Education and Consumption: The Effects of Education in the Household Compared to the Marketplace

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This article considers various differences between the effects of education in the marketplace and households. It shows that the household sector rewards skills that are useful at the many tasks that household members must execute, whereas the marketplace rewards skill at specialized tasks. In addition, increased supplies of more educated persons reduce returns to education in the marketplace, whereas if anything, increased supplies raise household returns to education. The greater demand over 40 years for household and market skills may have raised returns to education in households compared to those in the market sector.

I. Introduction

Since the first systematic studies about 50 years ago of the monetary returns to education, thousands of estimates have been prepared for a large number of countries. Typically, sizable rates of return of the order of 7–15 percent have been found, with magnitudes dependent on country, level of education, and time period. Adjustments for various measures of ability, family background, and still other factors have failed to reduce these estimates by much, if at all, whereas some adjustments, such as for errors in reporting school years, have raised estimated returns.

Many fewer studies have concentrated on benefits from education other than earnings, such as in health, child rearing, marriage, and consumption of new goods, though studies of outcomes in these areas show apparently large effects of education on such "consumption" activities (see Ehrlich and Yin 2005; Elias 2005; and Ehrlich, Hamlen, and Yin 2007). There is also reason to believe that consumption returns to education have risen over time perhaps even relative to market returns. To correct this imbalance in emphasis, our study concentrates mainly on the consumption benefits of education and discusses earnings only to draw differences between the effects of education in the workplace and household.

In order to highlight what we think are the key differences between the household and market sectors, we examine a model in which the

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fundamental production structure is the same in the two sectors. In particular, we assume that both sectors produce a wide range of goods that require individuals to perform a large number of distinct tasks. We believe that a model with the same underlying production characteristics is useful for at least two reasons. First, a wide range of "outputs" are actually produced in both sectors. In the market sector, firms produce food, housing, transportation, health care, and so forth; in the household, individuals handle their finances, make investment decisions, prepare meals, provide health care, raise and educate children, and so forth. Second, both sectors have changed in similar ways over time. In both sectors, technological change has transformed production, capital goods have replaced human effort in both households and the marketplace, and new and more complex technologies provide a range of new goods and services.

So instead of focusing on differences in the goods mix, our analysis focuses on differences in the way production is organized in the two sectors. In particular, we highlight that (1) the division of labor is much less extensive in the household: households consist of a relatively small number of individuals each of whom is responsible for many activities; and (2) individuals work together (cooperate) in the marketplace to produce output for sale, whereas they produce for their own consumption in the household. As a result of these differences in organization, individuals typically perform a relatively small range of tasks in the market, whereas they perform many tasks in the household. Our goal in this article is to flesh out some of the implications of these differences in organizational structure between households and the marketplace. To concentrate on these implications, we take differences in organizational structure as given, though in principle one could attempt to derive them from a more primitive theory based on agency costs, a desire for privacy, or other factors that limit household size.

In the market sector, individuals combine their skills with other inputs, and the resulting output is sold. An individual's pay for time worked is determined by the market value of his marginal product. Compensation is determined by an individual's skill at his chosen task (as opposed to all tasks), and the value received depends on the market supply of skills and other factors. In contrast, compensation for time worked in households depends on the average of the production of an individual's time over many tasks. In addition, individual benefits from household production do not depend on the supply of skills and capital in other households.

While differences in the degree of specialization and cooperation between the market and household sectors have many implications that are developed below, the effect of technological progress that augments the productivity of skilled workers highlights the contrast between markets and households. Changes that make highly educated workers more productive at all tasks would unambiguously raise household productivity of educated workers; but they would not affect the household productivity of less educated workers. In contrast, changes that make educated workers more productive in the marketplace would make less educated workers better off to the extent that they are complementary to educated workers, perhaps because they perform complementary tasks. Moreover, such productivity increases could make highly educated workers worse off in the market if the demand for their services were inelastic.

The focus on how changes in the economic environment, such as technological change, affect the market and household sectors differently is of particular interest given the evolution of the market sector over the past several decades. As has been well documented, returns to education have increased substantially in the United States and other developed economies. That these returns have risen in spite of rapid growth in the relative supply of more educated workers means that other economic factors have shifted demand in favor of educated workers even faster than the growth in supply (Katz and Murphy 1992; Murphy and Welch 1992). The commonly recognized factors behind this shift are (1) skill-biased technological change associated with computerization and the expansion of labor-saving technologies, (2) the falling price of capital goods combined with capital-skill complementarity (Krusell et al. 2000), and (3) the shift of product demand toward more skill-intensive sectors.

These same changes appear to have occurred in households as well since household activities have become more physical capital and skill intensive. As the example of technological change discussed above suggests and as we show in greater detail below, differences in the degree of specialization and cooperation between the market and household sectors would tend to make the impact of changes in demand, technologies, and capital different in the household sector from what has been recorded in the marketplace.

Formally, the basic model that we develop involving specialization in the market sector by different education groups among a continuum of goods is closely related to Ricardian models of trade between countries with a continuum of goods (see Dornbusch, Fischer, and Samuelson 1977; Eaton and Kortum 2002). Some of our comparative static results have a close correspondence to the results of these models on the gains from trade. For example, the effects in our article of an increased supply of higher-educated persons on the earnings of the less educated are closely related to the results by Dornbusch et al. on the effects of an increased size of the rest of the world on the welfare of a particular country.

However, the focus is different because ours is on the effects of technological progress, changes in the number of persons with different amounts of education, and other variables on the gains from education in households compared with those in the market sector. Some of the results in these comparisons have not been derived, or at least not emphasized, in this trade literature. Yet they are crucial to our conclusions about why the gains from education are different in markets and households.

The article is organized as follows. Section II lays out our basic model of production, and it contrasts the utilities of more educated and less educated workers when production takes place entirely in households versus when production takes place only in the marketplace. Section III shows the differences between the impact of changes in technology and other factors in the market and household sectors. Many of the forces that mute the impact of such changes in the marketplace either do not operate or operate very differently in households. In particular, we show that the same types of underlying changes that have driven the evolution of market outcomes often generate even more pronounced changes in the household sector. Section IV integrates our models of household and market production by allowing individuals to buy goods in the market that they use to produce household commodities. Section V concludes with some suggestions for future research.

II. Production in the Market and Household Sectors

We begin our analysis with a simple model of production that we will use for both the market and household sectors. We assume that there is a continuum of tasks to be performed. For simplicity, we associate each of these tasks with the production of a specific consumption good and assume that an individual's output on a given task is simply his skill at that task multiplied by the time devoted to the task. Hence, an individual with skill level $S(x)$ on task x who spends $t(x)$ units of time working on task x will produce $Y(x) = t(x) \times S(x)$ units of task x output, $Y(x)$.

To keep things simple without any major omissions for our purposes, we assume that all individuals have essentially additively separable preferences over these goods of the form

$$U = \left[\int A(x) Y(x)^{(\sigma-1)/\sigma}\, dx \right]^{\sigma/(\sigma-1)}, \tag{1}$$

where x indexes the different tasks, σ measures the degree of substitutability between the outputs of the different tasks, and $A(x)$ measures the level of demand for the output of task x. We assume $\int A(x) dx = 1$, so that $A(x)$ measures the distribution of demand across tasks.

