Introduction

Begin today discussion of economic models of fertility. The textbook provides a perspective from demography. We agree on the facts, the difference is in interpretation and notions of causality. The book adopts, as you’ve no doubt noticed, a “transition” perspective, relating to the demographic transition — the movement from high–mortality–high–fertility equilibrium to low–mortality–low–fertility equilibrium.

We will adopt a supply and demand perspective. We’ll put the pieces in place and then investigate the broad theories of demographic equilibrium.

Supply is primarily determined by biology and the woman’s reproductive capacity. In healthy well–nourished populations (such as the United States) the biological capacity for childbearing is virtually unconstrained — women can have more children than they desire. However, among poor and poorly nourished populations women may be constrained.

For now focus on developed countries, where supply is not an issue. Also recognize that with modern technology the dichotomy between supply and demand is less clear. Even in rich settings, individual women will be constrained, as roughly 3 percent of the couples are infertile. Can make investments in reproductive technology to enhance fecundity, but we will not consider such (more complicated) models.

In demography fertility means births, while fecundity is the ability to conceive and give birth. Fertility applies to the population level while childbearing occurs at the household level.

Components of Demand

On demand there are several reasons why parents want children.

In agricultural settings children can be seen as productive inputs. By this perspective, the demand for children will vary with their productivity. This is the common reason for why fertility was high in the 19th century.

But with migration from rural to urban areas children’s economic productive value fell. People worked in factories, and not in fields, and child labor laws and their enforcement, and minimum schooling laws further reduced their productive value.

Old Age security Alternatively, children may represent a source of old–age support. Children can provide a place to live and assistance, health and financial to aging parents. Extended family members living together in a household was common. And in some societies, it is the responsibility of the oldest child or oldest daughter to care for the parents.
The rise of the modern welfare state with public pensions and old-age support should weaken this demand for children. We’ll review some of the empirical evidence later.

**Source of Utility** Finally, one can view children as another economic commodity, another source of utility. Parents can be seen as having preferences defined over the number and characteristics of their children. That is the utility function would include the number of children and their characteristics as arguments.

The language is unfortunate, but the analytical insights more than compensate. Rather than assuming children are unique and must be treated differently, the approach argues that children can be seen as another “economic commodity” for which economic calculus applies. Children generate a flow utility and are costly to raise. The issue is how far this perspective will take us.

**Child services** We do not have a good language to describe exactly what kind of utility flows (positive and sometimes negative) children produce. Use the language of “child services” as a catch-all for these flows. In the simplest case, child–services is proportional to the number of children, $cs \propto n$, however, one could also assume that the utility flow may depend on the ages, sexes and other characteristics of the children.

**Simple Neoclassical Model**

Formally, assume that parents maximize a utility,

$$U(n, s),$$

where $n$ is the number of children and $s$ represents a composite good that characterizes all other consumption. To keep things simple, we will consider a static, or one–period model of behavior. So the period is a lifetime. $n$ will be the cohort measure of the number of children ever born. I will assume $U$ has the standard properties, e.g., positive first derivatives and concave in both arguments.

The parents maximize that utility function, subject to their budget constraint,

$$I = p_s s + \pi_n n$$

where, $p_s$ is the per unit price of the composite commodity, $I$ is the household’s income, and $\pi_n$ is the per unit “shadow price” of children. I’ll talk about shadow prices in a moment, but for now treat them as regular prices.

Solve this problem yields the standard demand–for-children function (with the price of the composite good as the numeraire, $p_s = 1$)

$$n = N(\pi_n, I).$$

This is a standard demand function, and the effects of the price of children on completed fertility are characterized by the standard income and substitution effects of consumer theory, and changes in parental income give rise to income effects with respect to the “purchase” of children.
Slutsky Equation

\[
\frac{\partial q_i}{\partial p_j} = \left( \frac{\partial q_i}{\partial p_j} \right)_{dU=0} - q_j \frac{\partial q_i}{\partial I}
\]

For normal goods, the income effect is positive \( \frac{\partial q_i}{\partial I} \) – expenditure on the good increases with an increase in income. Indeed, the good’s share of expenditure remains constant if the income elasticity equals one, and increases if the income elasticity is greater than one, such goods are considered **luxuries**, while those with negative income elasticities are **inferior** goods. Potatoes are consider the classical inferior good.

**Give graphical treatment if class looks lost.**

The price effect has two components according to the Slutsky equation: the first is the pure substitution effect, the effect holding utility constant, and the income effect (the effect of a change in income holding prices constant).

Consider the effect of an own–price change \((i = j)\). The Slutsky equation is

\[
\frac{\partial q_i}{\partial p_i} = \left( \frac{\partial q_i}{\partial p_i} \right)_{dU=0} - q_i \frac{\partial q_i}{\partial I}
\]

Are there any unambiguous predictions on \( \frac{\partial q_i}{\partial p_i} \)? No. However, we know that \( \left( \frac{\partial q_i}{\partial p_i} \right)_{dU=0} < 0 \). And if \( q_i \) is not an inferior good \( \frac{\partial q_i}{\partial I} \geq 0 \), then \( \frac{\partial q_i}{\partial p_i} < 0 \).

Thus for a normal good an increase in the own–price is unambiguously negative. The consumer will substitute away from the now more expensive good, and the increase in price reduces the real income available to the household, and quantity demanded declines with the reduced income.

Applying this to the demand for children, we would expect that the increase in income will increase the expenditures on children. While an increase in the price of children will reduce the demand for children.

**Insight of the approach and Shadow Prices**

**Insight of Approach** By viewing children as another good or service, this approach implies that to understand the demand for children we need to know household income and the “price” of children.

Now let’s consider what I mean by **shadow** price of children. The relevant price here is the **shadow** price, which is the opportunity cost of using scarce resources. Shadow prices appear in many context, but especially in valuing non–market commodities. Slavery is illegal as is the market exchange of children. So unlike other economic goods and services, for children there are no market transactions by which to measure price.

