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Household skills and low wages

Kristin Dale

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Abstract Household skills provide job skills when tasks in jobs and household production are similar and jobs produce substitutes for home-made services. Opportunity costs of higher education are foregone earnings during schooling and foregone household production while studying and later in life. I show that individuals in jobs requiring household skills accept lower wage rates than traditional human capital theory predicts, and that individuals with low household skills tend to enter higher education. According to these results, declining household skills may have contributed to the observed increasing demand for higher education by women.

Keywords Household production · Human capital · Wage differentials

JEL Classification D13 · J24 · J31

1 Introduction

When a mother teaches her daughter to make a bed or clean a bathroom, it is probably to get a 'helping hand' while the daughter lives at home and to train a potential wife, as household skills make a girl independent of buying household services in the future. However, an unintentional effect of teaching household skills may be to influence occupational and educational choice by encouraging the daughter to turn into a chambermaid in the hotel industry. This paper presents the idea that household skills decrease demand for higher education by qualifying for some service occupations. Individuals with more household skills have less incentive to choose occupations that require higher education, because the future earnings of higher educated employees must not only compensate for tuition costs and foregone earnings during education but also absorb the indirect costs of lower household production while studying and later in life.

K. Dale (✉)
Department of Economics, University of Agder, Serviceboks 422, 4604 Kristiansand, Norway
e-mail: kristin.dale@uia.no

In economic literature, the home is the site of consumption and leisure. In her classic work, Reid (1934, pp. 6–7) distinguishes consumption and leisure activities that you prefer to do yourself (i.e. reading the newspaper) as opposed to household production that you would like somebody else to do for you (i.e. cleaning). Household skills are learnt at home in a learning-by-doing process and increase productivity both in household production and in occupations with tasks similar to household production. Of course, the types of household skills that are acquired at home vary according to time and space. Modern, industrialised economies are addressed here and such types of household production as caring for babies and dependants, cleaning, cooking, driving, gardening, laundry, car maintenance, house maintenance, shopping, production and repair of clothes and seeking household information. A person with much household skill has a high productivity at home in unpaid work and can earn a living from a job in firms like bakeries, restaurants, laundries, gardeners and day-care centers. Organised training may add to certain household skills; according to Becker (1991, p. 27): 'Some investments, such as on-the-job training, mainly raises the productivity of market time; others, such as classes in child care, cooking, or art history, mainly raise the productivity of household time.' However, classes in cooking increase productivity in jobs, such as kitchen help as well, whereas classes in child care increase productivity in jobs as a child care assistant.

In this paper, I present a model of how household skills can influence college enrolment. Household skills supplement the explanations suggested in the literature: college costs, borrowing constraints, business cycle, parental education, family income and wealth and scholastic preparedness (math and language skills). I return to the latter in Sections 3 and 4. According to my model, declining household skills may have contributed to the observed increasing demand for higher education. As mothers entered the labour market, learning-by-doing options for household skills were reduced, especially for girls, thereby increasing female demand for higher education.

My model is a partial equilibrium model in which persons with varying household skills choose between becoming a chambermaid earning a piece-rate wage v or becoming an economist by graduating from higher education and earning an hourly wage rate w. The wage rates v and w are exogenously given. I show how persons with more household skills than a critical value a^* will opt for the chambermaid job, while those with lower household skills than a^* will become an economist. I have elsewhere shown how this partial equilibrium can be embedded in a general equilibrium model.[1]

The remainder of the paper is structured in the following way: Section 2 presents the partial equilibrium model that shows that youth with more household skills are less inclined to choose higher education because of higher opportunity cost of

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[1] I do this in Dale (2002, pp. 42–46) where I show that (a) the relative supply of the inputs (cleaned rooms per day relative to economist hours) is an increasing function of v/w, with the elasticity of supply depending on the distribution of household skills in the population (this is inspired by Roy 1951), and (b) the relative demand for inputs is a decreasing function of v/w if the total output is a neoclassical production function. Thus, the relative wage rate v/w and the critical value a^* are determined endogenously in the labour market.

education. They are willing to accept lower wage rates in household skilled jobs than predicted by traditional human capital theory. Section 3 discusses limitations of the model, measurement problems of household production and skills and presents results from relevant studies. Section 4 addresses educational policy issues, and the concluding Section 5 suggests that the main idea that household skills represent an opportunity cost of schooling may be highly relevant in developing countries.

