Engineering science has aimed to increase the understanding of the principles and concepts that are common to and underlie a wide variety of technological problems. It supported the finite element method in structural engineering and, across the board, it supported research on tungsten carbide as a substitute catalyst for platinum. In the mid-1960's it initiated a concerted research effort to apply systems analysis and operations research to the efficient allocation of urban police forces. This work led to the development of a general methodology for the dispatching and deployment of police patrol forces and for evaluating the consequences of technological and administrative innovations. There are immediate applications to fire and emergency ambulance services.

Materials research has been an NSF function since the beginning, and the program was considerably augmented when the Foundation assumed the responsibilities for the interdisciplinary Materials Research Laboratories from the Department of Defense in 1971. Fundamental observations have been supported on the quantized nature of magnetic flux surrounded by a superconducting ring. These observations led in part to the development of superconducting interference devices, which have become of considerable technological importance. In another area, developments point toward high strength polymers which may possess an electric modulus as high as that of steel and a greater tensile strength, while at the same time weighing less than 20 percent as much as steel.

Thus a firm groundwork was laid in the social and applied sciences for the Research Applied to National Needs (RANN) program that was developed in response to the applied research authorization granted in the amended NSF Act of 1968. Interdisciplinary Research Relevant to Problems of Society (IRRPOS) was begun in 1969, and it was then only necessary to sharpen and focus research on selected environmental and social problems and on opportunities for future technological development in order to respond to the legitimate demands of a society for which the fruits of research had been, speaking without prejudice, a mixed blessing. Basic to the concept of RANN from the beginning was the eventual transfer of programs to mission-oriented agencies of the federal government and to industry. Again one example must suffice. Between 1971 and 1974, RANN led in the effort to define a solar energy research program to more fully understand and exploit this inexhaustible resource with which we are blessed. The payoff came with the formation of the Energy Research and Development Agency (ERDA) to which RANN was able to transfer funds, staff, and know-how. At the same time RANN was able to continue with concentration on innovative, long-range, high-risk, high-payoff projects in solar energy research. The NSF is indeed responding to national needs.

Conclusion

This has been one man's account of the return on the American people's investment in *A Foundation for Research*. There have been failures as well as triumphs, but those are for others to record. Research has enriched our lives and nurtured our livelihood but it has also brought inevitable problems which hopefully in these next years it can help to ameliorate. All in all it has been a 25-year success story with, best of all, rich promise for the future. We will fulfill that promise only if we succeed in *transforming research into wisdom in the compassionate use of knowledge in the affairs of mankind.*

Relevance of Demographic Transition Theory for Developing Countries

The theory offers only partial explanation of European trends and ambiguous advice for developing countries.

Michael S. Teitelbaum

The theory of the demographic transition is by now a well-known feature of discussions of human population phenomena, and recently it has also become an element of international politics. In the debates at the World Population Conference in Bucharest in 1974 the theory of the demographic transition was an active, if usually implicit, participant. It lay behind some of the most attractive and confident sentiments expressed ("Take care of the people and population will take care of itself," "Development is the best contraceptive"), and there is no reason to think that the proponents of these views believed they were espousing anything but the revealed wisdom of demographic science (*1*).

Yet popular adoption of a scientific theory usually lags far behind the elaboration of the theory itself. The theory of the demographic transition was originally developed nearly a half-century ago, and ironically its explanatory and predictive power has come into increasing scientific doubt at the very time that it is achieving its greatest acceptance by nonscientists. In scientific circles, only modest claims are now made for transition theory as an explanation of the very demographic experiences from which the theory was originally drawn —those of 19th-century Europe. When applied to the markedly different social and economic circumstances of modern-day Asia, Africa, and Latin America, the explanatory and predictive power of transition theory is open to further scientific questions.

Hence the credence given to assertions based upon transition theory that development will "take care of" population matters as it did in Europe justify an assessment of (i) what is known about what *did* happen in Europe and (ii) the extent to which the same processes may be expected in developing countries, given their similarities and dissimilarities from the countries of 19th-century Europe.