Throughout our analysis we consider two levels of education, which we denote as high school and college. For now, we assume that all individuals within a given education level have identical skills and that educated workers are more productive at all tasks but have a comparative advantage at some tasks relative to others. In particular, we order the tasks according to the degree of comparative advantage of the more educated workers so that the educated workers have a comparative advantage at the higher-index tasks. With these assumptions, the comparative advantage of college graduates, $R(x) = S_{\mathrm{COL}}(x)/S_{\mathrm{HS}}(x)$, is increasing in x, with $R(x) \geq 1$ for all tasks, where $S_{\mathrm{COL}}(x)$ is the productivity of a representative college graduate at task x and $S_{\mathrm{HS}}(x)$ is the productivity of a representative high school graduate at the same task.

Equilibrium in the Market Sector

Given the structure described above, the market allocation of workers will be determined by comparative advantage. College and high school graduates will specialize in different tasks, with college graduates performing the higher-index tasks and high school graduates performing the lower-index tasks. We denote the equilibrium cutoff level of tasks that separates the tasks performed by college and high school graduates by x^* and the corresponding cutoff level of comparative advantage $R^* = R(x^*)$. Since all individuals are identical within a given education level, all must earn the same amount regardless of which tasks they perform in equilibrium. The output per hour produced by college graduates working at task x is $S_{\mathrm{COL}}(x)$, so that the price of good x will be $P(x) = W_{\mathrm{COL}}/S_{\mathrm{COL}}(x)$ for $x \geq x^*$, where W_{COL} is the equilibrium wage of college graduates. Similarly, for $x < x^*$, prices will be $P(x) = W_{\mathrm{HS}}/S_{\mathrm{HS}}(x)$.

Since the utility function given in equation (1) is homothetic, we can act as if there is a single representative consumer in considering consumption levels. The utility function above is maximized subject to the budget constraint $\int P(x)Y(x)dx = W$, where W is earnings and $P(x)$ are the prices defined above. The first-order conditions for all x are

$$A(x)Y(x)^{-1/\sigma} = \lambda P(x), \tag{2}$$

with λ being the marginal utility of income times $[\int A(x)Y(x)^{(\sigma-1)/\sigma}\, dx]^{\sigma/(\sigma-1)}$. Hence, the equilibrium consumption of good $Y(x)$ will satisfy

$$Y(x) = \lambda^{-\sigma}A(x)^{\sigma}P(x)^{-\sigma}. \tag{3}$$

That $P(x) = W_{\mathrm{HS}}/S_{\mathrm{HS}}(x)$ for $x \leq x^*$ and $P(x) = W_{\mathrm{COL}}/S_{\mathrm{COL}}$ for $x \geq x^*$ implies that $W_{\mathrm{COL}}/W_{\mathrm{HS}} = R(x^*)$. Therefore,

$$\begin{aligned} P(x) &= \frac{W_{\mathrm{HS}}}{S_{\mathrm{HS}}(x)} \quad \text{for } x \leq x^* \\ &= \frac{W_{\mathrm{HS}}}{S_{\mathrm{HS}}(x)} \frac{R(x^*)}{R(x)} \quad \text{for } x \geq x^*. \end{aligned} \tag{4}$$

The gains to specialization are immediately evident in equation (4). The prices of products produced by high school graduates are the same as they would be without specialization by education level. However, the prices of products produced by college graduates are lower by the factor $R(x^*)/R(x) < 1$ for $x > x^*$. This reflects the comparative advantage of college graduates at those tasks and the gains from trade received by high school graduates. The market limits the comparative disadvantage of high school graduates at more skilled tasks to their disadvantage at the marginal task, $R(x^*)$.

Solving for the equilibrium quantities, prices, and time allocations is relatively straightforward. With the time devoted to the production of good x being $t(x)$, output on task x will be $Y(x) = t(x)S_{HS}(x)$ for $x < x^*$ and $Y(x) = t(x)S_{COL}(x) = t(x)R(x)S_{HS}(x)$ for $x \geq x^*$. In order to pin down prices, we need to choose units for measuring prices. One convenient set of units is to use the wage of high school graduates as the numeraire. Then equilibrium prices, production, and time allocations will satisfy

$$\begin{aligned} P(x) &= \frac{1}{S_{HS}(x)} \quad \text{for } x < x^* \\ &= \frac{1}{S_{HS}(x)} \frac{R(x^*)}{R(x)} \quad \text{for } x \geq x^*, \end{aligned} \tag{5a}$$

$$\begin{aligned} Y(x) &= \lambda^{-\sigma} A(x)^{\sigma} S_{HS}^{\sigma}(x) \quad \text{for } x < x^* \\ &= \lambda^{-\sigma} A(x)^{\sigma} S_{HS}^{\sigma}(x) \times \frac{R(x)}{R(x^*)^{\sigma}} \quad \text{for } x \geq x^*, \end{aligned} \tag{5b}$$

and

$$\begin{aligned} t(x) &= \lambda^{-\sigma} A(x)^{\sigma} S_{HS}^{\sigma-1}(x) \quad \text{for } x < x^* \\ &= \lambda^{-\sigma} A(x)^{\sigma} S_{HS}^{\sigma-1}(x) \times \frac{R(x)^{\sigma-1}}{R(x^*)^{\sigma}} \quad \text{for } x \geq x^*. \end{aligned} \tag{5c}$$

To solve the full equilibrium, we need to bring in the two supply constraints, that the total time demanded of college and high school graduates is equal to their corresponding supplies. Mathematically,

$$T_{HS} = \lambda^{-\sigma} \int_{x<x^*} A(x)^{\sigma} S_{HS}^{\sigma-1}(x) dx \tag{6a}$$

and

$$T_{COL} = \lambda^{-\sigma} \int_{x \geq x^*} A(x)^{\sigma} S_{HS}^{\sigma-1}(x) \frac{R(x)^{\sigma-1}}{R(x^*)^{\sigma}} dx, \tag{6b}$$

where T_{HS} and T_{COL} are the total time of high school and college graduates available in the marketplace. The equilibrium cutoff, x^*, can be determined from the ratio of these two conditions that eliminates x and equates relative demands and relative supplies:

$$\frac{T_{\text{COL}}}{T_{\text{HS}}} = \frac{\int_{x \geq x*} A(x)^{\sigma} S_{\text{HS}}^{\sigma-1}(x)[R(x)^{\sigma-1}/R(x^*)^{\sigma}]dx}{\int_{x<x*} A(x)^{\sigma} S_{\text{HS}}^{\sigma-1}(x)dx}. \tag{7}$$

There is a unique x^* that solves this equation since the denominator (the demand for high school labor) is monotonically increasing in x^* and the numerator (the demand for college labor) is monotonically falling in x^*. Once we have determined x^*, the remaining parameter, λ, can be determined from either equation (6a) or equation (6b), which can then be used to determine the absolute amounts of outputs and inputs. We omit this final step in our analysis since we are interested in relative quantities and prices. As can be seen from the right-hand side of equation (7), an increase in x^* shifts relative demand as the allocation of tasks changes (the extensive margin), and equation (5a) shows that the relative price of goods produced with college labor increases.

The aggregate degree of substitutability between college and high school labor is a combination of the substitutability of task outputs, σ, and the ease of switching tasks on the margin, determined by the distribution of comparative advantage in the neighborhood of x^*. The ability to switch on the extensive margin makes the degree of substitution between factors greater than the pure substitution between goods, σ.

