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Fertility Patterns of the Transition Onset: Insights of the Living Standard Model*

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A simple model of the living standard constraint upon fertility within a development context provides insight into fertility rate behavior over the transition from high to low rates. Explanation is given for situations where rates fluctuate and then increase to peak levels prior to declining, influencing population burgeoning. This rise prior to decline is well-documented but not explained in the literature, although proximate causes such as marriage age changes are noted. The strength and continuity of growth rates in per capita income and its distribution (a different experience than pre-World War II economies had) are related to fertility behavior today. Using data from 1960-88 for 27 countries, a strong relationship is found between percentage declines in birth rate and rates of per capita income growth as predicted by the model. The model is, of course, not a complete theory of fertility, nor does one exist.

I. Introduction

Increasingly attention has been focused on two aspects of the early stages of the transition from high fertility rates to low ones. First, prior to the transition to a downward trend, birth rates fluctuate widely, showing swings from peaks to troughs of as much as 20 points. Second, fertility rates may show a fairly prolonged increase to peak levels prior to the transition, starting from rates well below those found in natural fertility regimes. Latin American countries in particular show evidence of this (T. Dyson and M. Murphy, 1985). Thus, mortality declines are not the only cause of disproportionate population growth accompanying the transition.

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Moreover, transition to low rates is not uniformly associated with a similar modernization or development level (C. Scott and V.C. Chidambaram, 1985; Ansley Coale, 1979). Currently no explanation exists of why reproduction rates fluctuate prior to transition, with trough rates well below most natural fertility regimes, and why they may rise to a pronounced peak from lower rates prior to the transition to secular declines.

II. The Living Standard Concept

Interestingly, insights can be gained from one of the oldest ideas about fertility: the living standard concept. Parents refrain from having additional children if doing so would threaten lifestyle norms. Dennis Hodgson has surveyed the history of this idea and how it was superceded by the theory of the transition attributed to Kingsley Davis, Frank Notestein, and others working at Princeton's Office of Population Research in the 1930's and 1940's (D. Hodgson, 1983). However, the later theory has not held up well under the light of more robust data sets, and does not deal with behavior patterns of transition onset. On the other hand, the living standard concept as modified by Richard Easterline gives insight.

Richard Easterline introduced the idea that growth, which raises experienced living standards for the next generation's parents will create new norms and, along with incomes of that generation, greatly affect fertility changes (R.A. Easterlin, 1968, 1969). The concept is incorporated into a general theory of the demographic transition developed by Easterline, R.A. Pollak and M.L. Wachter; however it is not central to their explanation of transition onset (R. Easterline, R.A. Pollak and M.L. Wachter, 1980). Rather they explain the rise in fertility at the onset as caused by a relaxation of supply-side constraints. They assume there is a preference for large families in natural fertility regimes. They also assume that poor health and nutrition among the masses in impoverished less developed countries restrict conception, so that in most households desired family size falls short of reproduction levels. Development improves health and nutrition, causing fertility rates to rise at transition onset. Eventually they fall because parental tastes for large families is assumed to be an inverse function of the parents' per capita income level. As per capita income rises, more and more families restrict fertility, eventually setting in motion the downward trend in fertility.

Problems arise with this explanation. Disease outbreaks and nutritional shortfalls sufficient to restrict conception tend to be sporadic in less developed countries. In natural fertility regimes showing no evidence of pre-transition fertility movements, such as exist in most African countries, birth rates are persistently high (in the 40's and 50's), and generally fluctuate within narrow limits, according to U.N. and World Bank data. They cannot rise from such high levels by a large increment at transition onset.

In fact, the Dyson-Murphy data show there is a pre-transition stage that is distinct from the natural fertility stage, and that it eventually leads to the upswing at the onset of transition (T. Dyson and M. Murphy, 1985, 416-17). Countries in this stage show incidence of lower birth rates than those of natural fertility regimes, amidst swings of greater duration and amplitude. And prior to a continuous downward trend, birth rates show a pronounced upward movement from rates below those in natural fertility regimes, often reaching new highs. Supply-side factors such as sporadic outbreaks of disease or acute malnutrition cannot be expected to last as long as these pre-transition fertility swings, or to produce flctuations as high as 20 points in birth rates. Moreover, evidence does not support the Easterline-Pollak-Wachter hypothesis that continuous improvements in health and nutrition are behind the onset upswings (R. Gray, 1983; J. Bongaarts, 1980; J. Menkin, T. Trussell and S. Watkins, 1981).

