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Fertility and relative cohort size

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I. Sammanfattning

I den här artikeln skattas effekten på fertiliteten av förändringar i åldersstrukturen. Få faktorer är så oskiljaktiga från ekonomiska och demografiska teorier om underutveckling som höga födelsetal.Större delen av den empiriska litteraturen om fertilitet fokuserar på en några få traditionellt antagna bestämningsfaktorer: inkomster, mäns och kvinnors utbildning, spädbarnsdödlighet och landsbygdens befolkningsandel. Mera nyligen har Macunovich utvecklat Easterlins idéer om åldersstrukturens potentiella påverkan på fertiliteten och gett empiriska belägg för dess effekter. Vi följer upp Macunovichs bidrag genom:

(1) Estimation av fertilitetsekvationer i vilka åldersstrukturen och de traditionella bestämningsfaktorerna ingår samtidigt. Detta kan tolkas som en test av robustheten för en del av variablerna då man kontrollerar för de övriga. Eller också kan det tolkas som ett test av hypoteser rörande mekanismerna bakom variablernas påverkan på fertiliteten
(2) Test av kohortstorlekseffekternas likhet over kontinenterna och mellan utvecklade regioner och utvecklingsregioner..
(3) Test av den aspekt av mekanismen varigenom kohortstorlek antas påverka fertiliteten: genom kvinnors arbetskraftsdeltagande.

För att uppnå dessa målsättningar har vi ekonometriskt skattat en statisk panelregression med aggregerade paneldata för 90 utvecklade länder och utvecklingsländer observerade vart femte år over perioden 1950 till 1995. Vi finner att:

(1) Åldersstruktureffekterna går i den antagna riktningen. De är anmärkningsvärt stora och mycket precist skattade även efter kontroll för alla viktigare alternative bestämningsfaktorer för fertiliteten. Kohortstorleken har starka effekter som är oberoende av effekterna från inkomst, mäns och kvinnors arbetskraftsdeltagande, deras utbildning, landsbygdsandelen av befolkningen och spädbarnsdödligheten.
(2) Kohortstorlekseffekterna återfinns på alla kontinenter såväl inom den utvecklade världen som i utvecklingsregionerna. Storleksordningen är anmärkningsvärt homogen over både kontinenter och utvecklingsnivå. Av alla de variabler som inkluderats i regressionsekvationerna är kohortstorlek den enda som genomgående har en stor och signifikant effekt över alla regioner.
(3) Estimaten av kohortstorlekseffekterna överlever kontroll för kvinnors arbetsmarknadsaktivitet. Det betyder att effekterna kommer från någon mekanism utöver kvinnors arbetskraftsutbud (och även utöver de andra effekter som specifikationen kontrollerar för). Vi är därför fortfarande i behov av en empiriskt giltig teori för orsaken till att kohortstorlek har en negativ effekt på fertiliteten.

I. Summary

This paper estimates the effect of changes in population age structure on fertility. Few factors are as inseparable from economic and demographic theories of underdevelopment as high fertility rates. Most of the empirical literature on fertility focuses on a small set of traditionally hypothesized determinants: incomes, men's and women's education, infant mortality, and the rural share of the population. More recently, Macunovich develops ideas by Easterlin about the potential impact of population age structure on fertility, and provides empirical evidence for its effects. We continue along the lines of Macunovich's contribution by:

(4) Estimating fertility equations in which age structure and the traditional determinants are included simultaneously. This may be interpreted as a test of robustness of one set of variables when controlling for the others. Or it may be interpreted as a test of hypotheses concerning the mechanisms whereby one set of variables affects fertility.
(5) Testing for the consistency of cohort size effects across continents and between the developing and developed regions
(6) Testing one aspect of the mechanism whereby cohort size is hypothesized to affect fertility, through women's labor force participation.

To accomplish these objectives, we econometrically estimate a static panel equation using aggregate panel data on the relevant variables for 90 developed and developing countries observed every 5 years over the period from 1950 to 1995. We find that:

(4) Age structure effects are found in the hypothesized direction. They are remarkably large and very precisely estimated even after controlling for all the major competing determinants of fertility. Thus cohort size has strong effects that are independent of the effects of income, men's and women's labor force participation rates, men's and women's education, rurality, and infant mortality.
(5) Cohort size effects are found in every continent within the developing world, as well as in the developed world. Their magnitudes are remarkably similar across continents and levels of development. Of all the variables included in the regressions, cohort size has the most consistently large and significant effect across all regions.
(6) The estimates of cohort size effects survive controlling for women's economic activity rates. This means that cohort size effects are mediated by more than women's labor supply (and by more than all other effects controlled for in the specification). We are still in need of an empirically validated theory of why cohort size has a negative effect on fertility.