Several aspects of this equilibrium are worth noting. First, the equilibrium return to education is determined by the productivity differential on the marginal task x^*. When this marginal productivity differential is held fixed, changes in relative productivities such as increasing $R(x)$ by increasing the productivity of college graduates for $x > x^*$ will have differential effects based on the magnitude of σ. For $\sigma > 1$, increasing college productivity for some range of x's above x^* will increase the relative demand for college graduates and raise the earnings differential by pushing up x^*. In contrast, when $\sigma < 1$, raising the productivity of college graduates for $x > x^*$ lowers the educational wage differential. Second, when college graduates have a strong advantage at some tasks, $R(x) \gg R(x^*)$, high school graduates gain significantly since they buy these goods for a small fraction, $R(x^*)/R(x)$, of what it would cost them to produce the goods themselves.

In our model the supply of college and high school labor is perfectly elastic across tasks. As a result, the surplus over what high school graduates would be willing to pay for the inframarginal goods above x^* is competed away by producers (college graduates) and generates consumer surplus for the buyers (high school graduates). In the same way, college graduates gain on the outputs produced by high school graduates.

One particularly simple case is the one in which $\sigma = 1$ (Cobb-

Douglas), in which case the allocation of resources across tasks is independent of productivity and depends only on the demand for the task $A(x)$ and the type of worker assigned to the tasks. In particular, for a given value of $A(x)$, tasks performed by college graduates are assigned equivalent time measured in market-based efficiency units but less physical time than would be required for high school graduates. This case will be particularly useful for our comparison of the market and household sectors, which we consider next.

Equilibrium in the Household Sector

In order to illustrate the key differences between the market and household sectors, we next analyze the equilibrium if all production were to take place in the household as opposed to the market sector. This comparison allows us to see how the determinants of the returns to education differ across the two sectors, and it will lay the groundwork for the integrated model set out in Section IV below.

Much of the analysis remains the same when one is considering production in the household sector rather than in the market sector, except that both college and high school graduates must produce the full range of goods for their own consumption. In particular, from the perspective of high school graduates, the price of consumption of goods $x > x^*$ would rise by a factor $R(x)/R(x^*)$ relative to the market case. That is, prices would increase the most to high school graduates for the goods at which college graduates have the biggest comparative advantage (the highest-x goods). Similarly, from the perspective of college graduates, the price of goods for $x < x^*$ would rise by the factor $R(x^*)/R(x)$, with the largest rise for the lowest-index goods. Clearly, both groups would be worse off because of the lack of specialization. This is what Wesley Mitchell (1937) referred to a century ago in 1908 as the "backward art of spending money," where households are less efficient than firms because of the lack of specialization.[1]

Formally, high school graduates in the household sector solve the same utility maximization problem as in the market sector with the exception that $P(x) = 1/S_{\text{HS}}(x)$ for all x. The first-order conditions are then the same as in equations (2) and (3) above so that the optimal allocation of time across tasks satisfies

$$t(x) = \frac{TA(x)^{\sigma}S(x)^{\sigma-1}}{\int A(z)^{\sigma}S(z)^{\sigma-1}dz}, \tag{8}$$

where T is the fixed time available per household. The indirect utility

[1] As we will see in Sec. III below, this loss of the gains from specialization across education levels is only part, and maybe only a small part, of the efficiency loss from the lack of specialization in the household sector.

level received by a high school graduate in the household sector will then be

$$U_{\mathrm{HS}} = T\left[\int A(x)^{\sigma} S_{\mathrm{HS}}(x)^{\sigma-1} dx\right]^{1/(\sigma-1)}. \tag{9}$$

Similarly, the utility level received by a college graduate will be

$$U_{\mathrm{COL}} = T\left[\int A(x)^{\sigma} S_{\mathrm{COL}}(x)^{\sigma-1} dx\right]^{1/(\sigma-1)}. \tag{10}$$

The education premium in the household (which can be interpreted as the ratio of effective incomes) will then be

$$r^{\mathrm{HH}} = \left[\frac{\int A(x)^{\sigma} S_{\mathrm{HS}}(x)^{\sigma-1} R(x)^{\sigma-1} dx}{\int A(x)^{\sigma} S_{\mathrm{HS}}(x)^{\sigma-1} dx}\right]^{1/(\sigma-1)} = \frac{U_{\mathrm{COL}}}{U_{\mathrm{HS}}}. \tag{11}$$

Equation (11) expresses the effective income ratio of college graduates relative to high school graduates as a nonlinear weighted average of the level of comparative advantage on the various tasks (weighted by the expression $A(x)^{\sigma} S_{\mathrm{HS}}(x)^{\sigma-1}$).

In response to the change in prices due to, say, a change in technologies, the household allocation of resources across tasks will in general be different from that found in the market. The direction in which resources flow will be determined by the degree of substitutability across tasks. When substitution across task outputs is relatively poor, $\sigma < 1$, households will shift resources toward the sectors in which productivity falls (i.e., sectors in which prices rise). When $\sigma > 1$, the allocation of resources will shift in the opposite direction. The case in which $\sigma = 1$ provides a convenient benchmark case since the allocation of resources across tasks will not change with productivity. High school graduate households, college graduate households, and the market will all allocate resources across sectors in the same proportions. In terms of consumption, high school graduates will simply scale down their consumption of all goods with $x > x^*$ by the factor $R(x^*)/R(x)$ relative to the market sector outcome and maintain the same level of consumption for goods with $x < x^*$. For college graduates, we should see exactly the reverse: consumption of goods with $x > x^*$ would remain fixed relative to the market sector, and consumption of goods with $x < x^*$ would be reduced by the factor $R(x)/R(x^*)$ in the household sector. Exact calculations using the indirect utility functions given in equations (9) and (10) above can also be made for cases in which $\sigma \neq 1$.

Most important for our purposes, the overall comparative advantage of college graduates will differ between the market and nonmarket sectors. In the market sector, high school graduates buy output x at a price of $1/S_{\mathrm{HS}}(x)$ for $x < x^*$ and at a price of $1/S_{\mathrm{HS}}(x) \times R(x^*)/R(x)$ for $x >$

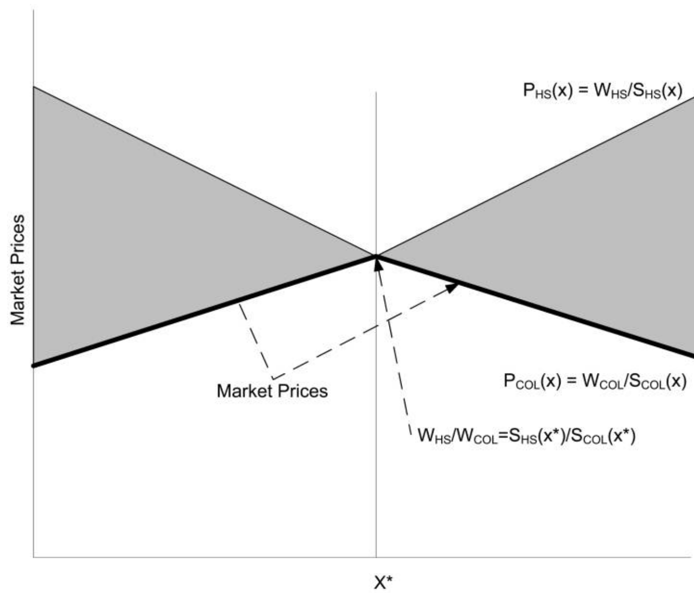

Figure 1.—Determination of market prices

x^*. This is equivalent to having productivity $S_{HS}(x)$ for $x < x^*$ and $S_{COL}/R(x^*) > S_{HS}(x)$ for $x > x^*$. For college graduates, we have the reverse story, with equivalent productivities $S_{HS} \times R(x^*) > S_{COL}(x)$ for $x < x^*$ and $S_{COL}(x)$ for $x > x^*$. When the market and household sectors are compared, the relative advantage of college graduates in the household will be greater because their effective relative productivity rises for all tasks with $x > x^*$ but will be lower because their effective relative productivity falls for $x < x^*$. Essentially, college graduates gain less in the household than in the market to the extent that they have to spend considerable time performing tasks at which they have little comparative advantage (low-x tasks) but gain more relative to the market to the extent that they now get the full advantage of their productivity advantage for tasks with $x > x^*$.

