary widely, as one would expect, but most studies confirm a negative marriage elasticity with respect to prices, and a positive mortality elasticity.⁹

Malthus's model cannot explain the sustained economic growth experienced by many countries from the nineteenth century. Economic historians emphasize that the Industrial Revolution in Britain and elsewhere reflected increases in TFP more than capital accumulation, but neither force can explain the fertility transition. The Malthusian model implies that most societies today would consist of couples who married young and had large families. Obviously that has not happened, which led economists such as Becker to ask why the elasticity of births with respect to incomes is now, apparently, negative.¹⁰

The demand for children

Virtually all micro-economic analysis of fertility today starts from Becker's model of the demand for children.¹¹ Becker's insight was that he could analyze the demand for children using the tools of consumer choice. The model yields important insights. For example, 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. We sketch Becker's model here because later we will organize our discussion around its implications. We start 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.

⁹ 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 actual population. 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.

¹⁰ In the Solow model there is no paradox; because the labor force grows at a rate determined exogenously to the model, higher incomes due to technical advance are not offset by increases in fertility and decreases in mortality.

¹¹ The important paper references are Becker (1960) and Becker and Lewis (1973). Becker (1981, Chapter 5) is a more elegant and expansive exposition.

Anything that increases the costs of children induces substitution away from children and towards other commodities. A pure increase in income would raise the number of children demanded, as we expect. But if the income reflects rising wages, then that increased wage may show up as an opportunity cost of having children, and reduce the number of children demanded via the substitution effect.

Later interest in the Becker model focuses on the possible trade-off between the *number* of children and their *quality*, usually called the “Q-Q” model. We now work with 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.¹² 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 would include books that children could share. A final cost p_c is the cost of augmenting the quality of any child.¹³ The household’s budget constraint is then:

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

where I is household income and π_z is the cost of the Z s. The marginal rate of substitution between quantity and quality is

$$\frac{MU_n}{MU_q} = \frac{q}{n} \frac{(1 + r_n)}{(1 + r_q + \varepsilon_{pq})} \quad (2)$$

Where r_n and r_q are the ratios of fixed to variable costs for quantity and equality, respectively, and $1 + \varepsilon_{pq}$ is the ratio of the marginal variable cost to the average variable cost of quality.¹⁴ The substitution effects between quantity and quality are stronger than in the model without the Q-Q tradeoff. Consider an increase in p_n . The household will substitute away from numbers to both child quality and Z s, as one would expect. But because of that interaction term $p_c n q$, the shadow

¹² This discussion follows Becker (1981) and uses his notation.

¹³ Becker allows p_c to vary with q .

¹⁴ That is, $r_n = \frac{p_n}{p_c q}$; $r_q = \frac{p_q}{p_c n}$.

cost of n depends on q , so the reduction in child numbers raises the shadow cost of numbers even more, inducing more substitution of quality for quantity.

This Q-Q model is now a workhorse of empirical microeconomics as well as UGT and other models of the role of fertility in long-run economic growth. There are three reasons to be more cautious about it than has been the case in much of the recent growth theory literature. First, the literature provides no clear definition of quality. A large literature takes a child's education as a proxy for its quality, which seems reasonable but also ad-hoc. Second, Becker's model assumes that q is the same for all children within a family. Thus parents cannot react to changes in the price of quality by, for example, educating some of their children but not all. We know this is at variance with the facts: for example, in most societies boys receive more education than girls. This simplification could be avoided by elaborating the model to have different kinds of children, and to assume that q is the same within a "child-class." A two-class model would account for differential treatment of boys and girls, for example. The Q-Q idea becomes less useful, unfortunately, if parents pursue more complicated strategies, such as having one high-quality child and $N-1$ low-quality children. One could imagine a set of returns to education and financing constraints that would lead a household to finance one child's education with the earnings of the other children. Such allocations could also reflect efforts to share risk across labor markets. Finally, we should note that much of the literature is imprecise about what the Q-Q model really implies. Rosenzweig and Wolpin (1980) show that what they call the q^1 model, which amounts to Becker's model with $p_c n q$ equal to zero, generates nearly all of the testable implications that are identified with the Q-Q model.¹⁵ In addition, estimation of the true model requires exogenous variation in all three child prices (p_n , p_q , and p_c). Child numbers and child quality are assumed to be substitutes in the utility function; the $p_c n q$ term in the budget constraint just makes the

¹⁵ See also Schulze (1981, pp.166-169)'s discussion of the Q-Q model.

substitution stronger. Conversely, as they show, the Q-Q model requires considerably more structure than Becker appreciated to test for the existence of a non-zero $p_c n q$ term.¹⁶

This model has considerable appeal in historical circumstances. We observe apparently sharp fertility declines that seem to reflect small changes in the economic environment. For example, as 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. A number of recent papers claim to use historical data to test the Q-Q model. This effort is commendable, as we have almost no idea whether this model helps to explain the historical transition. Unfortunately, the results are more mixed than one might hope. 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. They find, in their district-level data, a negative correlation: in areas with higher enrollment rates, parents had smaller families. This finding seems consistent with the central implication of 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 argue this intervention reduced the cost of child quality by making children better able to learn in school. They find, again, a negative correlation between school enrollment rates and fertility, and argue this is consistent with the Q-Q model.

The findings in these papers rate as among the best evidence we have for the Q-Q trade-off in the period relevant to the fertility transition. Unfortunately, nothing in them tests the q^2 model against the q^1 . That is, appealing as the idea might be, we have no real evidence that supports invoking the strong substitution effects that are the key implication of the Becker model.

¹⁶ 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). Easterlin’s insights have probably not received the attention they deserved.

This does not negate the entire idea of the trade-off, but it means the substitution in question is not of the sort implied in the Becker-Lewis framework.

3. Explanations and evidence

There are many economic explanations offered for the historical fertility transition.¹⁷ We can group them under six headings. The first is an exogenous decline in infant and child mortality, as in the “demographic transition” story. 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 quality directly. 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. An acute problem for empirical research is that many of these relevant changes occurred at roughly the same time.

“Demographic transition theory” and the role of mortality decline

A long tradition assigned to mortality decline a *causal* role in the fertility transition.¹⁸ The central idea, famously represented in the so-called “demographic transition theory” associated with the demographer Frank Notestein (1945), is that couples in high-mortality societies have a lot of births because that is necessary to ensure a surviving brood. An exogenous

¹⁷ The vast literature on the fertility transition also includes many contributions by those who argue it reflected some type of cultural change. See the papers collected in Coale and Watkins (1986) for especially influential views on the European fertility transition.

