Fertility, the Demographic Dividend, and Economic Growth[1]

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Abstract

We exploit differential timing of abortion legalization across countries between 1960 and 2005 to estimate the effect of changes in fertility on income, finding that reducing fertility by one child per women increases income per capita by about 20%. We estimate that most of the income gain is due to an increase in the number of workers per capita, because of a lower youth dependency ratio, and higher female labor force participation. We also find that reductions in fertility lead to increased investment in education and slower population growth, but little evidence of higher physical capital intensity or worker productivity.

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1. Introduction

Models of economic growth have traditionally taken account of demographic change by focusing on the effect of population numbers. In the Malthusian model a larger population puts pressure on fixed factors, such as land, and lowers the level of the fixed factor, and output, per worker. In the Solow model population growth tends to reduce the capital labor ratio, and output per worker, because it is difficult for capital to accumulate quickly enough to keep pace with a rapidly growing population. Recent theoretical models of economic growth have emphasized the importance of fertility decline to prevent income gains from being swamped by population numbers (Becker, Glaeser et al. (1999; Galor (2005; Galor and Weil (1999; Galor and Weil (2000)). A weakness of this focus on population numbers is that it ignores the effect other demographic variables, such as age structure and longevity, on the economy (Bloom and Canning (2008)). Age structure matters because economic behavior varies over the life cycle, while expected longevity matters due to its effects on life cycle decisions such as retirement and saving (Bloom, Canning et al. (2003), Bloom, Canning et al. (2007)).

In addition, there is little empirical evidence for the negative effects of population numbers on economic growth predicted by the Malthusian and Solow models (National Research Council (1986), Kelley (1988)). However, there is evidence that age structure matters for economic growth (Bloom, Canning et al. (2000)). A focus on population numbers leads to treating fertility and mortality as having symmetrical effects on the economy; a death is equivalent to an avoided birth. However, a focus on age structure effects implies that fertility and mortality have differential effects. While population numbers appear to have little effect on economic growth, mortality and fertility, if considered separately, do seem to have large impacts (Bloom and Freeman (1988), Brander and Dowrick (1994), Kelley and Schmidt (1995), Kelley and Schmidt (2005)).

While fertility is likely to have an impact on economic growth, it is difficult to establish a causal relationship from fertility to economic outcomes because fertility is itself a choice that may depend on economic circumstances. One common approach to try to resolve this problem is to explain economic growth with initial fertility using the fact that the timing of the fertility is before the growth to argue for a causal link. However the appeal to timing is weak if expectations play a role in decision making. For example, Bils and Klenow (2000) argue that expected growth may cause prior schooling rather than schooling causing growth; there may a similar problem with expected economic growth affecting current fertility decisions. To overcome this problem we construct a data base of abortion laws and use the timing of abortion legislation as an instrument for fertility. Abortion is a common method of fertility control and is a plausible instrument if the timing of abortion laws can be considered random. We will argue that in practice the precise timing of abortion legislation is contingent of chance factors rather than a systematic response to economic conditions.

Our approach to estimating the effect of fertility on income levels is similar to that employed by Acemoglu and Johnson (2007) who estimate the effect of life expectancy on income by instrumenting life expectancy using disease specific technological advances combined with initial levels of disease specific mortality.

Using this approach we find that a reduction in fertility by one child per women increases income per capita by about 20%. Fertility is bounded below, and so fertility decline cannot be a source of economic growth in the long run. However, over the course of the demographic transition (Lee (2003)) fertility falls from around eight children per woman to less than two, indicating that fertility decline may lead to a doubling of the level of income per capita, a sizable effect. Our results suggest that the rapid economic growth in some East Asian countries after 1970, and in Ireland after 1980, may have been in part due to the rapid declines in fertility these countries experienced (Bloom, Canning et al. (2000), Bloom and Canning (2003)).

We also investigate the mechanisms through which fertility affects economic growth. Income per capita can be decomposed into income per worker, workers per working age person (the participation rate), and working age people per capita. We find a significant effect of fertility on population age structure and the ratio of working age to dependent population. Secondly, fertility, and the presence of young children in the household, can affect the labor force participation rate of the working age, particularly female, population. We find that reductions in fertility lead to increases in female labor force participation. Bloom, Canning et al. (2007) provides a more detailed study of the effect of fertility on age specific female participation rates. These two mechanisms change number of workers per capita and account for about two thirds of our estimated effect on income levels. This is consistent with fertility decline being part of the explanation of the East Asian growth "miracle" since Young (1995) has argued that this economic growth was due to a large extent to rising numbers of workers per capita. The third mechanism is fertility's effect on output per worker due to induced changes in human and physical capital intensity and factor productivity. We find no evidence of an effect on the capital labor ratio but do find some impact of fertility on educational outcomes.

The rest of the paper is structured as follows: we present our data in section 2. The mechanisms through which fertility affects economic growth are discussed in section 3 of the paper. In this section we point out that some mechanisms imply an immediate impact of changes in fertility on income per capita, whereas others operate with a long lag. In section 4 we present the empirical results. We conclude the paper with a short discussion and summary.

2. Data

To analyze the effect of fertility changes on income per capita we exploit an unbalanced panel of 170 countries from 1960 to 2005. Out fertility variable is the total fertility rate, the number of children a women would expect to have over her fertile years if she had the current population's age specific fertility rates. In addition to income per capita we examine the effect of fertility on the component parts of income per capita: income per worker, the labor force participation rate, and the working age share in the total population. We also look at the effect of fertility on youth and old age dependency rates, male and female labor force participation, the population growth rate, the capital labor ratio, school enrollment rates, and the average years of schooling of adults to get a sense of the mechanisms through which fertility operates. Details of the variables used, their definitions, construction, and data sources are given in Appendix A.

We use an index of abortion legislation to use as an instrument for fertility. The abortion variable we construct is based on national abortion legislation data compiled by the United Nations Population Division (2002). The data contain detailed information on the legal availability of abortion over time.[2] The United Nations classifies legal reasons for an abortion into seven categories: to save the life of the woman; to preserve her physical health; to preserve her mental

[2] We are grateful to Mansour Farahani for synthesizing the abortion legislation information into a format compatible with our dataset.

health; rape or incest; fetal impairment; economic or social reasons; and direct request by the mother. We construct an index, where we give a score of 1 for each category under which abortion is legal. If a country does not allow abortion for any reason, the index score is 0. If abortion is legal for all of the seven reasons, the index score is 7. In some cases, the database indicates that abortion is available on request, but does not explicitly state availability for the other reasons. Since availability on request implies unrestricted access, we give a full score of 7 in these cases.

Even though the abortion data base provides information on the abortion legislation in each country, it does not contain all legal features which may restrict the actual access to abortion. For example, abortions are usually limited to some maximum number of weeks of pregnancy, and in many cases also require verification of the qualifying reason; for example by one, or two, doctors, or by a committee. We do not use data on these characteristics of a system. In countries with federal structures such as the United States and Australia abortion laws also show significant legal variations at the state level which are not captured by the national abortion data base (which we take to be the law in the region with the largest population).

Differences also exist in the degree to which abortion laws are enforced in practice. While there is evidence for doctors not conducting abortions after official liberalizations (Human Rights Watch (2006)) or the service being unavailable despite its legality (Grimes, Benson et al. (2006)), a large number of abortions are also conducted in countries where abortions are not legal. The liberalization of abortion laws could thus be viewed as a decrease in the price faced by individuals wishing to limit their fertility through abortion rather than an absolute control on abortion.

Further details of the construction of the abortion law index and how it varies across countries are available in Bloom, Canning et al. (2007). Summary statistics for the variables used in our empirical analysis are provided in Table 1.

Table 1 here

From an empirical viewpoint, most factors associated with demographic change are highly correlated across countries and time as summarized in Table 2 below: countries with high fertility rates are generally also characterized by low working-age share, and high population growth rates as well as low income per capita. We can also see that countries with high level of the abortion index tend to have low fertility.