The Theory of the Demographic Transition

The theory (*2*) of the demographic transition (*3*) is a descriptive interpretation of the transformations that took place in European demographic patterns during the 19th century. It seeks to characterize three "stages" of fertility and mortality levels, viewed as derivative from the fundamental economic and social changes of "development" or "modernization."

According to the theory, stage I of the demographic transition is that which has been characteristic of the human species throughout most of its history —an equilibrium of population size over the long term achieved by high birth rates and high death rates. Infant mortality is high and fertility is similarly high, although perhaps never at the biological maximum of the species. The high rate of mortality is taken as inevitable in the absence of modern forms of sanitation, agriculture, transport, and medicine. Given this high rate of mortality, a similarly high birth rate is required (by definition) of any population which has persisted. In order to maintain high fertility, societies in stage I of the demographic transition are characterized by powerful pronatalist norms supported by popular values both sacred and secular, and effectively enforced by a variety of societal sanctions, that is, by a pronatalism which is highly institutionalized and slow to change.

In contrast to the stable societal maintenance of a high birth rate, transition theory views control of the death rate as beyond the reach of preindustrial societies. However, since most people desire health and long life, new methods of reducing mortality are readily adopted as they become known, resulting in a gradual decline in mortality. Both high fertility and low mortality are viewed as blessings. In this sense the factors supporting high birth rates and high death rates are asymmetric, the equilibrium of stage I a potentially unstable one.

This instability leads to stage II of the demographic transition, characterized by declining mortality with fertility remaining at previous high levels under the control of traditional social institutions. This is the stage of the "population explosion," that is, the rapid growth of population resulting from an imbalance between birth rates and death rates.

Finally, individuals begin consciously to control their fertility, marking the onset of stage III of the demographic transition in which the birth rate gradually declines toward equilibrium with the now low death rate. The reduction of fertility typically lags behind the mortality decline because it cannot occur until the traditional social and economic institutions supporting fertility are weakened and new institutions emerge favoring a reduction in fertility to levels more commensurate with the lower levels of mortality. The theorists of the demographic transition explain the adoption of this new smaller family ideal by reference to the industrial and urban transformations of the 19th century. Industrial and urban life are seen as modifying substantially the role of the family in production, consumption, education, and recreation. The reduced importance of the family weakens the social pressures favoring high fertility, since it is through the extended agrarian family that many of these pressures are funneled by the society. The economic value of children is lowered by the growth of widespread or compulsory education, which removes children from the potential labor force. People come to perceive that mortality (especially infant mortality) has declined substantially, and that fewer births are required to achieve a certain family size of live children.

Through this multitude of major social transformations, the pressures for high fertility weaken and the idea of conscious control of fertility gradually gains strength (*4*). In the early stages no elaborate technology of fertility control is required, but there is more knowledgeable and effective use of folk methods such as coitus interruptus, abortion, and various crude devices. Later, pressures arise for more effective and less objectionable means of fertility control, leading to the development of more modern methods.

Current Status of Transition Theory

As has been noted above, the theory of the demographic transition is essentially a plausible description of complex social and economic phenomena which took place in 19th-century Europe. It is notably lacking in such components of theories as a specifiable and measurable mechanism of "causation" and a definite time scale. It has, however, generated some very general hypotheses which have been affirmed by subsequent events, for example, the proposition that mortality generally responds more quickly than fertility to the forces of medicine and development, and the prediction of the 1950's that regions such as Asia could therefore be expected to experience large population increases in the decades following (*5*).

It is notable, however, that only limited efforts have been made to examine the more specific and "explanatory" propositions of transition theory, especially those concerning the factors associated with the European *fertility* decline. The most intensive studies of this type have been in process in recent years by staff and associates of the Office of Population Research at Princeton, under the direction of Professor Ansley J. Coale. This European Fertility Study is an examination of the course of fertility decline in more than 700 provinces of Europe on a standardized basis, thereby allowing international comparisons and continental generalizations. Most of the component national studies have not yet been completed, but the data available provide fruitful opportunities for a preliminary empirical examination of transition theory. Only the briefest of summaries can be provided here; a discussion which is both more extensive and intensive has been presented elsewhere by Coale (*6*).