2 A model of educational choice based on earnings and household production

What characterizes investment in human capital? According to Mincer (1958), education is acquisition of human capital that raises productivity and earnings. Human capital theory recognises foregone earnings as part of the human capital investment. Because it is difficult to distinguish expenses for consumption and investment, Schultz (1961) estimates investment in human capital by its yield, not like real capital by its investment expenses. Bowman (1966, p. 114) criticises human capital theory for limiting returns to earnings by excluding income in kind from household production that reduces consumption expenses. My model addresses Bowman's criticism.

Gronau (1977) pioneers a model of the allocation of time where unpaid work is a separate use of time and household productivity varies among individuals, an approach which I use here. I model how the amount of household skills acquired during youth may influence an individual's decisions concerning future occupation and education, ceteris paribus. Paid and unpaid work largely offset each other according to Gronau (1986), Jenkins and O'Leary (1997) and Burda et al. (2006). Therefore, I assume total working hours for paid and unpaid work to be fixed, and, hence, fixed leisure hours, too.

For given market prices of commodities, maximised utility can be expressed in terms of money through a money-metric utility function (see Weymark 1985 for sufficient conditions). As for the relationship between home-made and market commodities, the qualitative results of my analysis require only that purchased market commodities (a maid or housecleaning services) can compensate for household production (unpaid cleaning of own dwelling) at some finite level of expenditure, i.e. household production is measured by the expenditure that could compensate for it. I will refer to maximised money-metric utility as 'consumption'. However, in the graphic explanations and the analytical derivations below, I will assume, following Gronau (1977), that there exists a household production function, which output in terms of consumption is a stable function of the number of hours in unpaid household production, independent of the total consumption possibilities available to the individual through spending income from paid work to purchase market commodities. The existence of a single composite consumption good, which can be both produced at home and purchased, is a sufficient condition for such a stable household production function. This is a common assumption in the literature following Gronau (1977); see, e.g. Burda et al. (2006). As a simplified representation of the real world, an individual can choose between two occupations, one for which household skills matters and another for which they do not. For the purpose of illustration, these are referred to as 'chambermaid' and 'economists'. An

individual decides upon higher education and occupation at the age of 18. Either she obtains a chambermaid job using her household skills as job skills or she enrols in a 5-year programme in higher education and graduates on time as an economist. Assume that the chambermaid will work from age 18 to 60 and the economist from age 23 to 60. To evaluate the situation in a lifetime perspective, I assume access to perfect capital markets, so the alternatives can be compared by discounting. Even though the tax system is crucial for the trade-off in households between 'make' or 'buy' (in particular, the relevant wage rate is the wage net of income tax and the relevant product price includes value added tax), taxes are not modelled; for a justification of this modelling choice, see Section 3.

To move from a dynamic to a static model (i.e. from a lifetime to a workday) and thereby facilitate illustrations, I make the additional assumptions:

- For schooling, costs for tuition, fees and books are zero.
- Students live in dormitories and do no household tasks and have no jobs while studying.
- In real terms, the wage rates are constant over time for each profession. Job productivity does not increase from learning-by-doing or on-the-job training.
- Household productivity does not increase from learning-by-doing as an adult.
- The number of workdays per year, k, is constant.
- The interest rate, r, is constant.

2.1 The chambermaid case

First, assume that the person becomes a chambermaid to capitalise on her household skills. Then, she allocates her time between paid work in a hotel and unpaid household production to maximise lifetime consumption. Assume that household production, $a_i f(H)$, consists of two elements, an individual productivity coefficient (a_i) and a general household production function, $f(H)$, identical for everybody. The household production $f(H)$ increases in hours (H), but at a decreasing rate because anyone starts with the tasks where the productivity is the highest. However, individuals vary in household skills and household productivity (a_i). Further assume that the chambermaid sells room-cleaning services in a competitive labour market at the piece rate v. Then, the hourly wage rate as a chambermaid is determined according to her actual household productivity in a piece-rate system. Generally, correct assessment of household skills is unrealistic, but this assumption keeps the analysis on the human capital track by abstracting from screening aspects. For simplicity, the modelling assumes an interior solution where both hours in household production and hours in wage work are positive. In this one-person model, the chambermaid seeks to maximise lifetime consumption. According to the above assumptions, this implies maximising total output from household production and wage work per workday:

$$\max_H [a_i f(H) + (12 - H)a_i v],$$

where a_i is the household productivity of person i, in accordance with her household skills; H is the number of hours in unpaid household production; $f(H)$ is the

household production function, $f(0)=0$, $f'>0$, $f''<0$ and $f' \rightarrow \infty$ when $H \rightarrow 0$; $(12-H)$ is the number of hours spent in paid work; and v is the piece rate per cleaned room in the labour market for chambermaids.