Table 2 here

For many countries the decline in fertility in the last 45 years has been rapid. For others, the decline has been less pronounced or non-existent. The onset of a rapid fertility decline is a signal that a country is on the trajectory of undergoing the demographic transition from high fertility (and high mortality) to low fertility (and low mortality). In Figure 1 we show the change in fertility that occurred between 1960 and 2000 across countries against their initial fertility rate. Countries that had a fertility rate below 5.5 in 1960 all experienced a dramatic decline in fertility; once the fertility transition is underway it tends to continue. Countries that had a fertility rate above 5.5 in 1960 either experienced rapid decline in fertility (Iran's TFR fell by five, from seven to two) and thus undertook a demographic transition trajectory, or maintained high fertility rates and either delayed, or have not yet begun their fertility transitions. In some countries fertility actually rose between 1960 and 2000, for example, Chad, Niger and Guinea-Bissau.

Figure 1 here

The cross-country relationship between the total fertility rate and log income per capita in the year 2000 is shown in Figure 2. As can be seen there is a strong negative relationship with low fertility countries having high income. However, this link may not reflect a causal effect of fertility on income; there is likely to be a substantial effect of income levels on fertility. High income level countries will usually have high wages, increasing the cost of children since high wages raise the opportunity cost of the time required for child rearing (Becker, Glaeser et al. (1999)). In addition, if high income countries have high returns to human capital, this may lead parents to a quality quantity tradeoff, reducing the number of children but increasing the amount of human capital invested in each child (Becker (1981)).

Figure 2 here

Figure 3 below summarizes the abortion index over time (in countries for which we have complete data over the time period). The global average index value was 2.8 in 1960 and has increased to a level just slightly below 4 in 2005, with most of the increases (liberalizations) taking place in the 1970s and 1980s.

Figure 3 here

3. The Effect of Fertility on Income Levels: Mechanisms

In this section we present a stylized model to illustrate the relationship between fertility and income per capita and the mechanisms behind this relationship. Let Y_t be aggregate income at time t while P_t is population. We begin with the identity that income per capita is income per worker, times workers per working age population, times the ratio of working age to total population

$$\frac{Y_t}{P_t} = \frac{Y_t}{L_t} \frac{L_t}{W_t} \frac{W_t}{P_t} \tag{1}$$

where L_t is the labor force, and W_t is the working age population. Taking logs of equation (1) we have

$$\log \frac{Y_t}{P_t} = \log \frac{Y_t}{L_t} + \log \frac{L_t}{W_t} + \log \frac{W_t}{P_t} \tag{2}$$

We investigate the effect of fertility on income per capita through its effect on each of these components, income per worker, the labor force participation rate of the working aged population and the share of the working aged in the total population.

Growth models have tended to focus on the first channel, the effect on income per worker, ignoring the other two channels, labor force participation and the working age share of the population. The participation rate and working age share are bounded and so cannot explain long run economic growth. However they can vary substantially over time and can help explain large movements in income levels.

We begin by focusing on the effect of fertility on the ratio of workers to total population, W/P. We assume a three period framework. People are born in the first period but do no work. In the second period they are of working age and in the third period they are old and retired. In period $t-1$, B_{t-1} people are born. A fraction of these individuals, m_{t-1}, die before entering period t. The survivors become the working age population in period t, W_t. Births in period t depend on the fertility rate f_t of women of working age (we assume the young and old have zero fertility)[3]. At the end of period t workers retire and enter old age, O_{t+1}. Not all workers survive into old age, and the fraction d_t will die before entering period $t+1$. Hence three cohorts will make up the population in period t, and the level of young, working-age, and old will depend on cohort fertility and death rates such that:

$$W_t = B_{t-1}(1-m_{t-1}) \tag{3}$$

$$B_t = W_t f_t / 2 \tag{4}$$

$$O_t = W_{t-1}(1-d_{t-1}) \tag{5}$$

From (3), (4), and (5) the youth and old-age dependency ratios are given by

$$\frac{B_t}{W_t} = f_t / 2 \tag{6}$$

$$\frac{O_t}{W_t} = \frac{2(1-d_{t-1})}{(1-m_{t-1})f_{t-1}} \tag{7}$$

We can derive the ratio of working age to total population as

$$\begin{aligned}\frac{W_t}{P_t} &= \frac{W_t}{W_t + B_t + O_t} \\ &= \frac{B_{t-1}\left(1-m_{t-1}\right)}{B_{t-1}\left(1-m_{t-1}\right)(1+f_t/2) + B_{t-2}(1-m_{t-2})(1-d_{t-1})} \\ &= \frac{1}{1+f_t/2+\dfrac{(1-d_{t-1})}{(1-m_{t-1})f_{t-1}/2}}\end{aligned} \tag{8}$$

From this relationship we can see that the working-age share is decreasing in the current fertility rate; the higher the current fertility rate f_t the higher the number of youth dependents relative to the number of workers. Similarly, higher survival to old age (lower adult mortality) lowers the working-age share. High fertility has a benefit after one period; it produces a large working age cohort which reduces the old age dependency rate.

If mortality and fertility rates stabilize the steady state ratio of working age to total population will be

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[3] We also assume that sexes are always of equal number in our model.

$$\frac{W}{P} = \frac{1}{1 + f/2 + \frac{(1-d)}{(1-m)f/2}} \tag{9}$$

Equation (9) implies that the steady state relation between working-age share of the population and fertility is highly non-linear. The working age share at first rises with the fertility rate and then falls. The working age share is at a maximum when fertility is

$$f = 2\sqrt{\frac{1-d}{1-m}} \tag{10}$$

When mortality rates on the transitions to working and old age are zero the working age share will be maximized with fertility at the replacement level (two children per working age woman). For low mortality rates the working age share will be maximized when fertility is close to the replacement level.

The model above is a stylized approximation to age structure dynamics for illustrative purposes. In general, if we fix a population's age specific mortality and fertility rates, the age structure of the population with converge to a stable distribution (e.g. see Preston, Heuveline et al. (2001)). Figure 4 below illustrates the relationship between the steady state working age share and fertility rates for different age specific mortality schedules.

Figure 4 here

We use age specific mortality rates from three different life tables (from World Health Organization): Zambia, with a life expectancy of 40 in 2005, Yemen, with a life expectancy of 60 in 2005, and France with a life expectancy of 80 in 2005. We assume that these age specific mortality rates are fixed and that the fertility rate is the same for each woman in her fertile years (16-49) and zero outside this range. We then calculate the working age share (population aged 16-64 relative to total population) in the stable population for these age specific mortality schedule and fertility schedules as we vary the total fertility rate (we simulate the evolution of the age structure and let it converge to its stable distribution for each combination of age specific mortality and fertility schedules).

Figure 4 shows that reducing the fertility rate from high levels of fertility usually increases the working age share. However, going further and reducing fertility when it is at or below the replacement rate can reduce the working age share. The fertility level that maximizes the working age share is around the replacement rate (just over two children per women) but the exact position of this turning point depends on age specific mortality rates. We expect a reduction in fertility to increase the working age share in high fertility countries but it may lead to a decline in the working age in countries that already have low fertility.

Figure 5 below shows the empirical relationship between fertility and the working age share of the population in the year 2000.

Figure 5 here

While the non-linear response of the working age share to the fertility rate may be important in low fertility countries, our sample is dominated by the negative relationship; countries with lower fertility have higher working age shares. Most of our sample has fertility rates in excess of the replacement rate where we expect this negative relationship. Countries with below replacement fertility may be enjoying the benefits of low youth dependency rates but are yet to see the effects of small working age cohorts on old age dependency. The observed working age shares are slightly higher than would be predicted by the steady state shares shown in Figure 4 which is consistent with the fact that fertility rates are falling and the short term gains from lower youth dependency rates are not yet being fully offset by the longer term losses from high old age dependency rates. The three outliers in Figure 5 with very high working age shares, but fertility above replacement, are Kuwait, Qatar, and the United Arab Emirates, oil producing countries that have substantial numbers of working age immigrants. Figure 5 suggests that even though the overall relationship between the total fertility rate and the working age share is non-linear, for the data we employ taking a linear approximation to the relationship will not be unreasonable.

