AN INVESTIGATION OF THE CAUSES OF MARITAL FERTILITY DECLINE

JONATHAN FRANKEL

Jonathan Frankel is a member of the Trinity College Class of 1996 with a double major in mathematics and economics. He is interested in how macroeconomic and multipersonal structures affect microeconomic decisions. Hence, his paper deals with how macro variables affect an inherently microeconomic decision, the decision to have children.

Section 1
A Discussion of the Economics of Fertility

I. FROM MALTHUS TO THE DEMOGRAPHIC TRANSITION

Population growth, its causes, and its consequences, have long been topics of interest to the human race. Economists, demographers, sociologists, historians, biologists, and others, have all spent long hours studying fascinating changes in population trends. Basically the only "fact" that this eclectic group of researchers can agree upon is that at the genesis of all population trends is the microeconomic decision of the individual household on whether or not to have a child. Even back in 1798, Thomas Robert Malthus realized that the decision to have a child was a personal and intimate "decision" between two adults (Malthus).

Writing during the early years of the industrial revolution in England, Malthus argued that population trends were ruled by "the passion between the sexes." Malthus believed that this passion would result in an expanding population that would be mainly limited by only one factor. That factor was the food supply. Malthus saw the population expanding towards its own downfall. With their desire for sex, people would generally not limit their procreation below the biological maximum. Further, although Malthus believed that per-capita food supply and wages could expand in the short-run, he thought that this would accelerate population growth and drop wages back to a subsistence level. In the long-run, Malthus believed that population growth would easily outrun the growth of the food supply. In one of the most famous examples of economics, Malthus argued that food supplies grow according to an arithmetic progression while population growth follows a rapid geometric progression.

Under standard Malthusian circumstances population growth was only limited by factors working through the mortality rate or what Malthus termed "positive checks." Positive checks encompassed massive disasters such as famines, wars, and epidemics. In later drafts of his famous population work, Malthus did mention a second set of controls, working through the fertility rate, which he termed "preventive checks." These "checks" really amounted to little more than the possibility of a later age of marriage according to Malthus and he himself didn't see them as true controls to population growth.

Today we know that the Malthusian scenario is not the only one. The industrial revolution that was just beginning during Malthus' time has run its course and has shown us that food supply can be expanded exponentially with the aid of technological and agricultural innovations. The industrial revolution has further shown us that even in the face of large population growth it is possible to have long-run growth in per-capita income. Most importantly, history has shown us that preventative checks can play as large a role as positive checks in curbing population growth. However, before we entirely forget our introductory story, let's use its ideas of positive and preventative checks to create a new story. Let's divide the historical time line of the developed world and place the dividing point around the time of the industrial revolution. If we do this, we come up with two eras of population history. In the first era population trends were ruled by Malthus' positive checks. This period saw high fertility rates and high mortality rates and often people couldn't have all the children they desired. In the second era population trends are ruled mainly by preventative checks. This era has lower fertility and mortality rates. The connection between the two periods is the industrial revolution. The change in both fertility and mortality rates that occurred between the two periods is called the "vital revolution" or the "demographic transition."

During the nineteenth and early twentieth centuries industrialized Europe experienced great changes in its population trends. There were unprecedented declines in both fertility and mortality rates. Further, in conjunction with these changing vital trends industrialized Europe saw an explosive boom in its population size. As time went by, population growth rates further increased due to the changing age composition of the populations caused by the initial population growth increases. All across Western Europe there was a seemingly unexplainable population explosion that coincided with the heyday of industrialization.

The declines in fertility and mortality did not go unnoticed by researchers. As time went by, the fact that there had been a major change in demographic history, roughly coinciding with the industrial revolution, became more and more apparent. By the mid-twentieth century some countries' total fertility rates were getting near replacement level. Further, also around mid-century, it became clear that some less-developed nations were beginning to experience a population explosion of their own. Hence, in the 1940's some researchers (mainly demographers) began to advance a theory to account for population trends during the industrialization of Western Europe. The "theory" sought to describe *what* occurred throughout Europe and to give ideas as to *why* it might have occurred. However, the theory was largely a repetition of the data available at the time and lacked much forecasting ability or explanatory value. The theory that emerged from these efforts is known as the "demographic transition theory."

II. THE DEMOGRAPHIC TRANSITION THEORY

The demographic transition theory states that population history can be divided into three main stages (Teitelbaum 1984, Wrigley 1969). Stage I is a period in which both high fertility and high mortality rates prevail. The rates are seen as fairly constant with only a few major fluctuations in the mortality rate due to events such as epidemics. In Stage I, many households cannot have the number of (surviving) children they desire due to high mortality rates and less than optimal health conditions that affect natural fertility.[1] Hence, Stage I represents a situation of excess demand in some, and possibly many, households.

In order to maintain their populations under high mortality conditions, Stage I nations are characterized by cultures and institutional structures which promote fertility. In Stage I nations households view mortality rates as largely beyond their control. The fertility promoting aspects of Stage I cultures are deeply imbedded and are enforced by societal norms. Hence, even when the reasons for high fertility perceived by Stage I households disappear, the actual practice of high fertility is likely to continue for a considerable period.

Even though in a Stage I nation households view mortality as beyond their control, the demographic transition theory assumes that all peoples seek good health and long life. Hence, any advance that might improve national health or reduce mortality is rapidly adopted. Due to the quick adoption of new technological and structural methods that reduce mortality, Stage I nations experience a fairly continuous and relatively sharp decline in the mortality rate[2] beginning with the first "medical" advance.

However, in contrast to the fairly sharp and continuous decline in the mortality rate, the fertility rate stays nearly constant during the period of medical advances. This is because the theory assumes that cultural fertility patterns are deep rooted, because the general public is probably unaware of the decline in mortality rates until long after it occurs, and because even with the decline in mortality the majority of the households in a Stage I nation are still likely to be in an excess demand situation. In other words, they are seeking more children than they are able to bear. The main consequence of this nearly constant fertility rate coupled with declining mortality is Stage II of the demographic transition and the beginning of what many have termed the "population explosion."

Stage II of the transition starts when mortality declines become "fairly continuous." As with most aspects of the transition theory, there is really no definitive criteria to judge the exact point at which a nation enters Stage II of the transition. Nations in Stage II of the transition experience unprecedented population growth due to the changing balance between birth and death rates. Sometime during Stage II the roots and even the beginnings of industrialization are laid, however no precise relationship between the development of industrialization and the stages of the transition is discussed in the transition theory. Finally, by the end of Stage II the major decline in the mortality rate has already occurred.

During Stage III, the fertility rate gradually declines toward a low-level equilibrium with the new low mortality rate. The theory argues that it is right before a society approaches Stage III that its households become cognizant of a significant decline in mortality and especially infant mortality. With this new information in tow, the households of a Stage III nation begin to see fertility as a rational and conscious decision. According to transition theory, fertility is a rational decision in all population stages. However, it is only in Stage III that fertility becomes a truly conscious and individual decision for the majority of society. Yet, it is important to note that this in no way implies that all members of society choose to limit fertility once it becomes a conscious and individual decision. For any given Stage III household there may be imperfect information problems or economic costs that impede fertility regulation. However, by Stage III it is unlikely that the majority of a nation's households will be in an excess demand situation. In fact, one of the main characteristics of a Stage III nation is the possible existence of an excess supply of children.[3]

Since excess supply is not merely an abstract entity, but a concept intricately related to the socioeconomic structure of the society within which the households under consideration reside, the correspondence between Stage III and the possible existence of an excess supply of children should be noted. The phrase "excess supply" states that at the price of children determined by socioeconomic forces the household under discussion is able to achieve a family size in excess of its desired family size. Hence, the idea of excess supply (and demand) hinges on price and thus on the factors that are included in price. In our discussion, price will include the psychological, temporal, and monetary costs of fertility control. However, these factors only become important components of price after an excess supply situation has been achieved. The fertility decline of Stage III clearly lags behind the mortality decline of Stage II. In fact, in some imprecise way the mortality decline serves as a prerequisite for the fertility decline (Notestein 1944) and the transition theory implies a causal relationship between the two declines. It is only after the mortality rate declines and the traditional socioeconomic framework changes that a nation can undergo the fertility decline coinciding with Stage III.