Any comparison of returns to college in the market and household sectors will come down to assessing the relative importance of these two categories of tasks and the degree of consumer surplus generated in the market on those tasks (i.e., the extent to which $R(x)/R(x^*) > 1$ for $x > x^*$ and $R(x^*)/R(x) > 1$ for $x < x^*$). Given our assumption that college graduates have an absolute advantage at all tasks, this second effect is bounded above by $R(x^*) = W_{COL}/W_{HS}$. In contrast, the gains to high school graduates from trading in the market compared to the household could be very large on some tasks (i.e., we could have $R(x) \gg R(x^*)$ for some tasks).

Figure 1 illustrates these ideas by plotting the price of goods in the market and household sectors for both college and high school graduates (expressed in units of high school graduate time in the market sector). In these units, high school graduates are allocated with one unit of income, and college graduates are allocated with $R(x^*)$ units of income, in either the market or household sector. Since the units of x are largely arbitrary, we let x represent the comparative advantage of college graduates so that $R(x) = x$. The figure shows the prices faced by both groups in the market sector and by each of the two groups in the household sector. The equilibrium price function in the market sector is the lower envelope of the two lines. The price function in the household sector for college graduates lies above the market price line to the left of x^*, and the household price function for high school graduates lies above the market price function to the right of x^*. The two shaded regions in the figure represent the losses for college and high school graduates in the household relative to the market. The advantage of college graduates relative to high school graduates in the household sector versus the market sector will then be determined by the relative sizes of these two areas (weighted by the distribution of inputs across tasks).

In the case in which $\sigma = 1$, this comparison is aided by the fact that the allocation of weight by market resources across tasks is the same in the market and household sectors. In that case, the amount of mass to the left and right of x^* will then be equal in both sectors to the relative supplies of college and high school graduates in the market. We will return to this in Section III below.

III. The Evolution of Education Premiums in the Household and Market Sectors

This section explores further implications of our model. In particular, we will address how changes in technology, factor supplies, and other elements affect outcomes in the market sector and household sector economies described above. Our analysis assumes that technological and other changes in the market and household sectors have proceeded in roughly parallel directions. We think that this fits well with the changes observed in the two sectors. In particular, both sectors have been characterized by three major events. First, both have seen a substantial decline in the demand for raw human labor. In the market sector, this has shown up in terms of a decline in the demand for laborers, operatives, and so forth (see Katz and Murphy 1992; Murphy and Welch 1992, 1993). In the household sector, this has shown up in the reduced household time devoted to meal preparation, laundry, and other activities that previously occupied substantial household time (see Greenwood, Rogerson, and Wright 2005).

Second, both sectors have experienced an introduction of more sophisticated technologies such as computers, advanced electronics, innovative medical care, and greater importance of information and communications. Finally, both sectors have had a decline in the real cost of capital goods and an increased use of capital: physical capital in the market sector and household durables in the household sector. Our basic thesis is that these changes have shifted comparative advantages in the two sectors in roughly similar ways but that the impact of these changes has differed because of the differences in market organization described above. In this section, we explore the implications of this thesis by considering the impact of the same changes in the two sectors.

The effects of changes in factor supplies represent the most striking difference between the market and household sectors. If we start from an equilibrium in the market as depicted in figure 1, an increase in the market supply of college (high school) graduates would shift the college effective productivity down (up) because their hourly earnings go down. Hence, college graduates would lose (gain) in the market sector and high school graduates would gain (lose). In the household sector, factor supplies would have no effect on either group since all individuals perform the same mix of tasks in equilibrium regardless of factor supplies. While this difference is obvious given the distinction in the way production is organized in the two sectors, our model highlights its importance given the substantial growth in the supply of educated labor in the market sector over time.

The difference between the supply effects can be seen clearly in the case in which growth in the demand for college labor, captured in our model by a rightward shift in the distribution of demand across tasks, is offset by growth in the supply of college graduates, so that the market premium for educated labor stays fixed. In that case, we can think of the productivity curves in figure 1 staying fixed, with a shift in the distribution of demand to the more skill-intensive tasks. The bottom line would be no change in the relative real income of college and high school graduates in the market since there is no change in nominal relative incomes, and preferences are homothetic. But the welfare of college graduates relative to high school graduates would rise in the household sector as a result of an increase in the tasks at which college graduates have a comparative advantage. Thus, if a corresponding shift in task demands in the two sectors is offset by a growth in the supply of college graduates that prevents college relative wages from rising, college graduates would gain relatively in the household even though their market wage compared to that of high school graduates stayed constant.[2]

What we have observed in the market over the past several decades

[2] One effect would run in the opposite direction if the inframarginal demands shifted in the reverse direction (toward less college-intensive tasks). This will not happen as long as the shift was uniform in the sense that $A'(x)/A(x)$ was increasing in x, where $A'(x)$ and $A(x)$ are the new and old demand distributions.

(and to some extent over the twentieth century) is a combination of the relative supply effect and the demand story. In particular, the history of the market sector has been characterized by substantial growth in the relative supply of and demand for college graduates (see Katz and Murphy 1992; Murphy and Welch 2001). Over recent decades, the growth in demand has outstripped the growth in supply, generating a rising premium for college graduates. Over the longer term, the growth in supply and demand has been more in balance, with periods of rising premiums offset by periods of declining premiums.

To examine the change in the relative welfare of college and high school graduates, we consider the simple case in which $\sigma = 1$, so that the allocation of time across tasks is the same in the household and market sectors. We can compare outcomes in the household and market sectors for both college and high school graduates by the income premium the consumer would require to compensate for the higher prices faced in the household sector. In the case of $\sigma = 1$, consumption of good x is simply $M \times A(x)/P(x)$, where M is income. The individual's utility is then

$$\begin{aligned} \ln(U) &= \int_1^\infty A(x) \ln\left[\frac{M}{P(x)}\right] dx \\ &= \ln(M) - \int_1^\infty A(x) \ln[P(x)] dx. \end{aligned} \quad (12)$$

The percentage change in income required to compensate the consumer for changing prices from $P(x)$ to $P'(x)$ is then simply

$$\text{Comp} = \int_1^\infty A(x)\{\ln[P'(x)] - \ln[P(x)]\} dx. \quad (13)$$

College graduates face the same prices in the two sectors for $x > x^*$ and face higher prices in the household sector for $x < x^*$. For $x < x^*$, prices in the household sector are higher by the ratio $R(x^*)/R(x)$. Hence, the compensating difference for college graduates is simply

$$\text{Comp}_{\text{COL}} = \int_1^{x^*} A(x)\{\ln[R(x^*)] - \ln[R(x)]\} dx. \quad (14)$$