Linearizing equation (8) about the sample means, and ignoring variations in mortality rates, we have that log working age share can be approximated by

$$\log\left(\frac{W_t}{P_t}\right) \approx \log(1+\bar{f}/2+\frac{1-\bar{d}}{1-\bar{m}}2\bar{f}^{-1}) - \left[\frac{2}{1+\bar{f}/2+\frac{1-\bar{d}}{1-\bar{m}}2\bar{f}^{-1}}\right]\left[f_t-\bar{f}\right]$$
$$+\left[\frac{\left(\frac{1-\bar{d}}{1-\bar{m}}\right)8\bar{f}^{-2}}{1+\bar{f}/2+\frac{1-\bar{d}}{1-\bar{m}}2\bar{f}^{-1}}\right]\left[f_{t-1}-\bar{f}\right] \quad (11)$$

Linearizing equation (9) we have that steady state working age share can be approximated by

$$\log\left(\frac{W_t}{P_t}\right)^* \approx \log(1+\bar{f}/2+\frac{1-\bar{d}}{1-\bar{m}}2\bar{f}^{-1}) - \left[\frac{2-\left(\frac{1-\bar{d}}{1-\bar{m}}\right)8\bar{f}^{-2}}{1+\bar{f}/2+\frac{1-\bar{d}}{1-\bar{m}}2\bar{f}^{-1}}\right]\left[f_t-\bar{f}\right] \quad (12)$$

Provided the sample mean of fertility is above the turning point given in equation (10) the coefficient on fertility in equation (12) should be negative. A full linearization would include terms in the mortality rates that govern the transition from childhood to working age, and from working age to old age. We ignore these terms and assume in our empirical specification that they can be captured by country fixed effect and time trends.

Note that the effect of fertility on the working age share in the short run is larger in magnitude than in the long run steady state. If fertility declines, in the short run we get the effect of a smaller youth cohort. In the next period this effect is offset by a smaller working age cohort which exacerbates any problem of old age dependency.

We now turn to the issue of labor market participation by the working age population L/W. If children require a time input from their parents this may reduce the time available for work. In principle the number of children born is also a choice variable making estimation of the effect of fertility on labor market participation difficult. Bloom Canning et al. 2007 construct a model in which fertility and female labor supply are jointly determined and use the abortion law index to instrument fertility when determining age specific female labor market participation. They find that female labor supply responds to fertility with each child born reducing a woman's labor supply by about 2 years over her reproductive life. They also find that female labor supply is responsive to the level of urbanization; in a rural environment, where the home is both a consumption and production unit, women may find it easier to combine child care with working. In addition they find female labor supply responds to the ratio of capital to the working age population, a proxy for the wage rate. Taking the participation rate to be a function of the fertility rate alone, assuming that any other relevant factors can be captured with fixed effects and time trends we have

$$\log\left(\frac{L_t}{W_t}\right)^* = \rho(f_t) \approx \rho(\bar{f}) + (\rho'(\bar{f}))(f_t - \bar{f}) \tag{13}$$

We expect the coefficient on fertility in this equation to be negative.

In the Solow model, a higher population growth rate is associated with a lower steady-state capital-labor ratio. In our framework the Solow model is a model of income per worker. The Solow model gives us steady state income at a fixed rate of labor force growth.

Given constant age specific mortality and fertility rates the age structure will converge to a stable population, in which the growth rate of working age and total population are the same. If fertility is fixed at f the labor force participation rate of the working age population will be fixed at $\rho(f)$. We first establish the relationship between the long run fertility rate and the population growth rate in our model. Given fixed fertility and mortality rates, labor force and the working age population will grow at:

$$\begin{aligned} n_t &= \frac{L_{t+1}-L_t}{L_t} = \frac{W_{t+1}-W_t}{W_t} = \frac{B_t(1-m_t)-B_{t-1}(1-m_{t-1})}{B_{t-1}(1-m_{t-1})} \\ &= \frac{B_{t-1}(1-m_{t-1})(1-m_t)(f_t/2)-B_{t-1}(1-m_{t-1})}{B_{t-1}(1-m_{t-1})} \\ &= (f_t/2)(1-m_t)-1 = (f/2)(1-m)-1 \end{aligned} \tag{14}$$

The growth rate of the labor force is increasing in the fertility rate. We now consider a model where each economy has a production function that takes the Cobb Douglas form with capital, K_t, and labor, L_t, and technology, A_t, to produce aggregate output, Y_t.

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha} \tag{15}$$

We assume $0 \le \alpha \le 1$. Suppose we have free movement of capital around the world so that capital adjusts to the level where its marginal product equals the world rate of return r. Then the optimal level of capital is K_t^*

$$\frac{dY}{dK} = \alpha\left(\frac{K_t^*}{A_t L_t}\right)^{\alpha-1} = r \tag{16}$$

Which gives us

$$K_t^* = \left(\frac{\alpha}{r}\right)^{\frac{1}{1-\alpha}} A_t L_t, \quad \left(\frac{Y_t}{L_t}\right)^* = \left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}} A_t \tag{17}$$

With perfect capital markets, the capital-effective labor ratio is equalized around the world. Capital adjusts one for one with labor supply and income per worker is independent of the number of workers.

On the other hand suppose we have an economy with no external capital flows but which saves at a constant rate. Capital accumulates according to

$$K_{t+1} = s_t Y_t + (1-\delta)K_t \tag{18}$$

Where s_t is the savings rate and δ is the rate of capital depreciation. We assume that the labor force grows at the rate n_t, while the labor augmenting technology grows at the rate g_t so that

$$L_{t+1} = (1+n_t)L_t, \quad A_{t+1} = (1+g_t)A_t \tag{19}$$

In per worker terms, we have the familiar (discrete time) capital accumulation equation,

$$k_{t+1} - k_t = \frac{s_t y_t - \left(\delta + n_t + g_t + g_t n_t\right)k_t}{(1+n_t)(1+g_t)}, \quad y_t = \frac{Y_t}{A_t L_t} \text{ and } k_t = \frac{K_t}{A_t L_t} \tag{20}$$

If the savings rate and population growth rate are fixed at s and n respectively the steady state capital-effective labor ratio is given by:

$$k_t^* = \left(\frac{s}{\delta + g + n + gn}\right)^{1/1-\alpha} \tag{21}$$

We assume that the capital stock per effective worker adjusts quickly to its steady state level. Then the level of income per capita in a balanced state growth path (with capital per effective worker at its steady state level) is

$$\left(\frac{Y_t}{L_t}\right)^* = A_t\left(\frac{s}{\delta + g + n + gn}\right)^{\alpha/1-\alpha} \tag{22}$$

Replacing the growth rate of labor force by the long run fertility and mortality rates using equation (14) gives us:

$$\left(\frac{Y_t}{L_t}\right)^* = A_t\left(\frac{s}{\delta + g + (1+g)((f/2)(1-m)-1)}\right)^{\alpha/1-\alpha} \tag{23}$$

This implies that income per worker should be higher when fertility is low since the growth rate of the workforce will be low, which eases any problem of capital dilution. Taking logs, we get

$$\log\left(\frac{Y_t}{L_t}\right)^* = \frac{1}{1-\alpha}\log\left(A_t\right) + \frac{\alpha}{1-\alpha}\log(s) - \log\left(\delta + g + (1+g)((f/2)\left(1-m\right)-1)\right) \tag{24}$$

Linearizing to determine the first order effect of fertility on income we have

$$\log\left(\frac{Y_t}{L_t}\right)^* \approx \left(\frac{\bar{Y}}{L}\right) - \left(\frac{(1+\bar{g})(1-\bar{m})/2}{\delta + \bar{g} + (1+\bar{g})((\bar{f}/2)\left(1-\bar{m}\right)-1)}\right)\left(f_t - \bar{f}\right) \tag{25}$$

The first-order effect we expect is that a high total fertility rate will reduce the level of income per capita. High birth rates will lead to rapid growth in the labor force, reducing the capital-labor ratio and income per capita.