The transition theorists argue that the socioeconomic environment of a Stage III nation fosters societal trends that favor lower fertility to go along with the previous mortality reduction. However, the theorists take another much more important step. "The theorists of the demographic transition attribute the adoption of the new smaller family ideal to the social and economic effects of the urban and industrial revolutions of the nineteenth century (Teitelbaum 1984, p. 4)." Hence, transition theorists imply that either a change in tastes for children relative to other goods or a change in the price of children relative to other goods occurs in Stage III nations. Further, the theorists argue that urban and industrial life lower the costs of contraception while increasing contraceptive knowledge and availability. Hence, through multiple routes, the demographic transition theory argues that urbanization and industrialization are the major causes of the fertility decline associated with a Stage III nation. This association between urbanization, industrialization, and fertility decline is the hallmark of the demographic transition theory. Yet, unfortunately, the proximate causes through which urbanization and industrialization affect fertility, such as education or occupational structure, are noticeably lacking in the transition theory, as are urbanization's and industrialization's associations with the proximate determinants of fertility itself (fecundity, age at marriage, etceteras).

With the three-stage outline, the idea of a lagged causal relationship between the mortality and fertility declines, and the idea of urbanization and industrialization influencing the fertility decline, we have discussed what might be termed the three main points of the demographic transition theory. However, there are a few other points that must be made before concluding our discussion of the theory.
First, central to the theory is the idea that the population explosion that begins in Stage II is caused by a decline in mortality under near constant fertility. A scenario in which rising fertility is the main cause of the population explosion is ruled out by the theory. In fact, the theory rules out any serious increase in fertility trends during this stage. Second, the transition theory states that trends favoring fertility reduction "spread

outward." In other words, the conscious individual regulation of fertility begins with the elites (usually defined by income) and spreads down through the classes. Further, and more importantly, the theory states that fertility declines begin in urban areas and only later spread out into the countryside.

Finally, the transition theory states that all its "tenets" have been uniformly displayed across nations. While "there have been many local variations in the speed at which the vital revolution has occurred," transition theorists claim that "there has been a rather remarkable uniformity in the direction and sequence of vital trends (Kirk 1946, p. 60)." Hence, the general outline and the tenets of the transition theory are claimed to hold for all industrialized European nations with the possible exception of France.

III. A CRITIQUE OF THE THEORY

As I will shortly argue and demonstrate, the demographic transition theory has little predictive or explanatory value. However, the demographic transition theory would still have importance if it merely told what actually happened to population trends during the industrialization of Europe. In other words, if a significant mortality decline did indeed precede a significant fertility decline, knowing that would be valuable in itself. Unfortunately, the demographic transition theory does not even properly describe a large *minority* of the population experiences of the developed world.

The demographic transition theory states that Stage I of an industrialized nation's population history consists of the following vital trends: a near constant fertility rate, and a mortality rate only affected by large scale events such as wars, famines, and epidemics. The latter statement about the mortality rate has held up nicely in the face of scrutiny. Unfortunately, the statement about the near constant fertility rate is blatantly false.

Standard demographic theory tells us that there are four main mechanisms through which the fertility rate can be changed: the percent married, the average age at marriage, the age and gender structure of the population, and the marital fertility index (Bongaarts). The last two factors do not seem to have played a major role in Stage I of the fertility history of a nation. However, the first two factors appear to be extremely important to Stage I fertility trend changes.

It is now granted that the fertility of many Stage I populations actually fluctuated greatly. Much of the pioneering work in this area was done by Professor E.A. Wrigley in his studies of England. It appears that throughout history, fertility has always been substantially an *economic* decision. Local periods of economic hardship have tended to reduce fertility in many areas. A contracting job market might have delayed a male's decision to marry or might have stopped him from marrying altogether. During a period where apprenticeships were common for enterprising young men, marriage was likely to be delayed.[4] During an era where it was common for a young woman to live in the home of another as a "domestic aid" before her own marriage, the age at marriage might be delayed (Wrigley 1985). After a few bad

harvests in a row, the farmer might not be able to afford a dowry for his daughter. These examples serve to illustrate that from the beginning of time fertility decisions have been tied to economic conditions and that fertility could (and did) fluctuate during a Stage I period.

Continuing within the three-stage framework, the next major tenet of the demographic transition theory is the idea that there is a lagged causal relationship between the fertility and mortality declines. The theory states that the major part of the mortality decline occurs before the fertility decline and that the mortality decline is in some way a prerequisite for the fertility decline. One of the best statements of this part of the theory has been given by Ronald Freedman. "Most sociologists and demographers would probably agree...that one of the two basic **causes** of the general [fertility] decline was...a sharp reduction in mortality which reduced the number of births necessary to have any desired number of children (F. van de Walle 1986, pp. 201-202)." In fact, while a lagged relationship between mortality and fertility has been supported both theoretically and statistically, it is only in a small minority of cases that the *major* decline in mortality actually preceded the *major* decline in fertility. Francine Van de Walle's 1986 study illustrates that in general significant fertility decline actually preceded significant mortality decline and that the general processes of fertility and mortality decline usually occurred simultaneously.

Since significant fertility decline actually preceded significant mortality decline the far majority of the time, it is implausible to think that mortality decline was the most significant cause of fertility decline. However, many nations in the van de Walle study have a statistically significant correlation between the dates of their fertility and mortality declines. Hence, it is currently believed that both declines are mainly caused by multiple exogenous factors, some of which might play a role in stimulating both declines. This new idea represents the first major principle of current transition theory.

Now that the fertility decline model of the demographic transition theory has been brought to the forefront, it is time to discuss some of that model's problems. Let us start by noting that the fertility model calls for declines to be fairly continuous after the advent of industrialization. In fact, urbanization and industrialization are seen as being the major causes of the fertility decline.

Once again, this is not the case. First, during the early stages of industrialization fertility has actually exploded in many areas. The best example of this was in England (Teitelbaum 1984, Wrigley 1969). The reasons for this fertility explosion at the advent of industrialization have been an active research topic over the past few decades and the findings of this research have been incorporated into the current transition theory.

There are at least two main reasons why there is a fertility explosion at the beginning of most industrialization periods. First, there is a supply-side reason. The coming of the urban-industrial complex brings with it many technological improvements. These improvements can serve to decrease (particularly infant and child) mortality and increase the health of prospective mothers. On both counts these improvements will contribute to an increase in the natural supply of children.[5] Since at the advent of industrialization (Stage II) many people will be in an excess demand situation, this increase in the natural supply of children raises completed fertility. However, since there is also a time delay before most people will realize that they can have more children, the increase in the natural supply of children even causes those who might not be in an excess demand situation to have higher completed fertility. Hence, on both counts the advent of the urban-industrial complex serves to increase observed fertility (Nag, Bongaarts).

The economic changes that occur at the advent of the urban-industrial complex serve to provide the second main reason why fertility increases at this period of time, the demand-side reason. Soon after the beginnings of industrialization, per-capita income generally increases. However, those who are living through industrialization have no way of knowing whether this increase in income is permanent or transitory. In the short-run time span immediately after the coming of industrialization tastes are constant and the income increase is viewed as transitory by most people. Since children are a normal good, the number of children demanded might temporarily increase causing another reason for a surge in fertility at the advent of industrialization.

This "two-sided" fertility explosion is even more important when one remembers that the demographic transition theory states that the population explosion that begins in Stage II is due to the decline in mortality. It is clear that this increase in fertility at the advent of industrialization helped contribute to the population explosion (Teitelbaum 1984). Further, since significant fertility declines usually preceded significant mortality declines, it can be said that up until the late nineteenth century the population explosion was generally due to fertility trends. In fact, at least in England, it appears that fertility has long been the controlling factor in population trends and that the short-run fluctuations in fertility demand are indeed important. "Both age at marriage and the proportion never marrying changed very substantially and jointly exercised what might be termed strategic control over population trends in England...[into] the nineteenth century (Wrigley 1985, p. 5)." In fact, history shows that fertility control through proportion married and age at marriage rates can be very effective. In the late seventeenth century these factors combined to dampen English population growth below replacement level (Wrigley 1985).

