RELATIVE COHORT SIZE:
SOURCE OF A UNIFYING THEORY OF GLOBAL FERTILITY TRANSITION?

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Abstract: Using United Nations estimates of age structure and vital rates for nearly 200 nations at five year intervals from 1950 through 1995, this paper demonstrates how changes in relative cohort size appear to have affected patterns of fertility across nations since 1950 — not just in developed countries, but perhaps even more importantly in countries as they pass through the demographic transition. The increase in relative cohort size (defined as the proportion of the population aged 15-24 relative to that aged 25-59) which occurs as a result of declining mortality rates among children and young adults during the demographic transition, appears to act as the mechanism of transmission which determines when the fertility portion of the transition begins. As hypothesized by Richard Easterlin, the increasing proportion of young adults would generate a downward pressure on young men's relative wages (or on the size of land holdings passed on from parent to child), which in turn would cause young adults to accept a trade-off between family size and material well-being, setting in motion a "cascade" or "snowball" effect in which total fertility rates tumble as social norms regarding acceptable family sizes begin to change.

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As emphasized by John Caldwell (1997), we still do not possess a "unifying theory" of the global fertility transition. We tend to "treat the earlier transitions, unassisted by national family planning programs, as qualitatively different" from those occurring in the last half-century. We have not even been able to develop a unified theory covering fertility transitions in currently developing countries (Caldwell and Caldwell, 1997). Notestein's (1945) framework, commonly known as the "demographic transition", doesn't explain the wide variation in timing of the fertility transition, relative to the mortality transition, and in rates of decline.[1] The old maxim "economic development is the best contraceptive", favored by economists, has come increasingly under attack.

I will not attempt a full review of the literature on this topic, which I'm sure is familiar to most readers. The purpose of this article is simply to point out an empirical regularity in the global data that appears to have gone unnoticed, but which synthesizes two hypotheses first put forward by Richard Easterlin (1966,1978b). The first is his hypothesis that relative cohort size affects male relative wages, which in turn affect fertility: what I'll refer to as his relative cohort size (RCS) theory. The second is the "supply-demand" (SS-DD) framework for explaining fertility in developing nations.

As demonstrated in a recent review and evaluation (Macunovich, 1998a), the RCS theory has been the focus of at least seventy-six studies using developed-nation data — but has never been applied in a developing-country context. Conversely, the SS-DD framework has been adopted widely as a descriptive tool in studying the fertility transitions of the past half century, but is not generally associated with fertility patterns in the MDCs. And while the RCS theory provides a quantitative mechanism for explaining the fluctuations in demand for children which lead to fertility booms and busts, the SS-DD framework, like the theory of the demographic transition, is limited in that it does not explain *why* the demand for surviving births declines when it does. Many factors have been identified as correlated with the decline, including reductions in infant mortality, the increasing net cost of children with economic development, the gradual replacement of children as a source of old-age support, and the increased acceptance of individual control over fertility – but these seem to be necessary rather than sufficient conditions for fertility reduction. None have a good track record in terms of identifying the point of initiation of fertility decline.

The data which will be presented here suggest that the RCS mechanism applies not just in MDCs but also within the SS-DD framework, providing that missing explanation. The analysis presented here is very simplistic, given the breadth and depth of the literature on the fertility transition. But in some ways that simplicity is its best feature, for in its lack of specificity it consolidates a framework that appears to describe the genesis of fertility transitions all around the globe, as well as fluctuations in fertility after the demographic transition has been completed.

Easterlin's Relative Cohort Size Theory

"The Easterlin, or 'relative cohort size', hypothesis posits that, other things constant, the economic and social fortunes of a cohort (those born in a given year) tend to vary inversely with its relative size, approximated by the crude birth rate in the period surrounding the cohort's birth. The linkage between higher birth rates and adverse economic and social effects arises from what might be termed 'crowding mechanisms' operating within three major social institutions – the family, school and labour market. . ." This is Richard Easterlin's definition of the his hypothesis as presented in *The New Palgrave* (1987b). He goes on to describe the labor market mechanism involved: imperfect substitutability between younger and older workers, leading to a deterioration in the wages of the young relative to those of the older generation. Since "a comparison between younger and older adults of the type just given translates into a comparison of children with their parents", and ". . .if parents' living levels play an important role in setting their children's material aspirations. . .then an increase in the shortfall of children's wage rates relative to parents, will cause children to feel relatively deprived and under greater pressure to keep up."

He hypothesized that this deterioration in a cohort's prospects relative to that of its parents may induce demographic adjustments on the part of the younger generation, including delayed marriage, reduced fertility, and increased female labor force participation as they seek to maintain their relative economic status. In this formulation it is relative, rather than absolute, income which is a factor in decision-making — and relative cohort size is seen as the primary determinant of secular shifts in relative income.

Easterlin (1978b) did bring relative income concepts into his discussion of the fertility transition when he wrote:

> "Because of the substantial upward trend in living levels during economic development, each generation typically comes from a more prosperous background than that of the preceding generation. Because of this, the views of each successive generation as to the material requisites of the 'good life' tend to be progressively higher. Goods which to one generation may have been luxuries become necessities to the next — the automobile is a case in point. This 'inter-generation taste effect', as it might be called, tends to raise the minimum living level which parents feel is necessary before they can 'afford' children. . .[T]here is a floor to the curvilinear indifference map at the minimum required living level. Below this floor the indifference lines become horizontal, signifying that welfare depends only on the parents' goods and having children adds nothing to satisfaction. With the progress of economic growth this 'subsistence' floor shifts upward and the marginal rate of substitution decreases at any given point above the floor, indicating that children become less attractive relative to goods. In effect, a third

> (‘subsistence level’) constraint is added to the analysis. ..along with the budget line and production constraints. (p.115)”

But the potential connection between *relative cohort size* and relative income — and hence fertility — has been applied only in the post-transition context (Macunovich 1996,1998a,1998d,1999). It has not been used to explain the fertility transition.

The SS-DD Framework

Economists have long discussed the demand for children, but Richard Easterlin (1978b) is generally credited with the formal juxtaposition of the economic concept of demand with the sociological concept of supply in a framework which incorporated not only the demand for children, but also the demand for, and costs of, *fertility regulation*. Perhaps his most well-known formulation of this framework is presented in his work with Eileen Crimmins (1985), where it was used to explain secular shifts in fertility during the demographic transition.

Their stylized framework divided the demographic transition into roughly five phases. The initial pre-transition phase is characterized by an excess demand for surviving births due to high mortality rates and involuntary infecundity. Declining infant mortality and, possibly, rising fecundability because of improved health and nutrition during the mortality transition transform this excess demand into a potential excess supply in the second phase, which in the third phase is exacerbated by a decline in the demand for children. This potential for an excess supply motivates fertility control behavior. Thus despite a continued fall in demand, any realized excess supply is gradually eliminated in a fourth phase, with the length of that phase a function of the cost of fertility regulation — psychic as well as economic. The model ends with a rough equilibrium between demand and achieved supply, despite a potentially very large excess supply.

Within this SS-DD framework the reduced mortality among children and young adults which in time produces an increase in relative cohort size would *add to the potential excess supply of surviving births* in the second phase of this framework, and thus generate additional motivation for fertility control (assuming that parents wish to have their children survive *to adulthood*, rather than just through infancy). But since this is only a conceptual framework it doesn’t provide any explanation for the *declining demand* for children that occurs in the third and fourth phases. In addition to changing norms and attitudes toward children (which still need to be explained), researchers have suggested changes in the costs and benefits of children, and changing relative prices, as factors in this decline – but the relationship between changing relative cohort size, and changing relative income, has not been examined in this context.

Tests of the RCS Hypothesis

Tests of this hypothesis fall into two general categories: the effects of RCS on male relative income; and the effects of changes in RCS and/or male relative income on fertility. The first of these categories was addressed in terms of the relative wages of U.S. Baby Boomers in the period prior to 1980 by, among others, Freeman (1979), Welch (1979) and Berger (1984) – all of whom demonstrated strong effects of the type suggested by Easterlin. Korenman and Neumark (1997) extended those analyses to demonstrate similar effects in a sample of fifteen industrialized nations in the period 1970-1994; and Macunovich (1999) demonstrated that the effects were still highly significant in the U.S. in the 1980s and 1990s. She demonstrated, in addition, that the effects are not "symmetrical"; that is, cohorts on the "leading edge" of a boom benefit from positive aggregate demand effects which to some extent counteract the adverse effects of large cohort size, while cohorts on the "trailing edge" fail to benefit significantly as cohort size begins to decline, because of economic slowdowns brought on by that declining cohort size. The turnaround in the growth rate of new young households as RCS declines confounds producer expectations, resulting in a general production cutback whose longer-term economic impact depends on the stability of financial institutions. Thus an increase in RCS typically produces a reduction in male relative income which is not ameliorated even once relative cohort size begins to decline.

The second category of tests, carrying the effects of RCS through to fertility, has been reviewed in detail elsewhere (Macunovich, 1998). There have been at least seventy-six of these, and "with an equal number of micro- and macro-level analyses using North American data (twenty-two), the 'track record' of the hypothesis is the same in both venues, with fifteen providing significant support in each case. The literature suggests unequivocal support for the relativity of the income concept in fertility, but is less clear regarding the source(s) of differences in material aspirations, and suggests that the observed relationship between fertility and cohort size has varied across countries and time periods due to the effects of additional factors not included in most models." In particular, the relationship between relative income and fertility appears to be more robust than that between RCS and fertility, probably because of the asymmetric effects of RCS on relative income, as mentioned above. In addition, Pampel (1993) demonstrates that differences in "institutional structures of collective social protection and changes in rates of female labor force participation" must be taken into account in analyses using cross-national data. These institutional differences tend to intervene in the relationship between RCS and relative income, thus weakening the observed relationship between RCS and fertility. As a result, tests of the theory using RCS and the TFR (Total Fertility Rate) in countries other than the U.S., Canada, Australia and New Zealand have tended to provide more ambiguous results.

Relative Cohort Size Effects — in the Third World?

It's very possible that the forces underlying any RCS effect in Third World countries result not from an imbalance between younger and older cohorts in a formal labor market, but rather at the level of the family or village. Increasing RCS would require intergenerational transfers – of agricultural holdings, for example – to be divided among ever-larger numbers of offspring, resulting in a secular decline in young people's "relative income".

Even in those cases where a formal labor market has been established, undoubtedly it is the case that institutional and cultural differences among countries must temper the relationship between relative cohort size and relative income. Strong unions, for example, which maintain high wages for current members at the expense of new labor market entrants (probably as a protective measure during periods of large relative cohort size), would tend to counteract positive effects of subsequent smaller relative cohort size.

Similarly, countries with strong policies encouraging wage cuts rather than layoffs during periods of excess labor supply might dilute relative cohort size effects, if wage cuts occur across all experience groups. Studies have found, for example, that while the U.S. tends to have "sticky wages" that promote high unemployment during such periods, many European countries trade that unemployment for lower wages.

An economy like Japan's must also experience more diluted effects of relative cohort size on relative income. There, rigid pay scales are often tipped strongly in favor of older more experienced workers in order to entice employees into long-term commitment. Young workers in this situation would rarely experience the benefits of smaller cohort size.

The rigidity of a nation's boundaries with respect to immigration, and its policies toward "guest workers" as for example in Germany, Austria and Oman, would also impinge on the relative cohort size/wage relationship. Tests for any relationship would be most appropriate at a regional rather than a national level, when workers can cross international boundaries fairly freely. And conversely, it is possible that very large countries such as China or the former USSR might contain many sub-national "markets" in which any relative cohort size effects would emerge most clearly – especially if the movements of their citizens are restricted by government.

And at the other end of the causal network it goes without saying that cultural and institutional differences must impinge on the relationship between relative income and factors such as marriage and childbearing.

These cultural effects may show up only as differences in the overall *levels* of marriage and fertility, however, rather than in the response to changing economic circumstances.

Proposed Synthesis of the Two Models

The focus is on a pre-transition society experiencing both high fertility and high mortality, where it is possible that the demand for children exceeds the biological supply. In addition, as noted by Bourgeois-Pichat (1967b):

> "Fertility in preindustrialized societies. . . is determined by a network of sociological and biological factors. . .Freedom of choice by couples is almost absent. The couples have the number of children that biology and society decide to give them.
>
> " One of the main features of the so-called demographic revolution has been precisely to change not only the level of fertility but also its nature. Having a child has been becoming more and more the result of free decision of the couple. And this change in the nature of fertility may be more important than the change in its magnitude. (p.163)"

That is, there will be either an absence of conscious fertility control, or control exercised only through cultural constraints within the community – not at the level of the individual couple.

Initially, a decline in infant mortality is observed: the first stage of the mortality transition. This may accompany economic development, or occur prior to that change, as a result of international public health interventions. Because "[h]igh levels of child mortality still found in low income countries are primarily due to gastroenteritis and diarrheal disease" (Schultz,1981:116), typically mortality rates fall first among infants, who are most susceptible to these diseases. Within the context of the SS-DD model, this reduction will result in an increase in the biological supply of surviving *infants*, but won't necessarily be translated into a significant increase in the supply of young *adults* until mortality rates decline among children, teens and young adults.

The reduction in infant mortality, followed by child and teen rates, will result fifteen to twenty years later in an increase in RCS – the size of cohorts just entering the labor market (and family formation) relative to the number of prime aged adults – and a decline in relative wages. The mechanism might be similar to that documented in the U.S. and other industrialized nations. An excess supply of young relative to prime-age males depresses the relative wages of the young men, to the extent that they are poor substitutes for older more experienced men. Alternatively, in less sophisticated economies the relative decline in earning potential for younger workers may occur in the form of reduced size of land holdings passed on from parent to child: parents forced to split land among a larger number of surviving offspring. However it occurs, it is important to note that this need only be a *relative* decline. That is, concurrent economic development might raise absolute wages at all age levels; but if the wages of younger workers progress more slowly than those of older workers, as they will for large cohorts, those younger workers will still tend to feel some level of relative deprivation.