¹⁸ Textbooks for economic development courses often still describe the historical fertility transition in this way, even if they do not emphasize the mortality decline as a causal force. Perkins, Radelet, and Lindauer (2006, pp. 240-243), for example, discuss Finland’s experience as if it were typical. Todaro and Smith (2009, pp.283-286) invokes the argument in a stylized way. Even Ray (1998, pp. 302-303), which is otherwise unusually sophisticated in its treatment of population issues, alludes to this argument.

mortality decline would induce couples to have fewer children because they would not need to have so many to achieve a given number of survivors. Notestein's account was motivated by the experience of developing countries after World War II, where public-health interventions created dramatic reductions in infant and child mortality in a short period. The mortality decline in Europe was not as abrupt. Historians and others still debate the causes of the historical mortality decline, but most scholars stress improvements in public health systems (such as clean water supplies and food-safety measures) combined with modest results from medical interventions (such as vaccines against smallpox).¹⁹ 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.

The decline in death rates in the nineteenth and twentieth century reflects mortality improvements 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 in 1850. 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 1850.²⁰ In Germany, in the decade 1871/80, 235 infants per thousand died before their first birthday. This figure declined to 162 by 1910 and 61 in 1939 (Marschalck 1984, Table 3.17).

¹⁹ The discussion is sometimes called "the McKeown debate." Thomas McKeown (1976) famously 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. Some reactions to McKeown and Fogel pose the introduction of public-health systems as an alternative explanation to "economics." Brown (1988) shows that the introduction of public-health measures reflected local incomes, as one would expect with a local public good. The best introduction and overview to this issue is Angus Deaton's review of Fogel's book, *Journal of Economic Literature* 44(1): 106-114.

²⁰ *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 empirical weakness in Notestein's argument is timing. Fertility in the United States declined for decades before any noticeable decline in mortality. The TFRs 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 accounts will not get us far. We should also note that mortality decline alone could not get us to the low levels of fertility we observe today. 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 an historical context these resources include breast-feeding (which isolates an infant from possibly contaminated water and food supplies); other nutrition; and protection from danger such as hearth fires. Most historical studies that consider the issue seriously find, indeed, that in a regression framework, reasonable instruments for infant and child mortality reduce mortality's impact on fertility. Brown and Guinnane (2002) are fairly typical in finding that while mortality has a strong, positive effect on fertility in an OLS model, in the counterpart IV model the effect is zero. Becker's model implies that reduced infant and child mortality could arise from 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 number of children and

care for them more intensively, in effect not relying any more on high mortality to cull their brood to its desired size.²¹

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 Z_s . If the strong substitution of the Q-Q model is at work, then even most reductions in p_n would induce a shift out of quality and into numbers. An exogenous mortality decline could actually *raise* fertility.²²

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. 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

²¹ 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. Other estimates were higher. Flandrin (1979) discusses the demographic implications of this practice; Sussman (1975) describes the organization of the wet-nursing business.

²² Two sets of theoretical discussions are worth noting in this context. First, Kalemli-Ozcan provides a theoretical mechanism through which changes in infant mortality reduces fertility. The argument requires that in high-mortality societies, parents have a precautionary fertility that disappears as mortality declines. This argument differs from the logic of the “demographic transition” claim in assuming risk aversion, that is, fertility does not fall as fast as expected child deaths. Compare Galor (2005b). Second, a number of recent growth papers study the effect of mortality decline on economic growth, focusing on a mechanism through which rates of human-capital accumulation increase as expected lifetime increases. In Kalemli-Ozcan’s model, the connection between mortality decline and human capital accumulation is through the parental budget constraint; as parents waste fewer resources on “precautionary” children, they have more available for education. Other papers assume that mortality declines promote human capital accumulation by lengthening the period during which this investment can yield returns. Some versions of this ignore the fact that most increases in life expectancy until the early twentieth century reflect reductions in infant and child mortality (for example, Cervellati and Sunde (2005)). Bar and Leukhina (2010) is more careful about the age-patterns of death.

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). In their model, 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.²³

We unfortunately do not have systematic evidence on what kinds of contraceptive methods couples used during the fertility transition. Indirect evidence supports the view that until the second half of the nineteenth century, most couples who sought to control their fertility did so with a combination of withdrawal (*coitus interruptus*) and abstinence from sexual relations.²⁴ 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 *coitus interruptus* that remained the most common contraceptive practice." Santow (1993) shows that *coitus interruptus* remained widely-used well into the twentieth century, even in countries where alternatives were available. In the Michael-Willis framework, withdrawal and abstinence count as low fixed-cost, high marginal-cost approaches. These two methods' popularity may surprise early twenty-first century readers, but we must bear in mind historical couples' objectives. Couples today associate birth control with the effort to prevent conception entirely, or to time births within narrow time-windows that reflect educational and professional. Much contraception in our society is used by couples with little or no commitment to a stable, long-term union. The French couples responsible

²³ See also Bailey (2010)'s useful graphical exposition.

²⁴ Santow (1995) provides the best recent evidence on this issue.

for that late eighteenth-century fertility decline, on the other hand, simply wanted to avoid having the six or seven births they could otherwise expect within a long marriage.

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, and in some (perhaps many) cases that is doubtful. McLaren (1978, p. 132) notes that only in 1885 did an English medical doctor author a birth-control tract. Some tracts, for example, stressed the dangers *coitus interruptus* supposedly posed to male health. Others contained useful advice on rudimentary contraceptive methods such as douching. The popularity of such guides as well as efforts to limit their dissemination suggests that couples viewed them as better than alternative sources of information.

The first “modern” methods appeared in the second half of the nineteenth century. These techniques relied partly on advances in medical 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 country, 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. Rubber condoms were at first expensive. Brown (2009, p.15) estimates that in the early twentieth century, a year’s supply of condoms would 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 and thus were more expensive to use.²⁵

²⁵ The contraceptive pill as 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. Abortion was not a crime in England until 1803, although throughout the eighteenth century it had been the subject of increasingly harsh commentary (McLaren (1978, pp. pp.30-36)). The techniques for inducing abortion (both “potions” and mechanical efforts) were too ineffective and dangerous to make them widely attractive as a means of limiting fertility.