A model is developed here drawing on the original Easterlin concept of experienced living standards that can explain the fertility patterns described as well as the transition to a pronounced downward trend. The explanation will be related to the following conditions:

1. Gradual replacement during pre-transition of natural fertility households by ones which control births in order to maintain living standards. This initially lowers birth rates and then, as control households dominate, the stage is set for swings of 10-20 points when income also fluctuates.
2. Phases of tightening and easing of income constraints by sizeable amounts in pre-transition caused by non-continuous, uneven growth patterns of less mature economies.
3. The possibility of a strong, prolonged, even accelerated, upswing in output and income associated with a broadened development base occurring at transition onset when a large majority of households control fertility, and most have lifestyle norms above past generations.

Generally, the model shows that ongoing increase in norms across more and more households eventually set the stage for continuous fertility declines commonly associated with the demographic transition. While the model is partial in the sense that it concentrates on just the economic aspects of fertility determination, its powers to explain the more recent empirical findings are quite strong and therefore of interest.

III. Background

Consider an economy with a positive average annual rate of increase in GNP per capita over a secular growth span. Even when growth is not interrupted the development process does not raise all family incomes in lockstep with changes in the economy's income. Different sectors, geographic areas, skill specialities or even industries are favored at different periods. Not all families share in prosperity, and those receiving income increments do not receive equal amounts. Most importantly, income growth may or may not accrue proportionately to the set of households which are in their most fertile years. The sharing of income among extended families will not offset completely the distribution of growth proceeds among fertile and infertile households. Incomes of fertile households through generations working in similar or new occupations, then, do not necessarily show a line of continuous growth or closely track the average change for the economy. And as the standard of living rises, the absolute increment to income necessary to support another child at the new standard also increases, so that even where income rises it may be insufficient to allow for an increase in family size.

Families of each generation will strive to maintain their lifestyles by adjusting their fertility when income levels fluctuate. However, mature couples raising their children can experience unusual growth in their incomes and be unable to adjust their total fertility upward greatly. Households often experience peak income growth at that stage of their lives. When this occurs, lifestyles rise, setting the stage for a new living standard norm for the next generation. In turn, norm changes affect fertility.

The interrelationship between average growth rates and lifestyle norms as they affect aggregate fertility is now examined with the help of a simple multi-period model. The analysis assumes all other basic variables affecting fertility are unchanged. And the form of birth control is left open.

IV. The Model

There are two sets of households: those that control fertility to maintain living standards, and natural fertility households which do not control fertility. Fertility rates for the latter set are assumed constant at levels determined by "supply-side" variables such as lactation, practices, sex taboos, etc. I now present a model that determines changes in the fertility rates of control households.

Express the set of household norm incomes for newly fertile couples at time t as: $A_t = \{a_t : a_t > 0\}$. Norm incomes are those needed during child-raising years by newly fertile couples to attain the lifestyle expeienced in their teenage year if the woman has the same fertility as her mother. (Where lifestyle experiences of mates differ, assume the higher standard prevails.) Groups of families experiencing similar lifestyles in the past will have similar norms so that their norm-sustaining incomes, that is the elements of set A_t, will cluster.

It is helpful to compare past and current norms. Mother and father are descendants of households of earlier generations (stem households of time zero). The term stem household is now defined as the parent's lineal household with the higher norm at time zero, so that each current household's norm is compared with only one stem household norm. Norm incomes, of course, must be compared in constant prices. Each current household's norm income $\{a_t\}$ can be mapped onto norm incomes of a stem household $\{a_o\}$ in set A_o, which, of course, contains fewer households. The stem household paired set $A_t \rightarrow A_o = S_t = \{(a_o, a_t): a_o \in A_o, a_t \in A_t\}$.