The effects of this labor market crowding may be exacerbated by crowding in the family, given increasing child survival rates, and in schools to the extent that they are available. The earning potential of young men will be reduced relative to their material aspirations as shaped in their parental households. They will feel less able to support themselves at an (age adjusted) standard commensurate with that experienced in their parents' homes. The resultant decline in relative income would lead young couples to wish to delay or forego marriage and/or reduce fertility in an attempt to maintain a higher level of per capita disposable income.

In this way, a society with little or no individual control of fertility will begin to experience a strong motivation for such control. Large cohorts are known for their disruptive effects on social norms (as, for example, in the U.S. in the 1960s and 1970s, and in Iran today). In this case, a large cohort's need for fertility control may mark a turning point in the society's attitudes with regard to contraception, and with regard to the individual's – as opposed to society's – right to control fertility. Easterlin (1978b) suggested this when he wrote

> "It is possible that the emergence of a pressure for fertility limitation is one of the first forms in which modernization comes to impinge directly on the mass of the population. The appearance of a problem that had not previously existed – that of limiting family size – and thereby the need for decision making of an entirely new sort, creates a pressure for attitudinal changes in a fundamental and immensely personal area of human experience. From this viewpoint the 'population problem' may have positive consequences, by contributing to modernized attitudes that may more generally favor economic and social development. (p.122-123)"

He cited Bourgeois-Pichat (1967a,b), Wrigley (1969) and Srinivasan et al (1972) in describing the shift from "social sanctions" to "family sanctions" in determining fertility – the development of deliberate individual control which is a fundamental aspect of modernization. Cognitive dissonance would lead to the widespread acceptance of the concept of fertility regulation, and the passing of that milestone could have a cumulative "snowball" or "cascade" effect, as declining average family size reinforces a society's acceptance of smaller numbers of children. This would explain the often-observed co-movement of fertility rates among older and younger women, and is a mechanism suggested by Ken Wachter (1991) in explaining cyclic movements in fertility in the U.S.

In this way an increase in RCS could trigger the initiation of the fertility transition. But fifteen to twenty years further on any fertility reduction will result in declining RCS: won't this tend to raise fertility rates again? The evidence in industrialized nations suggests that it will not. As demonstrated by Macunovich (1998b,1999,2000), relative cohort size effects on *relative income* are not symmetrical, because of differential aggregate demand effects on the leading and lagging edges of a baby boom – thus one should not expect them to be symmetrical in terms of fertility.[2] Without some external stimulus, male relative income will not begin to increase again when RCS begins to subside, but only after a considerable lag. Any potentially positive effect of decreasing relative cohort size on young men's wages will be counteracted for a time by the depressing effect of the economic slowdown induced by a turnaround in cohort size. This may have been the case in the industrialized nations in the 1930s and 1980s, and may also have been the recent experience of the "Asian Tigers". In addition, any potentially positive effects of declining cohort size will be counteracted by the negative "cascade" effect of changing cultural norms on fertility rates, as set out above.

A Look at the Data

The United Nations (1999) provides estimates for nearly 200 nations in the period from 1950 through 1995, of vital statistics and population age structure. These data are not ideal, since their preparation must of necessity have involved a considerable amount of interpolation, especially at greater levels of disaggregation. By far outweighing the disadvantages of the UN data, is the fact that they provide a unique source in terms of uniformity of geographical and chronological coverage: certainly an adequate source for an initial exploration of the hypothesis. The population data were provided in two stages: first (UN 1998b) for quinqennial observations and a limited number of age groupings (under 5, 5-14, 15-24 and 60+), and then most recently (UN 1999) in annual observations by sex for five-year age groups – although these latter are largely estimates and interpolations of the first set of data.

The vital statistics in the UN data, which are available only quinquennially, include aggregate rather than age-specific fertility measures, the best of which is the TFR (Total Fertility Rate), and although they do include a measure of infant mortality there are no other age-specific mortality measures. There is no information on income. But historic age-specific fertility and mortality rates aren't available in *any* source for most of the LDCs: even the more aggregated measures are often only fairly crude estimates. And for age distributions it's rare to find anything other than dependency ratios for the LDCs (the ratio of population under 14 and over 60 relative to the prime aged population).

Ideally an examination of RCS effects on fertility would have access to measures of male relative income, given the asymmetry of RCS effects and the potential for intervening institutional influences on wage structure – not to mention variables that might be used to control for changing economic costs and benefits of children, and availability of contraceptives. In the absence of such income data the analysis should in theory be based on fairly specific age groupings (those aged 15-24 relative to those aged 45-54, for example) in order to capture the effects of imperfect substitutability across experience groups. The inclusion of younger and older members of the 25-59 age group in the denominator of RCS will dilute measured effects if – as in many developed economies – those age groups are fairly good substitutes for workers aged 15-24. However, the appropriate measure of RCS may vary across nations depending on the sophistication of their internal labor markets. For this reason – and also because the UN five-year age groupings rely on a great deal of estimation – most of the analyses presented here make use of a very general measure of RCS: males aged 15-24 relative to those aged 25-59. Alternative estimates using a more specific RCS measure (males aged 15-24 relative to those aged 45-54) will be presented at intervals for comparative purposes.

The fertility measure analyzed here is the TFR, as a function of the infant mortality rate (as, for example, in Schultz, 1981) and as a function of RCS, (approximated using the ratio of 15-24 year olds first to those aged 25-59 and then to those aged 45-54). Although the TFR is an aggregate composed of fertility rates at all ages, it tends to be highly correlated with the pattern of fertility among women aged 20-29, since fecundability is highest in this age group – and there is a strong precedent for using the TFR in tests of Easterlin's hypothesis.[3] As a check on the validity of results based on the TFR, the statistical analyses presented in the next section include estimates based on a small subsample of countries and years for which age-specific fertility rates are available. These will demonstrate that the hypothesis appears to be supported both at the aggregate (TFR) and age-specific levels.

The U.N. data suggest that relative cohort size – probably acting through effects on male relative income – has played a crucial role in bringing about the fertility transition in developing countries between 1950 and 1995. Countries appear not to begin reducing their fertility, despite reductions in infant mortality, until mortality rates fall among children and young adults, permitting the proportion of those aged 15-24 to rise relative to those aged 25 and over. This is seen in country after country which has begun the fertility transition since 1950 – more than one hundred in all. Several which have not, such as Gambia, Guinea-Bisseau and the Democratic Peoples's Republic of Congo, have not yet experienced any increase in the ratio of 15-24 year olds to those aged 25 and over, despite marked and prolonged reductions in infant mortality in many cases.

[Figure 1, page 22]

The very pronounced relationship between relative cohort size and the Total Fertility Rate is evident both in the aggregate and in country-specific data, even using data reported at five-year intervals. Figure 1 presents graphs for a selection of Third World nations around the globe, where a characteristic relationship begins to emerge. Total Fertility Rates are constant or even increasing until relative cohort size begins to increase: at that point, the Total Fertility Rate begins to decline. Although the overall rate of decline might be affected by the trend in infant mortality, its point of initiation seems in all cases to depend on the trend in relative cohort size.

[Figure 2, page 23]

This relationship has been demonstrated around the globe, in country after country both small and large, regardless of religious or political orientation. Figure 2 shows that it emerges even at the regional level, in all developing parts of the world. It is important to note that the characteristic shape evident in these graphs is not a statistical artifact: the relative cohort size variable used here is calculated relative only to *prime aged adults*, not to the total population – thus RCS is not increasing as a result of the decline in the proportion of children in the population, since it is a ratio of 15-24 year olds to those aged 25-59. (Scaled) infant mortality rates are also presented in Figures 1 and 2, and although not immediately obvious because of the scaling, the levels vary widely from country to country, both at the point of initiation of fertility decline, and throughout its full extent.[4] For example, as indicated in Table 1 the transition in Hong Kong did not begin until infant mortality was down to 33, while in Egypt it began at the very high level of 175. And although Brazil and Iran exhibit very similar infant mortality rates in 1990-95 (47 and 43, respectively), the TFR in Iran (5.3) is more than twice that in Brazil (2.44).

[Table 1, page 27]

There are other aspects of the diversity among the nine countries in Figure 1. Population size (in 1995) ranged from only 260,000 in Barbados, to 1.2 billion in China. Hong Kong is only a city-state and Barbados only an island, as compared with the large geographic areas of the other seven countries. Iran is a predominately Muslim nation, while Brazil has large proportions of Roman Catholics. And China and North Korea are not free-market economies – yet they still exhibit this characteristic pattern. China's draconian "one child" policy has been credited by many for China's dramatic fertility decline. However, several recent studies such as Lavely and Freedman (1990) have indicated that the decline began – at least in urban areas – prior to that policy, and the data presented here suggest that the underlying motivation for such an urban fertility decline was the increase in relative cohort size.

Similar graphs, presented in the Appendix, have been prepared for the more than 130 countries which had not experienced a fertility transition prior to 1950. Most have by now begun the transition and conform with the pattern discussed above, but the effect is not mechanistic: there are differences among countries which undoubtedly result from cultural and/or institutional peculiarities not captured in these data. A few countries have experienced little if any fertility decline, as in Figure 3, but many such as Gambia in Figure 3 appear to be on the threshold.

[Figure 3, page 24]

In most cases the patterns of change in the two measures of RCS – the ratios of 15-24 year olds both to 25-59 year olds and to 45-54 year olds – were found to be very similar so that only the one measure is presented here, but for several countries this is not the case.[5] Interestingly, as demonstrated in Figure 4, there is a fairly close correspondence between changes in the TFR and the refined RCS measure (15-24 relative to 45-54), which is not so readily apparent between the TFR and the general measure of RCS.

[Figure 4, page 25]

In addition, there are several countries – such as Fiji and Nigeria – which appeared not to conform with the general pattern based on preliminary published data from the UN (1998b), but which fit the pattern quite well in the 1999 revisions provided on diskette. Thus it seems possible that "non-conforming" patterns may result from errors in the data, or are simply instances in which relative cohort size is too crudely measured, or is not directly reflected in relative income for some cultural or institutional (or economic) reasons. It is unfortunate that data are not available to measure relative income directly in all of these countries, since the hypothesized relationship is, after all, between relative income and the TFR, rather than directly between RCS and the TFR.

Experience During the Transitions of Currently-Developed Countries

Keyfitz and Flieger (1968) provide historical data for three of the currently industrialized nations around the time of their own fertility transitions: Sweden, France, and England and Wales. Although they do not provide the TFR, unfortunately, they do provide information on sex and age composition, together with the crude birth rate (CBR: births per 1000 population). These data are presented in Figure 5. Although not as conclusive, perhaps, as the patterns exhibited in most of the currently developing countries, these graphs do demonstrate a similar tendency for the fertility transition to begin just at the point when relative cohort size starts to increase. Only decennial observations are available for England and Wales, so it's possible that some of the increase there is missed, but there is a decided increase in RCS in France. Sweden experienced a sharp jump in RCS after 1825 which seemed to initiate a tendency for fertility to decline, but this was followed by an equally sharp drop in RCS, with some recovery in fertility, so that the real fertility transition only occurred after 1870 – when RCS increased once again.

[Figure 5, page 26]

Figure 6 suggests that improved survival rates among children and young adults was the primary reason RCS began to increase when it did in each of these three countries. The percent surviving to age 15 began to increase in 1870 in England and Wales – at the same point that RCS began to increase – whereas both RCS and the survival probability began to increase slightly earlier in France, in about 1865. A much longer history is available for Sweden, where there appears to be an explanation for the "on again, off again" changes in Swedish RCS and fertility between 1825 and 1870. The survival probabilities of children and young adults in Sweden increased markedly prior to 1825, producing an increase in RCS up to about 1840, but then faltered and did not resume their improvement again until after 1870, coincident with an increase in RCS and the beginning of Sweden's fertility transition.

[Figure 6, page 26]

Statistical Tests

A simple visual inspection of the relationship between RCS and fertility is inadequate as a test of the hypothesis, however: regression analysis can be used to determine whether the apparent relationship is statistically significant. The model to be tested is very simplistic, containing only RCS and infant mortality as explanatory variables. In order to control for the many other factors which are thought to play a role in fertility determination, a lag of TFR itself is included, which contains information about these other factors (and will control to some extent for changing norms and attitudes). That is, in this quinqennial data the value of the TFR in time $t-5$ is used as another variable in explaining the TFR in time t.

Relative cohort size is represented in the model using two variables: one to control for the *level* of RCS as suggested by Easterlin, and the other to control for its *rate of change*, in order to allow for asymmetry in the effects of RCS on fertility – an approach similar to the one adopted for relative income in Macunovich (1998b,1999,2000). The hypothesis is that a positive rate of change will tend to slow the decline in fertility when cohort size is rising, while a negative rate of change will tend to dampen fertility increases when cohort size is declining. It is assumed that any economic slowdown results not so much from *declining relative cohort size,* as from the *transition to decline* and its effect on expectations and business investment. Thus in theory it is important to be able to identify that point of transition, but this is difficult with the UN data since, although there are annual population estimates provided in the UN data, there are only quinqennial observations of TFR and infant mortality. The RCS rate-of-change variable is thus calculated as the value in year *t* minus the value in year *t-5*, since it would be inappropriate to attempt to associate quinquennial changes in the TFR with anything other than quinquennial changes in RCS.

A complication is introduced by the fact that levels of RCS will be lower in societies where the level of fertility has been low, or where the level of infant mortality has been high, creating a potential for spurious correlation among levels because of a relationship flowing *from past values* of fertility and infant mortality *to* RCS. The focus in this analysis is on any contemporaneous effects of changes in RCS on changes in the TFR; thus it is appropriate here to examine only *changes* in TFR, RCS and infant mortality. These changes, or first differences, in the value of each variable are calculated by subtracting the value of each variable in time *t-5* from its value in time *t*. Although a change in the TFR or infant mortality in time *t* will affect changes in RCS fifteen to twenty years later, there can be no possibility of an immediate effect, once the correlation in levels has been removed. In the case of infant mortality, it is expected that fertility responds to the *cumulative* effect of changes in infant mortality, rather than to changes in only the most recent period. Thus the variable used to control for the effects of infant mortality in year *t* is the *sum of the changes* observed between 1950 and year *t*.[6]

[Table 2, page 27]

Table 2 provides estimated effects of relative cohort size – both level and rate of change – and infant mortality on the Total Fertility Rate when *all* of the 184 countries in the UN data are included: the forty members of the “early transition” group like the U.S. together with Third World countries. Even though the lagged TFR exerts a very strong effect, RCS – and its rate of change – exhibit very significant estimated coefficients. Although the impact of infant mortality is significant, the standardized coefficients presented in italics indicate that the absolute effect of RCS is nearly twenty-five percent greater (-0.21 for RCS but only 0.17 for cumulative changes in infant mortality). Related models are presented in Appendix Table A2 on page 30 that introduce controls for individual country differences. Even with these additional controls the estimated coefficient on RCS remains highly significant, with the hypothesized negative sign. And despite the potential weakness of the RCS change measure used in the analysis, that variable is estimated to have a fairly strong and significant effect, with the expected positive sign.