In the nineteenth and early twentieth century, the U.S. and many European countries 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.²⁶ The policies themselves could also be self-contradictory. Germany’s *Lex Heinze* (1900) illustrates the point nicely. This Act made illegal any public display or advertisement of objects intended for “obscene” use. (Earlier court decisions had labeled contraceptives as obscene.) But retailers could still *sell* condoms and other devices. Even advertisements were still allowed, if they couched the devices as hygienic measures rather than contraceptives. At the same time, two other important German institutions were doing their best to *encourage* the use of condoms to stop the spread of venereal disease. One, the Army, conscripted every adult male. Part of a soldier’s basic training involved instruction on the use of condoms. And the Sickness Insurance Funds (discussed below) concluded in the 1890s that they would save money in the long run by making condoms available to their members, which eventually amounted to most of the population.

²⁶ The first British medical doctor to put his name on such a tract, Dr. H.A. Allbutt of Leeds, was punished by the General Medical Council for doing so. His book, *The Wife’s Handbook*, went on to sell hundreds of thousands of copies because of the notoriety (McLaren (1978, pp.132-133)).

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. Economists are more skeptical, stressing the incentives to reduce family sizes. We unfortunately do not have studies of the issue for the period of the historical fertility transition itself. Most accounts suggest that restrictions meant little in urban areas, where retailers and others found ways to evade the Comstock Laws and similar measures. Bailey (2010) is one of the few careful empirical studies of the issue, but deals with a period, the 1960s and later, that is well after the U.S. fertility transition. She concludes (p.122) from her study of the Comstock Laws that in 1965 that, without the bans in place, marital fertility in the affected states would have been eight percent lower.

What we know about the use of contraception in the past often comes from sources condemning its use. There are some actual surveys of practice from the early twentieth century, but unfortunately these pertain to decidedly non-random samples. The caveat aside, three sets of useful surveys confirm the impression that throughout the nineteenth and early twentieth century, withdrawal and abstinence remained the primary approaches used by married couples.²⁷

A fair summary of our knowledge of historical contraception would admit that the methods and information available to nineteenth-century couples made it harder for them to reduce family size than is the case today. But we should not over-stress the point: the methods available even prior to the fertility transition were sufficient to produce voluntarily reductions of the magnitude we observe in the nineteenth and early twentieth centuries. In an unfortunately neglected study, David and Sanderson (1986) show that even withdrawal could produce the fertility reductions we observe in the nineteenth century. They develop a model of a couple's lifetime fertility as a renewal process, and use it to derive estimates of the number of live

²⁷ 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.

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” amounts to what we know about the use of *coitus interruptus* in modern populations. Conscientious use of condoms would get the couple below *one* birth.²⁸

Empirical tests for the impact of new or improved contraceptive methods will founder on the fact that we do not really know what couples did or used. The best we can do is to develop proxies for the cost and availability of contraceptive, as well as study the impact of restrictions as in Bailey (2010). There is no reason to expect huge effects from the introduction of modern methods in particular, because couples clearly had access to close substitutes in the form of withdrawal and abstinence. Before leaving this subject we should stress one implication of the ubiquity of *coitus interruptus*. Some scholars argue that even the high, pre-transition fertility reflects some fertility control, largely achieved with withdrawal (Santow (1995)). This argument implies that what we call the fertility transition is not a shift from fertility at a corner solution to some interior solution, but an increase in fertility control itself. More directly, it underlines the endogeneity of contraception’s use. The French achieved their fertility transition with methods that had been known for centuries. The English presumably understood the same basic biological facts, but chose not to reduce fertility in the early nineteenth century. Changes in contraceptive technology can only get us so far.²⁹

²⁸ Their model is fairly standard in the demographic literature, and is based on Sheps and Menken (1973). They present a range of simulations; the one discussed here is unrealistic only in making these methods seem less effective than they actually are. Michael and Willis (1976, Table 2) report a similar exercise using different parameter values. In their model, a couple using no contraception would have 11.42 births. If they used condoms, they could expect 2.33 births (with a variance of 1.64). Withdrawal, in their results, would produce 2.74 births (with a variance of 1.79).

²⁹ 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

Increases in the direct costs of children

Two types of costs go into Becker's p_n , direct or out-of-pocket costs, and opportunity costs that are invariant to child quality. 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 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 well 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

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-stochastic 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 led stopping to replace spacing. For economists, the relevant concept is efforts to limit family size; but works relying on the demographer's definition would identify a *shift to stopping* as the onset of the fertility transition.

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, 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 in fact find that urban fertility was lower than rural fertility in the nineteenth century, although the precise causation has not been established. Once the fertility transition began, fertility usually fell first in urban areas, with rural areas then catching up, although there are exceptions: in the United States urban and rural fertility fell in step.

A second type of direct costs underlies a literature that started with the U.S. fertility transition. Richard Easterlin's (1976) famous explanation of 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 rises, parents either have to send their children further west, where land was cheaper, or have fewer children. Easterlin argues that parents preferred to have fewer children and be able to settle them locally. This influential argument has the virtue of focusing attention on a set of facts that have as yet escaped the attention of growth theorists. Fertility in the rural U.S. began to decline *long* before the late nineteenth century. Easterlin dates the beginning of the decline in New York state to 1805 and even Iowa, much further west, to 1835.³⁰ Later research has challenged the demographic details in his study, but most subsequent discussion focuses on the assumption that parents want to give each child a fixed bequest. Sundstrom and David (1988), for example, motivate their

³⁰ His fertility measure is the child-woman ratio, or the number of children age 0-9 per thousand women 16-44. This measure is easy to criticize; it is sensitive to in- and outmigration of both children and adults, as well as to variations in infant and child mortality. He uses this measure because it is all one can do with census-based information.

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.³¹

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 require physical strength. Nardinelli (1990), for example, argues that the appearance of children in the workforce in industrial Britain reflects mostly their shift from other activities, including agriculture. Family income increased because children's earnings were higher in industry. 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 the in this period, children could be fifteen percent of the workforce. Estimates for industrializing New England run even higher.³²

By the mid nineteenth century the use of children in industry especially became controversial. Governments imposed age restrictions and other measures that dramatically

³¹ 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 story is one where parents reduce child numbers when the costs of quality increased.

³² Goldin and Sokoloff (1982, Table 3) estimate that in 1820, as much as half the workforce in some large New England manufacturing firms was children.

reduced the earnings possibilities of children, especially in industry. The British “Factory Acts,” starting in 1833, imposed increasing 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. (A somewhat earlier measure in Prussia’s Rhineland forbade factory work by children younger than *six* .) Prussia introduced similar measures in 1839, with other German states soon following (Wehler (1996, p. 257)). Many governments coupled restrictions on child labor with 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 this development. 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. Moehling (1999) argues that latter for the United States and gives references to the debate.³³

There is no careful study of the effect such measures had on the demand for children, but the timing of the changes is broadly consistent with the timing of the fertility decline. Before pushing too hard on the idea of child-labor restrictions, however, we have to bear in mind their

³³ Doepke and Zilibotti (2006) develop an overlapping-generations model in which child labor restrictions emerge endogenously. In their model, skill-biased technical change leads parents to educate their own children, rather than have them work, and child-labor restrictions are used to prevent competition with adult wages. They remark that their model is consistent with the decline of fertility in Britain.