Evidence gathered since the formulation of the demographic transition theory also indicates that "urbanization" and "industrialization" do not cause the fertility decline associated with them in the theory. The example of England is the most illustrative here since England was the first nation to undergo the industrial revolution and since London was by far the largest urban metropolis. However, even though England had an industrialized economy by the early 1800s and even though she had the beginnings of the first "modern" economy by the late 1800s, England did not experience a significant marital fertility decline until 1894.[6] In fact, England is a perfect example of how industrialization can increase fertility. The economic prosperity of the mid-Victorian period (1850-1875 approximately) caused people to adopt a "good times attitude" and have more children in the face of short-run income increases. For many countries tested, urbanization and industrialization have little or no statistical correlation with fertility decline. Further, where such a correlation does exist, the variance is usually much better explained by inserting even seemingly random proximate variables into the regression. Even crude variables such as "literacy" seem to do a better job of explaining population fluctuations than either urbanization or industrialization.[7]

The major reason why urbanization and industrialization tend to show less statistical correlation with fertility decline than expected is because often fertility decline actually began in rural areas. Even as the original demographic transition theory was being formulated researchers began noticing "exceptions" to their urbanization-industrialization rule. The most notable example was the French fertility decline (Kirk 1946).[8]

Since France was the first country to experience significant fertility declines it was especially disturbing to the transition theorists that the French fertility decline began in *rural* areas. However, the fact that fertility decline sometimes began in rural areas is not the only lesson to be learned from the French fertility decline. A multivariate regression of the French fertility revolution has shown that there is one factor which has an extremely significant correlation with the decline in French marital fertility across nearly all *départements*.[9] This factor is land revenue per head of population, or "rural income," and it exhibits a strong negative correlation with fertility (E. van de Walle 1978). This suggests that income may have been an important factor in the fertility decision of nineteenth century Frenchmen. However, the demographic transition theory does not help explain the importance of rural income or the lack of a relation between urbanization, industrialization, and the fertility decline.

The tenet of the demographic transition theory that says that the marital fertility decline spread from the urban areas outward has been largely disproved. However, data has also failed to show that the fertility decline spread in the other direction. In fact, urban and rural fertility declines appear in general to have happened nearly simultaneously. There are two important lessons to be learned from this that have been incorporated into current transition theory. First, terms such as "urbanization" and "industrialization" encompass too many factors to serve as useful explanatory variables of fertility declines. We need to discover the specific factors through which urbanization might work to affect fertility. Second, urban-rural fertility differentials are not the proper differentials on which to focus.

If there is one thing that better data and better research into the demographic transition has shown, it *is* that fertility declines have *not* been homogeneous across nations. When nations are examined via regional areas, it is widely found that even neighboring regions can be simultaneously involved in quite different stages of the demographic transition. "Regional [fertility] differentials are always larger than urban-rural differentials (Sharlin, p. 258)." This important fact suggests far more than merely the obvious conclusion that regional differentials are more important than urban-rural differentials. This fact suggests that fertility decline actually occurs within discrete cultural areas and that urban-rural differentials are only subsidiary differences within a given cultural region. Hence, fertility decline might begin in a particular cultural area within a nation and the particular pattern of urban-rural differentials within that region need not be duplicated in other areas of the country.

Current transition theory states that where we do not find significant differences between regional fertility patterns, we should not expect to find different local patterns of urban-rural fertility differentials. Where regional cultural divisions are easily observable, if there is a difference in the timing of the urban and rural fertility declines within a given region, the urban decline occurs first. Hence, "urbanization" actually does appear to have an effect on fertility when regional differences are appropriately reckoned.[10]

The observance of regional differences in the fertility declines of the demographic transition has been common to all European nations except one. England has been a notable exception to the rule of regional precursors. This is not to say that all of England underwent the same fertility decline at the same time. However, it is to say that the English fertility decline experienced a remarkable homogeneity. England did not exhibit the extreme clustering patterns of either high or low marital fertility that were apparent in other countries, notably Belgium, Spain, and Germany.

The comparison between England and Germany provides a particularly illuminating example. Marital fertility decline in Germany experienced a far greater heterogeneity than in England despite the fact that the two countries had nearly comparable levels of industrialization at the outset of fertility decline (Teitelbaum 1984, Knodel 1974). The main point here is a principle of current transition theory that follows from the importance of cultural differences discussed earlier. Urbanization and industrialization are not equivalent to "modernization." It is currently accepted that the demographic transition occurred due to a mix of socioeconomic and cultural factors. Modernization takes into account the new cultural beliefs that likely played a major role in beginning and accelerating the fertility decline throughout Europe. Terms such as urbanization and industrialization fail to take into account the true importance of societal norms and the fact that the cultural norms necessary for a fertility transition that often *coincide* with industrialization might be able to come about under variant circumstances.

A qualitative glance at Germany and England will serve to illustrate the importance of societal and cultural trends and will go a long way towards explaining why Germany was characterized by a heterogeneous marital fertility decline and England was not. At the time of its fertility decline, England had both advanced industrial and sociocultural structures. Germany, on the other hand, had a comparable industrial structure encased within a semifeudal social structure. Further, Germany was characterized by far greater cultural heterogeneity as it encompassed many regions that had long and disparate histories. In addition, Germany was characterized by large religious differences which coincided with specific regions of the nation, such as Catholic Bavaria (Knodel 1974). England was not characterized by any major cultural or religious heterogeneity and had few foreign immigrants and linguistic barriers as compared with Germany.

Any heterogeneity England might have exhibited was reduced by the nineteenth century development of transportation and communications. English

railroads and transport systems reached every part of the country by the time of the English fertility decline. Much of Germany, on the other hand, could accurately be described as "uncharted territory." It is this type of development that allowed England to experience a homogeneous fertility decline. This fact has not been lost upon researchers.

Partially due to the seeming importance of factors such as communications in the English fertility decline, modern theorists have begun to look for links between fertility decline and proximate variables such as education and literacy. These correlations have often been statistically significant, but they introduce even more problems into the picture. First, there is the problem of measurement.

A variable such as education is troublesome to measure. Perhaps one should take into account years in school. Then, questions arise as to whether or not there is a true educational difference between say five and six years in school, whether a year in private school should count as much as a year in public school, and whether two fifth-graders, one with an A-average and one with a C-average, really can be said to have attained the same "education." Further problems arise when we consider the fact that what one gains from an education that affects fertility might as easily be gained through the workplace.

In addition, problems arise when we try to decide what it is about education that might affect fertility. Fertility can be affected by the increased time one spends in school, by attitudes that one gains from the educational environment, by the larger salary gained through education, or through a myriad of other factors (Michael). In short, even after one moves from a measure such as urbanization to a "smaller" measure such as education, the causes of fertility decline do not become much clearer and the correlations are nearly as ambiguous in interpretation.

IV. THE EASTERLIN SYNTHESIS

This measurement and definition problem helped lead to the Easterlin synthesis literature. Realizing the problems of measurement and definition, this literature aims for a general descriptive narrative. Further, realizing the problems of a demand-oriented model, such as Professor Gary Becker's New Home Economics[11], the synthesis literature aims to account for supply, as well as contraception constraints. Its broad descriptive powers are nearly as general as those of the initial demographic transition theory. However, the Easterlin synthesis is valuable in that it seems to properly explain what actually occurred during the European demographic transition.

The synthesis involves the supply of children and the demand for children, as well as the monetary, temporal, and psychological costs of fertility regulation. Its statement is simple. Throughout most of history any given nation's households are in an excess demand situation with regard to the "market" for children. During this situation demand-side factors are not the main limiting factors of fertility. Fertility is mainly limited by supply-side factors such as health and medical care.

Over time, due to changing socioeconomic and cultural (SEC) factors, the potential supply of children goes up. However, when this happens households are generally still in an excess demand situation and thus supply-side factors serve to cause a rise in fertility. While this is happening, similar (possibly some of the same) factors serve to cause a reduction a mortality. Hence, we get a population explosion due to falling mortality **and** rising fertility, which is what the current data tells us actually happened throughout Europe during the demographic transition. The falling mortality and rising fertility serve together to increase the number of surviving children households would have in an unregulated fertility regime.

After more time passes, SEC factors are unable to create further significant declines in mortality and are unable to generate further significant gains in the natural supply of children. However, at the same time SEC factors have been increasing supply they have also been lowering demand.[12] Eventually with the new high supply possibilities and the new lower demand for children, most of society will shift into an excess supply situation. Since people can now have more children than they would desire to have under ideal circumstances, there is a *motivation* for fertility regulation.

However, while motivation is necessary for fertility control, it is far from sufficient. Even when people can have more children than they ideally desire, it still might be economically optimal for them *not* to practice fertility regulation. This is due to the costs of fertility regulation which can occur in many forms: monetary, temporal, and psychological. Hence, even after society shifts into an excess supply situation, fertility will not immediately fall.

After a while, SEC factors serve to reduce both the economic and psychological costs of fertility control, making smaller families an economically feasible decision within the standard household decision making framework. However, even after fertility control is generally adopted it might take a while for significant declines in fertility to be realized. This is due to the effectiveness of the method of contraception practiced and to the effectiveness of the way the given method is used by an individual couple. Further, population growth continues to rise due to the shifted age structure caused by the initial fertility increases. Nonetheless, the point where the majority of society adopts fertility regulation is referred to as the threshold, and shortly after a society passes the threshold and the SEC infrastructure coinciding with it, fertility is expected to begin large declines.[13]

With the Easterlin synthesis, our discussion of current transition theory comes to an end. The main distinction between the original transition theory and the current transition theory is that the original theory sought a general explanation of what happened while the current theory seeks general explanations of why it occurred within a microeconomic and demographic framework. The following summary of modern transition theory and the Easterlin synthesis serves to make this distinction clear.