As illustrated in Fig. 1, consumption and total output are maximised by combining positive amounts of unpaid and paid work, because the decreasing marginal household productivity makes the first unpaid tasks more productive than the later ones. For example, because of her high productivity in cleaning, the chambermaid mostly cleans her home herself, and because of a lower productivity in sewing, she works in the hotel and buys her clothing. To maximise total output available for consumption, the chambermaid works unpaid at home for H_m hours to generate household production, $a_i f(H_m)$. At the point at which the market value of additional household production equals her wage rate as a chambermaid, she switches to the labour market and works $(12-H_m)$ hours. For these hours, the real wage rate, $a_i v$, is higher than the marginal productivity in additional household production.

Figure 1 shows that the optimal number of hours in unpaid and paid work for chambermaids depends *only* on the piece rate per cleaned room. A higher piece rate will increase hours in wage work and reduce hours in household production. Because the chambermaid's household skills determine both her household and job productivities, optimal hours in household production (H_m) are *independent* of her household productivity (a_i) when the employer pays a piece rate per cleaned room. However, the chambermaid's total output (at home and in the work place) depends crucially on her household productivity, a_i. These results are formally established in the Appendix.

2.2 The economist case

The above discussion and definitions allow us to treat the economist case more compactly. The economist has some household skills and 5 years of higher education
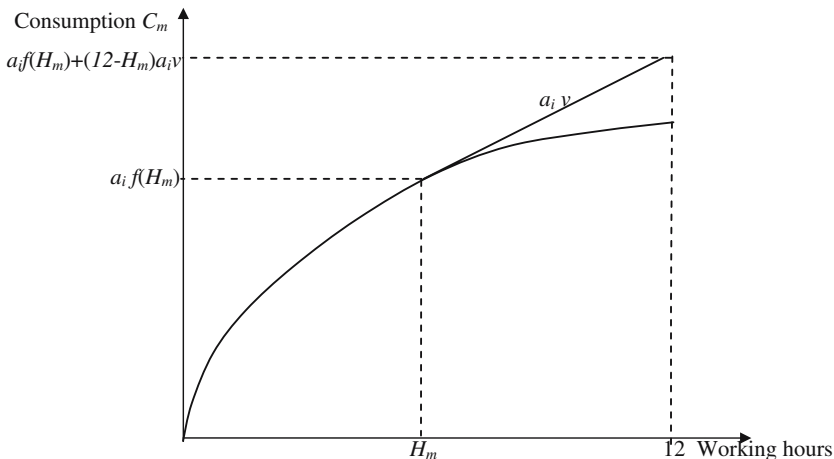

Fig. 1 The chambermaid (m): optimal allocation of time to unpaid and paid work

in economics and wants to maximise consumption and total output from household production and earnings per workday:

$$\max_H[a_i f(H) + (12 - H)w]$$

where w is the hourly wage rate of economists. Given the assumptions, the optimal allocation of hours to household production and wage work depends on the wage rate of economists and on the individual household productivity (a_i). In particular, the economist switches from unpaid to paid work where the slope of the common household production function multiplied by the person's household productivity equals the wage rate. Moreover, the optimal number of hours spent in unpaid work increases with higher household productivity and decreases with higher wage rate of economists, and vice versa for the optimal number of hours spent in wage work. These results are shown in the Appendix.

2.3 The *indifferent* individual and the novel wage gap

Why focus attention on the indifferent individual with household productivity a^*? Because she determines the equilibrium wage gap between the two occupations, and demonstrates why household skilled jobs may accept lower wages than predicted by traditional human capital theory. To be indifferent between becoming a chambermaid and an economist, the following must hold:

$$\max_H[a^*f(H) + (12 - H)a^*v]kA_m = \max_H[a^*f(H) + (12 - H)w]kA_e,$$

where A_m denotes the present value at the age of 18 of \$1 every year (from age 18 to 60) for a chambermaid, and A_e denotes the present value at the age of 18 of \$1 every year (from age 23 to 60) for an economist (see the Appendix for formal definitions).