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 effect of these restrictions would depend both on enforcement measures and parents' desire to evade them. We should also bear in mind the lesson of Moehling's paper: 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, including married women, were certainly quite numerous into the twentieth century. Horrell and Humphries (1995, Table I) estimate *wife'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.³⁴ Women were especially important in textiles and related industries. 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 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

³⁴ 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.

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.³⁵

Married women certainly worked prior to industrial revolution, but industrial work created new opportunities and trade-offs for women. Industrial work 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. Thus industrialization raised the opportunity cost of children. This opportunity cost affected fertility in two ways. Some industries did not hire married women, and these employment opportunities gave women an incentive to delay marriage.³⁶ Others would not employ married women, which means that the cost of foregone wages had to be reckoned as part of the costs of having children.

Several studies find that local employment opportunities for women lowered fertility. 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. She finds that the introduction of a textile mill reduced fertility in the surrounding area by about 11 percent c. 1900. Wanamaker attributes the reduction to differential migration, not the behavior of locals; she finds that the introduction of a textile mill provoked the migration of low-fertility couples. Nonetheless, even differential migration implies that the textile mills raised the opportunity cost of children. 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. Unfortunately, largely because of data issues, there are no studies of similar quality for earlier in the relevant period. Studies such as Brown and Guinnane (2002), which uses both textile mills and the

³⁵ Kocka (1990, Table 16). This figure refers only to establishments with five or more employees.

³⁶ 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 be otherwise unwilling to undertake factory work (Saxonhouse and Wright (1984, pp.4-5)).

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 makes it the only paper to successfully link 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 depress fertility at virtually all ages, so this effect seems not to just work by delaying marriage.

Given the clear and direct role of opportunity costs in the microeconomic model of the demand for children, it is somewhat surprising that Crafts' or Schultz's approach has not been imitated more widely. One limitation is the right measure of earnings opportunities for women; it is easy to label something as a "woman's" job or a "woman's product," but often these labels become less useful as relative prices change. But many of the high-quality micro-level sources used by economic historians could be supplemented by measures of local economic opportunity for women.

Changes in the costs of and returns to child quality

The growth-theory literature tends to focus on the idea that fertility decline reflects reductions in the cost of child quality or increases in the returns to quality – that is, increases in the net return to child quality. As noted earlier, the idea of child "quality" is slippery, and most studies simply use education as a proxy for quality. As an explanation for the fertility transition, 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 much 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 less formal on-the-job training. Here we must look to the development of formal primary schools, apprenticeship, and other institutional mechanisms for education. Tertiary education during the relevant period was restricted to a (very) 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 decisions that mattered: to make primary schooling universally available, which was something different from making it compulsory and enforcing that requirement. 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 (Melton 1988, pp.174-177).³⁷ 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 even 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 number of students. 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

³⁷ 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 more advanced schooling or in other ways (Nipperdey (1994, p.462)).

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 education outcomes and the most economically useful output of primary schools. Mitch (2004, Tables 12.5A and 12.5B) reports adult male illiteracy rates about 1860 for France of 35 percent, England, 30 percent, the United States (whites only) 6.6 percent, and Prussia 5 percent. 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 brought both countries to nearly-full literacy 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 were probably more important for encouraging schooling than the schools themselves.

What were the returns to education? Historical sources usually report only literacy status, not years of education, and occupation rather than income or wage rate. So we cannot estimate returns to education as is common 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)). Goldin and Katz's estimates do not net out the costs of acquiring that education. Mitch (1992) uses data on school fees, children's earnings, and the wage premium in occupations that required literacy to estimate the present value of acquiring literacy in Victorian Britain. The present value of the cost of acquiring literacy by attending 40 weeks of school as a youngster 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 parent's 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 idea. Some studies appear to interpret parental education as a proxy for children's education; that is, more educated parents seem to be the first to control their fertility. But this kind of effect can be interpreted in many different ways. Becker et al (2009) take the preferred approach, which is to estimate the impact of school enrollment rates on fertility. They exploit the Prussian 1849 census, and the fact that even with compulsory schooling regulations there were, in fact, variations in enrollment rates. They find that areas with higher enrollments also had lower fertility, which they interpret as support for the Q-Q model. 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 expand the argument to include insurance against accidents and ill-health, as well. 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 it simpler for children to run off and leave their parents to fend for themselves, making children a less desirable vehicle for

savings.³⁸ 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.

At an analytical level 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 peasant regions of Europe, 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 had not yet received an inheritance). At the other extreme, rural laborer's children in England would, from at least the early-modern period, leave home for good in their early teens. The best evidence suggests these children had no further economic relationship with parents. Thus the extent to which anything in parent-child ties changed during the nineteenth century depends 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, 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

³⁸ 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.

English population received poor relief in 1885, and about 3.4 percent of the German population in that same year. Social insurance, on the other hand, generally operated on insurance principles: covered individuals received specified payments triggered by specified events or conditions.

Many workers in the late nineteenth century were also covered by voluntary, private schemes that provided assistance in case of sickness, accident, or infirmity. Perhaps the most famous of these are the English Friendly Societies. These societies collected annual dues from members and provided a variety of forms of assistance to members in need. By the early twentieth century they were in serious financial trouble, however, mostly because their age-structure provide less income from dues than the costs of benefits. Similar organizations existed in the United States and elsewhere, although they were less common. Some individual employers and labor groups also created insurance schemes 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.³⁹

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 only covered worked in selected industries at first, although coverage broadened rapidly.⁴⁰

³⁹ Guinnane and Streb (2010) discusses Friendly Societies and the German organizations. Murray (2007) discusses the U.S. organization and provides references to the broader literature.

⁴⁰ Khoudor-Castéras 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).

Participation in the disability and old-age insurance program were limited by income. The German programs were largely funded by worker and employer contributions.

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 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 (Fischback and Kantor (2000)).

The timing of social insurance's rise in Europe hints that it is part of the story of the fertility transition. Unfortunately, I know of no careful empirical study trying to test the impact of social insurance's impact on the fertility transition. This brief history should make clear that we cannot identify a single date at which social insurance first appeared, and hope to use it as a natural experiment as has been so successful in examining the impact of other institutional changes. On the other hand, with care one might track the extension of such programs to different parts of a national population, and test the impact of the changes 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. But there may be more subtle influences, especially in Germany and the United Kingdom, where fairly dramatic changes were introduced in a short period.