Current theory states that mortality and fertility declines have historically coincided with each other and with many types of socioeconomic and cultural environments. However, while a lagged relationship between mortality and fertility does appear to exist, there is something more important to be noted from the data. We must realize that both declines are likely to be the product of similar exogenous variables.

Through the framework of the diverse SEC environments that have coincided with historical vital rate declines many factors have played a role in stimulating the declines, including the sometimes overlooked areas of government policy and political institutions. However, while specific SEC environments may vary greatly, there are specific variables that are generally significant factors in causing a "demographic transition," although these variables are not always of equal importance in each circumstance. These variables are most easily identifiable as part of an urban-industrial complex; however, they do not need either large cities or large-scale industry to manifest themselves. They are more products of "cultural modernization" than they are of either urbanization or industrialization. Identifying these proximate variables and their relative significance stands at the heart of current research.

Current transition theory further states that the decision to have a child represents a microeconomic decision of an individual household in which the concepts of supply of children, demand for children, and the costs of fertility regulation, all play a role. This decision is greatly affected by outside factors as well as internal constraints. This emphasis on the microeconomic decision making framework is very distinct from the emphasis placed on aggregate norms by the demographic transition theory.

Finally, current transition theory states that there is a somewhat definitive threshold at which impediments to fertility regulation are overcome. However, even after the SEC framework for this threshold is laid, there might be a need for some "exogenous shock" before the threshold will kick into effect.[14] Also, even after the general threshold is passed, it is still expected that "elites" will briefly lead the fertility decline (Wrigley 1969).

We now have some ideas as to *why* the demographic transition occurred as well as some ideas of *what* the transition entailed. When we take note of what occurred during the demographic transition, it becomes apparent that as far as we have come, we have not yet done an outstanding job of explaining the proximate causes of fertility decline. With the general framework of the Easterlin synthesis as its reference, contemporary research has finally begun to truly investigate the most proximate causes of fertility declines. Before now research has generally been concerned with motives at the expense of means.

V. THE DIFFUSION OF INFORMATION

In his review of historical fertility declines Ansley Coale identified three main conditions for fertility decline. First, fertility must be within the calculus of conscious choice. Second, effective techniques of fertility reduction must be known and available. Third, reduced fertility must be perceived to be advantageous (Coale 1973). While these factors have been widely accepted by the field, theoretical speculation and practical research has been concerned with motive rather than means (Cleland and Wilson). Hence, we have ideas that credit urbanization and industrialization with creating the motives for Coale's criteria to be adopted, but we are still unsure of the actual means by which Coale's criteria come to be adopted. The literature is ominously silent when it comes to explaining how fertility comes within the calculus of conscious choice, how effective techniques of contraception become known, and how reduced fertility comes to be perceived as advantageous. Further, the few writers who do account for means often forget to account for motives.

This split in the literature illustrates an important fact. Traditional economics views motive and means as separate entities. By a focus on supply and demand at the individual level traditional microeconomics concerns itself with what goods an individual prefers, but does not concern itself with how an individual comes to prefer those goods. The question of how an individual comes to prefer certain goods has often been viewed as outside the scope of economics. "Economists generally take tastes as 'given' and work out the consequences of changes in prices, incomes, and other variables...they explicitly delegate the discussion of tastes to sociologists, psychologists, or anthropologists (Becker 1976, p. 817)." Similarly, the view from the other side of the mountain, as illustrated by the opinions of communications Professor Everett Rogers, seeks to explain why goods and ideals come to be preferred without any concern to how they are produced.

What needs to be realized is that there is a necessary melding of the consequences of tastes with the production of tastes. This indeed is at the heart of Coale's criteria. If we desire to explain how fertility transitions occur, we must not only explain what demand choices are made in a new framework, but how those choices come to be seen as ideal or preferred. Easterlin made gains in this area with his synthesis of economics and sociology, but he only provided a general framework whose hypotheses are difficult to test. Establishing a more specific framework with testable hypotheses has been the goal of "diffusion theory."

"Diffusion exists when the adoption of innovative ideas (and corresponding behavior) by some individuals influences the likelihood of such adoption by others (Montgomery and Casterline, p. 458)." Hence, right from the definition of diffusion we can see a reason why traditional economics has ignored such factors. Diffusion is a measure that involves, indeed highlights, group interaction. It does not examine either the individual Robinson Crusoe or the nation that represents the summed activities of the individual Crusoes. At the heart of diffusion theory is the idea that people interact and that any given individual's preferences are determined by others' preferences, cultural norms, and societal institutions. Diffusion takes as endogenous the primary variables that traditional economics does not wish to explain.

Hence, the focus of diffusion theory is directed to the interplay between individuals and their reference groups. Individuals look to their reference groups for information; as the attitudes and behavior of reference groups begin to change so too may individual benefits to certain behaviors. The dynamic is one of "endogenous feedback" (Montgomery and Casterline).

The diffusion dynamic, as applied to fertility choice, can occur in circumstances where (I) individuals lack information about newly-feasible behavioral choices (e.g., contraceptive techniques); or (ii) uncertainty exists regarding the private benefits and costs of fertility control, so that the experiences of leading reference groups provide a type of demonstration effect; or (iii) negative sanctions are likely to

be applied to individuals who depart from customary practice, reflecting the existence of group norms, with the norms themselves evolving as group members come to adopt innovative behavior (Montgomery and Casterline).

Cleland and Wilson have verified that the conditions necessary for diffusion to occur are satisfied by pre-transition nations. Hence, we now need to examine how diffusion occurs. Diffusion often occurs through two main pathways communication networks and the mass media. Communication networks are closely tied to reference groups and involve both oral and written correspondence. Mass media pathways involve means such as television, radio, and newspapers.

Research has begun focusing on both areas, but fertility research has yet to have significant findings with respect to mass media pathways. A study of Taiwanese fertility has given pioneering insight into how communications networks work. In fact, the Taiwanese family planning program was set up with a diffusion objective in mind since Taiwan's national family planning program was preceded by a localized program that illustrated the benefits of diffusion (Montgomery and Casterline).

In the Taiwanese program home visits by health care workers aimed at stimulating discussion between friends, neighbors, and relatives. Further, group meetings were purposely designed to have discussion components to them. Finally, letters and posters were aimed at provoking further discussion. Montgomery and Casterline have run complex statistical regressions that have testified to the likely importance of these attempts in accounting for the rapid national fertility decline.

However, the Taiwanese study poses complex unresolved questions. It is still unknown whether social heterogeneity impedes or accelerates diffusion. To wit, one would expect that greater homogeneity would be a boon to diffusion. One might assume that people are more likely to listen to the opinions of those most like themselves and those they are closest with. However, the Montgomery and Casterline study concludes that social heterogeneity actually aids diffusion. Further, this idea is not without theoretical support. In a seminal research paper of sociology, "The Strength of Weak Ties" by Mark Granovetter, it has been argued that "weak ties" actually accelerate diffusion. This idea is based on the fact that large social structures beyond the control of individuals usually determine who people come into contact with. Hence, if people do not chose who they come into contact with and thus who can potentially influence their opinions, we might expect that diffusion is more likely to occur if they come into contact with diverse opinions. Thus, we might expect that diffusion and a dynamic of changing ideals is more likely to be associated with a heterogeneous society than a homogeneous one.

This last point about ideals begs a major question. What exactly is diffusing? Are we talking about goods, knowledge, or preferences? The answer is that we are talking about all three.

It seems that during the beginning of a fertility transition we are talking about the diffusion of goods and knowledge. Right before the threshold of a fertility transition, there is an excess production of children relative to what is demanded due to a lack of contraception, a lack of knowledge of what contraception is available, and a lack of ability to put fertility within the framework of conscious choice. The fact that a lack of a conscious framework can persist even when contraception is known to be available is evidenced by interviews cited by Pollak and Watkins.

As a fertility transition continues, there seems to be a diffusion of preferences favoring a lower family size. The example usually given to back up this point is the irreversible trends of historical fertility declines. If new family size preferences did not come about, we might expect that post-decline fertility could increase. However, with a few temporary fluctuations, fertility has not increased in nations experiencing a post-transition environment.