In all of these models, the positive effect of the lagged TFR supports the idea of a "cascade" effect on social norms regarding fertility during the transition, with the declining fertility rate in past years exerting a strong influence on fertility in subsequent years. This cascade effect together with the asymmetry of the relative cohort size effect accounts for the continuing decline of the TFR even once RCS has begun to decline in these developing nations.

Appendix Table A3 (page 31) presents results for various subsets of the UN data: four groups of countries based on their fertility levels in 1950-55 – from high (greater than 6.5 births per woman) to low (3.5 births per woman or less) – and eight groups of countries by geographical region. It can be seen in Appendix Table A3 that in all cases RCS exhibits the expected negative effect on TFR, and that this effect is always statistically significant when the RCS change variable is included in the model. Positive effects are estimated for infant mortality and the RCS change variables, as hypothesized, but their effects are not always statistically significant.

It is worthwhile noting the very strong relative cohort size effects estimated for the "First World" western developed nations as a group in these Appendix tables: a large and very significant negative effect of RCS, as hypothesized by Easterlin, and a significant positive effect of the RCS change variable, consistent with findings in models of male relative income (Macunovich, 1999).

Appendix Table A4 presents results similar to those in Appendix Table A3, but using the "more refined" estimate of RCS (males aged 15-24 relative to males aged 45-54). Although this version of the RCS variable is significant in the First World regression and improves the results of the Second World regression, as well as being significant for several of the more developed Third World groups (South America, East, Southeast and Southcentral Asia, and East Africa), it does not appear to be as appropriate for the less developed Third World countries. This finding suggests that labor markets in less developed economies differentiate more between new entrants and all other workers, than by specific levels of experience.

[Table 3, page28]

Finally, as a check on the relevance of the TFR in an analysis of relative cohort size effects, Table 3 presents results obtained from estimating the model using only younger women's fertility rates. The data used in this portion of the analysis cover only a small subset of the 1,288 observations in the full data set, based on availability. Table A1 in the Appendix provides a list of the countries included, and the number of observations contributed by each. Only quinquennial observations were used in the analysis of age-specific rates, to ensure comparability with the original TFR-based results (and because infant mortality was available only quinquennially). Table 3 demonstrates that the hypothesis is supported using only the age-specific fertility rates of a small sample of younger women. Larger RCS is estimated to reduce fertility (the coefficient on RCS is significant and negative), but this reduction is asymmetric: weaker when cohort size is declining than when it's on the increase (the coefficient on RCS change is significantly positive). This result holds for the developing countries alone, as well as in the sample as a whole.

Conclusions

The attempt here has been to demonstrate that changes in relative cohort size are important in determining the pattern of fertility – not just in developed countries, but perhaps even more importantly in countries as they pass through the demographic transition. The increase in relative cohort size that occurs as a result of declining mortality rates during the demographic transition, acts as the mechanism of transmission which determines *when* the fertility portion of the transition begins. The increasing proportion of young adults would generate a downward pressure on young men's relative wages, which in turn would cause young adults to accept a trade-off between family size and material well-being. This acceptance of a trade-off could mark a turning-point in a society's acceptance of contraception, setting in motion a "cascade" or "snowball" effect in which total fertility rates tumble as social norms regarding individual control of fertility and acceptable family sizes begin to change.

This seems to be an aspect of the demographic transition which has been overlooked in the past because of a focus on *absolute* rather than relative income, which is apparent in the following statement from Caldwell and Caldwell (1997:20-21):

> "The search for materialist thresholds is frustrating. If we compare Britain in 1871 with a range of countries in Asia and Africa a century later when their fertility was beginning to fall or soon would fall, some surprising findings emerge. . .In terms of real per capita income. . . Britain was at the start of its fertility decline, ten times as wealthy as Bangladesh, and almost twice as rich as Thailand. The proportion of its workforce working outside agriculture was four times that in Bangladesh or Kenya and more than double Sri Lanka's proportion. Its proportion of population living in conurbations with more than half a million inhabitants was eighteen times the proportion in Sri Lanka and even six times that in Thailand."

The evidence presented here suggests that one thing these countries had in common at the point of transition was increasing relative cohort size. Countries appear not to begin reducing their fertility, despite reductions in *infant* mortality, until mortality rates fall among *children and young adults*, permitting the proportion of those aged 15-24 to rise relative to those aged 25 and over. According to Richard Easterlin's (1980,1987a) hypothesis this would create downward pressure on the relative wages of young adults, leading them to reduce fertility in order to achieve their desired level of material aspirations. This phenomenon is observed in country after country which has begun the fertility transition since 1950 — more than one hundred in all — and evidence suggests that this was the case in earlier transitions as well.

These results are consistent with the hypotheses put forward by Watkins (1990), who suggested that "market integration" was one reason for a notable reduction in demographic diversity in European provinces in the nineteenth century. Labor market integration would have generated common trends across provinces in terms of relative cohort size. Similarly, Coale and Watkins (1986) found that fertility patterns in various cities in Europe generally resembled those in the cities' own hinterlands (i.e., market areas) more than they did those in other cities.

Thus relative cohort size can be thought of as the mechanism that prevents excessive rates of population change – reducing fertility when previous high rates, in combination with low mortality rates, have caused relative cohort size to increase, and increasing fertility when previous low rates have caused relatively small younger cohorts. It appears to have been operating not just in currently developed post-transition economies, but during both recent and historic fertility transitions, to the extent that social and economic institutions have permitted the transmission of relative cohort size effects to male relative income.

1.Simon Szreter (1993) writes that "[d]emographic transition theory is generally considered to have been given its classic formulation in two separate publications, by Frank W. Notestein and by Kingsley Davis, both composed in 1944 and published in 1945. In that year Davis (1945) edited an entire volume devoted to demographic transition theory" [p.661]. In addition, Szreter points out in an endnote that Warren S. Thompson, "America's then-leading demographer", had already "publicly presented" the concept in 1929 but "[a]t that time it seems to have suffered a stillbirth" [p. 694, endnote 7].

2.Two effects are important here. First, as demonstrated in Macunovich (1998c), increases in relative cohort size produce strong increases in the growth rate of personal consumption expenditures, which tend to strengthen economic growth and create expectations of further growth. When the growth of relative cohort size slows or reverses, these expectations are not realized, and the resultant cutbacks in investment expenditures and production can cause dislocations in the economy. Thus there is a tendency for economic conditions to be strong when cohort size is on the increase, and weak when it stops increasing. And, as demonstrated in Macunovich (1998b,1999,2000) the wages of young inexperienced workers tend to be boosted disproportionately in good times and depressed disproportionately in a weak economy. The combination of these effects leads to asymmetry in the effects of relative cohort size on relative wages.

3.Appendix Table A1 (page 29) presents correlation coefficients between the TFR and fertility rates at ages 15-19, 20-24 and 25-29, in countries for which age-specific data are available.

There is considerable precedent for using the TFR in tests of the Easterlin hypothesis (Easterlin 1966b,1978a,1987a; Artzouni and Easterlin 1982; Easterlin and Condran 1976; Abeysinghe1991,1993; Baird 1987; Carlson 1992; Chesnais 1983; Ermisch 1979,1980,1983; Lee 1976; O'Connell 1978; Ohbuchi 1982; Pampel 1993; Rutten and Higgs 1984; Shields and Tracy 1986; Wachter 1975; Wright 1989; Wright and Maxim 1987).

4.Infant mortality (in deaths per 1000) has been scaled in all graphical presentations, in order to display it along with TFR and RCS, by logging it and dividing by 11.

5.The two RCS measures differ substantively for

- Afghanistan (where the refined measure didn't rise despite an increase in the general one);
- Saudi Arabia, Kuwait, Qatar, and the United Arab Emirates (where the refined measure rose despite no increase in the general one);
- Albania, Armenia, and Azerbaijan (where the refined measure increased earlier that the general one); and
- Korea, Cape Verde, Central African Republic, Madagascar, Uganda, and Syria (where the refined measure increased later than the general one).

6.The use of a cumulative measure was suggested by a referee. Results are also available from the author of tests conducted using just the most recent change in infant mortality. The variable is marginally more significant in its cumulative form.

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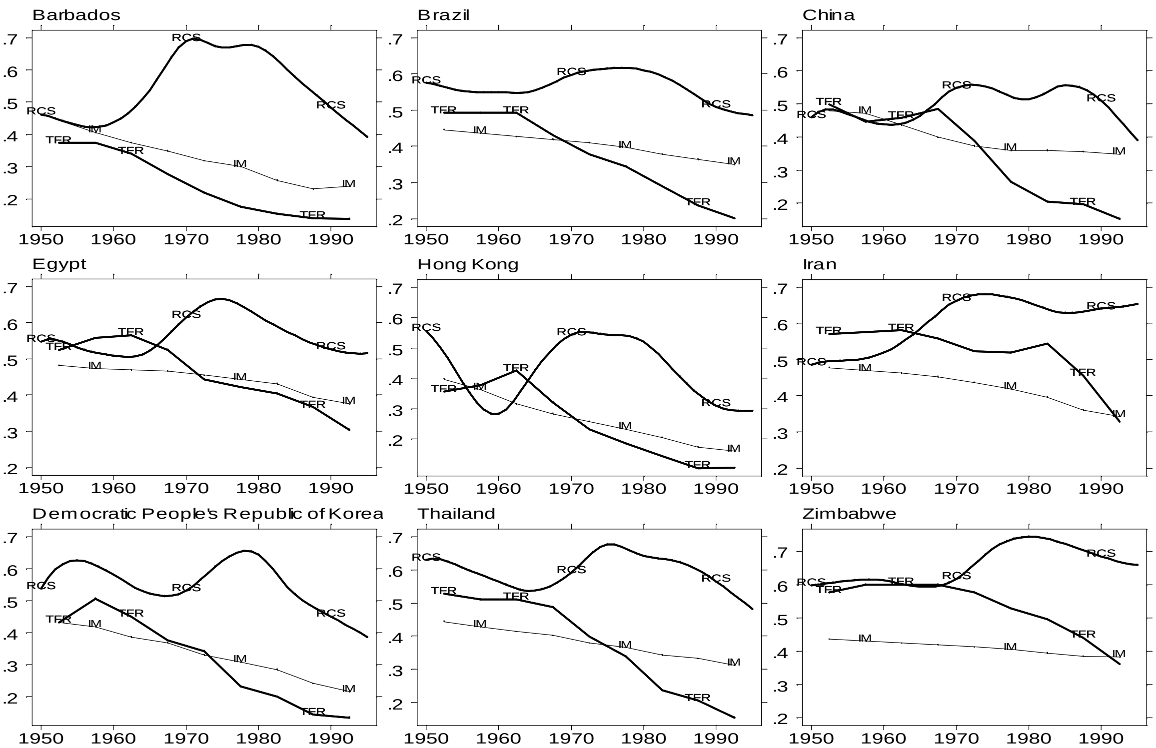


Figure 1: The relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM) in various individual countries, 1950-1995. *Source: United Nations (1999).*
RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000) has been scaled by logging and dividing by 11.

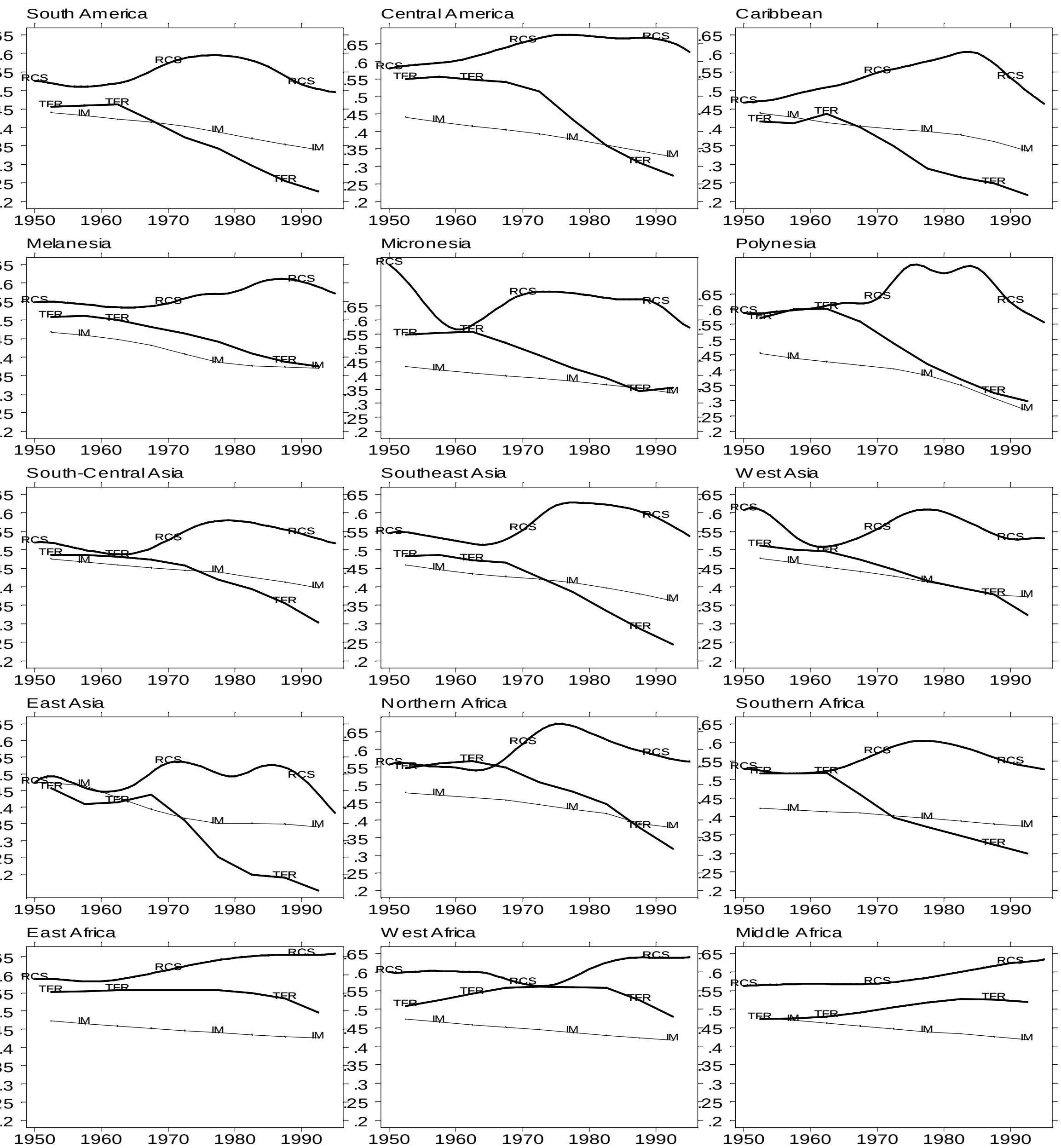


Figure 2: The relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM) in developing regions of the world, 1950-1995. *Source: United Nations (1999).*
RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000) has been scaled by logging and dividing by 11.