4. Conclusions

Recent interest in the fertility transition's role in long-run growth is welcome and important, but as this article argues, has not yet come near providing a satisfactory account of this extremely important episode in the development of the modern economy. The recent growth-theoretic literature has made important strides in identifying the key relationships, both demographic and in the interaction between households and the economy, that require further exploration. Further progress requires both additional work and a different perspective from both theorists and economic historians.

This article has identified a number of ways in which the theoretical literature has not fully appreciated the historical evidence. An most elegant model that explains a non-event (such as the “simultaneous” fertility transitions) will not get us far. In a different way, the examples used in this literature can be puzzling. Some papers draw their “facts” from England, others from Sweden, others from the United States. English economic history is wholly atypical, Sweden was and remains a small country, and, as we have shown, the U.S. has an unusual demographic history. More generally, progress in the theoretical literature will have to pay more attention to heterogeneity. Most models in use thus far adopt a representative-agent approach, which is entirely understandable; the dynamics are demanding enough within this context. But to the extent the literature stays with this approach, it will be forced either to treat some countries as anomalous or to bend the facts to fit inconvenient histories.

But the historical record points to at least two very important types of heterogeneity. The first is in marriage patterns and their role in fertility. Economists naturally tend to think of fertility as an average measure such as TFR. But at a microeconomic level, this approach glosses over an important fact. Prior to the fertility transition, Europeans had either a lot of children or zero. What we call the fertility transition was also a marriage transition: more people had at least some children, while the average number of children per family fell. Any of the causes of the fertility transition discussed above could plausibly have altered decisions about marriage; for example,

better contraception would make it easier for individuals who wanted only two children to have that number, and not have to choose between ten and zero.

We have only alluded to a second type of heterogeneity, which is within-country. Most models turn on mechanisms that could be true for at most part of the population. The introduction of child-labor restrictions did not affect agriculture at first, for example, so this change only matters for urban populations. Consideration of different incentives to reduce family size might provide better fit to the facts by themselves. And consideration of this type of heterogeneity could bring in the mechanisms by which demographic decisions among one part of the population create changes that may lead to different demographic decisions among others. Better schools might be the result of demands from one part of the population, but then induce others to shift from child numbers to child quality.

Greater empirical care by theorists might also pay an important indirect dividend in encouraging renewed willingness to dig into the many unused sources that would help us fill in the gaps in our knowledge of the fertility transition. Historical sources for the study of fertility can be challenging to use. Most have not been compiled in electronic form, and none contain the richness of, for example, modern surveys from developing countries. Some important methods, such as the “family reconstitution” approach pioneered in France and applied to fruitfully by Wrigley et al (1997), require painstaking linkage of records from several different sources. Exploitation of new sources holds out the possibility of understanding more clearly just who limited their fertility, and thus why they did so. (Many micro-level historical sources have more of a cross-section than time-series dimension, oddly enough, which means they are less well-suited to studying how specific types of couples react to changes over time.) Unfortunately, the difficulties of using these sources have probably discouraged some from working in this area. And professional incentives do not always reward this type of research; if the wider economics profession does not care about getting the facts right, why should a young empirical economist devote him or herself to this kind of inquiry? But there remains much that has not been used and

that could help to address the outstanding questions noted here. With some luck, theoretical interest in long-run growth could lead to renewed *empirical* interest in the outstanding questions noted here.

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.
- Bar, Michael and Oksana Leukhina, 2010. "Demographic transition and industrial revolution: A macroeconomic investigation." *Review of Economic Dynamics* 13: 424-451.
- 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.
- Bengtsson, T. and M. Dribe, 2006. "Deliberate Control in a Natural Fertility Population: Southern Sweden, 1766-1864." *Demography* 43(4): 727-746.
- Bleakley, Hoyt, and Fabian Lange, 2009. "Chronic Disease Burden and the Interaction of Education, Fertility, and Growth." *The Review of Economics and Statistics* 91(1): 52-65.
- 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., 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*

- Brown, John C., Timothy W. Guinnane and Marion Lupprian, 1993. "The Munich *Polizeimeldebögen* as a Source for Quantitative History." *Historical Methods* 26(3): 101-118.
- 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.
- Cervellati, Matteo and Uwe Sunde, 2005. "Human Capital Formation, Life Expectancy, and the Process of Development." *The American Economic Review* 95(5): 1653-1672.
- 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" *Population 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.
- Doepke, Matthias, 2004. "Accounting for Fertility Decline During the Transition to Growth." *Journal of Economic Growth* 9: 347-383.
- Doepke, Matthias and Fabrizio Zilibotti, 2005. "The Macroeconomics of Child Labor Regulation." *The American Economic Review*, 95(5):1492-1524.
- 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.
- 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.
- Flandrin, Jean-Louis, 1979. *Families in Former Times: Kinship, Household, and Sexuality*. Cambridge, UK.
- 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., 1988. "Basic Patterns in Annual Variations in Fertility, Nuptiality, Mortality and Prices in Pre-Industrial Europe." *Population Studies* 42(2): 275-302.
- 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, 1998. "Urban versus Rural: Fertility Decline in the Cities and Rural Districts of Prussia, 1875 to 1910." *European Journal of Population* 14:209-264.
- 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.
- 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 Jasliuniene, 2009. "The End of 'Lowst-Low' Fertility? *Population and Development Review* 35(4):663-699.

- 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, 2010. "Moral hazard in a mutual health-insurance system: German Knappschaften, 1867-1914. SSRN No. 1484753
- Hacker, J. David, 2003. "Rethinking the 'Early' Decline of Marital Fertility in the United States." *Demography* 49(4): 605-620.
- 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, 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.
- Kalemli-Ozcan, Sebnem, 2008. "The uncertain lifetime and the timing of human capital investment." *Journal of Population Economics* 21: 557-572.
- 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

La Porta, Rafael, Florencio Lopez-de-Silanes, and Andrei Shleifer, 2008. "The Economic Consequences of Legal Origins." *Journal of Economic Literature* 46(2): 285-332

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.

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

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

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, *Household Production and Consumption*. Chicago.

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

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.

Mroz, Thomas and David Weir. 1990. "Structural Change in Life-cycle Fertility During the Fertility Transition: France Before and after the Revolution of 1789." *Population Studies* 44(1): 61-87.