The main point to be gleaned here is that diffusion is a concept consistent with a number of substantive interpretations. Diffusion truly affects all aspects of the household decision making framework. It can affect both the psychological and monetary costs of fertility control. It can also affect the perceived benefits of fertility control.

More research on diffusion is greatly needed. Specifically, research is needed on diffusion as an explanation of historical fertility declines. The next section of this paper will work towards this end. With a good estimation of what happened in the past and of what is going on today, we may be able to discover what will happen in the future. Then, with a good understanding of the factors behind demographic transitions, we can start to address the "value" question of what is best both ethically and economically.

Section 2
Examining Historical Fertility Decline in England

I. INTRODUCTION

Even though it has lacked much statistical support, the standard demographic transition theory relating fertility decline to industrialization, urbanization, and lagged infant mortality, is still the most widely accepted explanation for historical fertility declines. This is illustrated by the words of Michael Teitelbaum when he states: "The best known 'explanation' of the European fertility decline is the theory of the demographic transition. Its basic premises are descriptive, with the history of population divided into three 'stages' (1984, p. 3)." While recent research projects, most notably the Princeton Fertility Project, have begun to expose the discrepancies between this theory and the available data, research into more advanced theories of changing fertility in an historical paradigm is still in a stage of infancy. These realities about the current status of research on historical fertility changes motivate two important questions: (1) "If tested using an available historical data set, will the standard theory prove to have statistical relevance?" and (2) "What might be another theoretically supportable model that can be tested using the dearth of well-kept historical records?"

The goal of this section will be to answer these two questions. First, we will specify models that fit the standard demographic transition theory. Second, we will specify more advanced models to analyze historical fertility change. This second model type will be based upon the idea that the diffusion of information is proximately related to the marital fertility decision. Indeed, right from the definition of diffusion we should be able to grasp its importance in determining the context for the household decision making framework. "Diffusion exists when the adoption of innovative ideas (and corresponding behavior) by some individuals influences the likelihood of such adoption by others (Montgomery and Casterline, p. 458)."

Since both model types will be examining the effects of their respective independent variables on a proxy for marital fertility, by using the same dependent variable in both models we can make comparisons between the alternative models. As this ability is highly desirable, in our analysis we will incorporate the same dependent variable into both models by utilizing the same historical situation (country and time period) in both models. This specification rule greatly limits the number of data sets at our disposal. For model estimation we need a nation that has continuous historical data for a demographic transition period and that can also provide good independent variables for both standard and diffusion models of fertility change.

England provides such data, although some imperfections still remain. Further, England provides a unique opportunity since it has a relatively homogeneous culture and hence allows us to minimize worry about the effects of regional cultural differences on fertility. Finally, our models will examine data from each of the seven census years during the period from 1851 to 1911. This period encompasses the major historical decline in English marital fertility. This fact has been brought to our attention through the work of the Princeton Fertility Project. "From the middle of [the nineteenth] century to the 1930s both mortality and fertility levels declined by about 50 percent (Teitelbaum 1984, p. 5)." Further, the Project notes that the far majority of the fertility decline occurred prior to the outbreak of the first World War.

II. MODELS

The Standard Demographic Transition Theory Models

It has long been believed that the key elements influencing marital fertility decline are urbanization, industrialization, and lagged infant mortality (Kirk 1946). Hence, the standard model states that:

$$MF = f(U, I, IM)$$

where MF = marital fertility, U = urbanization, I = industrialization, and IM = lagged infant mortality. This model predicts a negative relationship between marital fertility and urbanization, a negative relationship between marital fertility and industrialization, and a positive relationship between marital fertility and lagged infant mortality.

Most often, the negative relationship between marital fertility and urbanization is justified by the following reasoning. As urbanization increases people become members of a more modern society in which new goods and a new mind set play into the decision making framework of marital fertility. These new factors serve to raise the economic cost of children relative to other goods. The idea that urbanization increases communication, and hence speeds fertility decline and "fertility education," is used only as a secondary justification by the standard theorists for including urbanization in the model.

The negative relationship between marital fertility and industrialization is usually justified along similar lines. Industrialization directly produces many of the new goods that compete with children in the household decision making framework. Further, since industry is viewed as a break from a more idyllic past, industrialization is seen as producing a whole new decision making mind set. The advent of industry is viewed as producing a mind set which includes Charles Dickens' concepts of workers as "hands" and slaves to the clock in contradistinction to a more free mind set.

Specifically, in the English case, it can be observed that by the time of fertility decline industrialization and its corresponding mind set were well established. As the social historian E. P. Thompson states, "We are entering here, already in 1700, the familiar landscape of disciplined industrial capitalism, with the time-sheet, the time-keeper, the informers and the fines. Some seventy years later the same discipline was to be imposed in the early cotton mills (p. 82)."

From the above descriptions it is clear that standard transition theorists run into the problem of "theoretical multicollinearity" between industrialization and urbanization. Both variables are justified along the same lines and hence seem to be measuring similar effects on marital fertility. A further problem with these variables is that they both claim influences on marital fertility through a changing mind set, but their justifications fail to illustrate in what way the variables directly come to bear on the household decision making framework. In short, both variables appear to have theoretical loopholes and neither can be termed a proximate influence on fertility.

As opposed to industrialization and urbanization, lagged infant mortality is on sound theoretical footing and provides a proximate route through which the household decision making framework is influenced. The positive relationship between marital fertility and lagged infant mortality is predicated upon what might be termed the "replacement principle." If infant mortality is high it is less likely that a given birth will yield a child surviving to adulthood. Hence, households will have to have a greater number of births to achieve the same number of children surviving to adulthood. Thus, marital fertility will be higher.

The reason the relationship is lagged is because as a proximate determinant in the decision making framework the infant mortality rate's influence relies upon the assumption that the household has knowledge of the rate. As rates take time to be published and death stories take time to diffuse amongst the population, the relationship between the marital fertility rate and the infant mortality rate is theoretically sound only in a lagged context. This point should be underscored and the indirect recognition of the importance of information diffusion by the standard theorists should not be ignored.

With the theoretical justifications for the standard demographic transition model explained, we must now discover proxies for our variables; proxies that can be calculated from the available data. For "urbanization," we will appeal to a ratio defined by the following equation:

((number of people residing in towns) / (total population)) X 100

where the number of people residing in towns is calculated using the areas enumerated as towns by the Census of the given year. In other words, the urbanization ratio is the number which would commonly be referred to as the percent of the total population residing in urban areas.

For "infant mortality," we will appeal to an infant mortality rate defined by the following equation:

((number of deaths under one year) / (number of live births)) X 1000

where live births equals total births minus stillborn births. In other words, the infant mortality equation measures infant deaths per 1,000 live births.[15]

When trying to obtain a proxy for industrialization, we run into a problem. Since it is not clear what sectors comprise "industry" and since the specific method by which industrialization affects fertility is theoretically vague, we cannot easily come up with a measure of industrialization. One solution to this problem is to devise a proxy that represents the antithesis of industrialization. An obvious possibility is agriculture. The jobs included in the agricultural sector are defined by the Census and historical statistics of this sector exist. Agricultural employees are defined as people whose occupations are mainly engaged about either land or animals.

While this "well-defined" property of agriculture makes it an attractive variable, it is still unclear whether agriculture represents the foil of industry. In trying to address this problem we again come across anxiety since the process by which industrialization affects fertility is not well delineated. If "industry" is viewed as huge factories and mass corporations and "agriculture" is viewed as the family farm, it seems likely that agriculture *is* the antithesis of industry. Further, under such a situation, there are theoretical reasons to expect that agriculture would have effects in opposition to the expected negative effects of industrialization on fertility.

On the family farm children are not only "consumption" goods for their parents, but also production goods. From an early age children living on the family farm help in the running of the farm. Hence, under such a situation a child may actually bring positive accounting benefits to the farm in addition to the positive economic benefits he or she brings as a consumption good.

However, the family farm system was no longer the usual agricultural system in England by 1851. Having started in localities as early as the 1500s and being well completed by 1800, the process of enclosure turned English farms into vast capitalist corporations owned by a rich elite and worked by a salaried laboring class. The early completion and hardships of enclosure have been observed by economic historian K. D. M. Snell in his seminal work on enclosure. "Real wages *still* fell after about 1780 (by which time enclosure was largely completed). Their fall is significant when seen in the context of rising productivity (p. 224)." In other words, after enclosure the farming industry was more profitable, but the laboring farmers actually had lower real earnings.