II. Introduction

In economic and demographic theories, as well as in the popular consciousness, few factors are as inseparable from underdevelopment as high fertility rates. The relationship between the two is complex and reflects mutual causation. The most powerfully resonant ideas, flowing from Malthus's (1798) original grand pessimistic vision, are about the impact of high fertility on underdevelopment. Population growth brought about by high fertility always threatens to exceed the rate at which the food supply grows. Recurrent famines and starvation shrink the population and lower fertility, and are the essential mechanism whereby growth in populations and food supplies are reconciled. This vision of fertility-led population growth in constant tension with development echoes powerfully in modern times, in alarmist works such as Ehrlich (1968), but also in the less extreme economic and demographic models. For example, the standard Solow (1956) model of economic growth predicts that while long-term growth in standards of living are independent of the rate of population growth, increases in this rate cause permanently lower levels of output and consumption per capita.

On the other hand, it is also widely understood that development has an impact on fertility. Within economics, the most famous exposition of this idea comes from Becker (1960), and Becker and Tomes (1976). There are two components to this idea. The first element has to do with rising women's wages which is itself the result of rising women's education. As women's wages rise, the income that must be foregone by women in order to perform time-intensive child-rearing grows larger, making high fertility less attractive. The substitution effect of this opportunity cost runs opposite and may dominate the income effect of higher wages on the number of desired children. In contrast, growth in the male wage is usually believed to exert only a positive income effect on fertility since men traditionally do little child rearing. The second element has to do with rising demand for child quality as household income rises. If this demand rises strongly enough, households will prefer to raise fewer children of higher quality, rather than more children of lower quality as their incomes grow. Expenditures on children can rise as a function of income, as is required if children are a normal good, even if the number of children falls as long as the quality of children rises fast enough. Other theories emphasize the role of processes that accompany modernization. For example, demographic transition theories predict a role for infant and child mortality reductions in bringing down fertility since fewer births are needed to attain a target number of surviving children. Urbanization reduces the possibilities for using children as unpaid agriculture, as well as provides new state-run mechanisms for providing old age security, obviating the need for depending on offspring for productive household labor or retirement income.

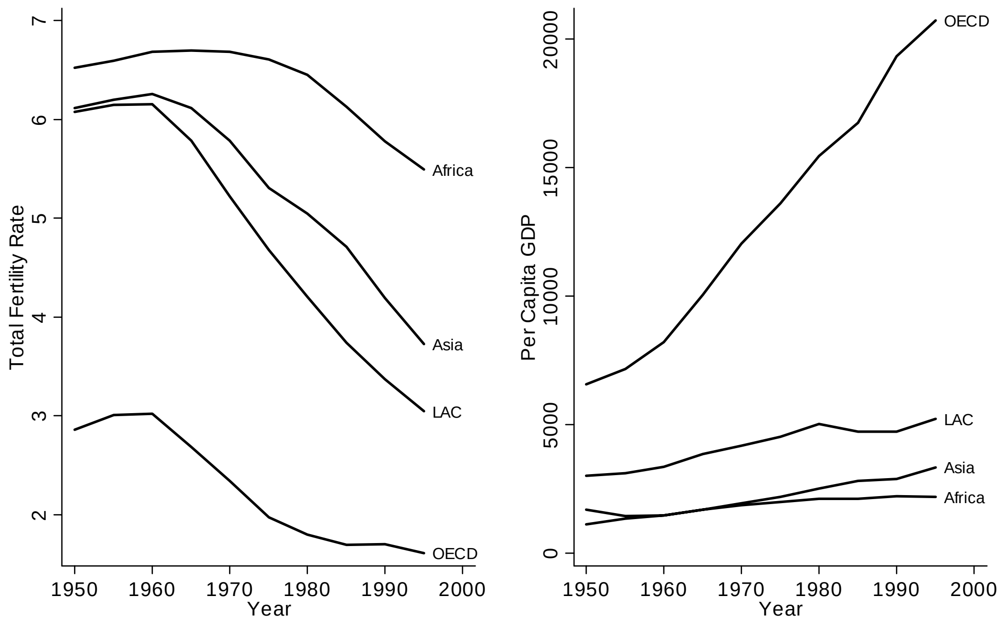
Clearly then, the relationship between fertility and development is one of mutual causation, and some theories are very explicit about these interactions. For example, in some microeconomic theories of development (Basu and Van 1998, Bardhan and Udry 1999), parents' fertility choices are determined simultaneously with prospective decisions concerning their children's schooling and labor. In these theories, multiple equilibria are possible: one characterized by low fertility, high human capital accumulation, and low child labor, and the other by high fertility, low human capital, and high child labor. History, social norms, expectations, or exogenous shocks usually determine which equilibrium results, but in either equilibrium, fertility and the human capital outcomes which are essential for development are determined simultaneously.