Murray, John E., 2007. *Origins of American Health Insurance: A History of Industrial Sickness Funds*. 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.
- Perkins, Dwight H., Steven Radelet and David L. Lindauer, 2006. *Economics of Development*. Sixth Edition. New York
- Ray, Debraj 1998. *Development Economics*. Princeton: Princeton University Press.
- Rollet, Catherine, 1982. "Nourrices et nourrissons 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.
- 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.
- 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
- Sussman, George D., 1975. "The Wet-Nursing Business in Nineteenth-Century France." *French Historical Studies* 9(2): 304-328.
- Todaro, Michael P. and Stephen C. Smith, 2009. *Economic Development*. Tenth Edition. New York.
- 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.
- David R. Weir, 1994. "New Estimates of Nuptiality and Marital Fertility in France, 1740-1911," *Population Studies*.

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

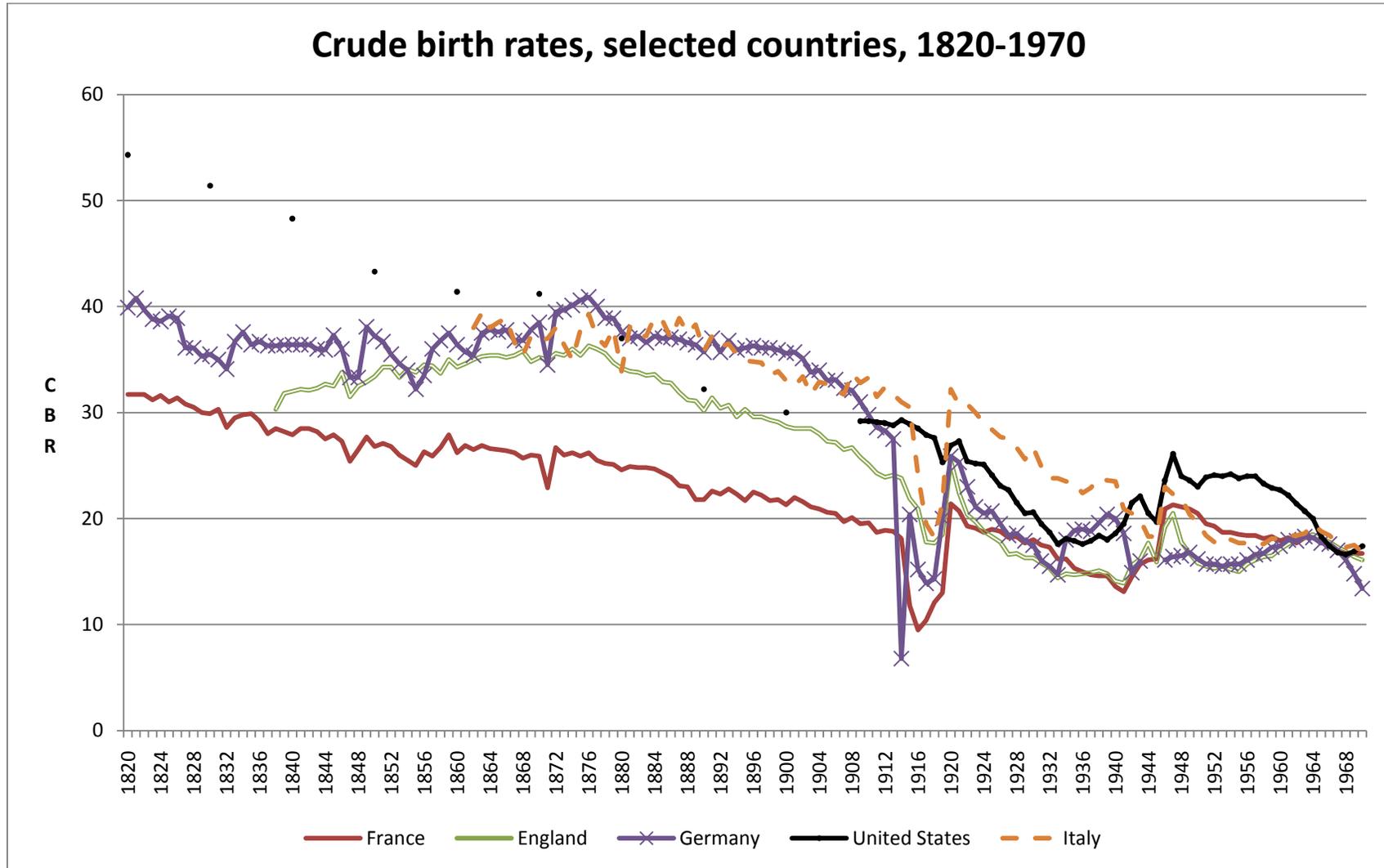


Figure 2

Fertility and mortality in Germany (Number of events per thousand population)