I prefer **full** price to shadow price. Shadow makes it sound mysterious and ephemeral, which the prices are not. The key is opportunity cost — the next best alternative use of the resource that determines its value.

What is the economic cost of an adoption? The adoption agency may charge a fee but that is not the shadow or full price of the cost of the adoption. There are other fees, such as for an attorney.
and or child psychology, and time costs in filling out the forms. The full cost is the sum of all these expenditures. And if the adoption were done overseas, say in China that has a surplus of girls up for adoption. The monetary adoption fee may be less, but the full price would include the travel cost to and from China and the time spent in China talking with adoption authorities.

An important source of the full cost is the recognition that procurement takes time. What is the shadow cost of a college degree? It includes tuition, student fees, the cost of books etc.. It would not include cost of living expenses, unless they were larger than what would be paid if not in school. (Yet living at home is not the same economic good as living on your own, so a further adjustment would have to be made for that comparison.) The largest cost of a college education is the income foregone while a student. Tuition for an Wisconsin resident is $7,010, books and fees another grand, and transportation another 500 or direct monetary costs of say $8,500. Yet bank tellers make $11 an hour and janitors make about $10. So the direct monetary costs or represent a half or one-third of the full cost. And of course, the cost of the “five–year” (six year for my brother) plan is not the out–of–pocket cost or the extra tuition cost.

Empirical Consistency?

How does the theory compare with empirical patterns discussed last week?

Assessing how the price of children has varied over time is not straightforward. Let’s defer that and consider the income effect. We know that real income increased substantially all through the 19th and 20th centuries (though it stagnated in the last 20 years of the 20th century). Yet, in the US completed fertility fell, from 7 children in 1800 to slightly fewer than 2 in 2000. Are we to believe that children are an inferior good?

It’s is enough of a stretch to discuss “child services” do not want to argue that children are inferior goods. Like potatoes — substitute away when get rich. That’s a hard sell.

Appreciation of the Economic Approach

Last time we noticed that a simple neoclassical model of the demand for children implies that if children are normal “goods” then increased lifetime income (or wealth) should increase the demand for children. By this perspective completed fertility should be higher in 2000 than in 1900 or 1800. Not true, and we’ll investigate a “fix” in a moment.

Yet let’s not underestimate the analytical gain to the approach — the demand for children function \( n = N(\pi, I) \) defines precisely what factors determine completed fertility. To understand changes in completed fertility over time we look to changes in (lifetime) income and in the shadow or full price of children. Moreover, income and prices are subject to measurement. Not exactly falling off a log, and it takes effort to construct, but as we will see economic theory provides us direction on how to construct these measures.

Notice as well that the presumption is that preferences or tastes are constant. The presumption is that people respond to changing incentives, incentives represented by prices and incomes. Women
today have fewer children than 100 years because prices and incomes have changed, not because they don’t like children as much. It is this intellectual discipline that gives Economics its analytical power. No norms, no culture, we tie the explanation to things we can measure and have a theory (as we will see) on how they should be measured.

It is true for comparisons across countries and societies we must be cognizant of differences societal differences. But usually societal differences manifest in prices, incomes, and more generally opportunities (e.g., different tax systems, or different forms of income support).

**Quantity–Quality Model**

The solution is to make one additional assumption and to augment preferences to include child quality. Assume that preferences are now

$$U(n, q, s),$$

where $n$ continues to represent the number of children, $s$ the parents’ standard of living, and $q$ is the quality per child. So, now the flow of child service which before had been assumed to be proportional to the number of children, now depends on the number and the **quality** of the children. The (lifetime) budget constraint becomes,

$$I = p_c C + p_s s, \quad C = nq$$

where $I$ again is total family lifetime income, $p_c$ is a price index of goods and services devoted to children, and $p_s$ is the price index of goods and services consumed by parents.

Notice by my notation convention, $p_c$ is a market price not a shadow price as before. Shadow prices will make their appearance shortly.

The distinctive feature is the (nonlinear) multiplicative interaction between the number of children and the quality of children in the budget constraint. $c = nq$ is child–services, and $p_cC$ is expenditures on children. This formulation assumes that parents are unable (or unwilling) to differentially target their spending on children.

Becker (1960) stressed that the income elasticities for $n, q$ and $s$ must satisfy

$$\alpha(\eta_q + \eta_n) + (1 - \alpha)\eta_s = 1$$

where $\alpha$ is the share of household income devoted to children, and the $\eta$’s represent income elasticities. **You should convince yourself** that this relationship follows directly from the budget constraint.

Let me give you a hint. And for those who have taken courses with me before, know that things I suggest you look at sometimes make their way onto exams. Not always but sometimes.

In the simple case with two goods $x_1, x_2$ the budget constraint is $p_1 x_1 + p_2 x_2 = I$. Holding prices constant and taking the total derivative of the budget constraint yields:

$$1 = p_1 \frac{dx_1}{dI} + p_2 \frac{dx_2}{dI}.$$
Multiple the first term on the rhs by a fancy representation of the number 1,

\[ \frac{x_1 I}{I x_1} \]

The first terms on the rhs becomes

\[ p_1 \frac{x_1 I}{x_1} \frac{dx_1}{dI} = \frac{p_1 x_1 dx_1/x_1}{dI/I} \]

And notice that

\[ \frac{dx_1/x_1}{dI/I} = \frac{d \ln x_1}{d \ln I} = \eta_1 \]

Where of course \( \eta_1 \) is the income elasticity of good \( x_1 \). Notice as well that \( p_1 x_1 \) is the expenditure on good \( x_1 \), and \( p_1 x_1 / I \) is the share spent on good \( x_1 \). We can do exactly the same operations on the second term on the r.h.s. Letting \( \alpha \) represent the share of expenditures on good \( x_1 \) we have

\[ 1 = \alpha \eta_1 + (1 - \alpha) \eta_2. \]

A share weighted sum of income elasticities must sum to one. That is, why all goods can not be inferior goods.