Let C_t be the set of household incomes available to each newly fertile couple over their family-raising years when these begin at time t. Elements of C_t for each household $\{c_t\}$ can be paired with $\{a_t\}$ for the same household to form a set of ordered household income pairs, $D_t = \{(a_t, c_t): a_t \in A_t, c_t \in C_t\}$. When the pairs are plotted on a graph with $\{c_t\}$ on the vertical axis and $\{a_t\}$ on the horizontal, then any households that plot below the 45° line will face an income constraint that will lower their lifestyle if fertility is the same for the newly fertile as for the previous generation. Those women in households above the 45° line can have higher fertility than their mothers and retain their experienced lifestyle.[1]

Now let B_t be a subset of A_t. The elements $\{b_t\}$ are the norm incomes of newly fertile couples in set A_t who experienced higher lifestyles than the families of time zero from whom they descended: $B_t \subset A_t$: $B_t = \{b_t: b_t \in A_t; b_t = a_t > a_o \text{ stem households}\}$. The elements of subset B_t will include more above-model than below-model lifestyle income norms. As growth proceeds more norms of set A_t exceed those of stem households in A_o. And as the constraint ($a_t > a_o$ stem households) changes so does subset B_t. This subset will include more and more of the higher elements of set A_t. This results in the norm-income pairs $\{(b_t, c_t) \in D_t\}$ having a greater chance of falling below the 45° line, given the development-generated pattern of in-

[1] If fertility is not controlled within marriage, then age of union is varied. This changes set A_t, for each t, and thereby aggregate fertility.

comes over time. As the plotting of all households moves clear to the 45° line and below, measures of aggregate fertility drop. But in early phases of growth, aggregate fertility may readily rise as the income constraint on households eases (L. Donaldson, 1991).

V. Role of Natural Fertility Declines

The model deals with households that control fertility. Of course societies move from natural fertility to controls. Natural fertility households have consistently high fertility rates which do not vary with income. Their relative importance must decline in order for overall birth rates to produce large fluctuations such as those of the pre-transition stage. They will continue to fall as transition gets underway, eventually becoming insignificant. In the process of doing so, they affect the behavior of overall birth rates.

Households are assumed to control fertility once their socioeconomic conditions improve to the point that their lifestyles appear sustainable. When additional children threaten living standards, they will restrict their family size. This can occur under agrarian development as well as industrial transformation, and at various levels of per capita GNP. In the pre-transition stage, the economy gradually gains in technical and institutional capacities, but lifestyle security does not extend to all houeholds. The percentage of households attaining more secure socioeconomic conditions varies with the eveness of development, with the degree of dualism (D. Donaldson, 1991). The rate of decline of natural fertility households is now set as a function of the economy's growth rate. In other words, it is assumed that the needed social changes accompany this growth so that lifestyles become more secure for more households.

VI. The Model under Different Growth Patterns

Several stylized growth scenarios are introduced and associated with norm changes and changes in the relative number of natural fertility households. The first two scenarios create a smooth progression toward transition onset, while the third explains pre-transition fluctuations. Before introducing the decline in natural fertility households, the behavior of birth rates for A-set households is examined by tracing a limited number of sets of newly fertile couples beginning at different time periods identified by subscripts 0, 1, 2... as in A_o, A_1. In period zero B_o is a null set. Set A_o exists within a dominately natural fertility regime with high overall birth rates.

The first case is that of a constant, uninterrupted growth rate in labor productivity where a percentage of A-set households each period receive higher incomes. The growth eventually creates the potential for rising, then falling fertility as an ever-enlarging subset of households (B_t) experience higher lifestyles. In period one, growth elevates a percentage of the populace with complete or nearly complete families to a higher lifestyle experience as their labor hours attain more goods. Couples in this group are not at the age to have many more children. Teenagers in such households who become parents in period two will have higher living standard norm incomes (subset B_2). Whether or not their fertility is greater than, equal to, or less than that of their parents in set A_1 depends on the level of their own and their spouse's labor productivity and hence household income over their fertile years compared to the one-time increase in norms.

Assume income increases in period two are not disproportionately distributed to households of subset B_2. Some households experience the same or lower income than their parents. Fertility for households in subset B_2 will be lower on average than for families in (A_2–B_2) because norms are higher. Even though fertility for some households in subset B_2 will fall, relatively few households in set A_2 belong to subset B_2. Since incomes are higher for these households with unchanged norms, their fertility rises.

The overall fertility rate will be falling because of the downward bias created as growth reduces the relative size of natural fertility households (plus the decline of fertility in some households of A_2). This sets the stage for growth in a subsequent period to be correlated with fertility upswings from levels below natural fertility rates.