Not all theories imply a negative relationship between population growth and development. A small number of writers, most prominently Kuznets (1960, 1967) and Simon (1981) argue that population growth enlarges the stock of human ingenuity as well as facilitates the exploitation of economies of scale. Simon invokes as evidence of this the long term tendency of natural resource prices to fall rather than rise as might be predicted in a Malthusian world. In a twist of the Malthusian theme, Ester Boserup (1965, 1981) argues that the adversity caused when population growth threatens to outstrip food and resource supplies can promote innovation which resolves the adversity. This is how, she argues, hunting and gathering became replaced by slash and burn agriculture, which was in turn replaced by multi-annual cropping. And yet, on the whole, most theories predict a negative relationship between fertility and development.

In the past two decades, a more nuanced view emerged in which the relationship between population dynamics and development was mediated by more than sheer population growth rates and population sizes. Special attention was paid to the role of age-structure changes produced by the demographic transition. According to a representative version of this view (see Bloom, Canning, and Sevilla 2003), the demographic transition begins with a decline in infant and child mortality due to the diffusion of new treatments for disease, public health infrastructure, and hygienic behavior. This reduced mortality eventually induces a response of lowered fertility. In the interval between the mortality decline and the fertility response, a baby boom cohort is created. The life trajectory of this boom cohort yields distinctive challenges and opportunities for development. Early on, the cohort produces a higher than average youth dependency ratio, producing demands that could potentially strain educational systems and household resources. But when this cohort grows into adulthood, it becomes the source of a potential demographic dividend by boosting a nation's labor supply, consumption demand, and pool of savings, all potentially aiding growth. And finally, when this cohort ages, it produces potential strains on systems of social support for the elderly.

Thus fertility, by being one of the main forces driving population growth and age structure, is inseparable from socio-economic development. The latter half of the 20th century saw many changes in levels of fertility and development across the globe. In most regions, there were dramatic improvements in both, though in Africa, there was very little progress. The developing nations of Asia (excluding Japan and South Korea which are considered part of the developed world in this paper) tripled its average national per capita output from $1135 in 1950 to $3350 in 1995 (in constant 1996 dollars). In that same time it reduced its total fertility rate from 6.1 to 3.7. The developed nations more than tripled its income from $6500 to $20,800 and almost halved its fertility rate from 2.9 to 1.6 over that same period. Latin America and the Caribbean showed less dramatic improvement. Per capita incomes only rose by about two-thirds from $3000 to $5200, though fertility halved from 6 to 3. Progress was slowest in Africa, where income grew by only about 30% from $1700 to $2200, and fertility fell by one from 6.5 to 5.5 over this period. Figure 1 shows all these trends.

Figure 1. TFR and Per Capita GDP



Source: UNWPP 2000 and PWT 6.1

Yet fertility remains high in many areas. It is still barely below 6 in Africa. And while Asia and Latin America have seen drastic declines, their fertility rates are still between 3 and 4, well above replacement levels. On the other hand, the challenges of economic development remain daunting. On average, figure 1 shows that the developing world is experiencing living standards considerably below those enjoyed by the developed nations half a century ago. African standards of living are about one-tenth those of the wealthiest countries. Future fertility reductions, especially in Africa, will almost certainly play a role in future development prospects.

Because of the role that fertility plays in development, both past and future, an understanding of its determinants remains important. On the issue of the empirical determinants of fertility, there is a large amount of research. For a recent summary, see Bulatao and Casterline (2001). We have already alluded to its central ideas. Women's education tends to lower fertility while men's education tends to raise it. Income growth tends to raise the demand for quality at the expense of quantity of children. Infant mortality declines reduce fertility by reducing the replacement motive. And urbanization tends to reduce fertility by lowering the possibilities for using children as agricultural labor, and by facilitating the use of formal social security systems rather than within-household intergenerational transfers for retirement income for the elderly.