Hence, there was no longer any innate production-side benefit for the agricultural laborer to have children. The children were not guaranteed jobs on the farm and were less likely to be a monetary boon to their "agricultural" parents. Hence, an urban child with the opportunity to work in the factories would have been as likely to monetarily aid his family as the child of an agricultural laborer. The agricultural laborers no longer owned the farm.

With these realities in hand an important question now arises. The question is what to do when the only well-defined sector that yields the possibility of being theoretically interesting cannot be soundly related to the standard transition model. There are two likely answers. We could either (a) dismiss agriculture or (b) find some way to use it in our modeling.

Dismissing agriculture from the standard demographic transition model as applied to England seems arguably sound since we have discovered no strong theoretical justification for including it. Further, it is likely that if the actual process by which industrialization affects fertility were illustrated, the process would correlate with urbanization. Hence, since we are including urbanization in our standard model, we will still have some (albeit a minor) inclusion of the effects of industrialization in our model.

However, dismissing agriculture from the picture entirely may be a bit hasty. Since most of the people employed in agriculture were salaried laborers we might expect agriculture to have a negative relationship with fertility. This idea is theoretically supported since we would expect that the mind set of a salaried laborer involves choosing between children and competing other goods. Far from the glory days of leisure and family farms, we might expect modern agricultural labor to negatively influence fertility much as we would expect modern industry to negatively influence fertility.

Hence, our answer is to run two "standard" models, one with agriculture and one without. It will be interesting to see the sign and significance of agriculture, but it should not be given too much importance due to ambiguous theoretical support for the variable. Further caution should be used when interpreting this variable since it is not necessarily continuous across time. Due to differences between the available data across years, in 1851, 1871, 1901, and 1911, agriculture is measured as the percentage of the total working-age male population employed in agriculture. In 1861, 1881, and 1891, the variable is measured as the percentage of the total working-age population employed in agriculture. Since nineteenth century English females were less likely to be employed than their male contemporaries, these three years' proxies will produce considerably lower agriculture measures.

Before stating the technical specification of our model we must define our dependent variable. Our proxy for marital fertility will be the index of marital fertility used by the Princeton Fertility Project (Teitelbaum 1984, Coale and Treadway 1986). The index indicates the degree to which married women of a given population approach the number of births they would have produced if they were experiencing the fertility schedule of the American Hutterite population. The Hutterites, an Anabaptist religious sect founded in the sixteenth century, have high fertility rates because they forbid the practice of contraception or abortion and because they do not nurse their infants for more than a few months. Their fertility rates have been accurately recorded since the latter part of the nineteenth century and the schedule for the decade 1921 to 1930 is used in computing the marital fertility index. The schedule from this time

period represents the highest reliably recorded historical fertility rates. Hence, the marital fertility index is a ratio between the fertility of a given population and "natural fertility."[16]

The maximal fertility schedule of the Hutterite population is determined after discovering maximum age-specific fertility rates for each five year interval of a female's childbearing years (15 to 50). In other words, the natural rate accounts for the fact that the average twenty year old woman can physically have more births than the average fifty year old woman and hence accounts for the age distribution of the female population. The maximal fertility schedule tells us that the average Hutterite woman, who marries at age 20 and remains married until age 50, will have 10.9 births. This number is a useful benchmark since research shows that a representative female from our data set begins reproducing around twenty years of age.

The defining equation of the marital fertility index is:

$$I_g = B_L / ò\, F(a)\, M(a)\, da$$

where I_g is the marital fertility index, B_L is equal to the average annual number of legitimate births in the ten-year period surrounding the census, $F(a)$ is the rate of childbearing of married Hutterites at age a, and $M(a)$ is the number of married women of age a.

Hence, the marital fertility index accounts for the age distribution of the population and also makes explicit allowance for the effect of nuptiality on fertility. Yet, as can be seen from the definitions above the index is not a perfect measure of marital fertility. The most obvious drawback of the index is that it measures births as opposed to surviving births. In other words, it is not really telling us the number of "children" people have, but the number of births that were required for them to have their children.

However, even with problems such as these, our marital fertility index is likely the most reliable index that can be constructed using the available data. The index will illustrate the general patterns that we are seeking to investigate. Further, it takes the all important step of correcting for the effects of nuptiality, thus distinguishing changing trends in *marital* fertility.

We are now ready to specify the functional form of our "standard"[17] demographic transition models, both with and without agriculture. In choosing a functional form, we must beware of theoretical considerations. Since we have no theoretical justification for any given functional form and since tests have shown linearity to prevail, we will employ a linear functional form.[18]

Second, we must pay attention to the type of data available. We are fortunate enough to have both time-series and cross-sectional data. This data includes observations of all the variables across 36 administrative counties[19] for the census years 1851, 1861, 1871, 1881, 1891, 1901, and 1911.[20] As theory gives us no reason to expect the effects of any independent variable to change over time, we elect to group the data from the seven census years together.[21]

While the variation of coefficients across time is inexplicable given current theory, we might still want to account for factors specific to individual counties. Hence, we want to create a model in which these effects can be absorbed into "error" components so that they do not affect the independent variable coefficient estimates or their significance. This goal is achieved by creating 35 dummy variables. We define the dummy variable C_i to be one if county = county i and zero otherwise. Hence, the observations from 35 of the 36 counties will have 34 dummy variables equal to zero and 1 dummy variable equal to one. One county will have all 35 dummy variables equal to 0. This is the county for which no dummy variable is defined. By not defining a dummy variable for one county we avoid the problem of strict multicollinearity.[22] Lancashire was chosen as the county without a dummy variable defined for it. Hence, for Lancashire observations all 35 dummy variables are equal to zero. However, it is important to note that Lancashire's data observations are still included in the data set and hence Lancashire still influences the estimation of our model. Thus, the decision to pick Lancashire as the "36th" county in no way biases our estimates or decreases their efficiency. The model described above, which decomposes county specific effects into dummy variables and hence creates different intercepts for each county-specific estimated equation is called a fixed-effects model (FEM). This format is particularly useful for the panel-data we are using since it helps to lessen the likelihood of both serial correlation and heteroscedasticity (Kelley and Schmidt 1994). Formally, our standard fixed-effects models are:

with agriculture: $Y = b_0 + b_1X_{1jt} + b_2X_{2jt} + b_3X_{3jt} + v_j + e_{jt}$

where Y= marital fertility, X_1 = urbanization, X_2 = infant mortality rate lagged ten years, X_3 = agriculture, v represents the vector of 35 dummy variables, j refers to a specific county, t refers to a specific year, and e is an error term;

without agriculture: $Y = b_0 + b_1X_{1jt} + b_2X_{2jt} + v_j + e_{jt}$

where the variables and symbols are defined as above. In addition to running the two fixed-effects models above we will also run the two models in their regular pooled cross-sectional form for comparison purposes.

The Diffusion of Information Theory Models

As can be seen from the theoretical justification for including infant mortality in the standard model, theorists have long realized that new information is essential to producing new decision making frameworks. In other words, it has long been realized that information is at the root of changing marital fertility trends. Hence, we would expect fertility changes to be observed in areas where information travel is well supported. In modern societies, this translates into an expectancy that increased television distribution and telephone use could help break old ideas and decrease fertility. However, in nineteenth century England there were no telephones nor were there any televisions. Hence, we need to come up with some other variables that measure how well information can flow in a given area.

One such variable is density. Density indicates the average amount of space per person in a given area. It is defined as the total population divided by statute acres. Hence, it gives a kind of theoretical measure of how well information flows, by telling how likely people are to come into contact with each other. We would expect that more dense populations have more communication and hence a higher rate of

information exchange. Thus, dense populations should aid the diffusion of new ideas and should have lower marital fertility. In other words, we expect a negative relationship between density and marital fertility. The density variable is particularly interesting because it likely measures some of the same effects as urbanization, but unlike urbanization is a proximate variable with sounder theoretical backing.[23]

While there are numerous other variables that sound good in theory, the available data provides few variables that can be realistically used as proxies for information exchange. However, there does exist another theoretically intriguing proxy for information exchange that is continuous across place and time. This variable is the percent of the people living in a county who were born there. This variable is defined as the number of residents of county i who were born there divided by the number of residents of county i. We will call this variable "incounty." If incounty is high, then relatively few people born outside of the given county reside there. If incounty is low, then many people residing in the given county were born outside of it. Hence, we would expect a low incounty measure to produce a high rate of information diffusion since many people residing in the county have been exposed to the ideas of other localities. Thus, we expect incounty to have a positive relationship with marital fertility.