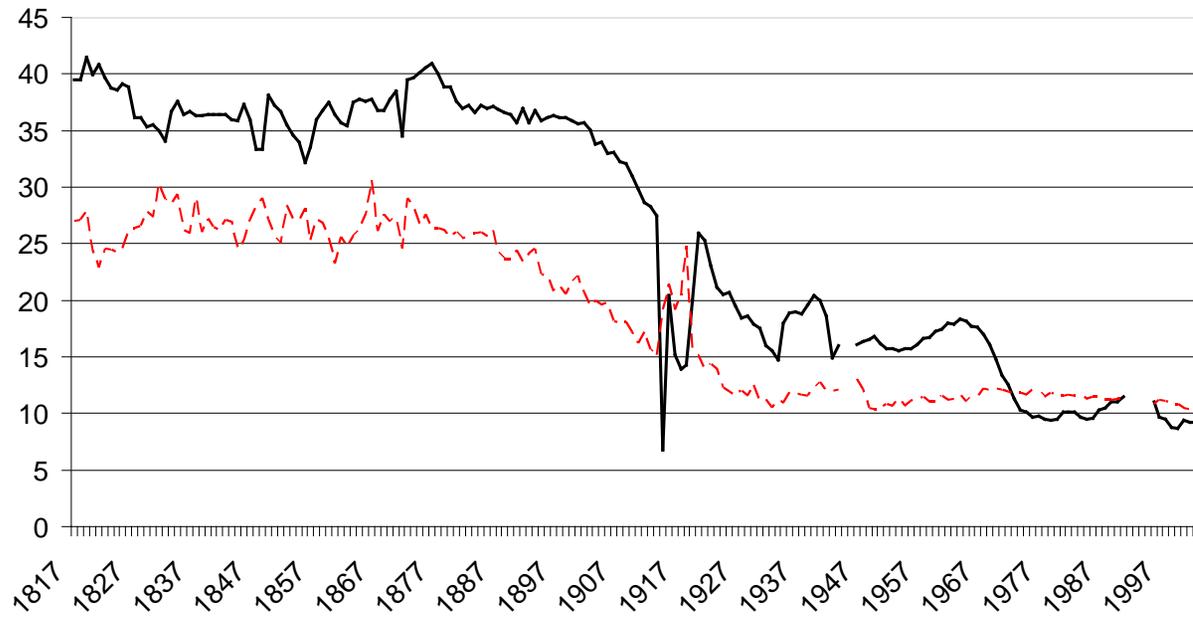
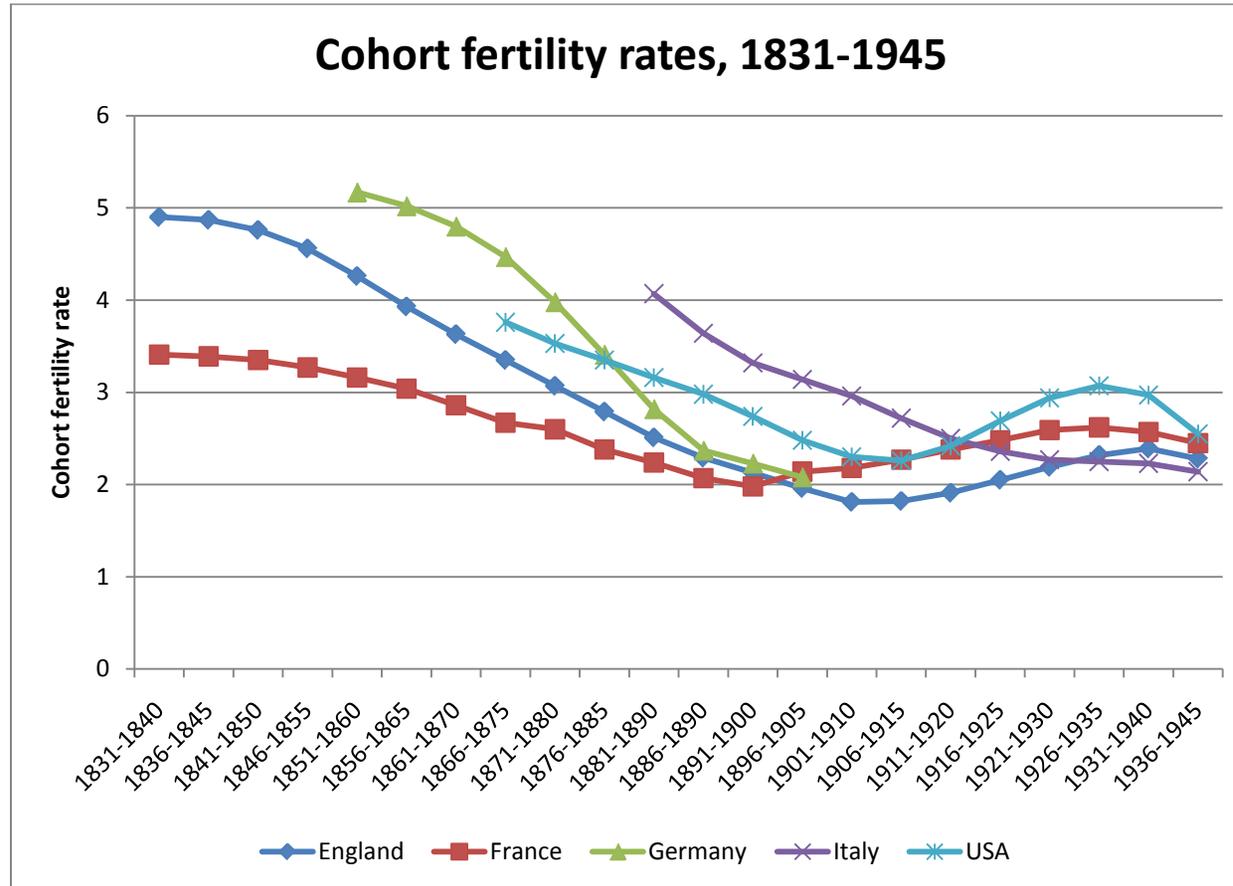


Figure 3: Cohort fertility rates



Source: Festy (1979)

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

French fertility, 1740-1910 (Indices, max = 1.0)