Because of the simplifying assumptions, we can transfer the analysis from a lifetime perspective to a representative period model by using the factor δ where $\delta = A_e/A_m$. The ratio δ captures several factors: the difference in productive years between the two occupations, the delay of household production and earnings because of higher education, and the discount rate, r. Because the economist has fewer productive years, which start later, and the discount rate is positive, δ is less than 1. Consequently, the economist must have higher total yearly output during productive years for a person to be indifferent between becoming an economist and a chambermaid. Hence, the output of a workday for the economist is multiplied by δ (adjusted) to compare to the output of a workday for the chambermaid.

$$\max_H[a^*f(H) + (12 - H)a^*v] = \max_H[a^*f(H) + (12 - H)w]\delta \qquad (1)$$

Figure 2 compares the optimal workday of the indifferent person as a chambermaid or an economist. Here, daily consumption (0D) is equal corresponding to the output for the chambermaid and adjusted workday output for the economist. Figure 2 shows that a chambermaid occupation makes the indifferent person produce more at home when accounting for household production, thus addressing

Bowman's (1966) criticism. To see this, consider the ratio of discounted value of household production in the two occupations:

$$\frac{0C}{0A} = \frac{0A + AB + BC}{0A} > 1 \qquad (2)$$

0C represents the optimal household production by the chambermaid. 0A represents the optimal adjusted household production by the economist. AB is the chambermaid's additional household production because of longer daily hours in unpaid household production. BC represents her additional years in household production while the economist is studying. Hence, for an indifferent individual, the discounted lifetime value of household production is higher if she becomes a chambermaid.

Figure 2 also illustrates how the indifferent person is compensated by higher lifetime earnings in the labour market as an economist, i.e. AD/CD>1. The person is indifferent towards the chambermaid's lower lifetime earnings and the economist's higher lifetime earnings because of an opposite compensating difference in lifetime household production. This result contradicts the human capital earnings function approach where an individual is assumed to be indifferent towards jobs with equal lifetime labour market earnings; see Freeman (1986).

The difference in lifetime earnings is made up of two components. First, the economist would have had higher lifetime earnings even if the daily working hours in paid work of the two occupations had been equal:

$$a^*v < \delta w \qquad (3)$$

as illustrated by the slopes of their paid work compensation lines in Fig. 2. Second, the economist chooses to work longer daily hours in paid work, i.e. $12-H_e>12-H_m$. Results 2 and 3 are formally established in the Appendix.
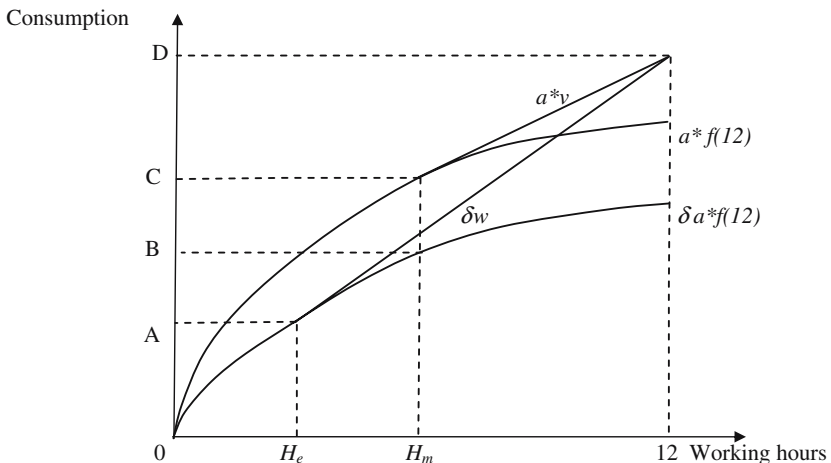

Fig. 2 Indifference between two occupations: chambermaid and economist

2.4 How household skills influence enrolment in higher education

In line with Roy's (1951) seminal analysis, I assume that skill heterogeneity w.r.t. a_i determines the distribution of individuals across occupations, keeping all else equal. In my model household productivity of the indifferent individual, $a*$, becomes a divider between occupations. Figure 3 illustrates what happens to earnings, consumption and educational choice as household productivity increases. Here, the piece rate for clean rooms, v, is normalised to 1, and everything is related to the hourly wage rate. Lifetime consumption consists of commodities bought by her earnings and produced at home.