Things are a little more complicated for \( C = nq \), and you can fill in the details.

How does the quantity–quality model help us resolve the empirical inconsistency? Now if children are a normal good, in the sense that total expenditures on children are an increasing function of income, then the sum of income elasticities of the number and quality of children must be positive, \( \eta_n + \eta_q > 0 \). But it is possible that \( \eta_n < 0 \) if \( \eta_q \) is sufficiently larger than 0.

Notice that the first order conditions of the maximization problem imply

\[ MU_n = \lambda qp_c = \lambda \pi_n, \quad MU_q = \lambda np_c = \lambda \pi_q \]

where \( MU' \)'s are marginal utilities and the \( \pi' \)'s are the shadow prices of the number of children and quality per child, and \( \lambda \) is the marginal utility of income.

These conditions imply that the shadow price of the number of children is an increasing function of the quality, and similarly that the shadow price of the quality of children is an increasing function of the number of children. Moreover, since \( n \) and \( q \) are chosen by the household these prices are endogenous. And thus, shadow prices are not market prices for which we assume are beyond the influence of the household (as we do in the usual setup with competitive markets).

Notice, the marginal rate of substitution between quantity and quality of children is \( MU_n/MU_q = \pi_n/\pi_q = q/n \). So the relative cost of the number of children tends to increase as the ratio of quality to quantity increases.

The additional assumption is that \( \eta_q >> \eta_n \) that the income elasticity of quality is larger than the income elasticity of number of children.

We see that \( q/n \) will increase with an increase in income if \( \eta_q > \eta_n \). (Draw picture Fig 7 in Hotz et al.)
Child Quality

We have been silent as to what is child quality. Could adopt a hedonic pricing approach following consumer durables (Lancaster and Rosen). But more commonly, quality based on the theory of human capital, parents invest in their children’s skills and abilities. (More later.)

Quality and quality theory retains the presumption that children are normal goods, but adds the assumptions that quality – quantity enter multiplicatively in the budget constraint and that the income elasticity of quality exceeds that of the number of children. So as incomes rose parents increased quality more than quantity and the larger rise in quality increased the shadow price of quantity, causing parents to substitute further away from quantity.

If we think of quality as investment in children, and specifically education, then the increased years of schooling represents higher “quality” children. In 19th century, children had perhaps a primary education, whereas now a high school is minimal prep and arguably need some post–secondary schooling.

Household Production

Must take a slight detour and build some tools before looking closely at price effects on the demand for children.

The critical tool is the notion of household production. There are some goods that can only be produced in home (e.g., own–children) and some which can be produced at home or purchased in the market place, and others (most) goods and services that can only be purchased in the market (e.g., jetliners). We view the household as a small firm: regardless of the household’s preferences, whatever it produces, it will produce most efficiently. The household as a firm will seek to find the least–cost method of producing a given output.

To keep quantities straight, denote as $Z$ the commodity produced at home, and denote labor input as $L$ and market goods used in the production process as $X$. For now, let’s think of there being only one person in the household, and using only one market good to produce $Z$ (i.e., considering only scalar objects).

The production function is

$$Z = f(L, X).$$

where $f$ has the usual properties, positive first derivatives in both arguments, and exhibits diminishing marginal returns.

As we will see, household preferences will determine $Z$, so rather than approach this as a profit maximization problem, it is easier to view the household’s problem as a cost minimization problem: for a given level of output find the optimal level of inputs $L, X$.

The (market) price of $X$ is $p_x$ and assume that the person could work in the market and earn wage $w$ per unit of time. Then to produce $Z_0$ units of the commodity the household’s problem is
\[ \min (wL + p_x X), \quad \text{s.t.} \quad Z_0 = f(L, X). \]

The solution to the problem yields the **cost function** which is the minimum cost to produce \(Z_0\) given factor prices \(w\) and \(p_x\). Denote the minimum cost function as \(C(w, p_x, Z)\).

**Ask:** What are the properties of the cost function?

**Answer:** Of course the (partial) derivative of \(C\) w.r.t. to \(Z\) is the marginal cost function, while \(\frac{\partial C}{\partial w} = L\) and \(\frac{\partial C}{\partial p_x} = X\) the factor demands for the “firm.”

To gain some insight, let’s restrict the production function to be homogeneous of the first degree (linearly homogenous). Remember, this means if we multiply all inputs by the same positive number output increases by that factor, i.e., for \(\lambda > 0\)

\[ Z = f(\lambda L, \lambda X) = \lambda f(L, X). \]

One can show that the cost function from a linearly homogenous production function is

\[ C(w, p_x, Z) = c(w, p_x)Z. \]

So for given factor prices, the marginal cost, \(c(w, p_x)\), is constant (and a function of the factor prices).

The easiest example is the Leontief production function

\[ Z = \min \left( \frac{L}{a}, \frac{X}{b} \right). \]

Thus to produce one unit of \(Z\) requires \(a\) units of \(L\) and \(b\) units of \(X\). Notice, this technology does not permit any substitution between the factors. Fix labor input at \(a\) and increase \(X\) from \(b\) to \(b + 1\), how much does \(Z\) increase? (**Ask.**) Answer: None?

Next time, we will solve for the marginal cost function associated with the Leontief production function.

You should should convince yourself that this production function is homogenous of degree 1. (**Do so**). Thus, the marginal cost function is

\[ MC = aw + bp_x \]

What do we have? For services and goods that can be produced at home or purchased in the market, household production gives us a systematic framework for thinking determining which products and services will be produced at home and which will be purchased by the market place. And for goods that can only produced at home, household production gives us a way of determining their shadow price (or full price).

As an example, and using the Leontief production function, consider household repair, say plumbing. Although plenty of skill involved for many small plumbing repairs, have a decision of whether to do it yourself or call in the plumber. \(L\) is the person’s time, so \(w\) is their wage, and \(X\) is materials (pipes, values, faucets, rings), including tools.
By definition, a cost minimizing firm seeks the lowest cost to produce a good or service. You call the plumber and you learn that it costs $30 for the service call and $30 an hour. From talking to the plumber you suspect it will take the plumber about an hour. Thus, in terms of household production, you look at your marginal cost and will fix it yourself if your marginal cost is less than $60 and will call in the expert if it is (expected) to be more.