One important finding of the Princeton studies is that overall fertility levels in pretransition Europe were far from uniform, but instead varied considerably from province to province and from country to country. This was due in part to differences in marriage patterns, but, when this factor is controlled, the fertility variation remains large—the lowest fertility levels are only two-thirds as large as the highest. A variety of explanations may be offered. Two possibilities are that fecundity (defined in demography as the biological capacity to reproduce) was affected by nutritional factors (*7*) or by the prevalence, duration, and intensity of nursing (*8*), or both. Another strong contender is the view that many pretransitional subpopulations were in fact practicing conscious fertility control (*9*).

The Princeton studies clearly document the importance to the overall level of fertility in Europe of the proportions married. The Western European marriage pattern (*10*) of late marriage and of extensive nonmarriage stands out in

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sharp relief from that of Eastern Europe, and is even more distinctive when compared with the very early and nearly universal marriage patterns of many modern developing countries.

When the cluster of socioeconomic variables to which transition theory attributes the European fertility decline (industrialization, urbanization, education, mortality decline, and other factors) are quantified and examined, it becomes quickly apparent that a number of confident propositions in some versions of transition theory are overly facile. In some areas such as parts of France, fertility began to decline before the spread of industrialization and urbanization, and prior to or simultaneously with the declines in mortality. Certain socioeconomic factors were associated with (but not necessarily causes of) demographic changes in some countries, but in others these relationships were not apparent at all. Indeed, in most countries the data show subnational regional clusters which tend to correspond more to cultural and linguistic groups than to the socioeconomic variables central to transition theory. Hence the causal model posited by transition theory has proven to be more elusive in the empirical data than in the theoretical propositions.

Coale (*6*, p. 65) summarizes the generalization of transition theory that remains in terms of three broad preconditions for a substantial decline of fertility within marriage:

> 1) Fertility must be within the calculus of conscious choice. Potential parents must consider it an acceptable mode of thought and form of behavior to balance advantages and disadvantages before deciding to have another child—unlike, for example, most present day Hutterites or Amish, who would consider such calculations immoral, and consequently do not control marital fertility.
>
> 2) Reduced fertility must be [seen as] advantageous. Perceived social and economic circumstances must make reduced fertility seem an advantage to individual couples.
>
> 3) Effective techniques of fertility reduction must be available. Procedures that will in fact prevent births must be known, and there must be sufficient communication between spouses and sufficient sustained will, in both, to employ them successfully.

The European data show that a high level of development was ultimately *sufficient* to establish these three preconditions for a decline in marital fertility across Europe. However, there is no evidence of any threshold levels of development which were *necessary* for this to happen, and it is apparent that the preconditions for fertility decline existed under situations of little social and economic development, as in parts of rural France and Hungary (*11*).

Relevance of Transition Theory for Developing Countries

The relevance of transition theory for the present situation of developing countries is an important issue of both science and policy. From a scientific perspective, the weaknesses and ambiguities of transition theory in explaining European experience may be further examined if one follows the current and future demographic processes of developing countries. For example, it is possible that the explanatory failures of the theory for Europe may be due in part to lack of adequate data on potentially important factors, since explanation of the ongoing fertility decline was not contemplated at the time these data were being collected. The application of modern techniques of demographic and socioeconomic measurement on a prospective basis in the developing countries may provide better opportunities to validate or refute (at least for those countries) the hypothesized relationships among mortality, fertility, and various social and economic changes (*12*).