In Fig. 3, dashed lines refer to economists and solid lines to chambermaids. The lifetime earnings of an economist are determined by the hourly wage rate for economists (an exogenous w) and her household productivity (a_i). For an economist, a very low individual household productivity means very little unpaid household production. As household productivity increases, the economist spends fewer hours in the labour market, and lifetime earnings are reduced (the declining dashed line), whereas the additional household production more than compensates lifetime consumption (the increasing dashed line in Fig. 3).

The lifetime earnings of the chambermaid are determined by the piece rate for clean rooms and her household productivity. As her household productivity increases, lifetime earnings of the chambermaid increase proportionally (given her constant hours of wage work), illustrated by the increasing lower solid line in Fig. 3. Furthermore, the chambermaid's household production increases proportionally as her household productivity increases (given her constant hours spent in household production); see the increasing upper solid line in Fig. 3. If the chambermaid is forced to devote all hours to the hotel industry, she would have consumed less (along the 45° line).
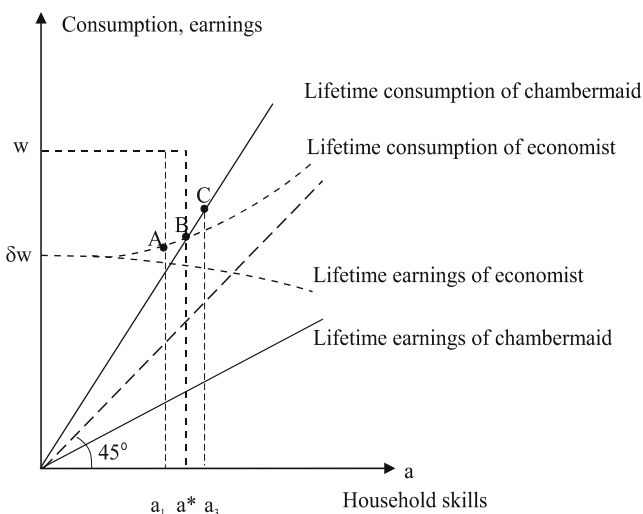

Fig. 3 How household skills and productivities impact enrolment in higher education

Figure 3 shows that the lifetime discounted consumption of the indifferent individual with household productivity a^* is equal for both occupations (B). However, most economists were not indifferent towards becoming a chambermaid and vice versa. If the person has a lower level of household skills and productivity, like a_1, she will choose the economics education to obtain A, her maximum lifetime consumption. In this model, people enter higher education because of a gap in household skills offering fewer opportunities in the labour market at 18 years of age. However, if the person has a higher level of household skills and household productivity, like a_3, she will choose to become a chambermaid to obtain C. Note that a person with higher household productivity (a_3) may earn a much lower hourly wage rate than a person with lower household skills (a_1), because $a_3v<\delta w<w$ in Fig. 3. However, for a sufficiently high household productivity (a_i), this does not hold.

3 Model results vs empirical evidence

Figure 3 shows that economists are worse off than chambermaids if all assumptions of this model are fulfilled and people opt for occupations accordingly. Should we feel pity for those who acquire higher education? The model of this paper does not contain scholastic ability (math and language skills), which is the actual entry criterion for higher education. In reality, the persons with low household skills, which in my model enrol in economics, actually fall into two groups: those with sufficient scholastic ability to become economists and those with insufficient scholastic ability. Those in the latter group are forced to end up as chambermaids with low productivity (at home and in the labour market). The model results, therefore, show a too rosy picture of actual chambermaids' earnings and household production. Hence, answering questions about actual enrolment into higher education and distributional questions between groups with varying education would require a more comprehensive model. The objective is to pinpoint one unnoticed occupational wage differential, which is driven by the evaluation of the indifferent person and compensated by household production in her case. This also justifies the choice not to introduce taxes for redistributive purposes in the model.[2] However, there is support for my claim that factors other than scholastic ability are also important determinants for the actual choice of higher education. Cigno (2001) and Rosen and Willis (1979) argue that persons choose education and occupation according to comparative advantage. Men entering college score lower in tests of mechanical ability and higher in math and reading comprehension than other male high school graduates according to Rosen and Willis (1979). Mechanical ability in their study and household skills in my model both capture learning-by-doing skills during youth.