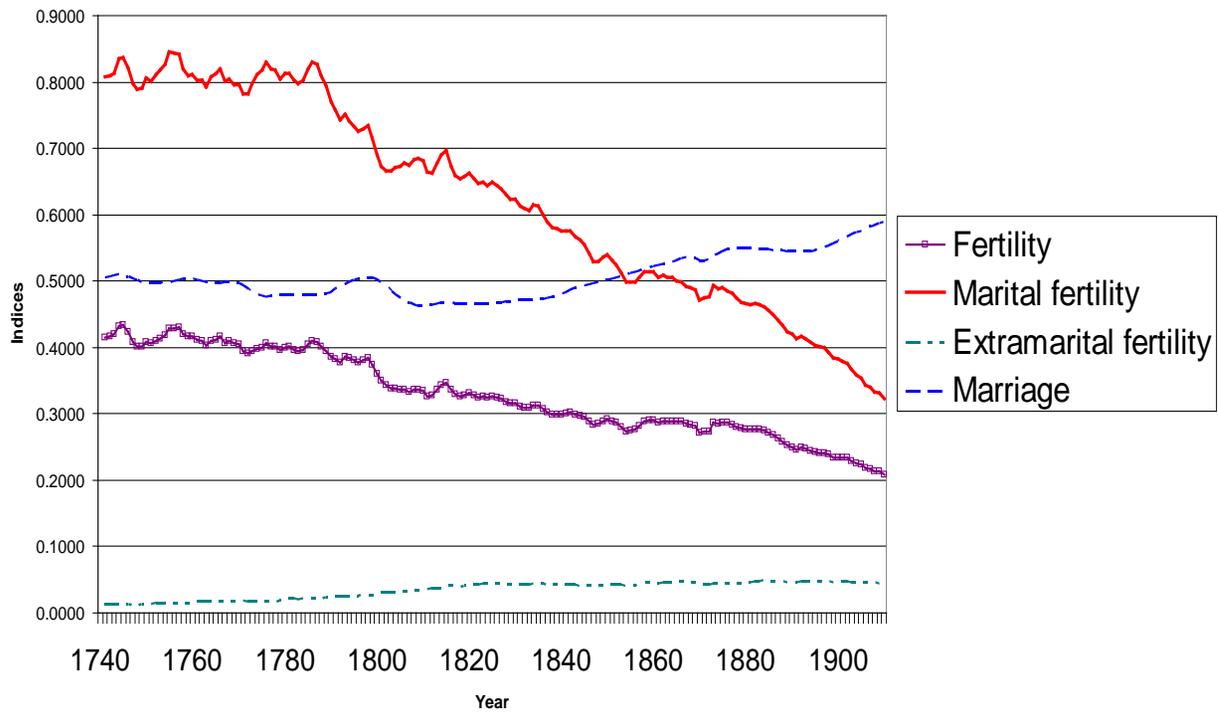


Figure 5: Malthusian comparative statics

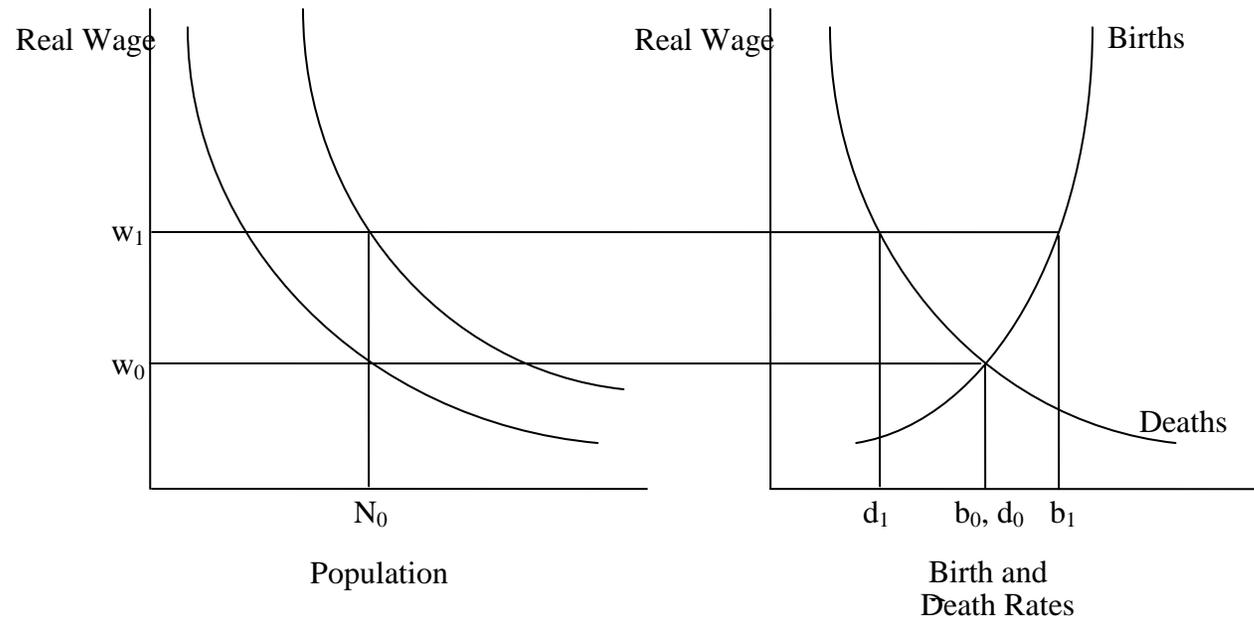
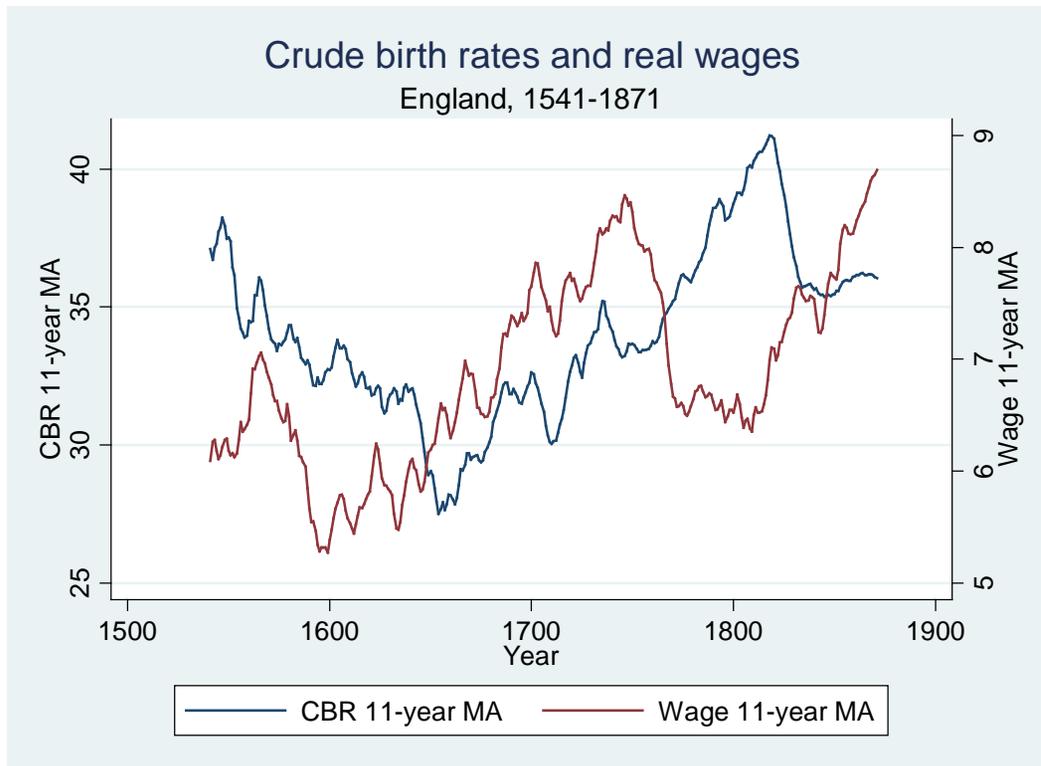


Figure 6: Fertility and the real wage in England



Source: 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. And 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.

Recent Developments In The Theory Of Very Long Run Growth: A Historical Appraisal Stephen Broadberry No 818. Warwick economic research papers. Department of economics.Â Abstract: This paper offers a historical appraisal of recent developments in the theory of very long run growth, focusing on three main areas: (1) linkages between wages, population and human capital (2) interactions between institutions, markets and technology and (3) sustaining the process of economic growth once it has started.Â Britain and Holland managed to maintain the real wage gains of the immediate post-Black Death period while limiting fertility and making a sustained investment in human capital.