These two variables appear to be the only proxies that can be gleaned from the available data that have reasonably strong theoretical ties to information diffusion. Hence, we now can specify the functional form of our diffusion model. The model will utilize the same dependent variable as the standard models. Further, it will have a linear functional form since when a variety of forms were tested linearity prevailed. Finally, for reasoning similar to that used earlier, our diffusion model will also be of the fixed-effects variety. The model is defined by the equation:

$$Y = b_0 + b_1X_{1jt} + b_2X_{2jt} + v_j + e_{jt}$$

where Y = marital fertility, X_1 = density, X_2 = incounty, v represents the vector of dummy variables defined earlier, j refers to a specific county, t refers to a specific time period, and e represents an error term. Again, we will also run a non-fixed-effects model for comparison purposes.

The "Complete" Models

While we can gain much information from the paradigms already delineated, it seems prudent to combine our frameworks to create a third type of fertility model. Such a model will provide us with even more insight and its statistics can be used for significance and relative importance comparisons between all of our independent variables. There will be two complete models, one with agriculture and one without agriculture. The core independent variables for the complete models will be urbanization, lagged infant mortality, density, and incounty. The dependent variable for these models will again be the marital fertility index. Finally, for comparison purposes we will again run both pooled cross-sectional and pooled fixed-effects formats of each model.

III. MODEL ESTIMATIONS

Before discussing the results of our model estimations it is important to review our models and our *a priori* hypotheses. We have five models, a standard model with agriculture, a standard model without agriculture, a diffusion model, a complete model with agriculture, and a complete model without agriculture. Additionally, each of these models will take on two functional forms, a fixed-effects format and a pooled cross-sectional format. The pooled cross-sectional models, from the standard model with agriculture through the complete model without agriculture (as listed above), will be referred to as models 1-5 respectively. The pooled fixed-effects models will be numbered 6-10 respectively.

The data set used in our estimations will be pooled together from all the census years because we do not expect the variable coefficients to vary across time. In other words, we expect that urbanization would have the same effect on marital fertility in 1911 as it would in 1851. From this pooled data, we expect to see a negative relationship between urbanization and fertility, a negative relationship between density and fertility, a positive relationship between infant mortality and fertility, and a positive relationship between the incounty variable and fertility. Finally, we expect a negative relationship between agriculture and fertility, but our theoretical support for this relationship is a bit ambiguous.

Pooled Cross-Sectional Models

All the pooled cross-sectional models (1-5) yield parameter estimates for agriculture, urbanization, and infant mortality, that are significant at the one-percent level.[24] Hence, our hypotheses about the relationships between these independent variables and marital fertility are consistent with our results. It should be noted, however, that for reasons discussed at the end of this section, models which do not utilize agriculture as an explanatory variable are uniformly preferred.

Unlike our standard variables, in the pooled cross-sectional framework, our diffusion variables generally do not yield statistically significant parameter estimates. In fact, the only case of a diffusion variable producing a significant parameter estimate (at any reasonable confidence level) in a pooled cross-sectional framework involves the incounty variable of Model 3. Its parameter estimate is consistent with our hypothesis at the one-percent level.

Yet, we may gain some comfort from the fact that the signs of the diffusion coefficients are always consistent with our hypotheses, and from the observation that the F-value for the joint significance of the entire model is significant at the one-percent level throughout models 3-5. Still, the pooled cross-sectional estimates of our diffusion variables cast some doubt on the variables' explanatory power. However, before coming to any conclusions on this topic we might wait and see what stories the pooled fixed-effects models have to offer.

Pooled Fixed-Effects Models

Similar to our cross-sectional models, the pooled fixed-effects models produce standard variable parameter estimates significant at the one-percent level across all models. However, unlike our cross-sectional models, the fixed-effects models also produce diffusion variable parameter estimates that are consistent with our hypotheses at the one-percent level. In fact, all the pooled fixed-effects models that involve diffusion, models 8-10, produce such significant results.

Model 8 yields the statistically significant density parameter estimate that we were unable to attain in Model 3 and models 9 and 10 also yield significant parameter estimates for both diffusion variables. This is a particularly important observation because in our cross-sectional complete models we were unable to find our diffusion variables statistically significant. Now they are not only statistically significant, but significant at the one-percent level. The potential relevance of pooled fixed-effects modeling is further underscored by the fact that the F-value for the joint significance of the diffusion variables in each model is significant at the one-percent level, whereas the corresponding values for models 4 and 5 were statistically insignificant at any reasonable confidence level. Hence, it appears that diffusion effects are stronger when modeled within a fixed-effects framework. This is significant because it is precisely this type of framework that aims to account for the regional groupings central to the concept of diffusion.

Before concluding discussion on our model estimations, it is interesting to note the results obtained when we standardize the beta-coefficients on each of our models. By standardizing the beta-coefficients we are accounting for both the variances and the units of measurement of the variables. Such standardization allows us to control for inter-variable differences in these factors, and hence to compare the relative importance of the different explanatory variables within a given model. Three important discoveries are realized when we utilize this procedure. First, even where agricultureÕs t-score is much greater than some of the other variables, it's relative explanatory importance is minimal. In general, agriculture contributes the least towards explaining the variation in marital fertility. Second, with the exception of the complete fixed-effects models, our estimations show that urbanization has the greatest relative explanatory power. Its standardized coefficients are often about twice those of the other explanatory variables. For instance in the fixed-effects standard model without agriculture, the standardized estimate of urbanization is -0.83 whereas the standardized estimate of lagged infant mortality is 0.47.

Finally, in the complete fixed-effects models, the relative explanatory power of the different variables is very similar when measured using the standardized beta coefficients, with the exception that agriculture is notably less important. In fact, in the model without agriculture, the standardized estimates are nearly equal. For this reason, as well as the preceding two, we prefer models which do not utilize agriculture as an explanatory variable. Specifically, Model 10 is preferred due to its lack of the agriculture variable, its fixed-effects format, its inclusion of all the theoretically sound variables, and its high adjusted r-squared (0.55).

IV. CONCLUSIONS

We have made several discoveries.

Both the pooled cross-sectional and the pooled fixed-effects standard models suggest that urbanization and lagged infant mortality were likely influences on marital fertility in England during the period of the English demographic transition. Specifically, we might generalize that urbanization (lagged infant mortality) should be expected to have a negative (positive) influence on fertility.

Further, both forms of the standard models tell us that agriculture may have had a negative influence on fertility throughout the period in question. While to wit we might expect agriculture to positively influence fertility, based on the arguments presented in Part II of the agricultural situation in England during the time period under consideration, it seems that a negative theoretical relationship between agriculture and marital fertility is possible. Additionally, due to measurement problems and a questionable association between the "negative hypothesis" and the specific proxy employed for "agriculture," findings involving the agriculture variable should be viewed with caution. Caution should be further stressed due to the relative unimportance of agricultureÕs standardized beta coefficient, the robustness of which is supported across all models. Yet it is important to note that the significant results for all of our standard transition variables (including agriculture) hold across all models.

In both forms of the diffusion model, our variables are jointly significant. Further, with the exception of the density variable in Model 3, all variables are individually consistent with our hypotheses at the one-percent level. The idea that density exhibits a negative relationship with marital fertility while incounty exhibits a positive relationship with marital fertility is thus supported. These discoveries, as well as the individual and joint significance of the diffusion variables observed in our fixed-effects complete models, lend credence to the idea that the diffusion of information plays an active role in influencing marital fertility decisions.

The fact that our pooled cross-sectional complete models failed to show statistical significance for our diffusion variables plausibly indicates the importance of accounting for regional differences. Since the fixed-effect complete models produced both significant individual and joint scores for the diffusion variables, we are reminded of the important and hard to measure role that local peculiarities play in the marital fertility decision making framework. Indeed, the fact that the diffusion variables showed statistical significance in the complete model only when regional differences were allowed to be absorbed by dummy variables, underscores the idea of diffusion itself. Diffusion occurs in discrete areas and through discrete reference groups. The fact that the standardized beta coefficients for our diffusion variables were similar to those of our standard variables in the fixed-effects complete model without agriculture further underscores the importance of diffusion in affecting the household decision making framework when diffusion is appropriately reckoned.

While all findings should be continuously retested using new data, the data available from the English demographic transition yields support for the idea that the diffusion of information has significant effects on the marital fertility decision making

framework. While the variables used might not be perfect proxies for diffusion, they still garner support for theoretically sound diffusion theories. This point should be underscored by the fact that England is a relatively homogeneous society and that we would expect diffusion to be accelerated by heterogeneity. Hence, since the historical data from England is consistent with our theories of the diffusion of information, it is ever the more likely that other, more heterogeneous, data sets will support our hypotheses.