More recently, Macunovich (2000) develops and provides evidence for an original idea by Easterlin (1978) that age structure, more specifically, relative cohort size (RCS) should have a negative effect on the total fertility rate (TFR). The essential mechanism is a combination of cohort crowding and relative income aspirations. The demographic transition creates large cohorts of young males that, upon entering the labor market, experiences lower wages because of their abundance and imperfect substitutability for older more experienced workers. The lower wages could result in lower participation rates as they fall below reservation levels. On the other hand, if young males have relative income targets because they aspire to the standard of living enjoyed by their parents, then the lower wages may cause them to increase their labor supply and participation. Thus, the effect of relative cohort size on male participation is ambiguous. However, we would expect that male participation should have a positive effect on fertility for the same kind of income effect reasons that male education has a positive effect on fertility. On the other hand, it is argued that women's labor force participation will rise, largely due to the relative income motive. The combination of higher women's participation and the expensiveness of children in the light of the younger generation's relative poverty lead to lower fertility. Macunovich (2000) provides evidence for this cohort size effect, using cross-country panel regressions in which the independent variables are levels and changes in RCS, lagged TFR, and infant mortality, and finds significant effects in the hypothesized directions.

It is remarkable how little of the literature on fertility determinants has been influenced by the age structure hypothesis. None of the studies in Bulatao and Casterline (2001) mention age structure, and none of the cross country empirical work on fertility determinants (with the exception of Macunovitch's) includes age structure as an independent variable. Yet if age structure does have an effect, it would clearly be important to integrate it into models of fertility determinants. Many of the traditional determinants of fertility such as income, education, and the labor force participation of women are variables that have been theorized to themselves be functions of age structure (Bloom, Canning, and Sevilla, 2003, Easterlin 1978, Macunovich 1996). A better understanding of the roles of these determinants will be made possible by seeing what their residual effects on fertility are, once age structure has been taken into account. On the other hand, if an age structure effect exists, we would come to a deeper understanding of the precise mechanism through which this effect is realized if we estimate age structure effects in a model that includes both the traditional variables and the hypothesized variable that mediates the age structure effects, women's labor force participation. Macunovitch's work itself, while providing evidence for age structure effects, does not include any of the other traditional determinants of fertility. We are thus unable to tell the importance of age structure effects when controlling for other determinants.

We therefore estimate a static panel equation in which the dependent variable is the total fertility rate, and the independent variables are the traditional determinants of fertility, the relative cohort size of reproductive age women, and the labor force participation of women and men. Because it has been argued that the relationship between the independent variables and fertility may vary by region and level of development (Bulatao and Casterline 2001), we estimate regressions on a pooled sample of countries as well as by region. We use four regions: the OECD, the developing Asian countries, Africa, and Latin America and the Caribbean. This disaggregation allows us to see the extent of the heterogeneity of age structure and other effects.

II. Data

Data on TFR, RCS, and IMR are obtained from the United Nations World Population Prospects 2000 (United Nations 2002). RCS is taken to be the share of the population aged 15-34 in the adult population aged 15-64 calculated from this dataset. Per capita GDP is measured using the variable RGDPCH from the Penn World Tables 6.0 (Heston and Summers 1994). Total years of schooling in the adult population aged 15 and above for males and females are measured using the variables TYRM15 and TYRF15 from Barro and Lee (2000). The rural share of the population is obtained from the World Development Indicators 2002 (World Bank 2003).

Data on male and female economic activity is taken from the fourth edition of the ILO's Economically Active Populations dataset (International Labour Office 1997) which contains data on the age and sex composition of total and economically active populations for the world's countries during the years 1950, 1960, 1970, 1980, and 1990. The data source defines the economically active as "all persons of either sex who furnish the supply of labour for the production of economic goods and services as defined by the United Nations system of national accounts and balances during a specified time-reference period. According to these systems the production of economic goods and services includes all production and processing of primary products whether for the market, for barter or for own consumption, the production of all other goods and services for the market and, in the case of households which produce such goods and services for the market, the corresponding production for own consumption….By that definition, the active population includes: persons in 'paid' or 'unpaid' employment, members of the armed forces (including temporary members) and the unemployed (including first time job-seekers." Unpaid employment itself includes "Employers, own-account workers and members of producers' cooperatives; unpaid family workers, persons engaged in the production of economic goods and services for own and household consumption, and apprentices who receive pay." Since household production for own use counts as economic activity only for primary goods and for all other goods and services also supplied to the market, household maintenance activities like child-care and housekeeping do not count as economic activity. Economic activity as defined by the ILO is therefore broadly similar to the concepts of "labor force participation" and "labor supply".