Similarly, the compensating change in income for high school graduates would be

$$\text{Comp}_{\text{HS}} = \int_{x^*}^\infty A(x)\{\ln[R(x)] - \ln[R(x^*)]\} dx. \quad (15)$$

The advantage of college graduates in the household environment relative to the market environment is then given by

$$\text{ADV} = \int_{x^*}^{\infty} A(x)\{\ln [R(x)] - \ln [R(x^*)]\} dx - \int_{1}^{x^*} A(x)\{\ln [R(x^*)] - \ln [R(x)]\} dx. \quad (16)$$

These correspond to the two shaded regions in figure 1 weighted by demand. As such, the total equivalent income advantage for college graduates in the household sector can be written as

$$\ln\left(\frac{Y_{\text{COL}}}{Y_{\text{HS}}}\right) = \ln [R(x^*)] + \int_{x^*}^{\infty} A(x)\{\ln [R(x)] - \ln [R(x^*)]\} dx - \int_{1}^{x^*} A(x)\{\ln [R(x^*)] - \ln [R(x)]\} dx. \quad (17)$$

We can use equation (17) to measure the gain for college graduates in the household sector in terms of the return in the market sector, $\ln [R(x^*)]$, and inframarginal advantages and disadvantages of college graduates relative to high school graduates in the household sector (the second two terms). On the basis of outcomes in the market sector, we know that $R(x^*)$ has risen over time. We also know that the mass of activities of comparative gain for college graduates ($x > x^*$) has increased, and the mass of activities at which college graduates have an inframarginal disadvantage has decreased. Notably, both of these last two occurred in spite of the increase in x^*. As many have observed, on the basis of outcomes in the market sector, this implies that demand has shifted in favor of college graduates (see, e.g., Katz and Murphy 1992). In our model, this would mean that $A(x)$ has shifted toward high values of x since both the relative price and relative quantity of college graduates have increased.

The second two terms in equation (17) represent surplus terms and can be thought of in terms of the resources (measured by time in the household or value of inputs in the market sector) times the average difference between comparative advantage on those tasks and the marginal market task, x^*.

On the basis of the framework presented by Katz and Murphy, we can begin to analyze the components of equation (17). The first term in equation (17) depends only on the market premium for college graduates relative to high school graduates. The second two terms cannot be measured directly, but the mass of resources devoted to the two components (i.e., time spent on the two sets of inframarginal tasks) is

TABLE 1
College-Plus and High School Quantity and Price Data

	1967	2003
Relative wage	1.51	1.95
College share	.24	.58
High school share	.76	.42

simply measured by the fraction of market income going to high school and college graduates. Table 1 examines the relative prices and quantities underlying equation (17) for 1967 and 2003 based on Current Population Survey data. Under the assumption that $\sigma = 1$, the interpretation of these data together with the view that the evolution of technology has been the same in the household and market sectors would be that in 1967, 76 percent of the tasks performed were tasks at which college graduates had a comparative advantage of 1.51 to one or less. In 1967, only on 24 percent of tasks did college graduates have a comparative advantage of 1.51 to one or more. In contrast, by 2003 the fraction of tasks at which college graduates had a comparative advantage of 1.95 or more (a much higher threshold) was 58 percent. As such, in 1967, college graduates had a comparative advantage less than the market premium in roughly three-quarters of the tasks; whereas in 2003, college graduates had an advantage less than the market premium in only two-fifths of the tasks. Unless the average differentials above or below the market threshold moved very strongly in the other direction, it would seem that the returns to education in the household increased much more than the tremendous rise we saw in the market sector over this same period.

Figure 2 illustrates the change in terms of our earlier graph (fig. 1). Figure 2*a* depicts the situation in 1967 when three-quarters of the household tasks have educational advantages below the market advantage. Figure 2*b* shows 2003, when more than half of the tasks performed in the household have an educational advantage greater than that seen in the market sector.

The key to this contrast is the effect of supply and the distribution of comparative advantage across tasks. This can be seen by considering the extreme case in which college labor's share is very low. When the supply of college graduate labor is very low, college graduates will perform the market tasks only at which they have the greatest comparative advantage. As such the market premium will exceed their productivity advantage in almost all tasks. Their market compensation will then be the same as if they had that large of a comparative advantage at all tasks. If gradually over time we switched to the other extreme, where college graduate labor accounts for almost all the market supply, then the reverse would hold. College graduates would now perform all tasks except those for which they have the smallest comparative advantage. Their

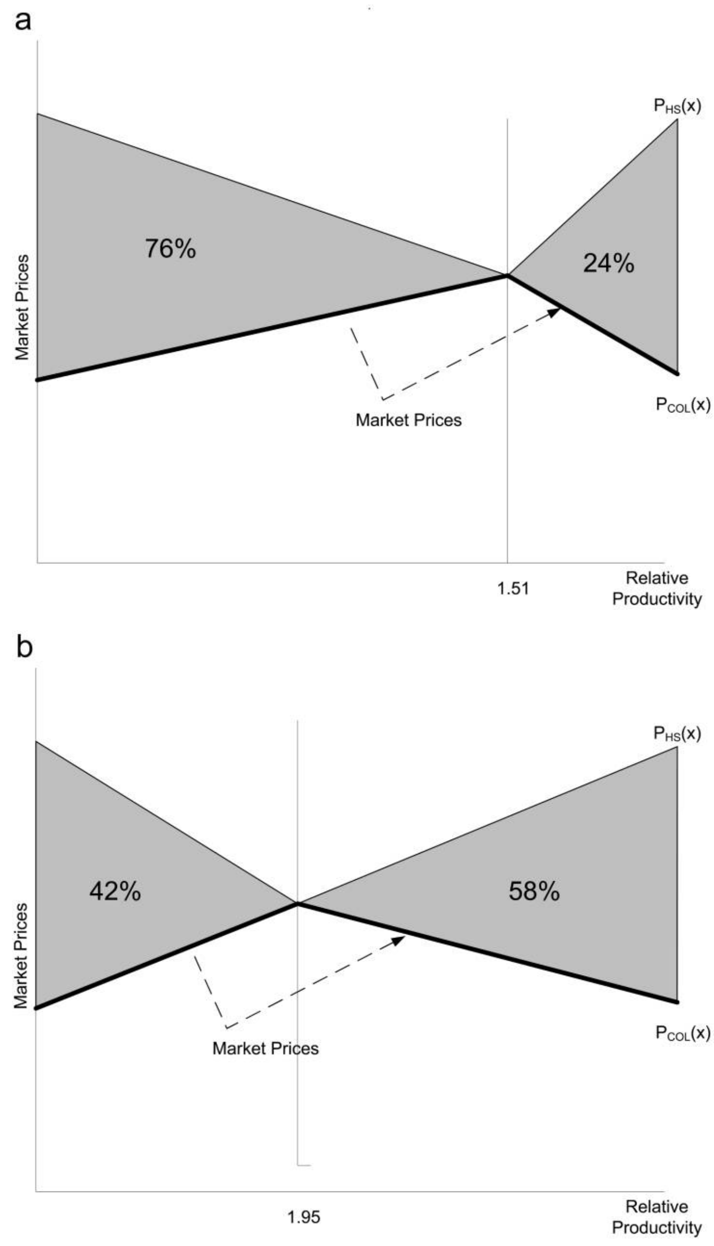

Figure 2.—Market equilibrium: *a*, in 1967; *b*, in 2003

market compensation would now reflect their comparative advantage on the tasks at which they have the least comparative advantage, and the market premium will be less than their productivity advantage on almost all tasks. Since the premium in the household is based on an average level of comparative advantage (see eq. [17]) rather than the supply- and demand-determined marginal task, each college graduate gains much more over time in the household relative to the market when the supply of college graduates increases.