1 Natural fertility refers to the maximum completed fertility that is biologically possible.
2 By mortality rate we will assume the likelihood of a child not surviving to adulthood. However, it should be noted that many medical advances lower multiple age-specific mortality rates. This is especially likely when the advances are not specifically directed at infants or the aged.
3 For a discussion of the excess supply concept see Easterlin 1978 or Easterlin and Crimmins 1985.
4 While under modern conditions we might consider, say, a five year delay in the age of a male at marriage unimportant to fertility trends since it is the woman whose reproductive period is naturally constrained to a very limited time span, in a Stage I nation this delay could significantly affect fertility trends since the male would be likely to have his reproductive span limited by a relatively shorter life span.
5 Natural supply refers to the amount of children a given mother can produce in the absence of fertility control and it represents a biological capacity which is influenced by the socioeconomic structure of the mother's society.
6 "Significant" refers to significance as judged by F. van de Walle's (1986) criteria. However, other judgments end up at similar dates. For example, see Teitelbaum 1984, pp. 220-221.
7 For examples of such regressions and their results, see the various individual country population studies published by Princeton University Press, most of which appear in the references.
8 For a discussion of the beginnings of the fertility decline in France, see E. van de Walle 1978.
9 This refers to a medium size geographic region distinguished by the French census.
10 As will be discussed later, urbanization is not really a good term to use to describe the influential factors at work.
11 Becker's new home economics represents a theoretical literature that assumes families are able to attain the number of children they desire and assumes away contraception constraints. In other words, it is a demand-oriented model that is defunct when supply is constrained.
12 For example, SEC factors may contribute to lower demand by raising the cost of children through increasing the value of the mother's time outside the home.
13 The threshold and the SEC trends associated with it in one country need not be the same as those of other countries.
14 For a discussion of this concept see Teitelbaum 1984, Conclusions.

15 For 1841, 1851, 1861, 1871, and 1881 the infant mortality rate used is comprised only of male births and deaths. The continuity and trends observable in the total infant mortality rate seem to be mirrored by the male infant mortality rate and hence this fact should not distort our findings.
16 While the choice of the Hutterites as our reference population is fairly arbitrary, it is important to note that the inclusion of the Hutterite fertility schedule does not simply represent the division of fertility by a constant. Since the schedule is age-specific, the inclusion of the Hutterite schedule helps us account for the age distribution of the English population across time periods.
17 Standard is in quotations to recognize the fact that we are testing variant forms that serve as proxies for the ideas of the standard demographic transition theorists.
18 Tests involving the quadratic, semi-log, and double-log functional forms, were run and the linear form consistently prevailed.
19 There are 43 administrative counties in England. The counties of Middlesex, Surrey, Kent, London, East Riding, West Riding, and North Riding, were excluded from the data set. The available data was able to yield neither reliable nor continuous data for these counties.
20 The infant mortality rate included in any given year is lagged. In other words, the data for Sussex for 1851 includes the infant mortality rate for Sussex for 1841.
21 Keeping the data sets separate by year would create a regression equation for each year and thus would allow the coefficients to vary across time.
22 If we defined a dummy variable for all 36 counties then each county observation in time would have 35 dummy variables equal to zero and one dummy variable equal to one. In such a model the dummy variables would sum to one in every observation and hence we would have strict multicollinearity. Such a model would produce worthless estimation results.
23 Yet, we must note that the density variable is imperfect since it takes account of effects on fertility that are independent of information diffusion.
24 All estimation results can be found in Table 1.

References

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

Gary S. Becker and H. Gregg Lewis. 1973. "On the Interaction Between the Quantity and Quality of Children." Journal of Political Economy. March/April. S279-88.

Gary S. Becker. 1976. "Altruism, Egoism, and Genetic Fitness: Economics and Sociology." Journal of Economic Literature. Volume 14. Pages 817 - 826.

John Bongaarts. 1978. "A Framework for Analyzing the Proximate Determinants of Fertility." Population and Development Review. Vol. 4, #1: pp. 105-132.

John Cleland and Christopher Wilson. 1987. "Demand Theories of the Fertility Transition: An Iconoclastic View." Population Studies. Volume 41. Pages 5 - 30.

Ansley J. Coale. 1960. "Introduction." in Demographic and Economic Change in Developed Countries. Princeton, Princeton University Press.

Ansley J. Coale. 1973. "The Demographic Transition Reconsidered."

Ansley J. Coale and Roy Treadway. 1986. "A Summary of the Changing Distribution of Overall Fertility, Marital Fertility, and the Proportion Married in the Provinces of Europe." in The Decline of Fertility in Europe. Princeton, Princeton University Press.

Richard A. Easterlin. 1978. "The Economics and Sociology of Fertility: A Synthesis." in Historical Studies of Changing Fertility. Princeton, Princeton University Press.

Richard A. Easterlin and Eileen M. Crimmins. 1985. The Fertility Revolution. Chicago, University of Chicago Press.

Mark S. Granovetter. 1973. "The Strength of Weak Ties." American Journal of Sociology. Volume 78, Number 6. Pages 1360 - 1380.

Allen C. Kelley and Robert M. Schmidt. 1994. Population and Income Change: Recent Evidence. Washington DC, The World Bank..

Dudley Kirk. 1946. Europe's Population in the Interwar Years. Princeton, Princeton University Press.

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

Princeton University Press.

John Knodel, et al. 1987. Thailand's Reproductive Revolution: Rapid Fertility Decline in a Third-World Setting. Madison, The University of Wisconsin Press.

John Knodel and Etienne van de Walle. 1986. "Lessons From the Past: Policy Implications of Historical Fertility Studies." in The Decline of Fertility in Europe. Princeton, Princeton University Press.

Thomas R. Malthus. 1993. An Essay on the Principle of Population. Oxford, Oxford University Press.

Robert T. Michael. 1973. "Education and the Derived Demand for Children." Journal of Political Economy. Supplement, pp. S128-164.

Mark R. Montgomery and John B. Casterline. 1993. "The Diffusion of Fertility Control in Taiwan: Evidence from Pooled Cross-Section Time-Series Models." Population Studies. Volume 47. Pages 457 - 479.

Moni Nag. 1980. "How Modernization Can Also Increase Fertility." Current Anthropology. October, pp. 27-36.

Frank W. Notestein. 1944. "Problems of Policy in Relation to Areas of Heavy Population Pressure." in Demographic Studies of Selected Areas of Rapid Growth. New York, Milbank Memorial Fund.

Frank W. Notestein. 1953. "Economic Problems of Population Change." in Proceedings of the Eigth International Conference of Agricultural Economists. London, Oxford University Press.

Robert A. Pollak and Susan Cotts Watkins. 1993. "Cultural and Economic Approaches to Fertility: Proper Marriage or *Mésalliance*." Population and Development Review. Volume 19, Number 3. Pages 467 - 496.

Everett M. Rogers. 1971. Communication of Innovations: A Cross-Cultural Approach. New York, The Free Press.

Allan Sharlin. 1986. "Urban-Rural Differences in Fertility in Europe During the Demographic Transition." in The Decline of Fertility in Europe. Princeton, Princeton University Press.

K. D. M. Snell. 1985. Annals of the Labouring Poor: Social Change and Agrarian England, 1660 - 1900. Cambridge, Cambridge University Press.

Michael S. Teitelbaum. 1984. The British Fertility Decline: Demographic Transition in the Crucible of the Industrial Revolution. Princeton, Princeton University Press.

E. P. Thompson. 1967. "Time, Work-Discipline, and Industrial Capitalism." Past and Present. number 38.

Etienne van de Walle. 1978. "Alone in Europe: The French Fertility Decline Until 1850." in Historical Studies of Changing Fertility. Princeton, Princeton University Press.

Francine van de Walle. 1986. "Infant Mortality and the European Demographic Transition." in The Decline of Fertility in Europe. Princeton, Princeton University Press.

Susan Cotts Watkins. 1986. "Conclusions." in The Decline of Fertility in Europe. Princeton, Princeton University Press.

Susan Cotts Watkins. 1991. From Provinces into Nations: Demographic Integration in Western Europe, 1870 - 1960. Princeton, Princeton University Press.

E. A. Wrigley. 1969. Population and History. London, Weidenfeld and Nicolson.

E. A. Wrigley. 1978. "Fertility Strategy for the Individual and the Group." in Historical Studies of Changing Fertility. Princeton, Princeton University Press.

E. A. Wrigley. 1985. The Local and the General in Population History. Exeter, University of Exeter Press.