Effective labor at time t is given by $A_t L_t$. We could think of A_t as exogenous labor augmenting technology. Alternatively we could think of A_t as the stock of human capital per capita that augments and increases labor inputs. In a world of complete capital markets, children would invest in human capital up to the point where its marginal return equals its marginal cost. In this case fertility is likely to have little effect on human capital investment. However, in practice families may be credit constrained. In this case a larger number of children may lead to lower human capital investments per child, a quality – quantity tradeoff. Theoretical work that relates fertility and economic development highlight the quality-quantity trade-off, and argue that the increasing returns to education associated with economic development raise the incentive for an altruistic parent to have fewer children and invest more in each child's education Barro and Becker (1989; Becker (1960; Becker, Murphy et al. (1990; Galor (2006).

This reduction can take place due to constraints on the household, or if education if publicly financed, because of borrowing constraints on the public sector. Given a borrowing constraint, we can think of current enrollments as depending on the current youth cohort size and recent fertility. A simple approach to the Solow model augmented to allow for human as well as physical capital is to assume that investment in education, like investment in physical capital, is proportional to national income. In this case

$$H_t = eY_t / pB_t \tag{26}$$

Where H_t is the average years of schooling achieved by those born in period t, e is the rate of investment in education, and p is the price of a year of schooling in terms of real goods.

$$A_t = H_{t-1} = \# \tag{27}$$

Steady state # needs working out

$$\log A_t = A(f_{t-1}) \approx A(\overline{f}) + (A'(\overline{f}))(f_{t-1} - \overline{f}) \tag{28}$$

In steady state when the fertility rate is stable at f we have

$$\log A^* \approx A(\overline{f}) + (A'(\overline{f}))(f - \overline{f}) \tag{29}$$

Some of the mechanisms discussed in this section will operate quite quickly, while others may only respond to fertility rates with a considerable lag. We expect the youth dependency, female labor force participation rate, and enrolment effects, to be fairly fast since these effects depend to a large extent on current fertility. The effects on old age dependency only manifest themselves when any births lead to working age adults. The effects of fertility on income per worker may also be slow in arriving since the effect on the capital labor ratio, and human capital of the workforce, may be longer in coming. Labor force growth, and the human capital level of each working age cohort depend on the fertility in the previous period and a period in this model should be viewed as a generation, and is somewhere between 20 and 40 years long.

4. Estimation Results

Equation (2) shows that log income per capita can be decomposed into log income per worker, the log of the labor force participation rate, and the log of the working age share. Equations (12), (13), and (25) show linear approximations of the effect of fertility on each of these components. Combining these we have

$$\ln\left(y_{it}\right) = \beta_0 + \beta_1 f_{it} + u_i + v_t + \gamma_R R_i t + \varepsilon_{it} \tag{30}$$

where $ln(y_{it})$ is the natural logarithm of income per capita and f_{it} is the total fertility rate of country i in period t. In addition in this relationship we include country fixed effects u_i, year dummies v_t, regional time trends $\gamma_R R_i t$ and an error term ε_{it}. R_i is a dummy variable taking the value one if country i is in region R and zero otherwise. Table 8 lists the countries in our sample by region. The idea behind adding these variables in addition to fertility is to control for other factors that may be affecting growth in income per capita in the region.

In general for each component part of income per capita we will have a range of other variables that will affect that outcome. For example, Bloom, Canning et al. (2007) estimate a model of female labor supply where, in addition to fertility, they control for the level of urbanization, male and female education levels, the capital labor ratio, and the infant mortality rate. Adding these other controls can correct for omitted variable bias and isolates the affect of fertility on the outcome of interest, holding other factors constant. However this approach may be over-controlling if we are interested in the total effect of fertility on income per capita. As we have seen in our theory section above, the fertility rate will affect education levels and the capital labor ratio. Controlling for these variables in equation (30) would not allow for the effect of fertility on income through these variables. We may therefore regard equation (30) as a reduced form relationship, where all endogenous variables have been netted out, giving the total effect of fertility on income per capita including all indirect effects.

Since fertility is endogenous we will instrument it with our abortion index. Abortion will be a valid instrument if it is correlated with fertility but uncorrelated with the error term in equation(30). Countries may have different cultures that affect both abortion legislation and behaviors that influence income per capita. In addition, the upward trend in the abortion index shown in Figure 3 may be correlated with time trends in other exogenous variables that affect income per capita. We control for these effects in equation (30) using country fixed effects, year dummies, and region specific time trends. These control variables mean that when we instrument using abortion legislation identification of the effect of fertility is coming from *changes* in a country's laws relative to the average trend in its own region. The level and regional time trends in abortion laws therefore have no effect on our results. Abortion laws tend to change abruptly over time (a detailed table of national data is provided in Bloom, Canning et al. (2007)), and our results depend on the exact timing of abortion law changes relative to the underlying world and regional trends in laws.

While the level and time trend in abortion law may be endogenous, we can argue that the exact timing of these legal changes can be regarded as random. Bloom, Canning et al. (2007) provide examples of how abortion law changes have come about that support this view. In addition there is a theoretical argument supporting discontinuous change in abortion laws. When preferences are uni-modal, the outcome of a political system that reflects the median voter will change smoothly with changes in the distribution of preferences. However, preferences over abortion legislation tend to be bi-model with many people either preferring strict controls, while many others prefer a very liberal regime. With a bi-modal distribution of preferences, the outcome of a voting system that reflects the will of the median voter will jump abruptly as the number of people near one mode of the distribution grows above 50%. Thus while the underling long run trend in abortion law may be endogenous, the precise timing of legal changes may be random.

We estimate equation (30) and report the results of different specifications in Table 3. The first three columns of Table 3 give results for the effect of fertility on income per capita using ordinary least squares estimation without instrumentation. Column 1 includes as controls only the year dummies, We get a point estimate of -0.43 which indicates that a reduction in the total fertility rate by one will increase income per capita by about 43%. This is consistent with Figure 2 which shows a large variation in income per capita at different levels of fertility. However, when we also include country fixed effects, and then regional time trends, in columns 2 and 3, the estimated magnitude of the effect is much smaller around 4% . This indicates that changes in fertility rates, relative to trend, do not seem to have a large impact. Note however that using fixed effects we are essentially indentifying the effect for fertility from changes in fertility rates. It may be that there is substantially more measurement error in fertility relative to the magnitude of its changes than relative to its level. The low signal to noise ratio in fertility in a fixed effects framework may bias the estimated coefficient downward.

Columns 4-6 of Table 3 repeat the analysis of columns 1-3 but instrument the total fertility rate with our abortion index. Our preferred specification is column 6 where we control for country fixed effects, year, and regional time trends. We estimate that reducing the total fertility rate by one increases income per capital by just under 20%. This estimated effect is substantially larger than when we did not instrument as reported in column 3, and should correct for both reverse causality and measurement error in the total fertility rate. It appears that measurement error is a more substantial problem in column 3 than reverse causality since with reverse causality we would expect the estimated coefficient in column 6 to become smaller in magnitude rather than larger.