While over the recent period the college premium has risen substantially, over the longer term, education returns in the market have shown less of a trend; quantity changes have been even more dramatic. Thus, in the longer term, returns are likely to be even more skewed toward rising in the household than in the market sector given the larger increase in tasks at which college graduates have a comparative advantage and the fact that the growth in demand has been completely offset by supply growth in the market sector.

The model outlined here and existing evidence from the market sector can help us understand the source of this growing premium. We discuss several factors in turn.

Technological Change

In our model, changes in technology can be thought of in terms of shifts in the productivity functions $S_{HS}(x)$ and $S_{COL}(x)$ for a fixed definition of tasks. Educationally, neutral changes in productivity would be captured by equal proportional shifts in these two schedules and would hold comparative advantage, $R(x)$, fixed. For the case in which $\sigma = 1$, when these changes are inframarginal, they will have equal effects on the welfare of college and high school graduates in both the household and the market. The reason is that shares devoted to the different goods are the same for the two groups and the same in the household and in the market.

When $\sigma > 1$ and the change is inframarginal, the group specializing in the tasks for which productivity increased will gain the most in the market sector, since the demand for their services will rise and relative wages will tilt in their favor. How much they gain in relative terms will depend on how much the cutoff level must move to equate supply and demand. In the household sector, both groups will gain an amount based on how much resources are allocated to that task. With $\sigma > 1$, groups will devote relatively more time to the tasks at which they have the greatest comparative advantage, and the relative gains will tend to follow the same direction but will not necessarily be of the same magnitudes as in the market sector.

When $\sigma < 1$, the contrast between changes in the two sectors is more extreme. In this case, the relative wage of the group specializing in the tasks in which productivity increased falls since the cutoff must move against them in order to clear the market. If that move is sufficiently large, they will be worse off, whereas the group not specializing in those tasks always gains more than they and always gains in absolute terms. In the household sector, both groups gain from education-neutral technical advance, with the group allocating relatively more time to that sector gaining more.

The distinctions between the market and household sectors for technical changes that are education specific are even greater. In the case in which the change is inframarginal and in the favor of the group not specialized in a given task, the change has no effect on the market sector equilibrium but will clearly benefit that group in the household. In the case in which $\sigma < 1$, the contrast will be even more extreme since the less productive group will devote more rather than fewer resources to the activities at which they have a comparative disadvantage. Increases in productivity on tasks not performed in equilibrium have no value in the market sector, but since all tasks are performed in the household, increases in productivity are valued on all tasks. Hence, increases in productivity on tasks with a comparative disadvantage will be disproportionately valued in the household when $\sigma < 1$.

When the increase in productivity is education specific and occurs for the group specialized in that activity, the effect in the market sector is the same as when productivity increases for both groups. Hence education-biased and education-neutral technical change would have the same effect on market outcomes in this case. When $\sigma = 1$, both groups gain equally in the market sector case even though the productivity gain occurred for only one group. When $\sigma > 1$, the group experiencing the productivity gain will gain more than the group with no productivity gain since relative wages will shift in their favor; when $\sigma < 1$, the group experiencing no productivity improvement will actually gain more. In the household, of course, only the group experiencing the productivity gain will be affected.

Induced Technological Change

As has been emphasized by Acemoglu and Linn (2004) and others, an increase in the relative supply of educated workers could induce technological change that favors those workers because of the greater payoff to such innovations induced by the greater supply. In the market sector, the induced change may offset, or even more than offset, the loss in relative earnings generated by the imperfect substitutability of educated and less educated workers. However, given the evidence that substitution between education levels is relatively low (Katz and Murphy and others estimate the elasticity of substitution to be roughly 1.4),[3] this induced

[3] In fact their estimate should already account for some of the induced demand effect to the extent that it operates over the frequency used in their empirical analysis.

demand effect would need to be very large to offset the negative price effect directly caused by the supply change with a fixed technology. If the induced technological progress effect is not quite strong, it will only mute rather than offset the downward effect on educational premiums of greater supply.

In our opinion, induced technological change is more likely to be important in the household sector. Industry-level and other economies of scale that operate through the market size effect are likely to be found for household goods as well as for production methods. With a more educated consumer population, products will be tailored to more educated consumers. Since there is no compensating imperfect substitution force to offset in the household case, the induced change effect is the only force that will operate. As a result, with induced technological change, growth in the supply of educated workers will actually increase the education premium in the household even if the induced technical change effect is relatively weak.

Changes in the Demand for Tasks

Changes in the demand for tasks, shifts in the $A(x)$ function in our model, will have substantial effects in both the market and household sectors. In the market sector, the major effect happens when demand shifts between tasks performed by different groups. Shifts within tasks performed by a single group that hold overall demand fixed have no effect. For example, shifts in demand from tasks at which college graduates have a modest relative advantage compared to the market premium (i.e., $R(x)$ close to $R(x^*)$) to tasks at which they have a great advantage ($R(x) \gg R(x^*)$) would have a neutral effect on college and high school graduates. In the household sector, of course, such a shift would benefit college graduates relative to high school graduates since the tasks at which the college graduates have the greatest comparative advantage have become more important.

Changes in the relative demand between tasks performed by one group and tasks performed by the other will affect the market return to education by shifting demand in favor of one of the two groups. Hence, shifts in demand from less skilled tasks to more skilled tasks will have an effect to the extent that demand is shifted from tasks below x^* to tasks above x^*. However, given that prices are determined by relative advantage on the marginal task, this effect will be the same regardless of whether the shift goes from tasks slightly below x^* to slightly above x^* or from well below x^* to well above x^*. In the household, the effect of a shift toward higher-x tasks will not depend particularly on the level of x^*. Changes in the composition of demand across tasks over time can be generated by many forces including differential income elasticities across goods or changes in the prices of complementary or substitutable inputs (which we do not explicitly model but could be added in a straightforward way).

Capital-Skill Complementarity

One force that has operated in both the market and household sectors is the declining cost of capital goods relative to both labor inputs and consumption goods. The decline in the relative costs of capital goods has caused growth in the capital-labor ratio in the market and growth in consumer durables in the household. One key effect of the declining relative price of capital goods and rising capital inputs works through capital-skill complementarity, where capital goods serve as substitutes for low-skilled labor and complements to high-skilled labor. It is important to realize that this force works on both margins. It works to reduce the demand for less skilled labor by allowing capital goods to be used at activities previously requiring less skilled workers. It also serves to enhance the demand for high-skilled workers by generating new tasks to design, operate, and control more sophisticated devices. The role of capital-skill complementarity in generating growth in the relative demand for more skilled labor, and thereby raising the return to education, has been explored for the market sector by Krusell et al. (2000).

These same forces have been important in the household. In the household, consumer durables have reduced the time required for menial household tasks such as laundry, cleaning, and so forth (see Greenwood et al. 2005). These types of tasks are the tasks that less skilled workers perform in the market sector and therefore are the tasks at which college graduates have the least comparative advantage. As the time devoted to these tasks in the household sector declines, college graduates gain more than high school graduates since college graduates earn a smaller return on these types of tasks. The large time devoted to menial tasks in the past served as a "tax" on education since they required educated workers to spend more time on tasks at which they had less comparative advantage, although they reduced the tax by substituting toward servants and other market input.