In period three, newly fertile couples in subsets B_3 can be children of any households in set A_2. Constant rates of growth set the stage for rising norms in a percentage of lower and higher norm households. As a result, the proportion of couples in set A_3 having higher norms than those of period zero enlarges as growth continues. Moreover, set A eventually becomes the dominant force in fertility changes as growth diminishes the relative position of natural fertility households. This set the stage for fertility to rise when growth relieves the income constraint on lower-norm households.

Eventually, as norms continue to rise, fewer and fewer couples experience norms of A_o households and more and more experience norm increase from high lifestyle bases. The higher the norm, the larger the income increment needed to support another child. Thus, even with a constant growth rate in income, the number of children per household drops since only a percentage of households each period experience higher income; yet each period the number and the level of their norms is higher. Thus the downswing of pre-transition birth rates and upswing of transition onset is followed by transition's downward trend.

Higher rates of continuous growth will quicken the pace of increases and declines of A-set fertility. At onset, rises in fertility rates from pre-transition lows can occur at a faster pace, reaching peak levels earlier. However, norm levels per period for all households in subset B_t will be higher. Thus, when such households do not share in growth they will lie further below the 45° line. As subset B_t enlarges, the rate of decline in fertility will be quicker since norms are higher with more rapid growth. On the other hand, with very low growth rates, norms will adjust upward only very gradually. Lifestyles do not rise significantly for many and their norms remain the same. Transition will eventually occur if growth is steady, but its onset will be prolonged. Obviously, there can be periods under rapid and slow growth rates where A-set households above and below the 45° line offset each other's impact on the fertility rate.

Second, consider a situation of a transition onset with a continuously accelerating growth in labor productivity. In period one the growth rate is the same as case one, but rises each period thereafter. Norm levels will be higher per period compared to case one, but so will incomes. The income constraint will be lessened since household incomes are increasing more rapidly throughout the fertile years, while norms change only once per generation. Fertility in its rising phase will go higher, but eventually shows similar downward progression, given realistic assumptions about the rate of income acceleration. The probability that fertility rates will rise in earlier periods is stronger here than in case one.

The third case gives insight into fertility fluctuations found during pre-transition by assuming that growth is interrupted. Growth in period one creates a subset B_2 and is followed by stagnation in period two. Fertility in period two will fall modestly from period one for A-set households since families of subset B_2 as a whole will have fewer offspring, while the number of children will remain more or less constant in the households with unchanged norms. In general when growth is interrupted, the downward adjustment in birth rates will be greater the more households in set B_t relative to A_t. Fertility will remain depressed for control households until growth resumes. Interrupted growth slows the rate at which norms rise; and if prolonged periods of stagnation occur, norms in some households can fall. It creates a one-time fall in fertility as movement occurs from positive to zero growth. When growth resumes, constraints are eased and birth rates move upward for a A-set households.

Stagnation during pre-transition will also slow the downward bias from reductions in natural fertility households, placing a floor under the decline of overall birth rates. Thus fertility falls less the larger the percentage of such households. In fact, if stagnation is prolonged, the percentage of natural fertility households rises since their fertility is uncontrolled. Progression toward transition onset will be slow on average in the case of interrupted as opposed to constant growth since natural fertility households decline more slowly, and subset B_t will tend to include relatively fewer households of set A_t for similar time spans. Interrupted growth with negative movements in GNP would create even more pronounced fluctuations in fertility rates.

Income distribution is also important to the behavior of fertility since it determines the dispersion of $\{a_t, c_t\}$ around the 45° line. If, starting in the pre-transition phase income growth is concentrated in a very few sectors and/or higher-income households, the rest remain natural fertility households. Moreover, the households in subset B_t will be relatively small. This will moderate rises in lifestyle norms and slow the decline in fertility for a given growth rate. It is common for inequality to worsen, then lessen as development proceeds (H. Chenery, *et al.*, 1974).

The fact that fertility declines in LDC's are slower in agriculture and for those more recently migrating from rural areas (M. Haines, 1979; R. Repetto, 1979) is explainable by their relative income experiences. Growth in income per capita in agriculture is more moderate than growth in other sectors, and subject to high fluctuations due to various causes, including weather and blight. Recent migrants from rural areas will arrive in urban areas with lower norms and experience income growth in most cases. The lessened income constraint results in their fertility being higher than longer-term urban residents with higher norms. Of course, as has long been noted, children may be cheaper to support in rural than urban areas for a given living standard, and may more readily contribute to their own upkeep. For a given rise in norms for urban households, then, the income constraint is somewhat more binding.