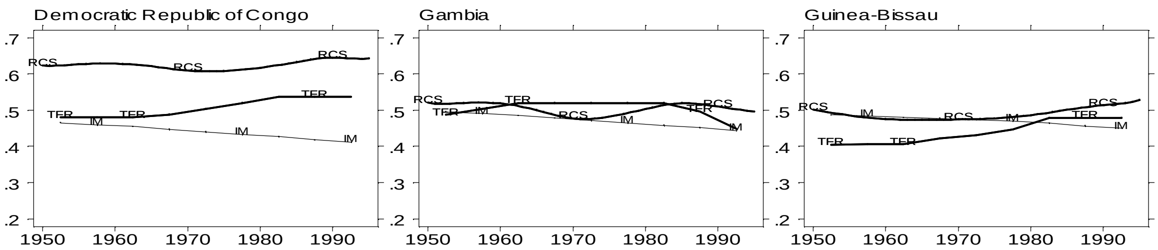
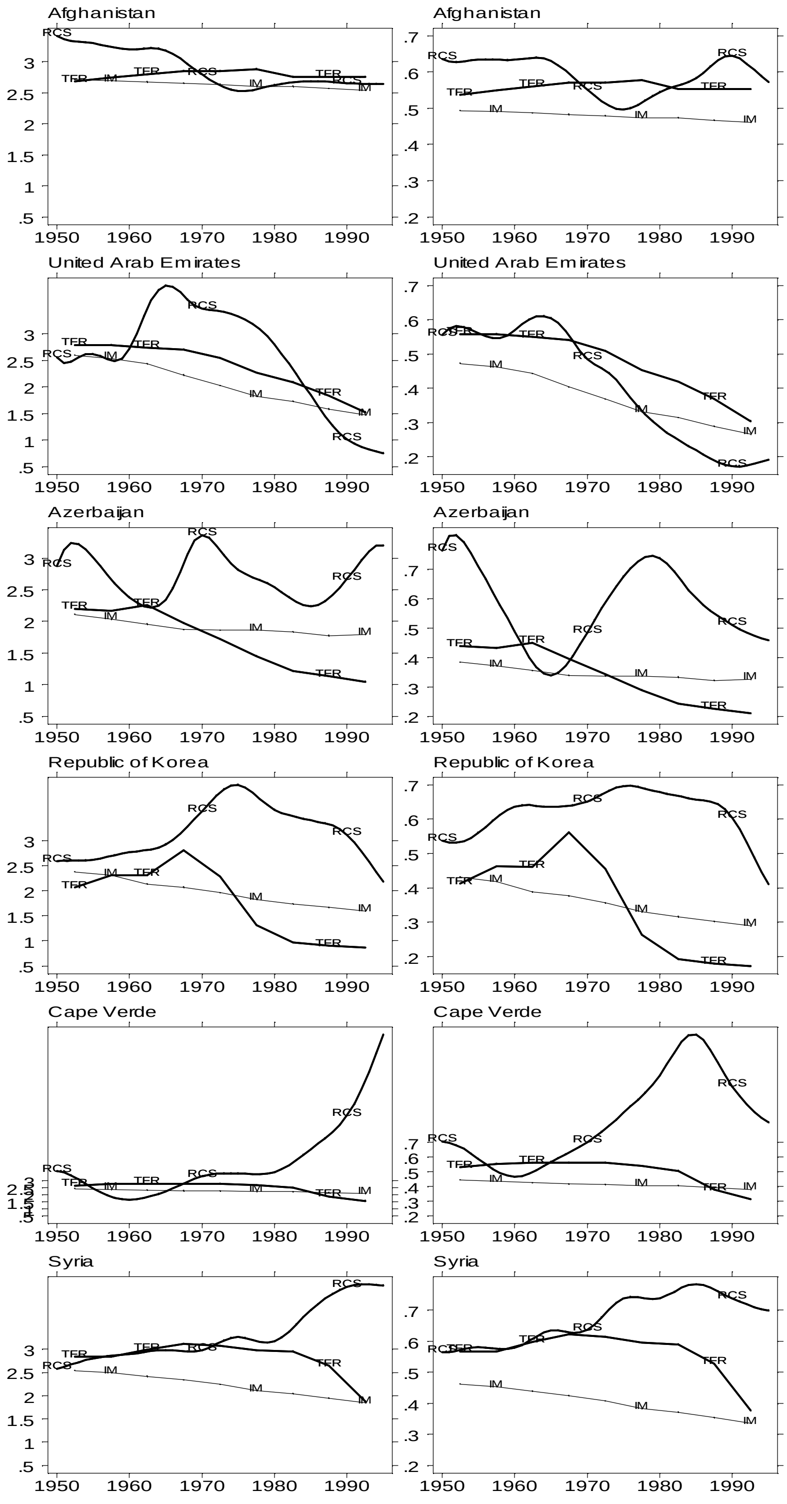


Figure 3: Three countries which, by 1995, had shown little sign of beginning the fertility transition. *Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000) has been scaled by logging and dividing by 11.*

Figure 4:
Examples of the fourteen countries that display substantive differences between the patterns of the general (15-24/25-59) and refined (15-24/45-54) measures of RCS. In each case the refined measure – presented on the left – corresponds more closely to the pattern of the TFR. The fourteen countries are:

- **Afghanistan** (where the refined measure didn't rise despite an increase in the general one);
- **United Arab Emirates, Saudi Arabia, Kuwait, and Qatar** (where the refined measure rose despite no increase in the general one);
- **Azerbaijan, Albania, and Armenia** (where the refined measure increased earlier that the general one); and
- **Korea, Cape Verde, Syria, Central African Republic, Madagascar, and Uganda** (where the refined measure increased later than the general one).



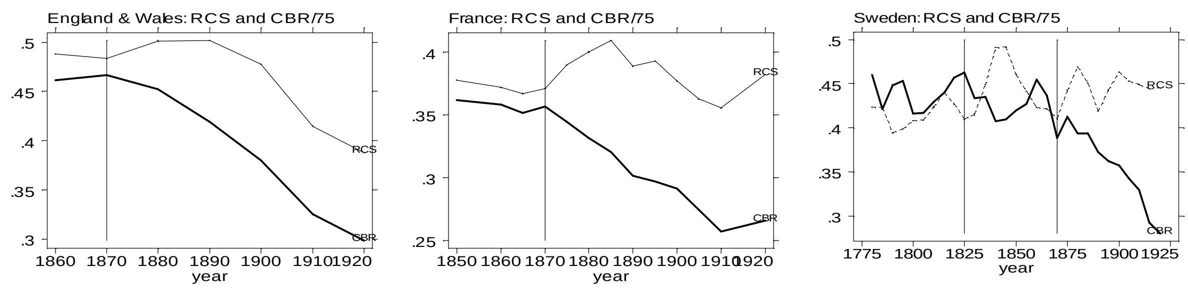


Figure 5: Relative cohort size and the crude birth rate during the fertility transition in England and Wales, France and Sweden. *(Crude birth rate is births per 1000 population, but is scaled by dividing by 75. Relative cohort size is the population aged 15-24 relative to the population aged 25-59. Source: Keyfitz and Flieger, 1968).*

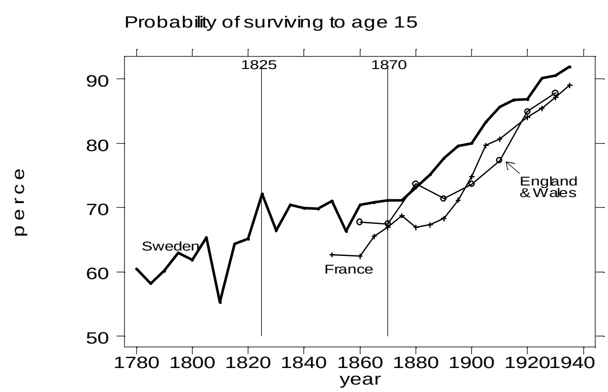


Figure 6: Probability of surviving to age 15 in England and Wales, France and Sweden. *(Source: Keyfitz and Fkieger, 1968).*

Country	Infant Mortality Rates		
	1950-55	*1990-95*	*at the start of the fertility transition*
Barbados	132	9	87
Brazil	135	47	109
China	195	44	81
Egypt	200	67	175
Hong Kong	79	6	33
Iran	190	43	78
South Korea	115	11	100
Thailand	132	32	84
Zimbabwe	120	70	101

Table 1: Infant mortality rates (deaths per 1000 live births) in countries presented in Figure 4. *Source: United Nations (1999).*

RCS	**-0.987**	**-1.307**
	-0.155	*-0.205*
	(6.3)	*(6.7)*
RCS change		**0.449**
		0.083
		(2.7)
infant mortality	**0.002**	**0.002**
	0.168	*0.173*
	(6.7)	*(6.9)*
lagged TFR	**0.458**	**0.448**
	0.450	*0.440*
	(18.0)	*(17.5)*
No. of obs	**1288**	**1288**
adj R-sq	**0.259**	**0.263**

The dependent variable is the first difference of the Total Fertility Rate (TFR).
Relative cohort size (RCS) is estimated as the number of males aged 15-24 relative to those aged 25-59.
All independent variables are expressed as first differences, and infant mortality is the cumulative change from 1950 to year t.
t-statistics are italicized in parentheses, and standardized coefficient estimates are in italics.

Table 2: Estimation, allowing for asymmetry, of the effects of changes in relative cohort size and infant mortality on changes in the Total Fertility Rate in 184 countries between 1950 and 1995, using OLS regression with no controls for individual country differences.

	developing nations		**full sample**
age group	***15-19***	***15-19, 20-24 & 25-29***	***15-19, 20-24 & 25-29***
Relative Cohort Size	**-115.036**	**-165.737**	**-78.948**
	-0.467	***-0.332***	***-0.174***
	(2.1)	***(2.6)***	***(2.8)***
RCS change	**103.965**	**146.198**	**61.488**
	0.479	***0.333***	***0.153***
	(2.2)	***(2.6)***	***(2.4)***
lagged fertility	0.161	0.112	0.099
(age specific)	*0.193*	*0.130*	*0.106*
	(0.9)	*(1.1)*	*(2.0)*
infant mortality	0.049	0.153	0.118
(cumulative decrease)	*0.199*	*0.307*	*0.205*
	(0.9)	*(2.7)*	*(3.8)*
intercept	-0.550	-1.829	-3.367
	(0.2)	*(0.5)*	*(2.1)*
# of Obs.	27	81	336
F-statistic	1.91	4.22	7.60
prob>F	0.1446	0.0039	0.0000
adjusted R-square	0.1227	0.1387	0.0731

The dependent variable is the first difference of age-specific fertility rates.
Countries included in the sample are listed in Appendix Table A1.
Relative cohort size (RCS) is estimated as the number of males aged 15-24 relative to those aged 25-59.
Age-specific fertility data taken from Coleman (1999) and USCensus (1999).
t-statistics are italicized in parentheses, and standardized coefficient estimates are in italics.

Table 3: Effects of changes in Relative Cohort Size (allowing for asymmetry) and infant mortality on changes in younger women's age specific fertility rates in a sample of LDCs and MDCs.