At the same time, the influx of more sophisticated technologies in the household, such as computers and the Internet, has enhanced the demand for skilled workers in the household just as it has in the marketplace. On the basis of evidence from the market sector, we know that such new technologies benefit educated workers more than less educated workers, particularly when they are first introduced. This advantage may fall somewhat over time as new devices mature and become simplified and easier to use.

IV. Market Goods and Household Production

Our discussion to this point has contrasted the gains to education in two polar cases, a pure market economy, where all goods are produced in the market and education has no effect on household productivity, and a pure household economy, where all goods are produced and consumed entirely in the household.

In this section, we consider a hybrid economy in which education confers an advantage in both the market and household sectors (as opposed to just one of the two sectors). To keep things simple, we maintain the same structure as above regarding the comparative advantage of college graduates in particular activities. However, we now assume that the productivity advantage gained through education is split between the market and the household sectors. Education confers an advantage at both producing and consuming certain goods. Analytically, we do this by splitting where the advantage occurs between the household and market sectors according to the parameter α, $0 \leq \alpha \leq 1$. The market productivity of a high school graduate on task x is now $S_{HS}(x)^{1-\alpha}$, and household productivity on that task for that same individual is $S_{HS}(x)^{\alpha}$. The structure of consumption is that each task x requires task-specific goods, $Y(x)$, which are produced outside of the household and purchased in the market but consumed in the household. In particular, in the marketplace, high school graduates can produce $S_{HS}(x)^{1-\alpha}$ units of output, $Y(x)$, per unit of time; college graduates can produce $S_{COL}(x)^{1-\alpha}$ units of the same output per unit of time. In the household, skill aids the consumption of these goods (e.g., education makes purchased health care inputs more effective), so that high school graduates can produce $S_{HS}(x)^{\alpha}$ units of task output per unit of $Y(x)$, and college graduates can produce $S_{COL}(x)^{\alpha}$ of that same task output from the same amount of purchased inputs. In this framework, productivity on household tasks determines the amount of output received per unit of goods purchased in the market, just as market productivity determines output produced per unit of time in the market sector. Because of the way we have set things up, when the same individual produces and consumes the good for a certain task himself, productivities and comparative advantage are the same as in the two polar cases described in Section II above.

In this analysis, we abstract from the use of time in the household by having output in the household depend only on goods and consumption efficiency. This can easily be modified to allow for time allocation in the household. We focus here on goods consumption since we think that education is an important complement to the consumption of many goods including health care, financial services, and education even if time inputs in the household are not substantial for these goods. For our current analysis, we assume that the ordering of comparative advantage across tasks is the same in the household and market sectors; but this too is not essential, although it makes interpreting the results of the analysis somewhat simpler. The biggest gain comes on the empirical front. The assumption that the distribution of advantages is the same in the two sectors makes understanding the household somewhat easier since the change in the mix of goods consumed in the household will now be directly related to the mix of goods produced in the marketplace.

Given that household output on task x for high school graduates that purchase $Y(x)$ units of task-specific goods is $S_{\mathrm{HS}}(x)^{\alpha}Y(x)$, the preferences used above imply that high school graduates will choose their mix of goods purchased from the market to solve

$$\max U = \left\{\int A(x)[S_{\mathrm{HS}}(x)^{\alpha}Y(x)]^{1-(1/\sigma)}dx\right\}^{\sigma/(\sigma-1)}$$
$$\text{subject to} \int P(x)Y(x)dx = W_{\mathrm{HS}}, \tag{18}$$

where W_{HS} is the equilibrium market income received by a high school graduate. With the same results from above, the solution to the high school graduate's consumption problem is

$$Y(x) = \frac{W_{\mathrm{HS}}A(x)^{\sigma}S_{\mathrm{HS}}(x)^{\alpha(\sigma-1)}P(x)^{-\sigma}}{\int A(z)^{\sigma}S_{\mathrm{HS}}(z)^{\alpha(\sigma-1)}P(z)^{1-\sigma}dz}. \tag{19}$$

The utility received by a high school graduate will be

$$U_{\mathrm{HS}} = W_{\mathrm{HS}}\left[\int A(x)^{\sigma}S_{\mathrm{HS}}(x)^{\alpha(\sigma-1)}P(x)^{1-\sigma}dx\right]^{1/(\sigma-1)}. \tag{20}$$

Similarly, the utility received by a college graduate will be

$$U_{\mathrm{COL}} = W_{\mathrm{COL}}\left[\int A(x)^{\sigma}S_{\mathrm{COL}}(x)^{\alpha(\sigma-1)}P(x)^{1-\sigma}dx\right]^{1/(\sigma-1)}. \tag{21}$$

The ratio of utilities (which measures the ratio of effective incomes) will be

$$\frac{U_{\mathrm{COL}}}{U_{\mathrm{HS}}} = \frac{W_{\mathrm{COL}}}{W_{\mathrm{HS}}}\frac{[\int A(x)^{\sigma}S_{\mathrm{COL}}(x)^{\alpha(\sigma-1)}P(x)^{1-\sigma}dx]^{1/(\sigma-1)}}{[\int A(x)^{\sigma}S_{\mathrm{HS}}(x)^{\alpha(\sigma-1)}P(x)^{1-\sigma}dx]^{1/(\sigma-1)}}. \tag{22}$$

Since the market sector has the same organization as in Section II above, with the exception that productivities are now $S_{\mathrm{HS}}^{1-\alpha}$ and $S_{\mathrm{COL}}^{1-\alpha}$ rather than S_{HS} and S_{COL}, the ratio of wages will be equal to $R(x^*)^{1-\alpha} = (S_{\mathrm{HS}}/S_{\mathrm{COL}})^{1-\alpha}$, and we will have $P(x) = 1/S_{\mathrm{HS}}(x)^{1-\alpha}$ for $x <$

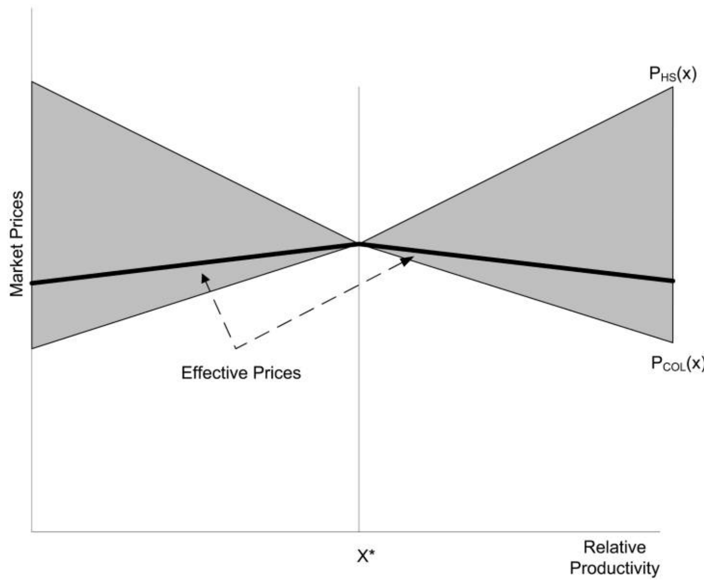

Figure 3.—Determination of prices when market goods are used in household production

x^* and $P(x) = R(x^*)^{1-\alpha}/S_{\mathrm{COL}}(x)^{1-\alpha}$ for $x > x^*$. Substituting these into equation (22) yields the ratio of equilibrium utilities as

$$\frac{U_{\mathrm{COL}}}{U_{\mathrm{HS}}} = \tag{23}$$

$$\left(\frac{\int_{X<x^*} A(x)^{\sigma}\{S_{\mathrm{COL}}(x)^{\alpha}[R(x^*)S_{\mathrm{HS}}(x)]^{1-\alpha}\}^{\sigma-1}dx + \int_{X>x^*} A(x)^{\sigma}[S_{\mathrm{COL}}(x)]^{\sigma-1}dx}{\int_{X<x^*} A(x)^{\sigma}[S_{\mathrm{HS}}(x)]^{\sigma-1}dx + \int_{X>x^*} A(x)^{\sigma}\{S_{\mathrm{HS}}(x)^{\alpha}[S_{\mathrm{COL}}(x)/R(x^*)]^{1-\alpha}\}^{\sigma-1}dx}\right)^{1/(\sigma-1)}.$$