One’s ability to solve mechanical problems determines $a$, whereas $b$ is probably fixed across households (for a given plumbing problem). Also, people have different (implicit) hourly rates of pay. Thus, our model of household production implies that we should see those with high mechanical skills (low $a$) and individuals with low market wages more likely to fix their plumbing problem.

We will use household production framework to determine the shadow price of children. As you may anticipate, a large component of the cost is the value of the time input (by the mother, especially) for childbearing and child raising away from other productive activities.

Indeed, assuming that childbearing is a relatively time intensive activity, (especially for mothers), the opportunity cost of children (aka the shadow price) tends to increase relative to sources of satisfaction not related to children, leading to a substitution effect against or away from children.

**Time Allocation and Demand for Children**

(Besides the quality–quantity tradeoff) a second major reason for a negative relationship between income and fertility is the hypothesis that higher income is associated with a higher cost of female time, either because of higher female wage rates or because higher household income raises the value of female time in nonmarket activities.

By assuming that children are relatively time–intensive for mothers, the opportunity cost of children tends to increase relative to sources of satisfaction not related to children.

Assume households have preferences over the number and quality of children ($n$, $q$) and adult standard of living $s$ (e.g., consumption of goods and services not related to children).

Assume that $s$ and child–related sources of utility can not be purchased directly in the market, but have household production functions for $q$ and $s$. The production functions depend on (mother’s) time input and purchase of market goods, $x$.

To keep things simple, we’ll assume the husband works in the market and not at home, and contributes his income $H$.

Total family income is $H + wL = I$, where $w$ is the woman’s wage rate, and $L$ is the time allocated to the market. Her time allocation in $s$ is $t_s$ while that in children $t_c$, similarly goods purchased to produce $s$ and $c$ are $x_s$ and $x_c$. The total time constraint is $L + t_s + t_c = T$. Assume the price of market goods is one, so the budget constraint is

$$x_s + x_c = I = H + wL.$$
Edgeworth Box and Production Possibility Curve

Assume wife can only work in the HH., \( w = 0 \) Draw Figure 8 in Hotz et al. without 0’0” line segment.

Two panels, on the left draw the Edgeworth box with goods (vert) and time in HH production (horz). Time runs from 0 to \( T \). Production of \( C = nq \) increases from left to right, while production of \( s \) increase from right to left. Show the isoquants (as usual) for \( c \). Then the contract curve shows all efficient allocations of (mother’s) time and goods to produce a given combination of \( c, s \).

We know that efficiency in production requires that the marginal rate of transformation for \( c \) and \( s \) must be equal. So the set of tangency points define the contract curve. The absolute value of the slope of the common tangency point is the shadow price of the woman’s time (\( \hat{w} = f_x/f_t = g_x/g_t \) for production functions \( f \) for children and \( g \) for \( s \)).

You can see that the shadow price of time is rising as we increase the production of \( c \). (Notice that the slope of a ray from the origin to the contract curve increases as \( c \) increase. And similarly for the slope of a ray from \( O' \) (origin of \( s \)); so the value of time is very dear with large production of \( c \) (has a high opportunity cost in the foregone production of \( s \)).

Notice that the contract curve is below the diagonal because of the assumption that children are relatively time intensive.

Now introduce second or right panel, with axes child services (horz) and parents’ consumption (vert).

The contract curve traces out all the efficient combinations of \( t, x \) to produce \( c, s \). Thus, the allocations on the contract curve trace out the production possibility curve, relating the maximal amount of \( c \) and \( s \) that can be produced with the given endowment and prices (\( p_x, w \)).

Preferences and the marginal rate of substitution between parent’s consumption and child services determine the optimum or equilibrium point. As is usual efficiency requires that we equate the MRS and the MRTS.

Increase the Husband’s Income

Now consider the effect of increasing the husband’s income. How will that change the picture?

**Answer:** The vertical side of the Edgeworth Box increases, as now the household has greater income and at fixed prices \( p_x \) can purchase more good inputs. Woman’s time does not increase so that side of the box does not change.

There will exist a contract curve for the augmented Edgeworth Box and we can use it to trace out the new production possibility frontier. Given the relative time intensive nature of children, an increase in income will shift out the production possibility curve less in children and more in parents’ consumption \( s \). (Draw Fig 11 in Hotz et al.)

Under the assumption that child services is a normal good, an increase in income will increase the demand for \( cs \). However, because child–services are relatively time intensive, the increase in income increases the shadow price of the woman’s time, so the income effect for \( c \) will be reduced
by the substitute effect, as at the new higher income, households substitute away from the higher priced good.

And if we maintain the assumption that the income elasticity of quality is greater than the income elasticity of \textit{quantity} as we discussed last time the demand for quality may be on net, positive, while the demand for quantity may be negative.

\textbf{Allow the woman to work in the labor market, } \( w > 0 \)

Now let’s permit the woman to work in the market place, equivalently assume that \( w > 0 \). So she has a choice to make on how to allocate her time between the production of household goods (which only she is able to produce) and working in the labor market (and earning income).

How do we have to modify the Edgeworth Box, and the Production Possibility Curve?

The axis of the Edgeworth box is defined as the time spent in household production. So, time allocated to the labor market reduces time in the household, but increases the amount of goods that can be produced. Thus, at market wage rate \( w \), we have a line segment with slope \( w \) emanating from the \( s \) goods origin \((0')\). Drop a line perpendicular from the line segment to determine the amount of time spent in the household (as time spent in the market reduces 1 for 1 time available for the household production).