VII. Summary and Implications of the Model

The fact that there is no simple monotonic relationship between income levels or development levels and fertility rates over the transition has long been noted in the demographic literature (E. Mueller and K. Short, 1983). The living standard concept as modeled here shows the complexity of the relationship and can explain pre-transition swings, rises in fertility at onset and continuous declines after onset. While the model probes a fundamental idea from fertility literature, it is not designed to be a complete theory of fertility, nor does one exist.

In pre-transition, birth rates fluctuate widely as compared to natural fertility regimes, reaching rates well below natural fertility, but also approaching these levels again. In the models the stage is set for such fluctuations initially by the downward movement in overall birth rates as the relative number of natural fertility households falls. The emerging dominance of control households requires sufficient development to create more secure living standards. At first norms are modest, but they move higher when experienced lifestyles are above those of the previous generation. While pre-transition and rising lifestyle norms are associated with growth, not all households share in growth, and periods of stagnation or slowed growth are also possible. Once control households dominate, the easing and tightening of income constraints for established norms caused by interrupted growth will give rise to broad fluctuations in fertility rates. However, as norms gradually rise over generations the model shows that more and more households are constrained by income even though growth continues, causing the transition to a downward fertility trend.

Sequential combinations of the stylized growth cases discussed could produce fertility patterns similar to those identified in the paper by Tim Dyson and Mike Murphy (1985). In particular, the major finding — that fertility often rises to its highest peak prior to the onset of the demographic transition to low rates — is readily derived from situations of constant or accelerating growth, or by periods of strong growth followed by a slowdown in its rate of increase. The strength of the rise and pace of decline would be greater the stronger the growth phase. Figure 1 illustrates transition onset with different growth cases as well as pre-transition and natural fertility regimes.

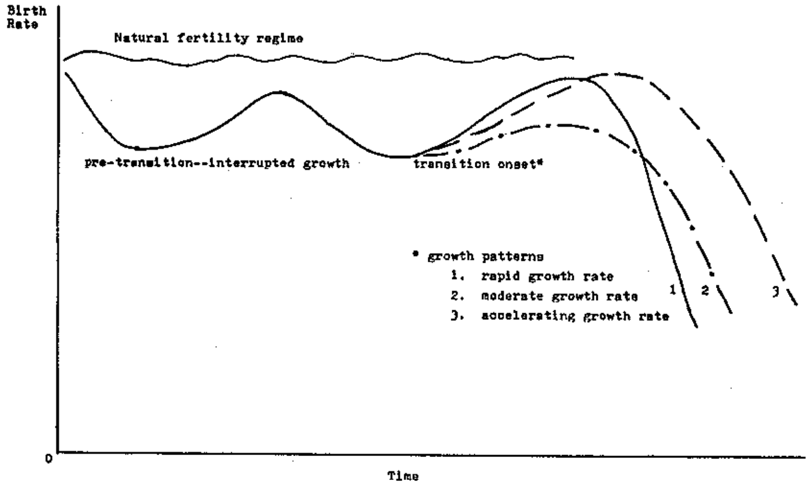
Finally, real world conditions needed to produce patterns found by Dyson and Murphy exist. Development literature has long noted that interrupted growth is common among economies at earlier stages of development (R. Dorfman, 1991; World Bank, 1991, Ch. 6). Also, there is a stage of development that can produce a strong, sustained upswing in income per capita as the economy diversifies, absorbs new technology more rapidly, develops physical and human capital at a strong pace, and reaps scale economies as markets enlarge (L. Donaldson, 1984, Chs. 1, 12). The next section presents supportive evidence from countries experiencing pre-transition and transition over the 1960-88 period.

VIII. Empirical Applications

Cross Country. Table 1 gives data on birth and infant mortality rates as

Figure 1

GROWTH PATTERNS AND FERTILITY BEHAVIOR



well as GNP per capita for countries in transition for the period 1960-88. Generally countries included in Table 1 had declines in crude birth rates over the 1960-88 period from high levels to rates in the 20's or below. In three cases, declining rates fell to 30-31 in 1988 — Dominican Republic, Venezuela and the Philippines. In four cases, Hong Kong, Singapore, Jamaica and Sri Lanka, birth rates were in the mid-to-high 30's in 1960 rather than the mid-to-high 40's, suggesting transition was underway prior to 1960. The countries are listed in descending order of the magnitude in percentage terms of their 1960-88 birth rate declines (column four). This ordering does not correspond to their rankings by per capita GNP or development level. Infant mortality rates for 1988 show a range from 7 to 68 per thousand. In all cases rates were much higher in 1960 (column 7).