	Correlation between TFR and age-specific rates			# of quinquennial observations for regression in Table 3
age group	***15-19***	***20-24***	***25-29***	
Afghanistan	0.9870	0.9885	0.9975	3
Albania	0.9654	0.9809	0.9711	5
Argentina	0.9940	0.9968	0.9983	3
Austria	0.9525	0.9542	0.8963	3
Australia	0.6989	0.8554	0.9591	4
Belgium	0.7210	0.8498	0.9496	3
Brazil	0.5674	0.9849	0.9978	7
Canada	0.8414	0.9003	0.8030	4
Denmark	0.2272	0.2415	0.9839	3
Finland	0.5222	0.6909	0.9871	4
France	0.8080	0.8955	0.9408	4
Greece	0.6773	0.8951	0.9790	7
Hungary	0.7601	0.9398	0.9317	9
Ireland	0.9542	0.9862	0.9929	3
Italy	0.9908	0.9733	0.9760	4
Japan	0.8783	0.9219	0.8135	9
Luxembourg	0.5624	0.6615	0.9150	4
Monaco	0.9984	0.9999	1.0000	4
Netherlands	0.7156	0.6463	0.7978	4
New Zealand	0.8375	0.9526	0.9844	4
Poland	0.9275	0.9106	0.9955	8
Portugal	0.9677	0.9797	0.9811	4
Romania	0.9022	0.9651	0.9966	6
Spain	0.9283	0.9865	0.9972	4
Sweden	0.1570	0.4751	0.9842	4
Switzerland	0.8794	0.9401	0.9549	9
Turkey	0.9705	0.9909	0.9912	3
U.K.	0.8691	0.8506	0.9201	3
U.S.	0.9496	0.9528	0.9825	9
Total	0.7054	0.8430	0.9154	141

Appendix Table A1: Countries included in the sample for age-specific regressions in Table 3, indicating correlations between TFR and age-specific fertility rates of younger women, and number of quinquennial observations contributed to the analysis. *Source: Coleman (1999) and US Census (1999).*

	Full Model with All Interactions					Parsimonious Model				
	Relative Cohort Size	Change in RCS	Lagged TFR	Infant Mortality	Inter-cept	Relative Cohort Size	Change in RCS	Lagged TFR	Infant Mortality	Inter-cept
Basic model	**-2.097**	**1.856**	0.369	0.001	-0.077	**-1.762**	**0.629**	0.320	0.002	-0.060
	-0.329	***0.345***	*0.362*	*0.047*	*.*	***-0.277***	***0.117***	*0.314*	*0.153*	*.*
	(-2.4)	***(2.1)***	*(3.4)*	*(0.3)*	*(-1.4)*	***(-8.9)***	***(4.0)***	*(6.2)*	*(4.3)*	*(-2.0)*
regional interactions:										
South America	0.552	0.250	-0.363	0.005	0.103					0.015
	0.018	*0.007*	*-0.116*	*0.163*	*0.065*					*0.009*
	(0.4)	*(0.2)*	*(-1.8)*	*(1.6)*	*(1.0)*					*(0.3)*
Central America & Caribbean	2.515	-1.988	-0.215	0.002	0.038					0.025
	0.136	*-0.121*	*-0.096*	*0.121*	*0.030*					*0.019*
	(1.9)	*(-1.5)*	*(-1.2)*	*(0.9)*	*(0.3)*					*(0.5)*
East, SE & South-Central Asia	1.837	-1.420	-0.412	0.005	0.165			-0.302	0.002	0.036
	0.154	*-0.139*	*-0.276*	*0.400*	*0.174*			*-0.202*	*0.117*	*0.038*
	(1.5)	*(-1.1)*	*(-2.5)*	*(2.1)*	*(1.6)*			*(-5.7)*	*(2.0)*	*(0.6)*
West Asia & North Africa	2.748	-2.135	-0.119	0.004	0.202					0.069
	0.226	*-0.234*	*-0.050*	*0.323*	*0.177*					*0.060*
	(2.2)	*(-1.7)*	*(-0.7)*	*(1.6)*	*(2.0)*					*(1.2)*
East Africa	2.009	-0.564	0.019	0.006	0.341				0.002	0.241
	0.052	*-0.014*	*0.004*	*0.218*	*0.245*				*0.098*	*0.173*
	(1.2)	*(-0.3)*	*(0.1)*	*(1.9)*	*(2.7)*				*(1.7)*	*(2.6)*
Middle, West & Southern Africa	2.464	-0.373	0.113	0.004	0.298	1.573				0.157
	0.141	*-0.022*	*0.029*	*0.232*	*0.280*	*0.090*				*0.148*
	(1.8)	*(-0.3)*	*(0.6)*	*(1.4)*	*(2.7)*	*(3.6)*				*(2.9)*
Second World	1.524	-2.050	-0.294	0.001	0.024			-0.267		0.010
	0.064	*-0.114*	*-0.073*	*0.048*	*0.019*			*-0.066*		*0.008*
	(1.4)	*(-2.0)*	*(-2.0)*	*(0.4)*	*(0.3)*			*(-2.2)*		*(0.2)*
fertility-level Interactions:										
3.51 - 5.5	-2.121	0.545	0.050	-0.001	-0.162					-0.136
	-0.168	*0.049*	*0.027*	*-0.040*	*-0.148*					*-0.124*
	(-2.0)	*(0.6)*	*(0.3)*	*(-0.4)*	*(-2.0)*					*(-3.2)*
5.51 - 6.5	-1.902	-0.016	0.316	-0.004	-0.224			0.257	-0.001	-0.121
	-0.141	*-0.001*	*0.189*	*-0.306*	*-0.257*			*0.154*	*-0.113*	*-0.139*
	(-1.6)	*(0.0)*	*(1.9)*	*(-1.9)*	*(-2.3)*			*(4.2)*	*(-2.0)*	*(-2.0)*
> 6.5	-1.328	0.342	0.408	-0.003	-0.163			0.341		-0.047
	-0.138	*0.044*	*0.261*	*-0.262*	*-0.199*			*0.218*		*-0.058*
	(-1.1)	*(0.3)*	*(2.4)*	*(-1.3)*	*(-1.7)*			*(5.5)*		*(-0.9)*
Number of Obs					1288					1288
F-statistic					14.17					31.87
Adjusted R-square					0.3560					0.3454

All variables used in differenced form. *Dependent variable is the Total Fertility Rate (TFR). Relative Cohort Size is the ratio of males aged 15-24 to those aged 25-59. Infant Mortality is cumulative change from 1950 to year t. t-statistics in italics and parentheses, standardized coefficients in italics below estimated coefficients.*

Appendix Table A2: Defining RCS as males 15-24 relative to 25-59 – Estimated effects, allowing for asymmetry, of changes in Relative Cohort Size (RCS) on changes in the Total Fertility Rate (TFR) in 184 countries between 1950-1995, using an aggregate time-series cross-section model with full interaction terms for seven regions and three 1950-55 fertility levels.

	Relative Cohort Size	RCS Change	Lagged TFR	Infant Mortality	Intercept	No.of Obs (Adj.R-sq)
						1288
all countries	**-0.987 (*6.3*)**		0.458 (*18.0*)	0.002 (*6.7*)	-0.049 (*2.6*)	(0.259)
	-1.307 (*6.7*)	**0.449 (*2.7*)**	0.448 (*17.5*)	0.002 (*6.9*)	-0.047 (*2.5*)	(0.263)
By Region:						84
South America	**-1.919 (*2.8*)**		0.449 (*4.3*)	0.003 (*1.7*)	-0.117 (*1.7*)	(0.305)
	-3.132 (*4.0*)	**2.566 (*2.9*)**	0.339 (*3.2*)	0.004 (*2.4*)	-0.086 (*1.3*)	(0.365)
						133
Central America	**-1.178 (*2.4*)**		0.407 (*5.5*)	0.001 (*0.6*)	-0.220 (*2.9*)	(0.204)
& Caribbean	**-1.296 (*2.1*)**	**0.171 (*0.3*)**	0.403 (*5.3*)	0.001 (*0.6*)	-0.217 (*2.8*)	(0.199)
						280
East, SE &	**-1.583 (*3.8*)**		0.239 (*4.1*)	0.003 (*2.9*)	-0.128 (*2.1*)	(0.111)
South-Central Asia	**-1.993 (*3.9*)**	**0.620 (*1.4*)**	0.219 (*3.7*)	0.003 (*2.9*)	-0.132 (*2.1*)	(0.114)
						175
West Asia &	**-0.770 (*2.9*)**		0.603 (*9.3*)	0.002 (*4.0*)	-0.013 (*0.3*)	(0.443)
North Africa	**-0.824 (*2.3*)**	**0.060 (*0.2*)**	0.601 (*9.2*)	0.002 (*4.0*)	-0.012 (*0.3*)	(0.440)
						112
East Africa	**-0.778 (*1.1*)**		0.752 (*8.7*)	0.004 (*3.2*)	0.098 (*1.7*)	(0.485)
	-1.582 (*2.0*)	**1.635 (*2.0*)**	0.743 (*8.7*)	0.003 (*3.0*)	0.092 (*1.6*)	(0.499)
						210
Middle, West &	**0.127 (*0.5*)**		0.776 (*13.4*)	0.001 (*2.5*)	0.012 (*0.4*)	(0.517)
Southern Africa	**-1.023 (*3.2*)**	**1.614 (*5.5*)**	0.790 (*14.6*)	0.001 (*2.2*)	0.011 (*0.4*)	(0.576)
						147
Second World	**-1.280 (*3.2*)**		0.156 (*2.0*)	0.002 (*1.9*)	-0.063 (*1.2*)	(0.095)
	-1.211 (*2.4*)	**-0.085 (*0.2*)**	0.159 (*2.0*)	0.002 (*1.9*)	-0.062 (*1.2*)	(0.089)
						147
First World	**-1.640 (*3.2*)**		0.440 (*6.4*)	-0.001 (*1.0*)	-0.140 (*4.0*)	(0.249)
	-2.622 (*4.7*)	**2.017 (*3.5*)**	0.414 (*6.2*)	0.000 (*0.1*)	-0.115 (*3.3*)	(0.305)
By Fertility Level in 1950-1955:						259
<= 3.5	**-0.717 (*2.0*)**		0.224 (*3.8*)	0.001 (*1.0*)	-0.087 (*3.1*)	(0.061)
	-1.040 (*2.5*)	**0.481 (*1.4*)**	0.222 (*3.8*)	0.001 (*1.2*)	-0.085 (*3.0*)	(0.064)
						196
3.51 - 5.5	**-1.670 (*4.3*)**		0.204 (*3.2*)	0.002 (*1.3*)	-0.184 (*2.9*)	(0.118)
	-2.069 (*4.5*)	**0.638 (*1.6*)**	0.174 (*2.6*)	0.002 (*1.5*)	-0.187 (*3.0*)	(0.125)
						364
5.51 - 6.5	**-1.427 (*4.0*)**		0.495 (*10.4*)	0.001 (*2.2*)	-0.064 (*1.6*)	(0.253)
	-1.612 (*3.6*)	**0.280 (*0.7*)**	0.488 (*10.0*)	0.001 (*2.2*)	-0.065 (*1.6*)	(0.252)
						469
> 6.5	**-0.535 (*2.4*)**		0.627 (*15.4*)	0.002 (*4.6*)	-0.031 (*1.0*)	(0.421)
	-1.009 (*3.5*)	**0.554 (*2.5*)**	0.625 (*15.4*)	0.002 (*5.0*)	-0.017 (*0.6*)	(0.427)

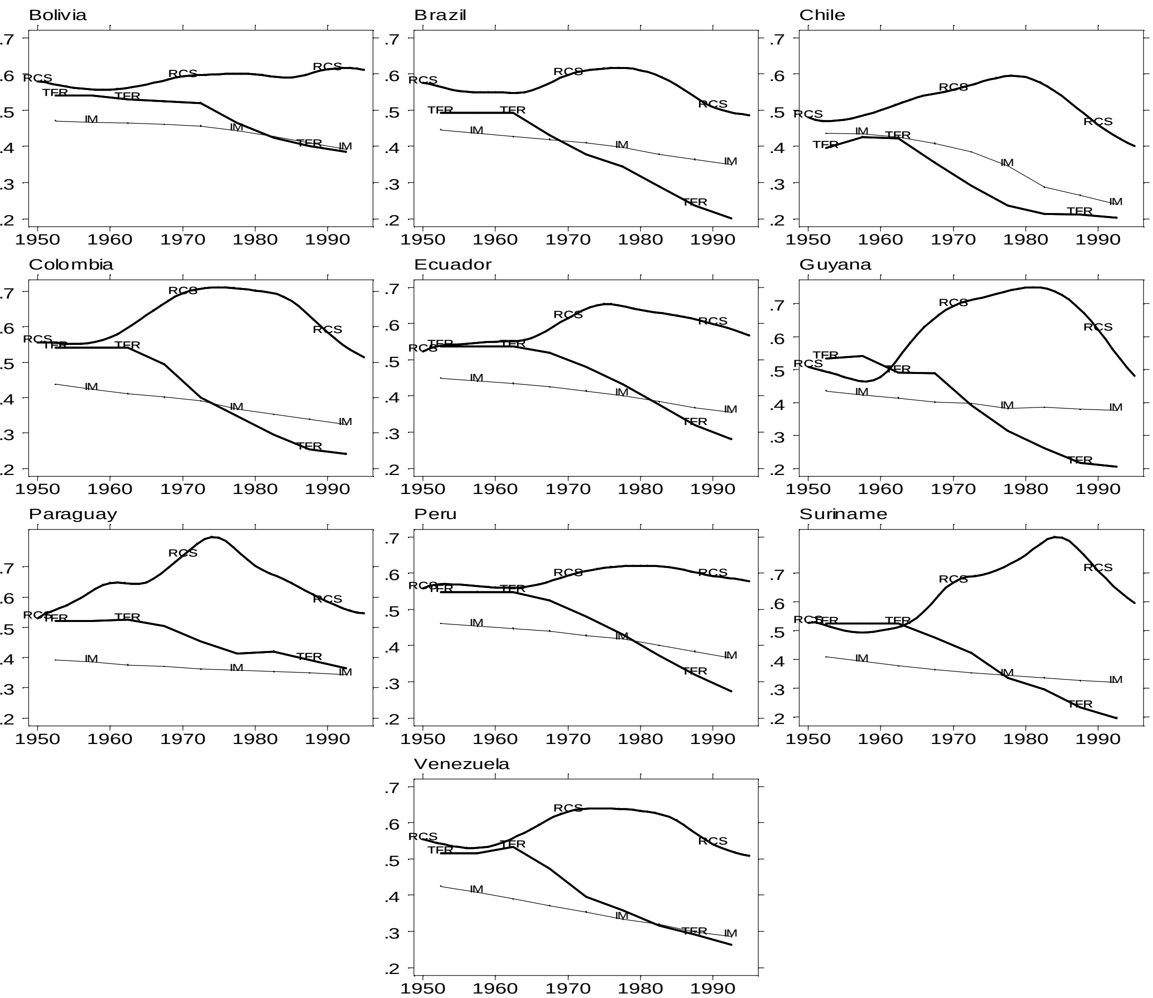
All variables used in differenced form.
Dependent variable is the change in the Total Fertility Rate (TFR). Relative Cohort Size is the change in the ratio of males aged 15-24 to those aged 25-59. Infant Mortality is the cumulative change from 1950 to year t.
t-statistics in italics and parentheses.