The relevance of transition theory to the modern era may be of even greater interest to policy formulation. If it can be shown that within a reasonable period of time social and economic development cause a "natural" decline in fertility, as is predicted by some on the basis of transition theory, the underlying assumptions on population issues held by many national leaders will have been validated. If, on the other hand, it appears that the theory of the demographic transition (whatever its validity for Europe) is not appropriate for the conditions of the modern developing countries, revised assumptions will be very much in order as leaders seek the correct policy stance on population issues.

In considering the relevance of transition theory to contemporary developing countries, the theory's general explanatory difficulties are compounded by very substantial differences between developing countries and 19th-century Europe in certain of the socioeconomic and demographic variables central to the theory. The situation is a mixed one: in some respects the different circumstances in developing countries suggest great obstacles to the timely completion of the transition by means of a "natural" decline in fertility along the European pattern. In other respects these differences provide reasons to anticipate an unusually rapid completion of the transition in these countries.

The differences which cumulatively militate against "natural" and timely fertility declines in the developing countries include at least the following:

A1) *Pace and source of mortality decline.* The declines in mortality of European countries were gradual, and were generally related to the social and economic forces of development and industrialization. The same is not true for many developing countries, where mortality declines have been far more dramatic and have often resulted largely from imported technologies which can be transferred with relative ease and are only marginally related to the pace and level of general development. The result is that mortality levels in developing countries are much lower than those of early industrial Europe, but the factors which brought this about may be less indigenous and hence have less impact upon fertility.

A2) *Fertility levels before decline.* Fertility in most developing countries today is much higher than in pretransition Europe. For example, the birth rate in early 19th-century Britain is estimated to have been generally less than 35 per thousand, whereas in many countries today (such as Tanzania and Iran) it is over 45 per thousand, and in some (such as Afghanistan) possibly over 50. These higher birth rates are due primarily to the practice in most developing countries of early and near-universal marriage, in distinct contrast to the 19th-century European pattern of late marriage and extensive nonmarriage.

A3) *International migration.* The untoward effects of too-rapid population growth in a given country can, in theory, be mitigated by international migration. In the 19th century the countries of Europe "exported" tens of millions of their citizens to the "new" continents of the Americas and Oceania and to overseas colonies elsewhere. Yet the political and economic realities of today mean that substantial international migration is no longer a potential outlet for excessive population growth.

A4) *Rate of population growth.* As

a result of the above differences, all of which operate in the same direction, population growth in most developing countries is literally extraordinary—quite unprecedented in human experience, including that of the European transition. Growth rates of developing countries today range as high as 3.4 percent (for example, in Algeria, Colombia, and the Dominican Republic, among others), with an average of about 2.5 percent. At the former rate a population would double in size in only 20 years (and would increase 32-fold in a century); at the latter rate doubling would take less than 30 years. In contrast, European nations undergoing their demographic transitions rarely experienced doubling times of less than 50 years, and the average was about 90 years. Hence, at no point in their transitions did European countries sustain the rates of population-related growth in demand for basic necessities and for social investment that are now confronted daily by the leaders of many developing countries. Such demands often compete with those for investment in key physical resources in industry and agriculture, and can thereby serve to impede social and economic development. The perversely circular effect may be to slow or even short-circuit any underlying "natural" tendencies toward completion of the demographic transition which result from the forces of development.

A5) *Momentum for further growth.* The rapid growth of developing countries will be more difficult to halt than the slower growth of transitional Europe. As a result of their much higher fertility, modern developing countries have very much "younger" age structures than Europe had, and therefore a far greater momentum for further growth. For example, even in the unlikely event that fertility in developing countries declined *within the next decade* to the "replacement" level now characteristic of developed countries, the population of the developing world would nonetheless continue to grow for 60 to 70 years, and by the year 2050 would have reached a size nearly 90 percent greater than its 1970 level. If replacement fertility is deferred until 20 years later, the increase would be over 150 percent. For specific developing countries with unusually young age structures, the force of growth momentum under these two assumptions would, of course, be even larger (*13*).