The relationship between percentage declines in crude birth rates and average annual growth rates for 1960-82 and 1968-88 is strong. There are only two outliers — Brazil and Jamaica. As predicted by the model, transition countries with sluggish growth — Venezuela, Trinidad, Tobago, and Chile — showed lower declines. So did Brazil, a dualistic economy with relatively high infant mortality rates, which experienced large fluctuations in year-to-year growth rates of income per capita, with some very high peak-growth years that contributed to a high overall growth rate relative to her birth rate decline.

Table 1

TRANSITION COUNTRIES
Crude Birth Rates, Infant Mortality Rates,
Per Capita GNP, 1960-88

Country	Per Capita GNP $ 1988	Crude Birth Rate 1988	Infant Mortality Rate 1988	% Decline Crude Birth Rate 1960-88	Average Annual Growth Rate Per Capita GNP		% Decline Infant Mortality Rate 1965-88
					1960-1982	1965-1988	
1. Korea	3,600	16	24	63	6.6	6.8	69
2. Hong Kong	9,220[a]	14	7	60	7.0	6.3	81
3. Singapore	9,070	18	7	54	7.5	7.2	80
4. Thailand	1,000	22	30	50	4.5	4.0	71
5. Mauritius	1,800	19	22	47[b]	n.a.	2.9	66
6. Indonesia	440	28	68	45	4.2	4.3	55
7. Colombia	1,139	26	39	45	3.0	2.4	58
8. Costa Rica	1,690	27	18	44	3.2	1.4	76
9. Jamaica	1,070	23	11	41	2.1[c]	-1.5	79
10. Sri Lanka	420	22	21	39	2.4	3.0	70
11. Mexico	1,760	28	46	38	2.6	2.3	49
12. Panama	2,120	26	22	37	3.3	2.2	68
13. Domincan Republic	720	31	63	37	3.2	2.7	48
14. Brazil	2,160	28	61	35	4.8	3.6	48
15. Venezuela	3,250	30	35	35	2.9	.9	59
16. Philippines	630	31	44	34	2.8	1.6	58
17. Trinidad & Tobago	3,350	26	16	32	3.0	.9	64
18. Chile	1,510	23	20	32	.6	.1	83

a) GDP
b) 1965-88
c) 1960-77
Source: World Bank, *World Development Report 1980, 1984, 1990.* N.Y.: Oxford University Press.

The second outlier, Jamaica, showed relatively declines in birth rates, given her growth performance. She is the only country experiencing interrupted growth with negative changes in average per capita GNP (1965-88). Her birth rate decline was already underway by 1960. She had one of the largest percentage declines in infant death rates, and her 1988 rate is the third lowest rate behind Hong Kong and Singapore. The model predicts that continued stalled growth in Jamaica will lead to a stalled transition.

Three other countries in Table 1 are noteworthy. Mauritius served as a conduit for trade with South Africa during the boycott period. General conjecture is that her growth performance is understated because of unrecorded trade. Colombia generally has sizeable unrecorded transactions also, which are traceable to drug trade. Costa Rica had somewhat higher birth rate declines than would be predicted by her growth rates. She is noteworthy for her prenatal programs which have helped reduce her infant mortality rate greatly to relatively low levels. Sri Lanka is also exceptional in her social programs affecting fertility.

Another group of countries showed characteristics of pre-transition but less strong indications of fertility transition. Their crude birth rates dropped to the 30's between 1960-88, and they had growth rates of GNP per capita in the moderate to lower ranges. They showed similar patterns to transition countries in that the lowest percentage declines in birth rates occurred among countries experiencing less growth. In moderate growth countries fertility declines either stalled out or declined from high levels starting later in the 1960-88 period. Thus the fall of crude birth rates in percentage terms for this group averaged about eight points less overall for similar growth performance. They also experienced lower rates of declines in their infant mortality rates. These countries are now discussed.