Appendix Table A3: Defining RCS as males 15-24 relative to 25-59 – Disaggregated estimates for 1950-1995 of the effects of changes in Relative Cohort Size (RCS, allowing for asymmetry) on changes in the Total Fertility Rate (TFR) in 184 countries, individually by region and by fertility level in 1950-55.

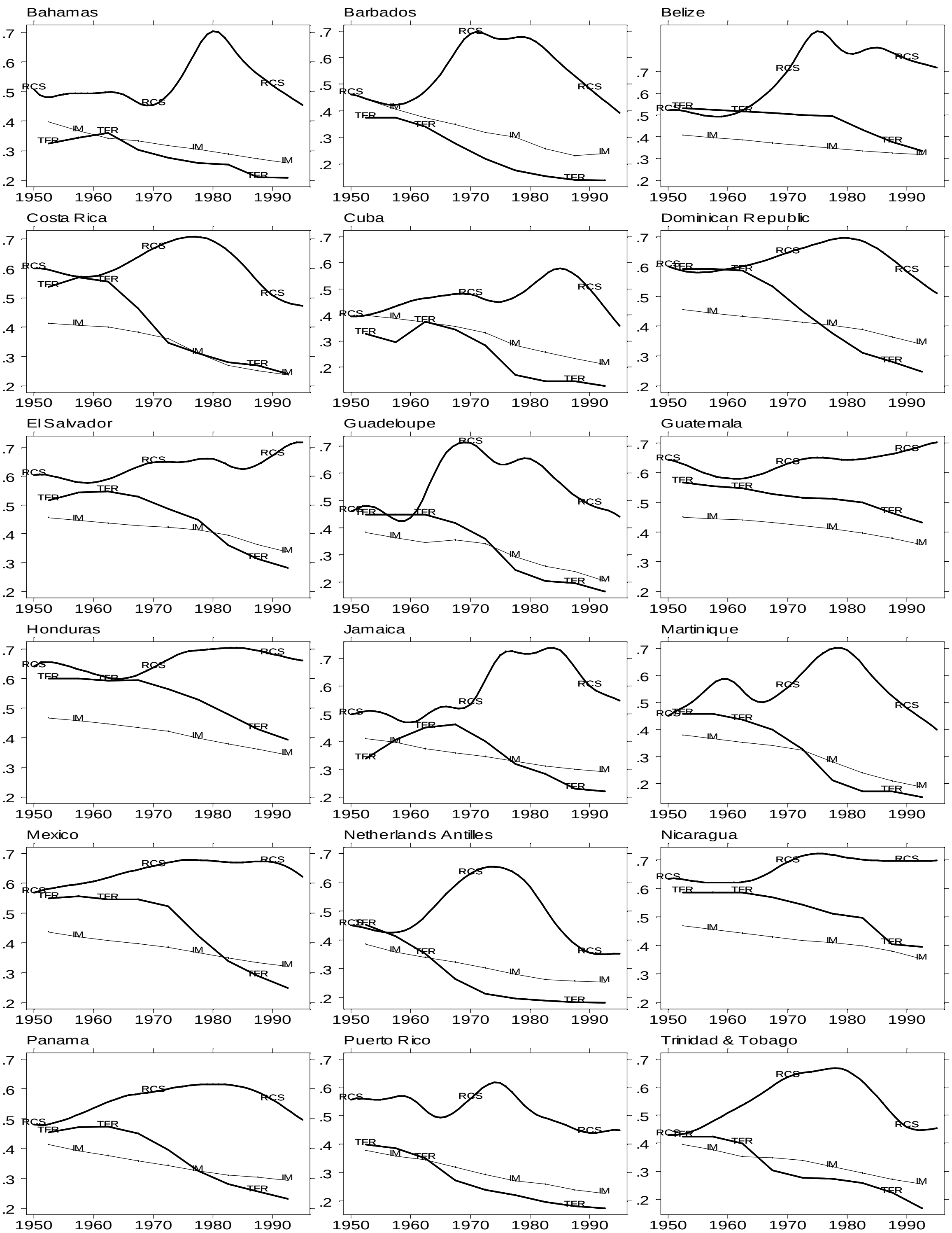
	Relative Cohort Size	RCS Change	Lagged TFR	Infant Mortality	Intercept	No.of Obs (Adj.R-sq)
						1288
all countries	**-0.152 (*5.8*)**		0.435 (17.2)	0.002 (6.5)	-0.050 (2.7)	(0.256)
	-0.176 (*4.8*)	**0.033 (1.0)**	0.432 (16.9)	0.002 (6.5)	-0.049 (2.6)	(0.256)
By Region:						84
South America	**-0.437 (*3.3*)**		0.357 (3.4)	0.003 (2.2)	-0.082 (1.2)	(0.330)
	-0.668 (*4.1*)	**0.392 (2.3)**	0.281 (2.6)	0.004 (2.6)	-0.057 (0.8)	(0.362)
						133
Central America	**-0.280 (*2.8*)**		0.377 (*5.1*)	0.001 (*0.6*)	-0.220 (*2.9*)	(0.215)
& Caribbean	**-0.187 (*1.4*)**	**-0.137 (*1.1*)**	0.397 (*5.2*)	0.001 (*0.6*)	-0.222 (*3.0*)	(0.216)
						280
East, SE &	**-0.324 (*4.0*)**		0.228 (*3.9*)	0.002 (*2.8*)	-0.123 (*2.0*)	(0.115)
SouthCentral Asia	**-0.359 (*3.2*)**	**0.040 (*0.5*)**	0.223 (*3.8*)	0.002 (*2.8*)	-0.124 (*2.0*)	(0.113)
						175
West Asia &	**0.002 (*0.0*)**		0.589 (*8.9*)	0.002 (*3.5*)	-0.031 (*0.6*)	(0.417)
North Africa	**0.010 (*0.1*)**	**-0.009 (*0.2*)**	0.588 (*8.8*)	0.002 (*3.5*)	-0.032 (*0.6*)	(0.413)
						112
East Africa	**-0.115 (*1.1*)**		0.735 (*8.7*)	0.003 (*3.1*)	0.092 (*1.6*)	(0.485)
	-0.341 (*2.6*)	**0.430 (*2.8*)**	0.720 (*8.8*)	0.003 (*2.4*)	0.068 (*1.2*)	(0.516)
						210
Middle, West &	**-0.025 (*0.8*)**		0.760 (*12.0*)	0.001 (*2.6*)	0.019 (*0.6*)	(0.517)
Southern Africa	**-0.082 (*1.4*)**	**0.094 (*1.1*)**	0.753 (*11.9*)	0.001 (*2.4*)	0.017 (*0.5*)	(0.518)
						147
Second World	**-0.229 (*3.3*)**		0.171 (*2.2*)	0.002 (*2.0*)	-0.049 (*0.9*)	(0.098)
	-0.360 (*3.7*)	**0.130 (*1.9*)**	0.135 (*1.7*)	0.002 (*2.3*)	-0.046 (*0.9*)	(0.115)
						147
First World	**-0.216 (*2.3*)**		0.408 (*5.9*)	-0.002 (*1.3*)	-0.145 (*4.1*)	(0.224)
	-0.448 (*3.7*)	**0.324 (*3.0*)**	0.402 (*6.0*)	-0.001 (*0.7*)	-0.120 (*3.4*)	(0.264)
By Fertility Level in 1950-1955:						259
<= 3.5	**-0.170 (*2.8*)**		0.217 (*3.7*)	0.001 (*1.1*)	-0.083 (*2.9*)	(0.073)
	-0.271 (*3.3*)	**0.114 (*1.8*)**	0.207 (*3.5*)	0.001 (*1.4*)	-0.078 (*2.8*)	(0.082)
						196
3.51 - 5.5	**-0.242 (*2.8*)**		0.215 (*3.3*)	0.001 (*1.0*)	-0.183 (*2.8*)	(0.070)
	-0.427 (*3.8*)	**0.239 (*2.6*)**	0.179 (*2.7*)	0.001 (*1.2*)	-0.180 (*2.7*)	(0.098)
						364
5.51 - 6.5	**-0.346 (*4.8*)**		0.465 (*10.0*)	0.001 (*2.1*)	-0.061 (*1.5*)	(0.267)
	-0.215 (*2.3*)	**-0.167 (*2.1*)**	0.487 (*10.3*)	0.001 (*2.2*)	-0.060 (*1.5*)	(0.274)
						469
> 6.5	**-0.051 (*1.6*)**		0.604 (*14.9*)	0.002 (*4.5*)	-0.037 (*1.2*)	(0.417)
	-0.062 (*1.4*)	**0.016 (*0.4*)**	0.602 (*14.8*)	0.002 (*4.5*)	-0.036 (*1.2*)	(0.416)

All variables used in differenced form.
Dependent variable is the change in the Total Fertility Rate (TFR). Relative Cohort Size is the change in the ratio of males aged 15-24 to those aged 45-54. Infant Mortality is the cumulative change from 1950 to year t.
t-statistics in italics and parentheses.

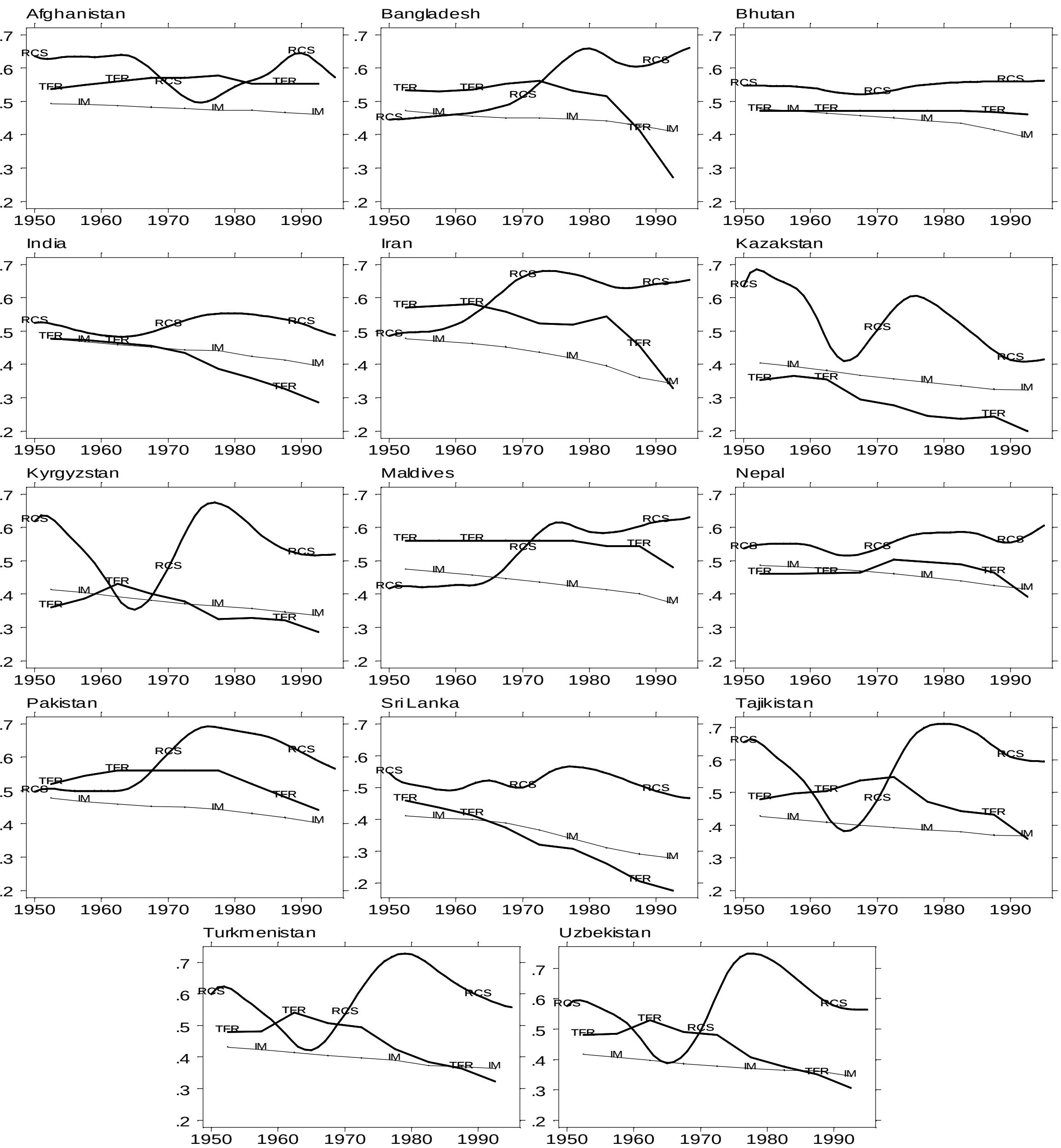
Appendix Table A4: Defining RCS as males 15-24 relative to 45-54 – Disaggregated estimates for 1950-1995 of the effects of changes in Relative Cohort Size (RCS, allowing for asymmetry) on changes in the Total Fertility Rate (TFR) in 184 countries, individually by region and by fertility level in 1950-55.