A6) *Opportunities for occupational and rural-to-urban mobility.* Occupational mobility away from agriculture and spatial migration from rural to urban areas provided alternative life opportunities for the increased rural population during the European transition (*14*). The much more rapid natural increase of modern developing countries presents great difficulties to the provision of comparable opportunities for occupational and spatial mobility. The increase in demand for nonagricultural employment often exceeds the increase in supply, and the extraordinarily rapid rates of urban growth in many developing countries are threatening to overwhelm their capacities of accommodation. Indeed, in some cases policies are being sought to *reduce* rural-to-urban migration flows although the population remains predominantly rural, thereby limiting the hypothesized effects of urban life upon family and reproductive values (*15*).

A7) *Fewer opportunities for female participation in the labor force.* There is some evidence that the increased entry of women into the nonagricultural labor force in Europe was a factor in fertility decline. If this is true, the more rapid rate of natural increase in developing countries today means that the entering labor force is growing faster as well. Ceteris paribus, this would tend to limit the growth in the demand for female labor.

A8) *Difficulties of providing universal education.* With school-age cohorts doubling in only two or three decades, many developing countries are understandably experiencing difficulties in expanding educational facilities at a rapid enough rate to provide educational opportunities for a growing proportion of those eligible. This means deferment of the goal of universal education, along with its hypothesized effects upon fertility behavior in the transition.

There are also differences between the situations of the European transition and those of modern developing countries which tend to favor more prompt and rapid fertility declines in the developing countries:

B1) *Pace of social and economic development.* For many developing countries, social and economic development has been more rapid than in 19th-century Europe. To the extent that such development "causes" or expedites the decline in marital fertility, this suggests more rapid completion of the demographic transition as well.

B2) *Methods of fertility control.* The European fertility declines appear to have been based upon increased and more effective use of traditional fertility control measures such as coitus interruptus and abortion, although by modern standards the effectiveness of the former was not high and the danger of the latter was great. Improved contraceptive technology and safe abortion techniques have now been developed, and additional approaches such as safe and acceptable voluntary sterilization are available for the first time in history. At any given level of motivation to control fertility, access to such improved methods is likely to mean more frequent and effective practice, with consequently greater demographic effects.

B3) *Greater latitude of deferment of marriage and increased nonmarriage.* The European demographic transition began in the context of late marriage and extensive nonmarriage. In developing countries today marriage is generally early and almost universal. Hence, although the 19th-century European transition relied primarily upon reduction of marital fertility (indeed, marriage occurred earlier and became more frequent, which tended to *increase* overall fertility), fertility in developing countries may be reduced via changes both in marriage practices and fertility within marriage (*16*), and will at least not tend to increase as a result of earlier marriages and higher marital frequencies.

B4) *Increased legitimacy of the small family norm.* The large family was taken as "normal" in most of 19th-century Europe; there were few obvious examples of alternatives, and cultural diffusion was in any case relatively limited. In contrast, the "demonstration effect" of the European transition has provided modern legitimacy for the small family norm and evidence that its achievement is feasible, and many factors (such as improved international communication and expanded trade) have accelerated the processes of cultural and intellectual diffusion.

B5) *Increased interest and planning capability of government.* Population growth rates in 19th-century Europe, high by historical standards (although low by 20th-century standards), were not considered to be excessive. Modern leaders are better aware of the fundamental importance of rapid population growth as a variable in development than their 19th-century predecessors,

and governments representing 81 percent of the *population* of the developing world (although still a minority of developing *countries*) have now declared their population growth rates to be excessive (*17*). In addition, many developing countries now have economists and planners able in principle to foresee future problems, whereas such planning at a national level was little known in 19th-century Europe.

B6) *Governmental ability to permeate subnational linguistic/cultural barriers.* Evidence from the Princeton European Fertility Study demonstrates the importance of subnational linguistic/cultural barriers in limiting or delaying the spread of the European demographic transition. Unlike much of 19th-century Europe, most modern developing countries have the administrative and technological infrastructure (for example, central planning and administration, widespread publication in multiple languages, improved transport, telecommunications, radio and TV, and postal systems) to enable them to better permeate such barriers.