El Salvador, Hondruas, India and Peru saw crude birth rates decline by 24, 25, 28 and 34 percent, respectively, between 1960-88. All experienced poor or disrupted economic conditions resulting in very modest increments to per capita GNP. The decline in birth rates in Honduras did not begin until the 1970's and her rate was a relatively high 39 in 1988. Strong growth, should it occur, could lead to rising fertility in these pre-transition economies, as happened in Paraguay. Infant mortality rates have declined to below 100, but remain high in these areas.

Ecuador, Tunisia, Turkey and Malaysia show declines in their birth rates of 30-34 percent from 1960-88 to the low 30's. All had growth rates of per capita GNP in the 3-4.5 percent range. Their infant mortality rates, while greatly reduced since 1960, remain relatively high except for Malaysia, where it dropped to 23. Declines in birth rates in Turkey, Malaysia and Tunisia stalled out between 1977-88. Egypt grew at 3.5 percent between 1960-88, but experienced a more modest decline of 25 percent in her birth rate, which also stalled out, declining only 2 points between 1977-88 from 36 to 35 per thousand. The model shows that, given ongoing growth in pre-transition, stalled rates may follow declines when the declines were do to the dwindling of natural fertility households from levels of dominance. Once control households dominate, there can be offsetting effects on birth rates, given modest norms. Growth eases income constraints, offsetting the negative effects for a period of norm rises and the continued decline of the remaining natural fertility households. Stronger growth could lead to rises in birth rates in these countries.

Over the 1960-88 period many countries remained natural fertility regimes. As expected from the model, predominately natural fertility regimes with birth rates in the 40's and 50's do not exhibit the growth-rate-birth-rate relationship of pre-transition and transition countries. Their birth rates remain high in the face of large or small changes in GNP per capita and declines in infant mortality rates. While the majority of these countries had very low incomes per capita, many did not.

Time Series. The data on reproduction rates vary in quality among countries. Conceptually, fertility rates are superior to birth rates, although these too are subject to error. Time series data for fertility rates are incomplete or do not exist for all but a few of the countries in Table 1. Data for ten or more years during the period 1960-85 were available for six transition countries. These data allow a time series confirmation of the relationship between rates of growth of per capita GDP and the percentage change in fertility rates, using a more refined measure of reproductive behavior. The use of GDP was dictated by data availability and is a statistically acceptable substitute for GNP.

The OLS regression is in log form, with per capita GDP and the infant mortality rate (both lagged two years) as independent variables. The coefficient of a log-linear equation is an elasticity coefficient. Thus in the case of GDP per capita its coefficient is the percentage change in fertility rates over the percentage change in GDP per capita. Results are given in Table 2.

The time series results are consistant with model predictions. The sign of GDP per capita is negative and the coefficient is significant at the 5 percent level of confidence or less except for two countries experiencing interrupted growth. The model indicates that stagnation tightens constraints, causing fertility to drop and then remain constant. As growth resumes, fertility may rise as constraints are first eased and before norms resume their rise. Thus time series data for limited spans over which countries experience interrupted growth will not show a negative relationship between growth rates and rates of change in fertility. Such is the case for Chile and Trinidad and Tobago over the period for which data were available. Of course, when compared in Table 1 for the period 1960-88 to countries with continuous growth, they experienced lower rates of decline in their fertility and lower average growth rates, lending support to the theory.[2]

[2] Interestingly, data for the United States for 1952-88 show highly significant coefficients, with a negative sign for the median level of per capita GNP, a positive sign for the infant mortality rate, and an adjusted R^2 of .95.

Table 2

LOG LINEAR OLS REGRESSOIONS WITH FERTILITY RATES AS DEPENDENT VARIABLE
(Available Data 1960-1985)

Country	Coefficient: GDP Per Capita (lagged two years)	Coefficient: Infant Mortality Rate (lagged two years)	DW	DF	R^2 adj.
Panama	-.398**	.635**	.5	22	.69
Venezuela	-.798**	-.058	.8	12	.59
Singapore	-.630**	.154	1.1	13	.98
Hong Kong	-.204**	.236**	1.7	15	.94
Trinidad & Tobago**	.674	.552*	.4	11	.24
Chile	.047	.463**	1.0	10	.78

* 10% level of confidence.
** 5% level of confidence or less.
Sources: International Monetary Fund, *Financial Statistics Yearbook,* annual issues.
United Nations, *Demographic Yearbook,* annual issues.
United Nations, *Demographic Yearbook, Historical Supplement,* 1979.
United Nations, *Yearbook of National Accounts Statistics,* annual issues.
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