At point \( a \) the shadow price of her time equals the wage (parallel lines). Draw point \( a \) in the production possibility curve. Now for higher production of child–services than \( a \) the shadow price of the woman’s time is rising, reflecting diminishing marginal returns in household production. Increasing the production of child–services beyond point \( a \), with the rising price of time, means that the value of her time in the household exceeds that of the market and she will not work. However, for levels of \( cs \) below \( a \) (or increases in \( s \)) the shadow price of time in the household is less than in the market. So for lower child-servies and higher \( s \) she will sell time in the market. Thus, the production possibility curve is characterized by the curve to point \( a \) and then the line segment from \( a \) to the northwest. Notice the woman’s labor market activity increases the consumption possibilities for \( s \).

Equilibrium, as before will be determined by the tangency of the marginal rate of substitution (between \( c \) and \( s \)) and the marginal rate of technical transformation. However, along the line segment, the shadow price of children (the absolute slope of the production possibility curve) is constant. So have equilibrium on line segment (if she works some of her married life in the market) or on the curved portion of the production possibility curve if she doesn’t.

Consider the effect of an increase in the woman’s wage, from \( w \) to \( w' \). How does the increase in the wage manifest in the diagram?

\textbf{Answer:} The tangency between the line segment and the curved production possibility frontier moves to the right (more child services). So the line segment is now steeper and outside the previous line segment. This implies that \( w \) increase increases the household’s opportunity set, and the opportunity cost of children.

An increase in the wage produces an income effect and raises the price of children. Increase demand from \( b \) to \( d \), with more or less of \( c \) depending on the relative magnitudes of the income and
substitution effects. And of course, even if the income effect dominates, so that $c = nq$ increases, the demand for $q$ may increase while that of $n$ may decline. It seems unlikely that $q$ would decline with the large increases in the parents’ standard of living $s$ witnessed over time.

Finally, let’s investigate the income effect for households with working wives (i.e., wives who work in the labor market). An increase in the husband’s income will reduce the time she works in the market (with an increase in income the value of her non–market time increased). But as long as she continues to sell at least some time to the labor market, the value of her time in the market place has not changed, it is still $w$, and consequently the opportunity cost of children does not change. In this case, there is no offsetting substitution effect on the shadow price of children. The increase in income increases the demand for child services. So, the model implies that following an increase in income, the demand for child services will increase more in (comparable) households in which the wife works than when she does not. (Because for working wives, the cost of children does not change, but in households with non–working wives the cost of children increases and produces a (at least partially) offsetting substitution effect.

**Easterlin’s Models of Fertility**

There are four primary complaints against the neoclassical model of fertility. I have touched on some of this before, so I will be brief.

1. Supply side – supply of births is not (always) infinitely elastic as zero supply price.

2. Children are **more** than consumer durables.

3. Reject atomistic decision making.

4. Preferences (represented by utility function) need not be constant across cohort.

**Supply of births is not infinitely elastic** The neoclassical model assumes that the supply of births is infinitely elastic at a zero supply price of births. Couples can have as many children as they desire as zero marginal cost. Notions of “excess fertility” and “deficit fertility” have no place in the (static) neoclassical model. Parents have exactly the number of children they desire (there is no uncertainty on the number of children). Birth control technology enters the framework in the backdoor (so to speak) via the cost of children.

However, reproductive biology also matters. Malnourished women are less able to conceive and carry the fetus to term. Plus, fecundability declines with age (its actually an inverted U-shape) and also varies with parity (number of children born). Thus, in many settings women (couples) are constrained and have fewer children than they desire. A more complete model will include a supply side of births.

**Children are more than consumer durables** Most non–economists react strongly and negatively to thinking about children as a consumer durable. The primary insight (application of Slutsky equation and decomposition into income and substitution effects) from the neoclassical model stems from treating the demand for children symmetric to other home–produced goods. Home production
is necessary to determine the shadow price of these non–traded goods (again to use the technical language of economist).

The neoclassical models thus reduce the determinants of fertility to two, its shadow price and income. All factors are presumed to operate through the shadow price or income. Many (non–economists) may accept that the cost of children and family resources matter and may even be primary, but will argue that they are not sufficient; more factors are involved. And specifically these factors have an influence outside of “costs” and income.

**Atomistic Decision Making** The neoclassical model assumes that individual households make decisions in isolation (except through market interactions) of another. Thus, we can specify the model of an individual, and not discuss the larger social context that surrounds the individual.

Perhaps this is the distinguishing feature between economists and sociologists perspectives on behavior. Economists assume that individuals decide, whereas as sociologists see people within groups and model group behavior. Thus, to the economist, individual consumption is determined by household resources (income) and market prices. But to the sociologist, individuals face additional constraints on behavior such as group norms or through an individual’s social role.

Easterlin adopts a more sociological perspective by arguing that potential childbearing depends on cultural practices, such as the length of breast feeding following a birth. A woman’s fecundity declines while she is breast feeding — this is nature’s way of limiting fertility. And societies vary about the usual length of breast feeding — some breast feed for as long as two years.

And some cultures have social taboos on sexual intercourse while the woman is breast feeding. This too clearly reduces the potential number of births.

**Changing Preferences** Models of fertility require that we think hard about what we assume about preferences. In many analyses, consensus on how people behave and specification of preferences is second–order. No so with fertility. As discussed before, the neoclassical model assume that preferences are constant. Changes in prices and incomes determine outcomes. If preferences (as represented by the utility function) are unrestricted that any change can be perfectly explained by changing preferences. Indeed, whatever our underlying explanation, we can adjust preferences to perfectly explain changes over type or across groups.

Denote preferences by \( \theta \) and consider trying to explain birth rates in two time periods. Let our conjectured explanatory variable be \( x_t \). Represent the theoretical model of fertility as \( b_t = g(x_t, \theta_t) \). For given \( b_t, x_t \), as long as \( \theta_t \) is free to vary, we can find a value (or sometimes more than one) of \( \theta_t \) that will perfectly link \( x_t, b_t \),

\[
\theta_t = G(b_t, x_t).
\]

To have any explanatory power if we allow preferences to vary, our theory must restrict preferences. Which in the equation above, this just means that some values of \( \theta_t \) must be excluded by our theory.