In column 4, 5 and 6 we use the abortion index to instrument for fertility. As shown in the first stage results in Table 5, the abortion index has a negative and highly significant effect on the fertility rate in each of our specifications. In column 3 of table 4 (which corresponds to the second stage estimates in column 6 of table 3) we see each point on our abortion index reduces the total fertility rate by almost 0.1 children, implying that moving from an abortion law index of zero, illegal under any circumstances, to an index of 7, abortion available on request, will reduce total fertility by about 0.67 children. The Cragg-Donald F statistics reported in Table 3 are substantially above the critical values reported in Stock and Yogo (2005) and indicate that there is a high correlation between our abortion index and fertility and we do not have that problem of a weak instrument.
decline in child mortality can be explained by the concurrent increase in contraceptive access Bjorklund (2006; Bongaarts (1984; Bongaarts (1994; McDonald (2006), the realization of preferences regarding the desired number of surviving children or the increasing opportunity cost of child rearing Aarssen (2005; Greenwood, Seshadri et al. (2005; Neuman (2007; Osili and Long (2007; Pritchett (1994).

There are two major concerns in the estimation of the reduced form relation between fertility and output per capita. The first concern regards the exogeneity of family size. In the theoretical framework presented, we assume the fertility rate to be independent of income per capita. Empirically, this assumption can easily be challenged. As individuals and countries become richer, demand for highly skilled labor increases, generating a demand for fewer, but more highly educated children in a classical quality-quantity framework in the tradition of Becker (1960). The second concern regards other omitted factors such as health or institutional settings, which are likely to have a direct effect on output per capita. We include country and time fixed effects in our specifications, which allow us to control for global trends as well as for all factors which remain constant in each country over the sample period.

To deal with the remaining endogeneity issues, we adopt an instrumental variables approach. A valid instrument for fertility in the income equation is a variable that is correlated with fertility, but is not correlated with the structural error. We use abortion laws as an instrument for fertility. The validity of the instrument does not require legal or institutional settings to be independent from income levels across countries in the presence of country fixed effect. What instrument validity requires, however, is independence of the timing of abortion law changes from changes in the level of income per capita within countries across time. Abortion laws are highly controversial in many countries, and are often driven more by somewhat random election outcomes than by changes in the broad preferences of underlying societies. Some relatively poor countries like Armenia or Lithuania adopted liberal abortion laws very early on; other relatively rich countries like Portugal have fully liberalized abortion only in the last five years of our sample period. While most countries have generally liberalized their abortion laws over time, the change in laws is not one-directional, with countries like Albania, Poland, and Chile having more stringent abortion laws today than they did in the past.

We can decompose log income per capita into three additive components using Equation (2) and the use Equations (12), (13), and (25) to give a relationship between fertility and each of these components. We report the results of estimating each of these relationships in Table 5. In each regression reported in table 5 we use our preferred specification including country fixed effects, time dummies, regional time trends, and instrument fertility with our abortion index. In column 1 of Table 5 we repeat the results for income per capita as the outcome variable for comparison. We find that our point estimates suggest that the change income per capita is due to changes in income per worker, labor force participation, and the working age share in almost equal proportions; a reduction in fertility of one increases each of these components of economic growth by around 6 to 7%. While the point estimates of the three effects are of roughly equal magnitude only the labor force participation rate, and working age share effects, are statistically significant. This may be because, as our theory above makes clear, the effects of fertility on labor force participation and working age share occur quickly. While we estimate the steady state effect of fertility on income per worker, this affect may actually be very slow to come about due a long time lag between changes in fertility and changes in labor force growth (which affects the capital labor ratio) and changes in the education level of the workforce.

In table 6 we report the results of regressions that attempt to uncover the mechanisms through which fertility affects income per capita in more detail. In each regression we include year dummies, country fixed effects, and regional time trends, and fertility is instrumented with our abortion law index. In the Solow model fertility will affect income per worker through its effect on the population growth rate and the level of capital per worker. In column 1 of table 6 we report a regression where fertility is used to explain log capital per worker. We find a very small coefficient which is statistically insignificant. On the other hand, in column 2 of table 6, we find that fertility has a substantial and statistically significant effect on the population growth rate. We estimate that an extra birth in the total fertility rate increases the population growth rate by about 0.6 percentage points. There are several reasons why this effect on population growth may not be reflected in capital per worker. The effect of population growth on the workforce is delayed until any children born reach working age. Even when they do reach working age the capital dilution effect only occurs if investment fails to respond to the larger number of workers.

In columns 3 and 4 of table 6 we examine the effect of fertility on male and female labor force participation separately. We find no significant effect of fertility on male labor force participation but a large effect on female participation. We estimate that an additional child born reduces female labor force participation by about 10 percentage points. This means about four years of lost labor force participation per child born and is about twice the estimate found by Bloom, Canning et al. (2007). However that paper focuses on the effect of fertility on the labor force participation of women of reproductive age. If older women are also affected by fertility, either through continuing caring for children, or by a persistence effect of withdrawing from the labor market when they were young, the two results may not be in conflict. In column 5 of table

5. Conclusion

The empirical results presented in the previous section have highlighted the large and negative effects of fertility on income per capita. The linear relation estimated implies that declines in fertility will always increase output per capita. However, this result should be interpreted with caution. As we have highlighted in section 2, the effect of fertility on the share of the population in the working age is highly non-linear. As total fertility rate falls below replacement rates, the main effect with be to increase old age dependency rates, reducing the relative size of the work force and output per capita.

Empirically, fertility rates have fallen below replacement in many countries; however, as shown in Figure 3 above, the fall in fertility has not led to the predicted decline in working-age shares until now. The second main reason for the lacking evidence on the inverse relation between fertility below replacement rates and working-age share lies in the fact that most countries with very low total fertility rates today have moved below replacement only recently. According to the World Development Indicators World Bank (2007), only 2 countries (Estonia and Latvia) had total fertility rates below 2 in 1960; in 2000, total fertility rate was below 2 in 61 countries. Given that the negative age structure effects of low fertility rates only come through once low fertility persists for several generations (so that a stable population distribution is reached), the full effects of the move to low fertility rates will only become apparent several decades from today. In other words: the generations currently retiring in most countries with low fertility rates still bore more than two children on average, which keeps old-age dependency rates moderate. Once the generations who have little more than one child on average begin to predominate, this balance will change, and lead to a sizable reduction in the relative size of the working-age share unless a high and continued inflow of (young) immigrants is sustained.

In a multiple equilibria demographic model of a low-income, high-fertility and mortality steady state and a high-income, low-fertility and mortality steady state, the demographic transition unfolds for those countries who escape the low equilibrium poverty trap and move toward the high steady state. In this model we highlight that the fertility decline can encourage this transition to the high-income steady state. The causal relationship of fertility affecting per capita income established in this paper and identified through the use of the abortion law index draws on this mechanism for poverty alleviation that is not often emphasized in the theoretical models. Causality is either modeled in the other direction, where income gains, the rise in returns to education, and mortality decline lead to the decline in fertility. Teasing out the effect of fertility decline on income per capita has a positive implication for population policies that may only exist for the purpose of population health and not for broader income gains. The analysis in the paper shows that the effects of fertility decline can extend to income gains.

In this paper, we explored the theoretical relationship between fertility and income per capita, and showed that female labor force participation and age structure effects are the contemporaneous channels through which fertility affects economic development. The theoretical set up implies a non-linear relationship between fertility and income per capita. However, the range covered in our sample restricts the analysis to a mostly linear segment of the mapping. This result does not imply that further decreases in fertility will continue to promote economic growth. Continued fertility rates below replacement are likely to lead to sharp increases in old age dependency rates and declines in the working-age share, thus offsetting some of the positive income effects experienced in recent decades.

The Malthusian and Solow models focus on the effect of fertility on total population numbers or growth rates. Our results suggest that the effect of fertility on the number of workers per capita, via its effects on age structure and female labor force participation, are substantial. Modles that abstract away these effects are liable to lead to an underestimation of the effect of fertility decline on economic growth during the demographic transition.