B7) *International assistance.* The present availability of international assistance (via the United Nations and other agencies) means that governments of developing countries may call upon substantial outside resources and expertise. Such assistance, if employed properly, can reduce delays in development processes which might otherwise result from indigenous shortages of capital, materials, technology, and know-how.

B8) *More rapid pace of fertility decline.* Kirk (*18*) and Beaver (*19*), among others, have noted that countries that *have* experienced fertility declines in recent decades have shown a more rapid pace of decline than in 19th-century Europe. This phenomenon may be attributable to varying combinations of the factors described above, especially more rapid development, sharper declines in mortality, greater governmental interest and capability, and the availability of effective contraception and safe abortion and sterilization.

Summary and Conclusions

When the available data on the 19th-century decline in European fertility are analyzed on a systematic basis, some major propositions of transition theory are empirically supported, but only those at a high level of generality. From a broad macrohistorical view it is correct to say that in the two centuries from the mid-1700's onward there were widespread and substantial declines in marital fertility which were associated with major social and economic transformations in European societies. However, the more specific and explanatory propositions derived from transition theory cannot explain all of the salient features of the European experience. In particular, the theory fails to explain fundamental phenomena such as variations in pretransition levels of fertility and in the timing of onset and the pace of the fertility decline which eventually became universal.

A recent study suggests that transition theory can achieve a similar moderate level of success in Latin America, especially when the traditional theory is substantially modified and additional causal variables including cultural factors are introduced. Once again the (modified) theory achieves considerable predictive power at a high level of generality—those Latin American countries with relatively high levels of development are more likely to experience the beginning of fertility decline than others. Again as in the European case, however, little success is achieved in predicting the timing of onset and the date of progress of fertility decline on the basis of transition theory (*20*).

Hence at high levels of generality the basic causal structure of transition theory appears sound. When the process of development is carried to the high levels achieved in Europe and some parts of Latin America, it appears to be sufficient to establish the preconditions for a natality decline. It cannot, however, be said to be necessary to this end, for these preconditions also arose in contexts of quite low social and economic development.

The substantially different socioeconomic and demographic characteristics of modern developing countries leave little doubt that their patterns of fertility decline will differ markedly from those of Europe. Still, there is no reason to think that a *high* level of development will prove to be any less sufficient or any more necessary for the establishment of the preconditions for fertility reduction; indeed, there is already good evidence that fertility declines have occurred in areas of both high and low development.

It must be recognized, however, that the high levels of development of Europe and parts of Latin America are not a realistic prospect for many developing countries, at least over the next few years or decades. When transition theory is applied to such circumstances, it fails to provide adequate answers to two questions of fundamental scientific and policy significance:

1) Sufficiency: Will the moderate levels of development to which many developing countries can realistically aspire in the medium-term future be sufficient to establish the preconditions for "natural" fertility decline?

2) Timeliness: If such declines do occur, will they occur soon enough and at a pace rapid enough to compensate for the sharply increased pace of mortality decline and higher initial fertility levels of these countries as compared with transitional Europe?

The current international debate hinges on these matters of sufficiency and timeliness. Those arguing that development will "take care of" population believe that development is sufficient (and also necessary) to bring about adequately prompt fertility reductions at an acceptable tempo. Those arguing in favor of voluntary population policies and programs—as additions to, not substitutes for, maximal efforts in the development sphere—emphasize the importance of development but doubt its sufficiency and timeliness for many countries, and hence call for direct efforts to enhance and accelerate its demographic impacts. Those urging coercive population policies accept the significance of development, approve of policies encouraging voluntary restraint, but hold that both of these are neither sufficient nor adequately rapid to meet the pressing need. All agree with the general proposition of transition theory that high levels of social and economic development will eventually have important downward effects upon fertility. Hence the structure of these theoretical postures is pyramidal, with each finding scientific support in different aspects of the same basic orthodoxy.