Do most economists believe preferences never vary? No. Education for example changes preferences. Courses in music appreciation and in literature open our minds and perspectives. College admission officers seek diversity so we learn about other cultures and people and realize we are more
alike than dissimilar. We become more accepting of people different from our selves, to see them as individuals and not apply stereotypes. Prejudice and discrimination declines (if not eliminated).

But we (economists) know the least amount the formation of preferences and how they may change across time and or groups. So, the methodological approach is to assume their preferences are fixed and focus attention on economic incentives that change in predictable and discernible ways.

Easterlin seeks to understand changes in fertility over a long period of time. The motivation behind the 1975 paper is to explain the demographic transition, the change from high–mortality–high–fertility regime to a low–mortality–fertility regime. This transition occurs over decades. Thus one can argue (as Easterlin does) that it is acceptable to consider changes in preferences.

**Easterlin 1975**

There are three components to his theory.

1. Demand for **surviving** children, $C_d$, if fertility regulation were costless.

2. Potential family size, $C_n$, the number of surviving children parents would have if they did not deliberately limit fertility, and

3. Costs of fertility regulation, $RC$, including both subjective (psychic) costs and objective costs, namely the time and money required to learn about and use specific techniques.

**Desired Family Size, $C_d$** Desired family size depends on the household balancing of its subjective tastes for goods and children against externally determined constraints of price and income in a way that maximizes its satisfaction.

It is through tastes or subjective preferences that attitudinal considerations stressed by sociologists operate such as norms regarding family size and the “quality” of children (standards of child care and rearing). Notes that nothing in economic theory prohibits an analysis of tastes, but as noted above most economists emphasize price and income changes.

Easterlin stresses that surviving children matter as parents ultimately interested in grown offspring. Notes that parental preferences may change to give greater emphasis to child “quality” to child quantity. Key to understand that in the neoclassical model of fertility, preferences are constant and the substitution from quantity to quality due to changes in shadow prices and incomes.

Argues that infant and child mortality rates are determined largely outside the household’s control.

**Potential Family Size, $C_n$** Again this is the number of surviving children a household would have if fertility were not deliberately limited. This depends on “natural fertility” and an infant’s chance of surviving into adulthood.

By this perspective, anything that reduces infant and child mortality increase potential family size. And given survival probabilities anything that increases natural fertility increases potential family size. For example, an increase in maternal nutrition increases fecundability and potential family size.
Natural fertility is the number of births a household would produce in the absence of \textit{intentional} fertility control. The operative word here is \textit{intentional} and this makes the concept of natural one of those that is intuitively plausible yet empirically elusive.

To think about fertility control necessarily implies some method (or technology) to limit fertility. Easterlin correctly notes that if we have a demand based explanation of fertility, we must be able to observe the use of fertility–limiting practices.

\textbf{Intent} supporting fertility limitation practice has implications on effectiveness of public programs to reduce fertility. Easterlin gives the example that a couple may follow a lengthy lactation period follow a birth because of social norms (doing as others do, fitting in). Alternatively, the couple may have a lengthy lactation period as a conscious attempt to limit fertility. In the first case (customs), family planning programs of subsidizing and providing modern contraceptives are likely to be ineffective, while the program is likely to reduce fertility in the second. In the second case, a more effective and less costly method is likely to be adopted.

\textbf{Fertility Regulation} Notes that $C_n > C_d$ is a necessary but not sufficient condition for fertility regulation. Why?

Fertility regulation also imposes costs on the household (psychic and monetary), and so adoption of fertility regulation requires that the costs are less than the benefits ("motivation").

And as long as fertility regulation or contraceptive is costly, fertility regulation will not be perfect — there will be excess fertility. Only if costs are zero will the number of children born exactly equal the desired number of children. Hence, there will be "unwanted children."

Not keen on the use of terminology of “unwanted children.” Unwanted children not simply a matter of preferences (as we usually think of wants) but also depend on the availability and price of contraceptives. Thus, it mixes notions of preferences and opportunities. Unfortunate.

\textbf{Summary} That’s it for the analytical framework. Easterlin advocates including potential supply of children into the analysis, and advocates the direct study subjective (tastes) considerations.

\textbf{Example of Explanatory Power} To see the explanatory power of his approach. He limits the discussion to pre-modern households, as these households may presume may be biological constrained in their child bearing. Consider again the effect of an increase in income. He is willing to assume that children (quantity) are a normal good, and so an increase in income increases the demand for children.

However, because the household is premodern and thus $C_n < C_d$. An increase in income may increase fertility even if the household is making no effort to control its fertility. The idea is that as parents’ living conditions improved (from very low levels) natural fertility would increase, although increments would become gradually less until eventually a point would be reached at which further living level changes would leave natural fertility unaffected because of biological and cultural limits on a woman’s reproductive years. One mechanism could be through improved maternal nutrition that increases fecundability and hence natural fertility. A cultural factor could be through the age at marriage — in times of greater prosperity couples could marriage at younger ages, and additional years of marriage would increase potential family size. Or the increased income could be used to purchase improved medical care, lowering maternal mortality (say in child bearing).
The diagrams that appear in the second half of the paper argue that shifts in potential supply of fertility are central to understanding fertility trends and population growth. The claim is that shifts in potential supply are important in early stages of economic development, while demand factors become dominant at later stages of development.

Some demographers believe the supply constraint on reproductive performance is the predominant source today of inter-individual and inter-country and inter-temporal variation in fertility in all but the most industrialized countries. (Schultz (1981) p. 126)

Economists are more inclined to believe that most populations are demand constrained, and that individuals in most societies exercise some regulative control over their reproductive potential.

**Easterlin Hypothesis: Cohort Swings in Fertility**

In a series of papers, Richard Easterlin developed a model of fertility with endogenous preferences. Preferences are no longer fixed, but depend on other factors, internal to the model.