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Table 1 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Total fertility rate	1169	4.4	2.0	1.1	8.5
ln GDP per capita	1169	8.2	1.1	5.1	11.1
ln GDP per worker	1105	9.1	1.2	6.2	12.2
Abortion index	1169	3.2	2.4	0.0	7.0
Working-age share	1145	57.3	6.5	45.2	74.3
Youth dependency rate	1145	66.9	23.4	21.2	111.9
Old-age dependency rate	1145	9.6	5.7	1.4	27.7
Labor force participation rate	1129	68.5	10.2	45.2	95.8
Female labor force participation rate	1129	51.8	18.9	10.9	96.9
Male labor force to participation rate	1129	84.8	5.6	63.2	97.8
Capital to labor ratio	1105	0.0303	0.0376	0.0002	0.2356
Population growth rate	999	2.1	1.5	-4.7	11.5
Primary school enrollment rate	887	91.1	25.4	8.0	150.7
Secondary school enrollment rate	861	52.6	33.9	1.1	160.7
Tertiary enrollment rate	789	15.4	16.7	0.0	94.7
Average years enrolled	771	9.3	3.5	0.7	17.7
Average years of schooling for people >15 yrs	773	4.9	2.9	0.2	12.0

Table 2 Correlation Matrix

	Total fertility rate	ln GDP per capita	ln GDP per worker	Abortion index	Working-age to total population	Labor force to working-age population	Youth dependency rate	Old-age dependency rate
Total fertility rate	1.00							
ln GDP per capita	-0.82	1.00						
ln GDP per worker	-0.78	0.99	1.00					
Abortion index	-0.55	0.51	0.44	1.00				
Working-age to total population	-0.93	0.79	0.73	0.61	1.00			
Labor force to working-age population	0.13	-0.28	-0.40	0.15	-0.04	1.00		
Youth dependency rate	0.94	-0.82	-0.76	-0.61	-0.98	0.04	1.00	
Old-age dependency rate	-0.74	0.74	0.69	0.54	0.72	0.04	-0.83	1.00
Female labor force to working-age population	0.04	-0.20	-0.33	0.22	0.03	0.96	-0.04	0.13
Male labor force to working-age population	0.37	-0.42	-0.46	-0.21	-0.31	0.55	0.32	-0.27
Population growth rate	0.73	-0.54	-0.49	-0.42	-0.70	-0.05	0.74	-0.71
Capital to labor ratio	-0.72	0.85	0.82	0.56	0.75	-0.07	-0.79	0.80
Primary school enrollment	-0.59	0.53	0.55	0.28	0.43	-0.30	-0.43	0.32
Secondary school enrollment	-0.85	0.86	0.83	0.57	0.83	-0.17	-0.86	0.78
Tertiary enrollment	-0.69	0.74	0.70	0.53	0.71	-0.06	-0.73	0.70
Average years enrolled	-0.85	0.84	0.83	0.54	0.78	-0.23	-0.80	0.71
Average years of schooling for people >15 yrs	-0.84	0.83	0.79	0.57	0.79	-0.06	-0.82	0.74

Table 3 The effect of Fertility on Income per Capita

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: log GDP per capita						
Total fertility rate	-0.433***	-0.063***	-0.047**	-0.369***	-0.551***	-0.196**
	(0.010)	(0.018)	(0.020)	(0.026)	(0.160)	(0.086)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	Yes	Yes	No	Yes	Yes
Regional time trends	No	No	Yes	No	No	Yes
Estimation method	FE	FE	FE	IV	IV	IV
Observations	1169	1169	1169	1169	1169	1169
R-squared	0.552	0.953	0.960	0.541	0.897	0.957
Cragg-Donald F-stat				373.0	16.15	35.05

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4 First Stage: The effect of Abortion Laws on Fertility

	(1)	(2)	(3)
Dependent variable: Total fertility rate			
Abortion index	-0.410***	-0.072***	-0.096***
	(0.020)	(0.020)	(0.018)
Year dummies	Yes	Yes	Yes
Country fixed effects	No	Yes	Yes
Regional time trends	No	No	Yes
Observations	1169	1169	1169
R-squared	0.354	0.928	0.950

Note: Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5: The Effect of Fertility on the Components of Income per Capita

	(1)	(2)	(3)	(4)
Dependent variable:	ln(GDP/P)	ln(GDP/L)	ln(L/W)	ln(W/P)
Total fertility rate	-0.196**	-0.061	-0.071***	-0.068***
	(0.089)	(0.085)	(0.019)	(0.010)
Year dummies	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Regional time trends	Yes	Yes	Yes	Yes
Estimation method	IV	IV	IV	IV
Observations	1169	1105	1129	1145
R-squared	0.957	0.965	0.897	0.941
Cragg-Donald F-stat	35.05	32.38	32.75	34.49

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: The Effect of Fertility on Income per Capita: Mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	Log capital per worker	Population growth rate	Female labor force participation rate	Male labor force participation rate	Working age share	Youth dependency rate	Old-age dependency rate
Total fertility rate	0.021	0.645***	-9.947***	0.495	-4.076***	12.38***	-0.964**
	(0.099)	(0.292)	(2.210)	(0.695)	(0.646)	(1.780)	(0 .416)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimation method	IV	IV	IV	IV	IV	IV	IV
Observations	1105	999	1129	1129	1145	1145	1145
R-squared	0.976	0.690	0.906	0.897	0.935	0.957	0.955
Cragg-Donald F-stat	32.38	14.87	32.75	32.75	34.49	34.49	34.49

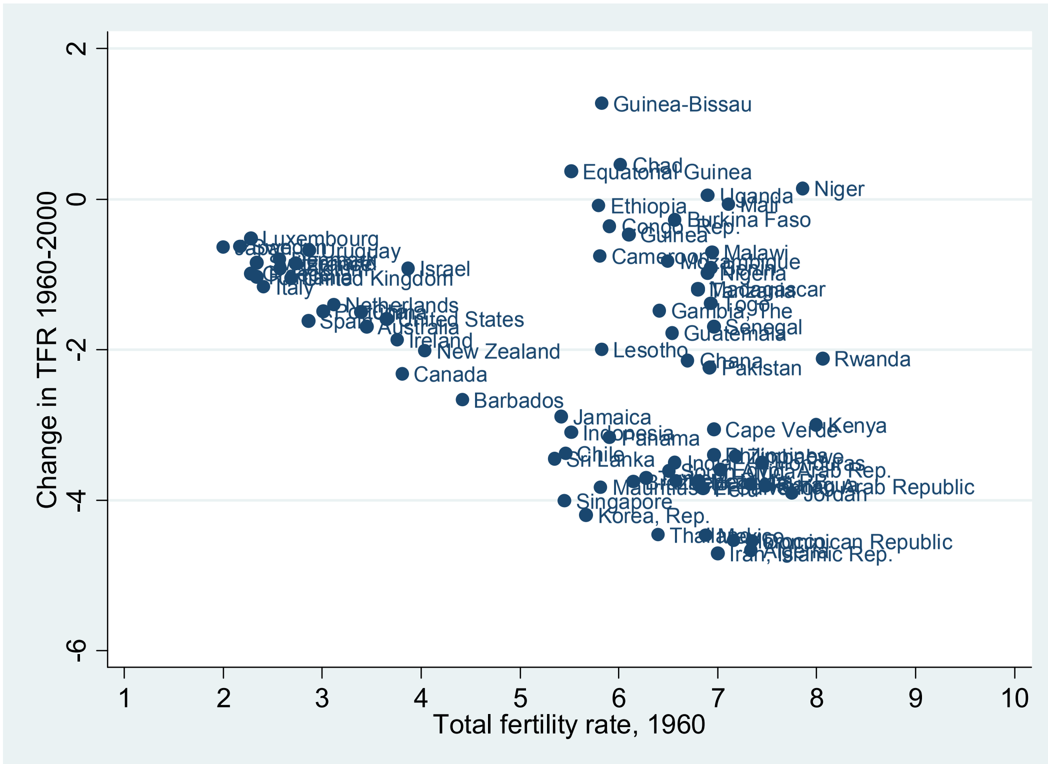
Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 7: The Effect of Fertility on Education