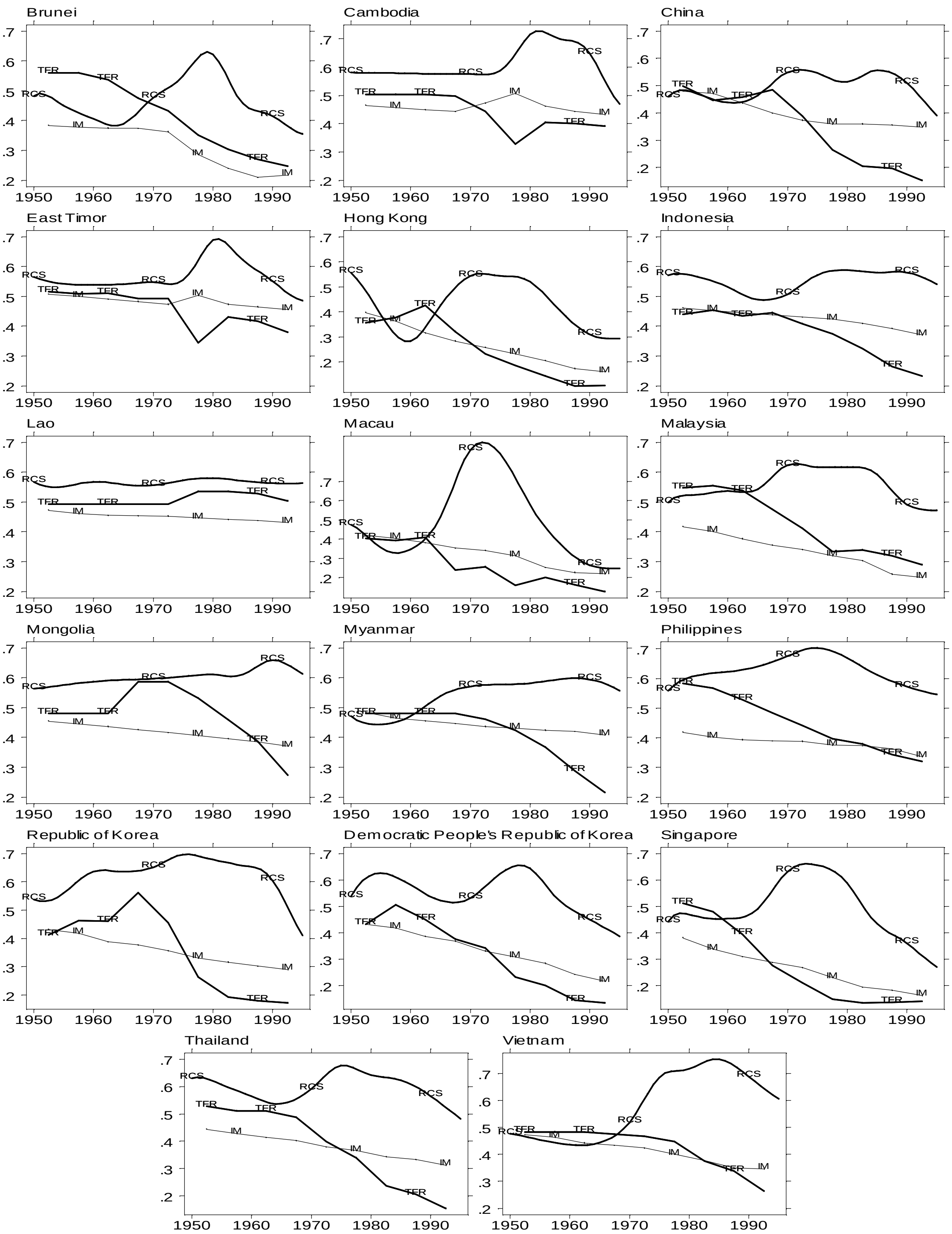
Appendix Figure A1: South American countries in transition: the relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM), 1950-1995.
Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000 live births) has been scaled by dividing its logarithmic value by 11.



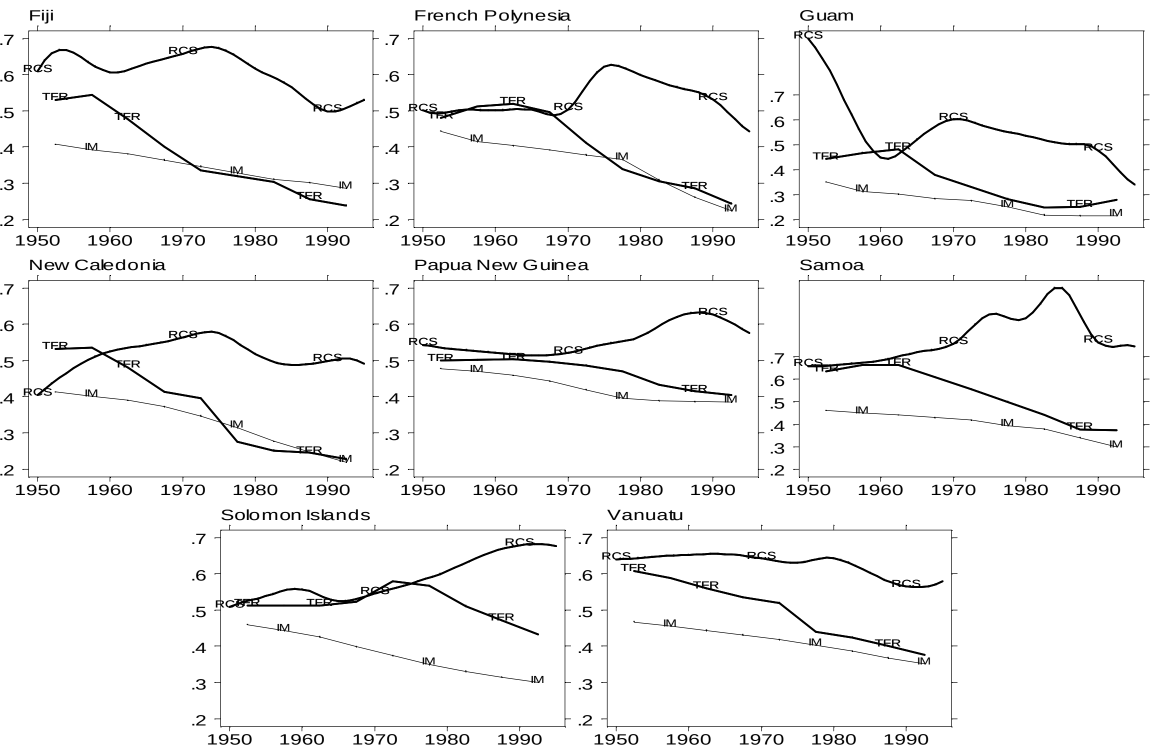
Appendix Figure A2 : Central American and Caribbean countries in transition: the relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM), 1950-1995.
Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000 live births) has been scaled by dividing its logarithmic value by 11.



Appendix Figure A3: South-Central Asian countries in transition: the relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM), 1950-1995. *Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000 live births) has been scaled by dividing its logarithmic value by 11.*

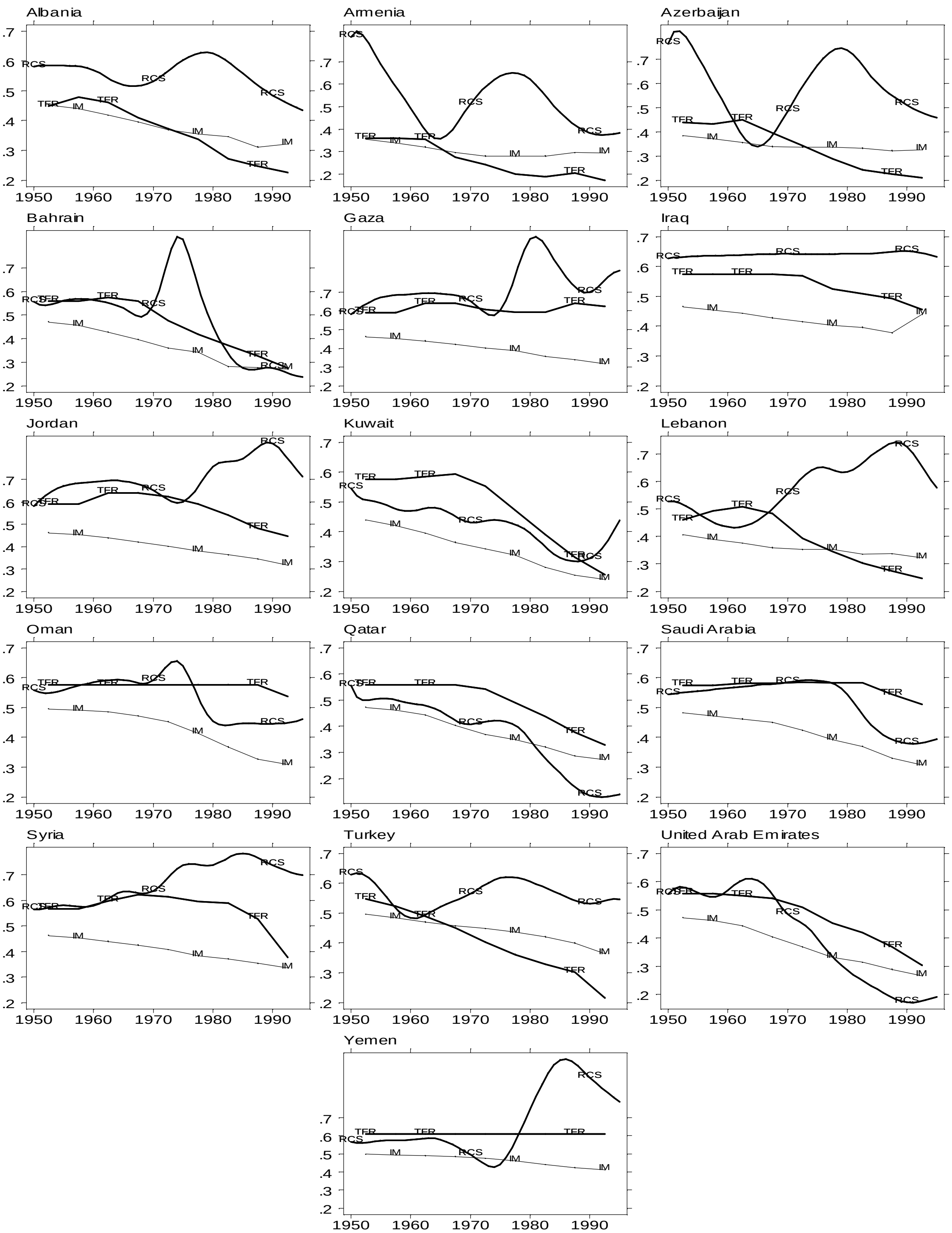


Appendix Figure A4: East and South-East Asian countries in transition: the relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM), 1950-1995. *Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000 live births) has been scaled by dividing its logarithmic value by 11.*

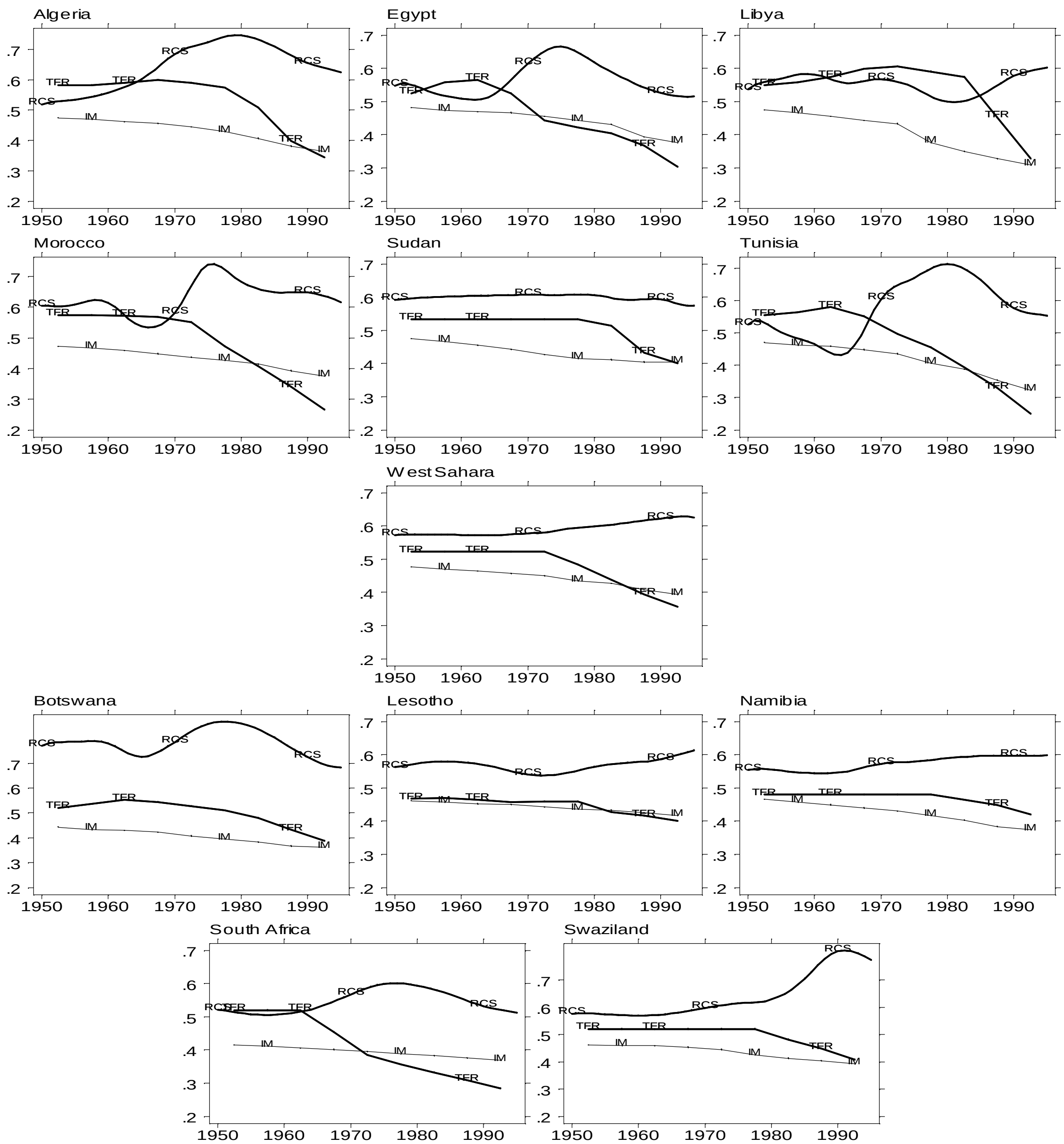


Appendix Figure A5: Pacific Islands in transition: the relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM), 1950-1995.