If this be so, it may well be asked why the debate about the modern relevance of transition theory is so strident, so lacking in scientific objectivity. The answer is the familiar one of politics, for over the past decade population has willy-nilly become an important issue of international affairs. In this arena, perspectives deriving from political rather than scholarly

considerations have been wrapped in the scientific mantle of transition theory.

The politicization of population issues is, in principle, not a bad thing. Indeed, if policies are to be considered, it will have to be done via the political process. But politicization is not a friend of science, particularly when, as with transition theory, the empirical evidence is ambiguous and may be interpreted as supportive of diverse political perspectives (*21*). At present in the field of population policy, decisions must respond primarily to political priorities and constraints rather than to the demands of scientific validity. In particular, it is clear that there is great political virtue in a simplistic interpretation of transition theory asserting that in all circumstances development will "take care of" population matters. Nonetheless, scientists are obligated to report that close examination of transition theory in both historical and modern perspective shows that policy-makers would be ill-advised to adopt such a simplistic and deterministic view (*22*). In dealing with the intertwined issues of population and development, the challenge facing both scientists and policy-makers is to gain greater understanding of the processes of the demographic transition in their full subtlety and complexity and thereby to seek a more informed basis for policy.

References and Notes

1. An extensive report on the Bucharest debates is presented in W. P. Mauldin, N. Choucri, F. W. Notestein, M. S. Teitelbaum [*A Report on Bucharest* (Population Council, New York, 197 → *Stud. Fam. Plann.* **5**, 357 (1974)]. For a discussion of the bewildering variety of extant positions on population and development, see M. S. Teitelbaum [*Foreign Aff.* **52**, 742 (1974)]. The importance for policy of theories on the relation between fertility and development is discussed in H. Leibenstein [*Int. Labour Rev.* **109**, 443 (1974)].
2. The term "theory" is used in a qualified manner throughout this article, since it can be argued that the theory of the demographic transition is not a theory in a strict scientific sense.
3. The generalizations of transition theory developed gradually from the work of a number of scholars, including W. S. Thompson [see *Am. J. Sociol.* **34**, 959 (1929)] and A. Landry, A. M. Carr-Saunders, F. W. Notestein, and C. P. Blacker [see citations in D. V. Glass, in *Public Health and Population Change*, M. C. Sheps and J. C. Ridley, Eds. (Univ. of Pittsburgh Press, Pittsburgh, 1965), pp. 13–14]. More extensive summaries of the theory are presented by F. W. Notestein [in *Proceedings of the Eighth International Conference on Agricultural Economics* (Oxford Univ. Press, London, 1953), pp. 15–31] and by G. J. Stolnitz [in *Population: The Vital Revolution*, R. Freedman, Ed. (Doubleday-Anchor, New York, 1964), pp. 30–46].
4. The adoption of this idea is not uniform across all segments of society. It is usually embraced initially by the elite, whose social situation makes them better aware of the changing social milieu and who also have greater access to knowledge of methods required for reasonably effective fertility control.
5. See, for example, the discussion in Notestein (*3*), pp. 22–23.
6. A. J. Coale, in *Proceedings of the IUSSP International Population Conference* (International Union for the Scientific Study of Population, Liège, Belgium, 1973), pp. 53–72.
7. R. E. Frisch and J. W. McArthur, *Science* **185**, 949 (1974).
8. The evidence on this subject has been reviewed → J. Knodel and E. van de Walle [*Popul. Stud.* **21**, 109 (1967)]. They report that in their German data the high correlation between breast-feeding and fertility nearly disappears when statistical control is provided for infant mortality, thereby raising some doubt as to the demographic impact of lactation practices.