What aspects are measured about household production? Time inputs and purchased inputs are measured. There is presently no measure of the amount of various home-made goods and services produced nor of individual household skills or productivities. Measurement problems of household production and household

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[2] See Balestrino et al. (2003) for an interesting analysis of optimal second-best redistributive taxation of households, which differ in both market and non-market abilities. Note that the optimal solution may imply a combination of income and indirect taxes.

skills hamper testing of my model's results. Generally, estimations of earnings functions may address the lack of household productivity measures by using panel data and differencing away individual fixed effects to control for household skills that vary among individuals in ways unknown to researchers. Besides, instrumental variables may be used when appropriate.

Parents, siblings and the home environment influence a child in various ways. For instance, important psychological factors like self-confidence and conscientiousness are influenced by parenting styles. Different types of skills may interplay in complex ways, so that skills may be substitutes in some areas and complements in others. Dunifon et al. (2001) uses a unique data set and contributes to identify a home-related measure of family 'organisation and efficiency' (using *total family housework hours* and *interviewers' assessments of the cleanliness of the respondents dwelling*). They find that organisation and efficiency is predictive of children's education and parents' and children's earnings 25 years later. This result of Dunifon et al. (2001) that higher family organisation and efficiency increases years of schooling appears to contradict the result of the present paper. Can these results be reconciled? Family organisation and efficiency captures several factors like (a) the child's own cleaning experience, (b) learning good manners, i.e. to wipe one's feet and not spread one's belongings around and (c) parents' chores that create a nicer home for homework, encouraging more completed schooling. Consequently, family organisation and efficiency is wider than the individual household productivity at age 18 in my model, which corresponds only to factor (a). Hence, the results are not necessarily contradictory.

Because my model hinges on household skill heterogeneity among youth, Solberg's (1994) time-budget study for 11–12-year-old Norwegian children in the mid-1980s is relevant. On average, these girls do more household production than boys, and girls dominate housework and caring for children, while boys dominate repair and outdoor tasks. Whether the family runs a farm or another business influences what tasks children do. Solberg (1994) supports the main idea in my model that youth have had different learning-by-doing at home before making their educational and occupational choices.

The new indifference condition for occupational choice accounts for differences in wage earnings and differences in household production. It resonates with several studies (Aslaksen and Koren 1996; Jenkins and O'Leary 1997) reporting a smaller dispersion of extended income (including earnings and household production) than of earnings. In addition, other studies (Arai et al. 1998; Kniesner 1981; Bernhardt et al. 2003) report low-wage occupations in cleaning, hotel and restaurants, catering, private service, private household, day-care, retail, etc., i.e. jobs where tasks are similar to household production. To what extent household production might compensate low earnings was not addressed in them.

4 Issues of educational policy for future research

While the model of this paper does not discuss how the distribution of household skills comes about, with this model and Dunifon et al. (2001) as a backdrop, one may still ask about effects of various upbringings. In particular, should parents

promote household skills? An affirmative answer is not warranted. If youth household chores reduce their homework hours, there is a negative correlation between youth's higher household skills and their scholastic preparedness. This negative correlation may deny a girl being brought up in a traditional way entry into higher education, so that she ends up as a brighter than usual chambermaid. Such wasting of academic talent may be important in families with low income and wealth when parents demand youth to do chores because they cannot afford to buy similar services. Presumably, this was more of a problem to previous generations, like today's grandparents.

Why has girls' enrolment into higher education risen recently? In addition to improved labour marked opportunities, reduced learning of household skills may play a role. In modern economies, more goods and services are bought in the market place and fewer produced at home as mothers have entered the labour market. The reduction in household production has reduced children's learning-by-doing of household skills, particularly for girls, and according to this model, more girls have less household skills and, therefore, choose higher education.