In its simplest form (as summarized by Schultz (1981), p. 152 fn. 2) the central idea is that individuals decide what is a reasonable standard of living on the basis of secular progress and the economic status of their parents, when they are teenagers. (Note that secular means long-run.) If individuals fare better than they anticipated, they feel they can then afford more children than one would have predicted on the basis of the long-run fertility trends. Children are, thus, viewed as supernumerary expenditures (supernumerary means exceeding more than is necessary, required or desired) that absorb a substantial proportion of the excess or shortfall of actual to expected incomes.

Kuznets explored the relationships between indicators of aggregate economic growth and long swings of demographic series. Kuznets noted in the US from 1870 to 1955 that first immigration and then in the twentieth century birth rates responded to long swings in modern economic growth and to associated cycles in capital formation. Until immigration was restricted in 1930s, the periods of buoyant economic demand for labor in the US economy were always periods of large scale European immigration that held down wage fluctuations. After WWII rapid economic growth sharply raised the wages of scarce young entrants to the labor force.

Easterlin shifted attention from overall aggregate trends to the economic status of particular cohorts of parents relative to the consumption standards to which those cohorts had become accustomed during their adolescence. In this interpretation, unanticipated swings in the economic status of cohorts are translated into deviations in cohort fertility, measured from long-run secular (downward) trends.

Easterlin observed there was a positive elasticity of the demand for children with respect to unanticipated swings in the level of cohort permanent income. Youth entering the labor force after WWII were better off than they had expected to be, having been raised during the depression and war years. Part of their unanticipated gains as adults were spent on the formation of larger families during the 1950s. Conversely, youth entering the labor force during the 1960s and 1970s did not fare as well relatively and their marriage and birth rates fell accordingly.

The premise of the Easterlin hypothesis is two-fold. One as described above that individuals form their preferences on children while teenagers, and basis their notion of prosperity relative to
long-term or secular trend. And second, that the age-composition of the population is of paramount
important, because young and old workers are imperfect substitutes. Small young cohorts do well in
the labor market, because their skills are scarce. And they realize this gain through their entire lives.
Because when old, they are not good substitutes for the now (plentiful) young.

This is probably the most widely accepted explanation of 20th century US fertility. Has spawned
a large number of studies, work that continues today. Study published in 2005 applies the explanation
to a set of European countries.

**Some limitations as explanation**

1. No explanation is internally generated for the secular decline in fertility.

2. The theory virtually ignores demand. Yet, aggregate demand conditions (depression or boom)
could swamp cohort-size effects. And some consideration to technology must also be given to
understand why technology does not change to increase the substitution possibilities between
young and old workers.

3. Gives only token attention to the secular increase in women’s labor force participation.

4. Problematic is that before 1930 there is no relationship between the age-structure and fertility.

**Family Planning**

The textbook and the material from the Population Reference Bureau do a good job of summarizing
the history and structure of family planning programs. Family Planning has been one of the most
studied elements of population policy.

The programs grew in international prominence during the 1960s and the rapid population growth
in developing countries. Introduction of modern public health and medicine (mostly combatting
infectious diseases) reduced child and infant mortality rates. Mortality rates fell first and rapidly,
fertility rates lagged behind. Hence, population growth which had been moderate became quite
large. (Remember the rule of “72” and doubling times; a net growth rate of 2 percent doubles the
population in roughly 35 years, while a growth rate of 6 percent doubles the population in twelve
years.) The grim consequences of geometric population growth recognized since Malthus came to
the fore. Advocates of zero-population growth and early notions of “sustainability” emerged.

The Tsui (2001) article provides a readable summary of the voluminous literature on effect of
family planning programs on fertility. She concludes that the programs account for (caused) roughly
half of the decline in fertility. This is the consensus estimate in the literature.

There is no denying the programs are coincidental with fertility reductions. The debate is over
causality. To clarify notions of causality, it is sometimes useful to restate the causal mechanism
in terms of a **counterfactual**— what would have happened in a situation not observed (hence the
counterfactual part). An interesting counterfactual is that if Tsui is correct and the family planning
programs reduced fertility by half, then in countries with family planning programs fertility would
have declined by half even in the absence of any economic development.
Or to say the same thing, this is where notions of experimental design are useful. If we could design a social experiment, say and randomize the type and level of family planning programs across economies we would observe fertility to fall by half for countries receiving the “family planning treatment” independent of their level or rate of economic development. There isn’t a tight relationship between family planning, economic development and fertility but generally family planning programs have their largest effect in countries undergoing their most rapid economic development.

The question is whether economic development creates a demand for fertility control (economic growth improves the educational and market opportunities for women, raising the shadow price of children and a reduction in the demand for children, and increasing the demand for fertility limitation) or whether access to improved methods of fertility control allowed women to make educational investments and commitments to the labor market they could not previously make.

The primary source of disagreement is whether (to use Easterlin’s Economic Analysis of Fertility) \( C^d < C^n \) and there is pent-up demand for fertility limitation before the initiation of the family planning program. That is, before the implementation of the family planning program there are couples would prefer to regulate their fertility but the costs they face are too high. So the number of realized births is more than desired.

If you return to Easterlin’s 1975 article and review his figures in which he plots \( C^d \) and \( C^n \) over time, supply increases first followed by a decline in desired fertility. The idea is that the reduction of infant and child mortality (exogenously) shifted the supply of potential births. This led to \( C^n > C^d \) and a demand for contraception. Family planning programs reduced the cost of fertility limitation and this increased the use of modern contraceptives and lower fertility rates.

Ron Lesthaeghe, a famous European demographer, gave a talk this week, and he talked about fertility decline (in general) as occurring when three necessary conditions are satisfied: “Ready and Willing and Able”. He’s applied this perspective in understanding fertility behavior in countries. He is a leading proponent of “idealtional” change — that is changes in social norms, attitudes that drive fertility change. In Ready he assigned economic factors that put couples in a situation where they want to limit their fertility. All the price and income stuff we’ve discussed.