The benchmark data for the activity rates are obtained from the third edition of the EAP dataset for the years 1950, 1960, and 1970, and from population censuses, sample surveys of the economically active, or similar surveys conducted from 1974 to 1994 and published by national and international statistical agencies for the years 1980 and 1990. These baseline data are adjusted using what the ILO calls a "pragmatic" approach "(where) choice of methods and techniques for estimating activity rates…was based on an evaluation of…criteria pertaining to the source and quality of the data and to national data compilation practices….Whenever…data…was unavailable, the rule was to draw on information or data on countries…at a similar level of socio-economic and cultural development." Most adjustments of baseline data were performed to harmonize definitions of the economically active, as well as to raise the activity rates of women in agriculture who worked as unpaid family workers. These rates seemed "deliberately overlooked…for socio-cultural reasons, or…under-enumerated by comparison with data from neighboring countries with the same socio-economic profiles. Fuller details of data construction methodology and country-by-country details can be obtained from ILO (2000). Summary statistics of the data are presented in Table 1.

Table 1. Summary statistics of the data

Variable	Nobs	Mean	S.D.
TFR	334	4.6	2.02
RCS aged 15-34	334	0.57	0.07
MAR aged 15-34	334	83.8	5.6

FAR aged 15-34	334	49.5	19.5
RGDPCH	334	5782	5893
Rural share	334	55.3	24.7
Years of school, f	334	4.1	2.9
Years of school, m	334	4.9	2.7
IMR	334	73.2	52.8

III. Analysis

Our specification regresses the total fertility rate tfr on the following independent variables:

1. The age structure variable RCS^{15-34} which equals the number of adults aged 15-34 as a fraction of the number of total working-aged adults aged 15-64.

2. The activity rate or labor force participation rates of females and males aged 15-34, denoted FAR^{15-34} and MAR^{15-34} respectively.

3. The log of per capita output $\log(rgdpch)$.

4. The proportion of the population that is rural $rshare$.

5. The total years of schooling of the female and male population older than 15 years of age denoted by $tyrf15$ and $tyrm15$ respectively.

6. The log of the infant mortality rate $\log(imr)$

7. Country and period fixed effects μ and v

8. An error term ε

Countries and years are indexed by (i,t) respectively. The regression specification is:

$$tfr_{it} = \beta_0 RCS^{15-34}{}_{it} + \beta_1 FAR^{15-34}{}_{it} + \beta_2 MAR^{15-34} + \beta_3 \log(rgdpch)_{it} + \beta_4 rshare$$
$$+ \beta_5 tyrf15_{it} + \beta_6 tyrm15_{it} + \beta_7 \log(imr)_{it} + \mu_i + v_t + \varepsilon_{it}$$

The double linear functional form was chosen using the method of quasi-R-squares, which showed that the linlin and linlog forms do equally well relative to the loglin and loglog forms. We estimate the basic specification separately for each of the four regions, and then pool all regions together. Table 2 shows the results.

Table 2. Regression results

	Asia	Africa	Latin America	OECD	Pooled
RCS 15-34	-9.796 (4.501)**	-12.294 (3.759)***	-13.277 (3.931)***	-6.488 (1.775)***	-10.859 (1.802)***
MAR 15-34	-0.022 (0.045)	0.073 (0.037)*	0.056 (0.045)	0.036 (0.018)*	0.017 (0.018)
FAR 15-34	0.016 (0.018)	-0.047 (0.016)***	-0.048 (0.019)**	-0.008 (0.008)	-0.007 (0.007)
Log RGDPCH	-0.171 (0.363)	-0.448 (0.254)*	-0.292 (0.358)	-0.239 (0.437)	-0.297 (0.173)*
Rshare	-0.030 (0.024)	0.002 (0.015)	0.043 (0.019)**	0.031 (0.013)**	0.027 (0.009)***
Tyrf15	-0.561 (0.281)*	-0.423 (0.218)*	-0.104 (0.198)	-0.139 (0.168)	-0.411 (0.111)***
Tyrm15	0.737 (0.223)***	0.223 (0.139)	0.118 (0.186)	0.073 (0.154)	0.283 (0.092)***
Log IMR	1.0881 (0.791)	1.134 (0.435)**	0.660 (0.341)*	-0.156 (0.382)	0.374 (0.221)*
Number of observations	55	101	87	91	334
Number of countries	15	30	22	23	90
Elasticity	-1.122 (0.516)**	-1.198 (0.366)***	-1.674 (0.496)***	-1.380 (0.378)***	-1.340 (0.223)***