In addition, novel activities enter homes, and household skills increase in scope. Home-based PCs contribute towards information-gathering and recreational activities, and children operating PCs acquire computer skills. If computer learning-by-doing at home predominantly affects boys, we can expect male youth to possess most computer household skills. Two conditions are relevant to this model. First, household production in computing must substitute for market services. For instance, people with computer science skills may install various software and internet access themselves, use internet banking, buy tickets or do more advanced tasks like assemble a computer. Secondly, if computer science jobs get piece-rate pay, the model predicts that youth with high computer science productivity may choose such a job at the expense of higher education. 'Household skilled' male-dominated jobs will appear in computer science according to the model in this paper.

If one is concerned that youth in industrialised countries will turn into adults with too low household skills to support a healthy lifestyle, then such a gap in household skills might be bridged by adding home economics topics to the curriculum of compulsory education. Could it be beneficial to supply modernised programmes in home economics that meet requirements of vocational programmes in child care, cleaning, kitchen or nursing assistance? Because of increasing household skills from such programmes, the graduates could expect higher wages and earnings in household skilled jobs and higher productivity at home.

5 Concluding remarks

When young people have finished compulsory education, they have to choose whether to look for a job or for further education. Human capital theory argues that wage differences among occupations and the ability to learn during education are important factors influencing occupational and educational choices. This paper argues that, in addition, the amount of household skills that young people possess may influence these choices. The focus is on modern economies and such kinds of household production as child care, cleaning, cooking, driving, gardening, laundry,

car maintenance, house maintenance, production and repair of clothes, shopping and PC work. Learning-by-doing in household production enhances household skills. The model in this paper indicates that occupations that use household skills, such as a chambermaid, may pay lower wage rates than traditional human capital theory predicts. This stems from the result that future earnings of higher educated employees not only have to compensate for educational costs and foregone wage earnings during education but, in addition, for lower household production while studying and later in life. The model predicts that youth who acquire much household skills may often enter occupations where household skills raise productivity in occupational tasks. However, youth with little household skills are predicted to choose occupations that require higher education, all else equal.

Presumably, household skills are more important in developing countries where education is non-universal and shorter. However, a different technology of household production makes extensions complex. Returning to the introductory example, if the daughter has not been taught to make a bed and clean a bathroom, but to fetch water and firewood, she needs additional training to become a chambermaid in the hotel industry. However, the main idea – that household skills will reduce incentives for enrolment in education – is highly relevant for understanding the pattern of enrolment into, as well as completion of, primary and secondary education in developing countries. Thereby, household skills may be fruitful in research about child labour and low-educational enrolment in developing countries.

Appendix

The following notation is used: $A_\mathrm{m} = \sum_{t=18}^{60} \left[1 \big/ (1+r)^{t-18} \right]$ and $A_\mathrm{e} = \sum_{t=23}^{60} \left[1 \big/ (1+r)^{t-18} \right]$.

Consider the problem of the chambermaid maximising lifetime consumption, C_m:

$$\max_H C_m = \max_H [f(H) + (12-H)v]a_i k A_m.$$

From the first-order condition, optimal number of hours in household production H_m satisfies

$$f'(H_m) = v \quad or \quad H_m = H(v), \tag{4}$$

where H is the inverse function of f', implying that $H' < 0$. Hence, the chambermaid's optimal hours in household production and in wage work depend only on the piece rate per cleaned room and is notably independent of individual household productivity.

Consider next the economist maximising lifetime consumption, C_e:

$$\max_H C_e = \max_H [a_i f(H) + (12 - H)w]kA_e.$$

From the first-order condition, optimal number of hours in household production H_e satisfies

$$f'(H_e) = \frac{w}{a_i} \quad or \quad H_e = H(w/a_i). \tag{5}$$

Because f is a strictly concave function, Eq. 5 shows that the optimal number of hours spent in unpaid work increases with higher household productivity and decreases with higher wage rate of economists, and vice versa for the optimal number of hours spent in wage work.