Willing is that attitudes and information are such that allow people to be willing to change. Here the sociological arguments come to the for on why we behave according to dictates of a community or group, and not based on the individual calculus. In terms of a family planning programs, the programs frequently had media campaigns, or in Indonesia which is the poster child for a successful family planning program, they targeted community leaders. Talked with community leaders and the wives of the leaders. Once the leaders accepted contraceptives others in the community would follow. The programs also established local clinics that offered information and counseling on the health risks involved with IUD or oral contraceptive. Here the barrier to use may be “Knowledge, Attitudes or Practice”. The family planning programs distributed more than just free birth control pills.

Able is the direct supply effect, that individuals have access to the contraceptive methods. The shadow price or the full price of the contraceptive method is includes the time and travel cost to obtain the contraceptives. Not a big deal if you can stop at the local Walgreens on the way home from work, but another matter if traveling from a remote rural area or an area with poorly developed transportation facilities.
He gave a masterful talk and with his sound bite of Ready–Willing–Able he knows how to market his ideas. The evaluation of family planning programs is difficult because understanding the behavior is not the monopoly of one discipline.

All of the social processes can be presence and the force of economic development need not be absent. And in conversation with Lesthaeghe, he agreed that economics has a role. We differ on the relative weight of the various roles, and particularly on how we think about causality.

Thus, sorting out causality requires sorting out temporal ordering of events, which is (virtually) impossible to do with the available data. And to further complicate matters, economic development and family planning programs need not operate through different channels. For example, economic development and family planning may both serve to reduce the psychic costs of fertility regulation: economic development may increase the cost of time for some women who become the first–users of modern contraceptive methods. Results on their experience may be sharing with friends and family members. This can create an informational externality (as the cost of adoption declines as the prevalence of modern contraceptives increases) and lead to increased demand for contraceptives. The same kind of informational externality generated by converting village leaders to adopt modern birth control methods. Understanding the role of social networks is important, and that is a point of commonality. Differentiating the explanations is subtle, whether economic development changed the payoffs and costs to childbearing or a few leaders or whether the initial factor was the intervention by the program. There are are subtle differences that are not easy to tease out of data (with the best of data, and the existing data are far from optimal).

Let me close with an example of why understanding causality is important. Assume that economic development serves to reduce the demand for surviving children, $C_d$. Family planning program introduced that lowers the shadow price of fertility limitation. (The time and transportation costs to obtain the contraceptives are part of the shadow price.) In this example, economic development and the family planning program interact to reduce fertility. It is wrong to ascribe the total reduction to one cause or the other.

But assume a policy analyst doesn’t recognize the role of economic development. Initiatives in countries such as West Africa with strong traditions of high fertility and virtually no economic development will fail, ($C_d \geq C''$); if there is no desire to limit fertility family planning initiatives will not be effective in reducing fertility. Lesthaeghe would agree and argues that an important advantage of his perspective is that it allows us to identify the source of the bottleneck prohibiting fertility reduction (or adoption of modern contraceptive practice). By his view the three conditions are necessary. If one is not satisfied then fertility reduction will not occur. Thus for places like West Africa the question becomes “which condition is not satisfied.”

However, a similar conclusion is partially true to the economist who does not assess the influence of the family planning program. In this case, claims of “only economic development” will be wrong. In the absence of family program initiative, fertility may decline but more slowly (and perhaps much more slowly) than in the presence of the program.

A closing comment is that the cost benefit analysis of family planning programs involves some philosophical difficulties. The problem is that in evaluation the value of fertility reduction the number of people in society is not the same in all evaluation states. Indeed, with an effective program the
population has to be smaller. Should the social planner attempt to maximize total welfare or average welfare? One issue is how or whether to think about the utility of the “unborn.” If we use total utility then the total can increase by the marginal person may have a life “barely worth living.” Interesting issues in the nexus between philosophy and economics and Amarta Sen has written exclusively on it these kinds of public choice questions. Here related to optimal population size.

Interaction of Infant and childhood mortality and Fertility

Besides working through the evaluation of family planning initiatives, another primary topic of fertility within developing countries is the relationship between infant and child mortality on fertility. We’ll talk next week on education and more generally human capital, as investments by parents (of which education is a primary one) is the next topic in the class.

As we will see and as mentioned, in most of the settings modern public health measures reduced infant and childhood mortality. Then it is easy to see that if parents have a target level of surviving number of children, a reduction in mortality reduces the number of births required to reach the target.

An important feature of this literature is that the theoretical perspective switches from a static or lifetime view to a dynamic one in which couples make decisions sequentially. It takes time to reach the target or desired number of (surviving) children. Things can change, and people adjust.

The perspective assumes that the reduction in mortality was exogenous; that is, beyond the individual’s choice. The question then is to what extent do couples respond to realized death of a child. In thinking about a dynamic perspective, the answer depends on when at what part of the reproductive career does the death occur. If childhood death rates are high, a death may occur too late in a woman’s life to allow her to have another child even if she wanted to. Expectations of future mortality gives rise to a motive to hoard children. The idea is that expecting the future death of a child, the couple has more births than its target number of surviving children. Yet, this is a costly policy because children require substantial time and material resources. And to have a high probability of having at least the target number of surviving children entails having one or more “excess” children with moderate to high probabilities. If however infant mortality rates are dominant, and assume child mortality confined to the period immediately after birth. Neonatal mortality are deaths of infants within the first 28 days of their life. If infant mortality rates are high, then a child death will occur when it is likely the woman can replace the lost child. This environment gives rise to a replacement strategy – a response to a realized death. You should be able to convince yourself that an individual following a replacement strategy will have lower fertility than one following a hoarding strategy. This is because the replacement strategy allows responses for only realized deaths not anticipated or expected deaths.

Ben Porath (1976) wrote an influential paper that raised many of these issues. One of the interesting features is to study dynamic behavior, another is to study learning. How quickly do individuals learn about their mortality environment? About their own individual (or village) level of mortality risk? So the topic affords possibilities to study dynamic decision making and learning.