Equation (23) implies that the full education premium, including gains in both the market and household sectors, will reflect individual productivity on all tasks together with the productivity of the market trading partners on the commodities purchased from them in the market. The effective productivities for college graduates are now $S_{\mathrm{COL}}(x)$ for $x > x^*$ and $S_{\mathrm{COL}}(x)[R(x^*)/R(x)]^{1-\alpha} > S_{\mathrm{COL}}$ for $x < x^*$, and the effective productivities for high school graduates are now $S_{\mathrm{HS}}(x)$ for $x < x^*$ and $S_{\mathrm{HS}}(x)[R(x)/R(x^*)]^{1-\alpha} > S_{\mathrm{HS}}$ for $x > x^*$. Comparing these results with those of the pure market case, we see that high school graduates gain less from access to the market since they still have a comparative disadvantage in the household at the high-x goods. Similarly, college graduates gain less since they have a comparative disadvantage in the household at consuming low-x goods. In terms of our earlier figures, the effective prices (given by the inverse of the effective productivities) are as illustrated in figure 3.

As can be seen from figure 3, this economy represents a sort of weighted average of the polar pure household and pure market cases. Trading in the market allows individuals to avoid some of their comparative disadvantages, but not all of them. The equilibrium ratio of full incomes now is a combination, weighted by the parameter α, of the advantage on the marginal, x^*, and average tasks. In particular, in the central Cobb-Douglas case, equation (23) reduces to

$$\ln\left(\frac{U_{\mathrm{COL}}}{U_{\mathrm{HS}}}\right) = (1-\alpha)\ln[R(x^*)] + \alpha\int A(x)\ln[R(x)]dx. \quad (24)$$

In this case, the equilibrium ratio of effective incomes is a simple geometric weighted average of the marginal and average levels of comparative advantage. On the basis of the change in the distribution of comparative advantages over time discussed above (illustrated in fig. 2), the overall gain to college graduates relative to high school graduates will exceed the gain observed in the market as long as the average advantage has at least kept pace. Since the equilibrium advantage on the marginal task has been depressed by the tremendous growth in supply of more educated workers, we suspect that this is likely to be the case. The basic intuition is simple: market premiums for more educated workers have increased as the distribution of activities has shifted to tasks at which they have a large comparative advantage. The growth in supply has limited the growth in the equilibrium premium by shifting x^* to the left. In contrast, the growth in the average level of comparative advantage is not influenced by the shift in x^*. To the extent that college graduates have a consumption advantage at high-x goods such as health care, financial services, and education, their household gains are likely to be large given the large growth in these sectors.

V. Concluding Comments

The household and market sectors are similar in many ways. They are both large sectors that use much labor and capital, although the household sector definitely uses more labor and probably more capital as well. Both sectors engage in an enormously varied set of tasks ranging from simple ones that require little human or physical capital to highly complicated ones that are knowledge intensive. In addition, both have seen a strong shift during the past several decades toward knowledge-intensive tasks and away from those using low-skilled inputs.

Yet differences between these sectors are large and significant, and this article concentrates on a few fundamental differences. The market sector is organized around exchange, specialization, and the division of labor by tasks, whereas households have little exchange or specialization by tasks. This implies that the household sector rewards skills and talents that are useful at a large variety of tasks, whereas greater market rewards go to those specialized at difficult tasks. The market sector tends to be more efficient than the household sector at using labor and capital since extensive specialization and exchange raise market productivity.

However, returns to education and other training could still be greater in households if persons investing in such human capital acquired general skills that were particularly useful at household tasks. This is likely for investments in education since education improves a person's skills at processing information, preparing for future events, and managing multiple tasks. These skills are especially important in the modern household because these households perform many complicated tasks that must be coordinated.

The value of education in the market sector rose at an unprecedented rate during the past three decades. Much less recognized is that education also became much more valuable in households, as knowledge became more important to health, the education of children, financial management, marital stability, and other activities. The same forces that raised returns in the market sector—such as technological progress biased toward workers with greater human capital, lower prices of capital goods, and increased demand for more knowledge-intensive goods—were also important to households.

The framework developed in this article is valuable in analyzing further the anatomy and returns to human capital in the household sector. We hope to extend the discussion in this article in future work, and we now conclude this article by mentioning some of the topics omitted here that should be treated in future work.

First, this article treats only single-person households and neglects the long-standing division of labor among tasks between men, women, and other household members. The household division of labor by gender has shrunk sizably as women have invested much more in skills that prepare them for higher-level market tasks. What are the implications of this important development for household efficiency, returns to human capital in the household, and marital matching, divorce, and other important aspects of family formation and dissolution?

In addition, this article assumes that all workers of equal education are identical in both the market and household sectors. However, the gains from specialization and the division of labor in the market sector imply that workers have an incentive to invest in specialized human capital that is highly productive at only a limited set of market tasks. Each specialized worker then combines with other specialized workers to produce and distribute the various outputs produced in the market sector. Such specialized investments can be incorporated into our analysis by building on the discussion in Becker and Murphy (1992).

Human capital that is highly specialized to the market may not be productive in households since general human capital is more productive in households. For example, specialized workers who engage in only a few rather simple tasks may lose "autonomy" that would make them less able to handle the responsibility for many decisions that households must cope with. The conflict between the advantages of specialization at work and the disadvantages of specialization in the household may be what Adam Smith meant in his major qualifications to the gains from specialization: "The man whose whole life is spent in performing a few simple operations . . . has no occasion to exert his understanding, or to exercise his invention in finding out expedients for removing difficulties which never occur. He naturally loses, therefore, the habit of such exertion, and generally becomes as stupid and ignorant as it is possible for a human creature to become" (Smith 1937, 734). Future analysis is needed of the importance of coordination and decision-making skills in households and how different types of human capital investments in both the market and household sectors affect these skills.

Finally, most of the discussion in this article assumes that the household and market sectors are separate sectors. Section IV modifies that to require households to transform goods produced in the market sector into commodities that are consumed. Households differ in their productivity at such transformation activities because of differences in education, other human capital, and their experiences at market activities. A natural generalization of this discussion would allow households to use both market goods and their own time to produce commodities and to substitute market goods for their own time when that is efficient. One would then expect educated households to substitute toward market inputs for commodities that require mainly low-skilled labor and less educated households to substitute market inputs for their own time for household commodities that require skilled inputs. The analysis of how well households of different types can substitute market inputs for their own time is a promising avenue for further work.

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