To make the estimates of the cohort size effects easier to interpret, the last row of this table transforms the coefficients of RCS into their corresponding elasticities. We draw the following four lessons from these regressions. First, there is a uniformly strong relationship between relative cohort size and fertility. This relationship exists across continents and levels of development, and is quite precisely estimated as seen from the high levels of statistical significance. The magnitudes of the elasticities are also consistently above 1. Thus, relative cohort size must be considered an important correlate if not determinant of fertility in every region of the world regardless of level of development. Second, every independent variable other than relative cohort size has only an inconsistently significant relationship with fertility. For example, male and female activity rates, women's education, rural share of the population, and infant mortality are statistically significant in only two out of four continents, while income and male education are significant in only one out of the four continents. Third, where the traditional independent variables are significant, they do have the expected sign. That is, we see that male activity rates, male education, rural population share, and infant mortality are positively correlated with fertility while female activity, female education, and income are negatively correlated with fertility. Fourth, and perhaps most relevant for the assessment of the Easterlin/Macunovich hypothesis regarding the mechanism whereby cohort size affects fertility, we see that the significant effect of cohort size on fertility survives the inclusion of the female activity rate.

This table reproduces many of the other findings in other empirical work: the inconsistent effect of income, the negative and positive effects of female and male schooling respectively, the positive association between mortality and fertility. But what we find remarkable is the strength and statistical significance of the effects of cohort size in the presence of these competing determinants. Thus we can make an even stronger claim than Macunovich, that relative cohort size exerts its strong negative effect on fertility, even after controlling for most of the other hypothesized determinants of fertility. There are two possible interpretations of this significance. First, that the effect of cohort size is quite robust to the inclusion of controls. And second, that the effect of cohort size is not completely mediated through these controls. In particular, we find that the theoretical argument for a cohort size effect working through women's work is insufficient: women's work itself is not consistently associated with fertility, and the impact of cohort size on fertility does not disappear in the presence of control for women's work.

This leads us to another conclusion. Most traditional analyses of fertility determinants that focus on the other factors such as income, education, and infant mortality usually ignore the role of age structure. They do so at significant risk of omitted variable bias. Our results show that most of the hypothesized effects appear at a global level of aggregation: income and female education reduce fertility while child mortality, rurality, and male education raise it. But the effects are less consistent at the intra-continental level, and the variable that shows the most consistent role both within and across continents is cohort size.

Finally, we investigate the most important mechanism that is hypothesized to created the negative relationship between cohort size and fertility, the positive association between cohort size and female economic activity. To do this, we estimate the following static panel equation

$$far^{15-34}{}_{it} = \delta_0 RCS^{15-34}{}_{it} + \mu_i + v_t + \varepsilon_{it}$$

where the dependent variable is the activity rate of females of peak reproductive age, which we take to be 15-34, and the independent variable is the share of that age group in the working age population aged 15-64. If the Easterlin/Macunovitch story holds, we would expect that large cohort sizes would be associated with higher female activity rates. Our parameter should therefore by positive. Table 3 shows our results.

Table 3. RCS and FAR 15-34

	Asia	Africa	Latin America	Pooled
RCS 15-34	7.113 (15.631)	1.873 (16.681)	-65.425 (27.377)**	0.805 (11.759)
Number of observations	180	250	125	555
Number of countries	36	50	25	111

The table shows that contrary to the Easterlin/Macunovich implication, larger cohorts tend to produce lower activity rates for its females, more in line with the usual cohort crowding effects expected of men. Of course, it is still possible that the cohort crowding mechanism still works in another form. Some economically active women may still have sufficient free time to bear children, and crowding may require them to increase their economic activity, and lower their fertility. Thus crowding could promote the intensity of female activity and lower fertility without changing the proportion of economically active women. But whether this alternative story is true has yet to be directly verified.

Thus we find that two tests we perform of the Easterlin/Macunovich mechanism, introducing female economic activity in the full specification and testing for a positive relationship between cohort size and female economic activity do not yield supportive results. This in fact leads us to an unusual situation: since the most clearly enunciated hypothesis for why relative cohort size has an effect on fertility is not strongly supported by the data, and since relative cohort size has a strong effect on fertility even after accounting for all the traditional determinants of fertility, we find that we as yet do not have a sufficient theory that explains the strong association between cohort size and fertility. Relative cohort sizes depress fertility for reasons other than through affecting activity rates a la Easterlin/Macunovich.

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