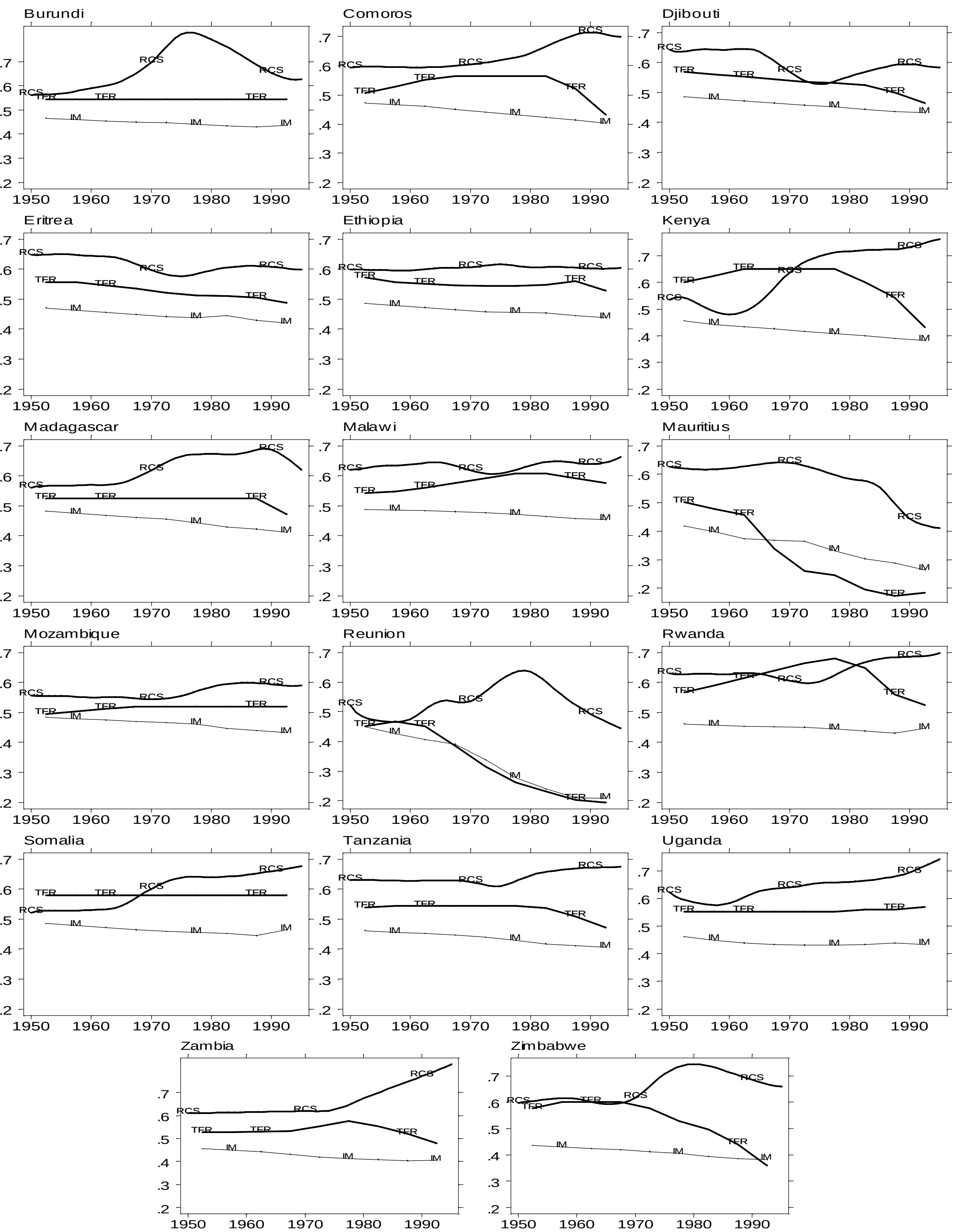
Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000 live births) has been scaled by dividing its logarithmic value by 11.



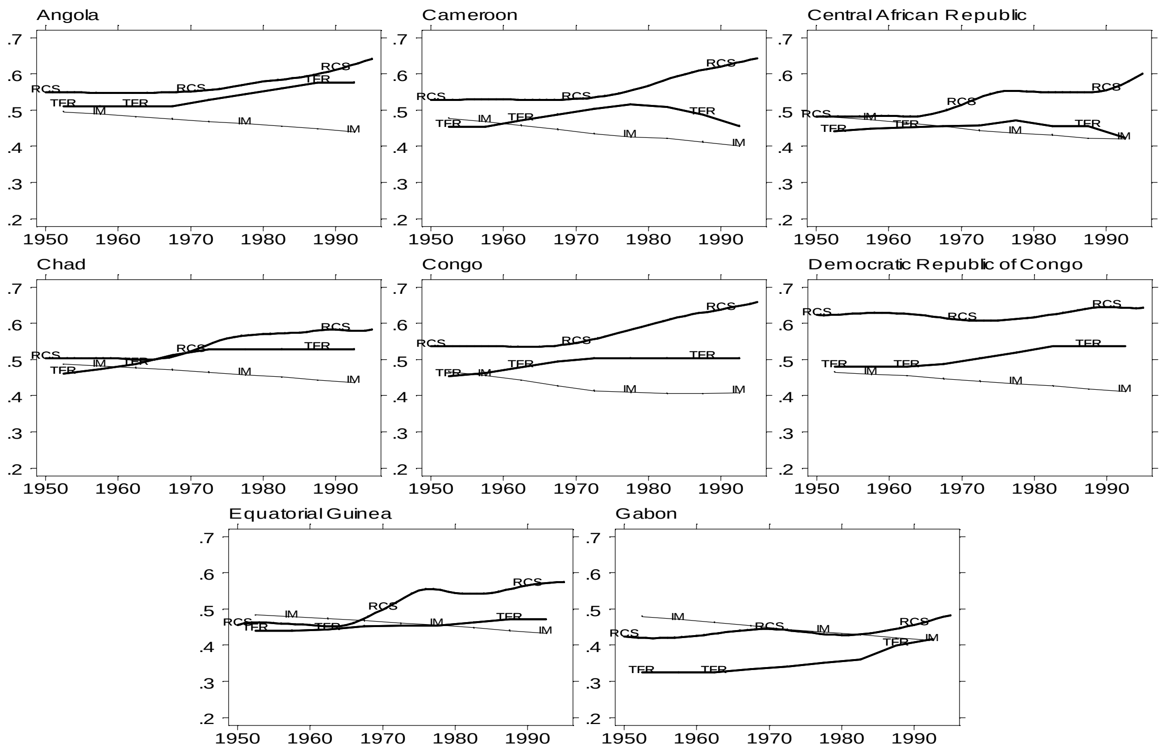
Appendix Figure A6: West Asian countries (and Abania) in transition: the relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM), 1950-1995. *Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000 live births) has been scaled by dividing its logarithmic value by 11.*



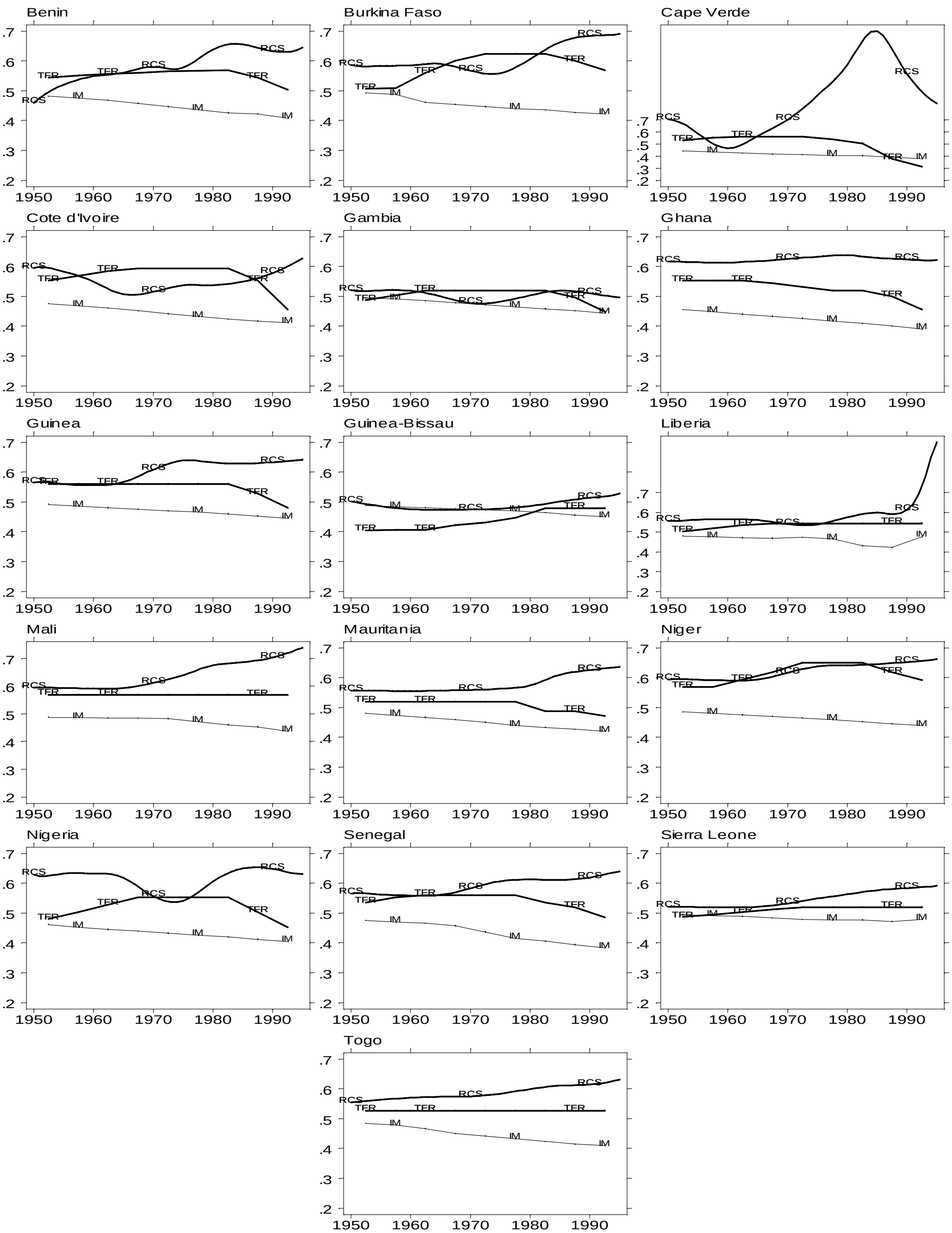
Appendix Figure A7: Northern and Southern African countries in transition: the relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM), 1950-1995. *Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000 live births) has been scaled by dividing its logarithmic value by 11.*



Appendix Figure A8: East African countries in — or approaching — transition: the relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM), 1950-1995. *Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000 live births) has been scaled by dividing its logarithmic value by 11.*



Appendix Figure A9: Middle African countries in — or approaching — transition: the relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM), 1950-1995.
Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000 live births) has been scaled by dividing its logarithmic value by 11.



Appendix Figure A10: Western African countries in — or approaching — transition: the relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (IM), 1950-1995.
Source: United Nations (1999). RCS = ratio of males aged 15-24 to males aged 25-59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000 live births) has been scaled by dividing its logarithmic value by 11.

KEY TO REGIONAL GROUPINGS OF COUNTRIES:

FIRST WORLD:

North America:

- USA
- Canada

Oceania:

- Australia
- New Zealand

Western Europe:

- Austria
- Belgium
- France
- United Germany
- Luxembourg
- Netherlands
- Switzerland

Northern Europe:

- Denmark
- Finland
- Iceland
- Ireland
- Norway
- Sweden
- UK

Southern Europe:

- Albania
- Greece
- Spain
- Portugal
- Malta
- Italy

SECOND WORLD:

- Belarus
- Bosnia Herzegovina
- Bulgaria
- Croatia
- Czechoslovakian Republic
- Estonia
- Georgia
- Hungary
- Latvia
- Lithuania
- Moldova
- Poland
- Romania
- Russian Federation
- Slovakia
- Slovenia
- Ukraine
- Yugoslavia
- former Yugoslav Republic of Macedonia

South America:

- Argentina
- Bolivia
- Brazil
- Chile

Colombia
Ecuador
Guyana
Paraguay
Peru
Suriname
Uruguay
Venezuela

Central America & the Caribbean:

Belize
Costa Rica
El Salvador
Guatemala
Honduras
Mexico
Nicaragua
Panama

Caribbean:

Bahamas
Barbados
Cuba
Dominican Republic
Guadeloupe
Haiti
Jamaica
Martinique
Netherlands Antilles
Puerto Rico
Trinidad and Tobago

East, SE and South-Central Asia:

East Asia:

China
Democratic People's Republic of Korea
Hong Kong
Japan
Macau
Mongolia
Republic of Korea

SE Asia:

Brunei
Cambodia
East Timor
Indonesia
Lao
Malaysia
Myanmar
Philippines
Singapore
Thailand
Viet Nam

Pacific Islands:

Fiji
New Caledonia
Papua New Guinea
Solomon Islands
Vanuatu
Guam

French Polynesia
Samoa
South-Central Asia:
Afghanistan
Bangladesh
Bhutan
India
Iran
Kazakstan
Kyrgyzstan
Maldives
Nepal
Pakistan
Sri Lanka
Tajikistan
Turkmenistan
Uzbekistan

West Asia & North Africa:
West Asia:
Armenia
Azerbaijan
Bahrain
Cyprus
Gaza Strip
Iraq
Israel
Jordan
Kuwait
Lebanon
Oman
Qatar
Saudi Arabia
Syrian Arab Republic
Turkey
United Arab Emirates
Yemen
North Africa:
Algeria
Egypt
Libyan Arab Jamahiriya
Morocco
Sudan
Tunisia
Western Sahara

Middle, West & Southern Africa:
Middle Africa:
Angola
Cameroon
Central African Republic
Chad
Congo
Democratic Republic of the Congo
Equatorial Guinea
Gabon
Western Africa:
Benin
Burkina Faso

Cape Verde
Cote d’Ivoire
Gambia
Ghana
Guinea
Guinea-Bissau
Liberia
Mali
Mauritania
Niger
Nigeria
Senegal
Sierra Leone
Togo

Southern Africa:

Botswana
Lesotho
Namibia
South Africa
Swaziland

Eastern Africa:

Burudi
Comoros
Djibouti
Eritrea
Ethiopia
Kenya
Madagascar
Malawi
Mauritius
Mozambique
Reunion
Rwanda
Somalia
Uganda
United Republic of Tanzania
Zambia
Zimbabwe