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	Primary enrollment	Secondary enrollment	Tertiary enrollment	School (average years enrolled)	Total years of schooling (average for a person >15yrs)
Total fertility rate (t-10)	3.491	-6.016	-9.568***	-0.439	-0.635**
	(2.524)	(3.981)	(2.521)	(0.315)	(0.254)
Observations	749	725	667	649	591
Cragg-Donald F-stat	36.97	26.29	32.48	27.46	19.73
R-squared	0.878	0.948	0.908	0.956	0.976

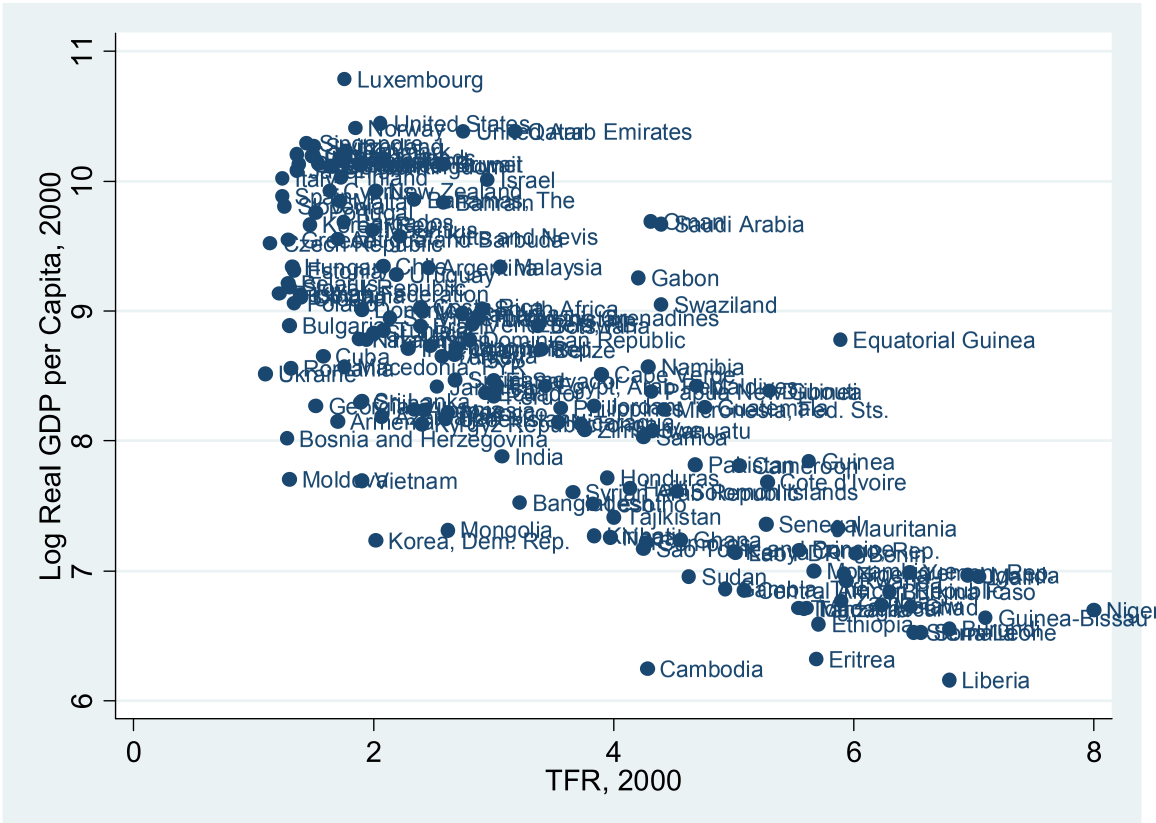
Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Figure 1: Change in the Total Fertility Rate 1960-2000



Source: World Bank (2007)

Figure 2 Income per Capita and Fertility in 2000



Source: Total fertility rate from World Bank (2007); Log Real GDP per Capita from PWT 6.2.