9. See, for example, the following: N. E. Himes, *Medical History of Contraception* (Williams & Wilkins, Baltimore, 1936); P. Demeny, in *Population and Social Change*, D. V. Glass and R. Revelle, Eds. (Arnold, London, and Crane, Russak, New York, 1972), pp. 153–172; D. E. Dumond, *Science* **187**, 713 (1975); and D. E. C. Everseley, in *Population in History*, D. V. Glass and D. E. C. Everseley, Eds. (Aldine, Chicago, 1965), pp. 46–52.
10. See J. Hajnal, in *Population in History*, D. V. Glass and D. E. C. Everseley, Eds. (Aldine, Chicago, 1965), pp. 101–143.
11. The so-called "threshold hypothesis" [supported in *Popul. Bull.* **7**, 134 (1963)] was also found to be wanting when subjected to the empirical test of European data [see E. van de Walle and J. Knodel, in *Contributed Papers of the IUSSP Sydney Conference* (International Union for the Scientific Study of Population, Liège, Belgium, 1967), pp. 47–55]. It must be emphasized that, although very high levels of development appear to be sufficient to establish the preconditions for marital fertility decline, such declines do not necessarily ensue. For example, in Central Asian republics of the U.S.S.R. such as Tadzhik S.S.R., Turkmen S.S.R., and Uzbek S.S.R., high levels of marital fertility have persisted up to 1970, and indeed the 1970 levels may be higher than those of 1926 (A. J. Coale, personal communication).
12. See the discussion of these possibilities in R. Freedman [*Popul. Index* **31**, 425 (1965)]. A recent publication presents an interesting attempt to apply transition theory on a retrospective basis to Latin American data [see S. E. Beaver, *Demographic Transition Theory Reinterpreted* (Lexington Books, Lexington, Mass., 1975)].
13. For example, under the two alternative assumptions described, by the year 2050 the population of Nigeria would have increased by 108 and 205 percent, that of Bangladesh by 125 and 248 percent, and that of Mexico by 118 and 229 percent, respectively [see Teitelbaum (*1*), pp. 747–749].
14. See, for exam → K. Davis [*Popul. Index* **29**, 345 (1963)].
15. In addition, the patterns of urbanization observed in some developing countries differ in several important respects from those in other developing countries and in 19th-century Europe, and hence urbanization may not represent the same force for value change in all cases. See, for example, the discussion in *The Determinants and Consequences of Population Trends* (United Nations, New York, 1973), vol. 1, pp. 97–98. See also S. Kugnets, *Proc. Am. Philos. Soc.* **118** (No. 1), 1 (1974).
16. The population policy of the People's Republic of China apparently places great emphasis upon increasing age at marriage [→ A. Faundes and T. Luukkainen, *Stud. Fam. Plann.* **3**, 172 (1972); J. S. Aird, in *People's Republic of China: An Economic Assessment* (Joint Economic Committee, Congress of the United States, Washington, D.C., 18 May 1972, 92nd Congress, 2nd Session), pp. 301, 316].
17. See Mauldin *et al.* (*1*), p. 392.
18. D. Kirk, in *Rapid Population Growth* (National Academy of Sciences, Washington, D.C., 1971), pp. 123–147.
19. See Beaver (*12*), p. 89.
20. See Beaver (*12*), especially pp. 145–152. Unfortunately this study of Latin American fertility patterns does not separate the effects of nuptiality from those of marital fertility, which may raise problems in dealing with some Latin American data. The level of analysis is also highly aggregated, that is, the nation-state as opposed to the province-level employed in the Princeton studies of the European fertility decline.
21. Scientists have had much experience with the facile application of inadequate evidence to social policy for political reasons. One need only mention the cases of social Darwinism, eugenics, and Lysenkoism, and the more recent excesses on subpopulation differences in intelligence.
22. Indeed, it may be argued that no current theory of fertility decline provides definitive guides to policy. For a discussion, see T. K. Burch, *Soc. Order*, in press.

23. I gratefully acknowledge the helpful comments of many colleagues, who unfortunately are too numerous to mention individually here. The European Fertility Study of the Office of Population Research, Princeton University, is supported by the National Institute of Child Health and Human Development.