Figure 3: Abortion Index: Average 1960-2005

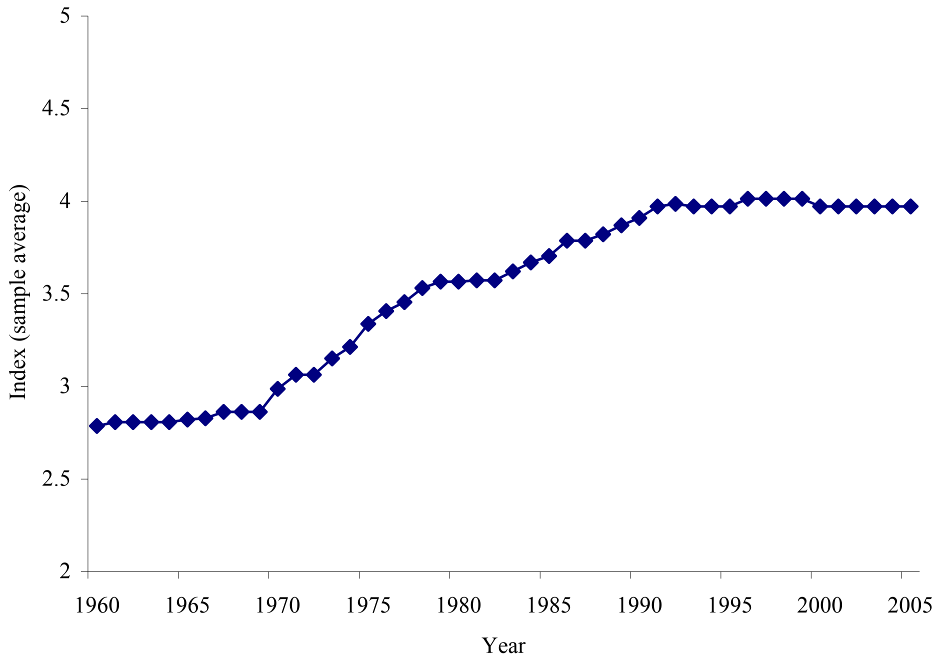


Figure 4: Relationship between fertility and steady state working age share

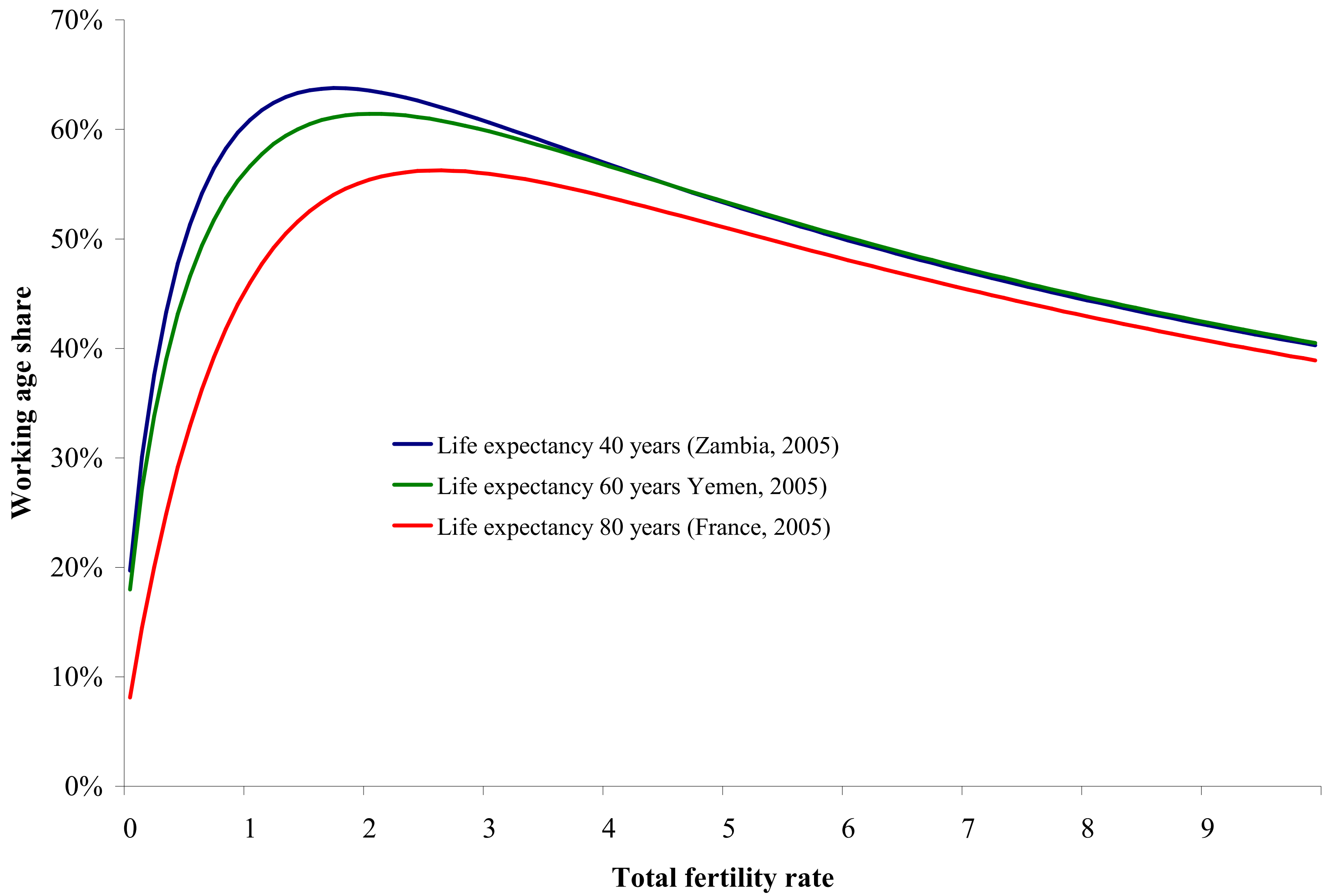
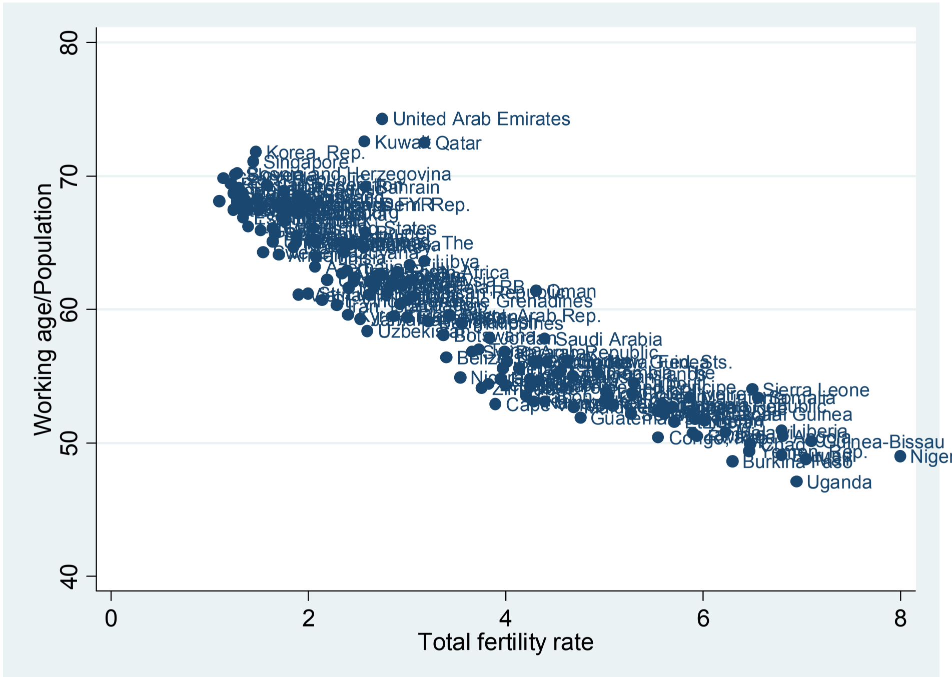


Figure 5: Total fertility rates and working age shares in 2000



Source: World Bank (2007)

Variable name	Unit	Definition	Source
Total fertility rate	number of children	Average number of children a women would have if she experiences the same age specific birth rates as in the given year over her fertile life. Fertility rates are interpolated over intervals of up to 5 years if they are missing in the data source.	World Development Indicators 2007
Log GDP per capita	International constant 2000 prices, PPP	The natural log of gross domestic product per capita	Penn World Tables 6.2
ln GDP per worker	International constant 2000 prices, PPP	The natural log of gross domestic product per capita	Penn World Tables 6.2. International constar
Abortion index	Index, 0 to 7	Legality of an abortion, 1 if legal for a categorized reason, 0 otherwise. Categories: life threatening; physical health, mental health, rape or incest, fetal impairment, economic, request.	Collated from qualitative data from http://www.un.org/esa/population/publicatior
Working-age share	Percentage	Number of people aged between 15 an 64 per 100 in the total population	World Development Indicators 2007.
Labor force participation rate	Percentage	Labor force aged 15 and 64 per 100 population between ages 15 and 64	International Labor Statistics and World Pop
Female labor force to working-age population	Percentage	Female labor force aged 15 and 64 per 100 women between ages 15 and 64	International Labor Statistics and World Pop
Male labor force to working-age population	Percentage	Male labor force aged 15 and 64 per 100 men between ages 15 and 64	International Labor Statistics and World Pop
Youth dependency rate	per 100 working age people	Number of people aged 0 to 14 per 100 people aged 15 to 64	World Population Prospects 2006
Old-age dependency rate	per 100 working age people	Number of people 65 and older per 100 people between ages 15 and 64	World Population Prospects 2006

Capital to labor ratio	Millions international dollars per worker	Capital (in millions) relative to the number of workers	Penn World Tables 5.6 and extrapolated bas given in Penn World Tables 6.2.
Population growth rate	Percentage	Average annual population growth rate. Calculated over a five year period as (P(t) - P(t-5)/P(t-5))*100/5	Annual average population growth rate ov World Development Indicators 2007.
Primary school enrollment rate	Percentage	Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Estimates are based on UNESCO's classification of education levels. Primary, or first level, provides the basic elements of education at elementary or primary school.	World Development Indicators 2003
Secondary school enrollment rate	Percentage	Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Estimates are based on UNESCO's classification of education levels. Secondary provi des general or specialized instruction at middle, secondary, or high schools, teacher training schools, vocational or technical schools; this level of education is based on at least four years of instruction at the first level.	World Development Indicators 2003
Tertiary enrollment rate	Percentage	Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Estimates are based on UNESCO's classification of education levels. Tertiary requir es, as a minimum condition of admission, the successful completion of education at the second level or evidence of attainment of an equivalent level of knowledge	World Development Indicators 2003

		and is provided at a university, teachers college, or higher-level professional school.	
Average years enrolled	Years	Average Years of education received by a child who is enrolled over their life at current age group enrollemnt rates. Calculated as 6*Primary school enrollment rate+ 6*Secondary school enrollment rate + 3*Tertiary enrollment rate.	World Development Indicators 2003
Average years of schooling for people >15 yrs	Years	Average total years of schooling of individuals older than 15 years in the population	Barro and Lee (2001)

The empirical evidence from a cross-country perspective indicates that high fertility has a negative effect on economic growth Brander and Dowrick (1994; Galor and Zang (1997). However, in a sample of European countries, where fertility rates are near or below long-run replacement level, increases in fertility can have a positive effect on income per capita Hondroyiannis and Papapetrou (2005).

In this paper we use an instrument that quantifies the degree of abortion legality across countries to identify the causal effect of fertility changes on economic development. The timing of liberalization (or limitation) of abortion laws across countries is a political, social, and religious issue that is independent of a country's average income. While the legalization of abortion does not fully explain availability or access to the procedure, we find that countries with more liberal abortion laws do have significantly lower fertility rates therefore we choose to exploit the relationship between abortion legalization and fertility rather than access to abortion which is can be income dependent.