Results 2 and 3 of the main text are formally established as follows: By combining Eq. 1 with Eqs. 4 and 5, it follows that the indifferent individual must satisfy $a_i = a^*$, where a^* is determined by

$$a^* f(H_m) + (12 - H_m)a^* f'(H_m) = [a^* f(H_e) + (12 - H_e)a^* f'(H_e)]\delta.$$

Now divide by a^* to obtain

$$f(H_m) + (12 - H_m)f'(H_m) = [f(H_e) + (12 - H_e)f'(H_e)]\delta, \tag{6}$$

and take into account that $0 < \delta < 1$, implying that

$$f(H_m) + (12 - H_m)f'(H_m) < f(H_e) + (12 - H_e)f'(H_e).$$

From the property that

$$\frac{\mathrm{d}}{\mathrm{d}H}[f(H) + (12 - H)f'(H)] = f'(H) - f'(H) + (12 - H)f''(H) = (12 - H)f''(H) < 0,$$

it now follows that $0 < H_e < H_m < 12$. Hence, the indifferent individual works longer hours at home if she takes on a chambermaid job and shorter hours in the labour market. Because $0 < \delta < 1$ and f is increasing, this implies that $f(H_m) > \delta f(H_e)$, which is a restatement of result 2.

The new result about wage rates, i.e. result 3 of the main text, can be restated as

$$a^* f'(H_m) = a^* v < \delta w = \delta a^* f'(H_e). \tag{7}$$

To show Eq. 7, first use Eq. 6 to obtain:

$$12[\delta f'(H_e) - f'(H_m)] = [f(H_m) - H_m f'(H_m)] - \delta[f(H_e) - H_e f'(H_e)]. \tag{8}$$

Because $H_m > H_e$, and $\delta < 1$, and also

$$\frac{\mathrm{d}}{\mathrm{d}H}[f(H) - Hf'(H)] = -Hf''(H) > 0$$

it follows that the right-hand-side of Eq. 8 is positive. Hence, the left-hand-side of Eq. 8 is also positive, consequently, $\delta f'(H_e) > f'(H_m)$, thereby establishing Eq. 7 and result 3.

References

Arai M, Asplund R, Barth E (1998) Low pay, a matter of occupation. In: Asplund R, Sloane PJ, Theorossiou I (eds) Low pay and earnings mobility in Europe. Edward Elgar, Cheltenham, pp 139–161

Aslaksen I, Koren C (1996) Unpaid household work and the distribution of extended income: the Norwegian experience. Fem Econ 2(3):65–80

Balestrino A, Cigno A, Pettini A (2003) Doing wonders with an egg: optimal re-distribution when households differ in market and non-market abilities. J Public Econ Theory 5(3):479–498

Becker GS (1991) A treatise on the family. Enlarged edition, Harvard University Press, Cambridge

Bernhardt A, Dresser L, Hatton E (2003) The coffee pot wars: unions and firm restructuring in the hotel industry. In: Appelbaum E, Bernhardt A, Murnane RJ (eds) Low-wage America. Russell Sage, New York, pp 33–76

Bowman MJ (1966) The human investment revolution in economic thought. Sociol Educ 39(2):111–137

Burda M, Hamermesh DS, Weil P (2006) The distribution of total work in the EU and US. IZA-Discussion Paper 2270

Cigno A (2001) Comparative advantage, observability, and the optimal tax treatment of families with children. Int Tax Public Financ 8:455–470

Dale K (2002) Spillovers from household production to wage and profit formation. Ph.D.-dissertation, ISBN 8240500870. Norwegian school of economics and business administration, Bergen

Dunifon R, Duncan GJ, Brooks-Gunn J (2001) As ye sweep, so shall ye reap. Am Econ Rev 91:150–154

Freeman RB (1986) Demand for education. In: Ashenfelter OC, Layard R (eds) Handbook of labor economics, vol.1. Elsevier, North-Holland, Amsterdam, pp 358–386

Gronau R (1977) Leisure, home production, and work—the theory of the allocation of time revisited. J Polit Econ 85:1099–1123

Gronau R (1986) Home production—a survey. In: Ashenfelter OC, Layard R (eds) Handbook of labor economics, vol.1. Elsevier, North-Holland, Amsterdam, pp 273–304

Jenkins SP, O'Leary NC (1997) Gender differentials in domestic work, market work, and total work time: UK budget survey evidence for 1974/5 and 1987. Scott J Polit Econ 4(2):153–164

Kniesner TJ (1981) The low-wage workers: who are they. In: Rottenberg S (ed) The economics of legal minimum wages. American enterprise inst. for public policy research, Washington, pp 459–481

Mincer J (1958) Investment in human capital and personal income distribution. J Polit Econ 66:291–302

Reid MG (1934) Economics of household production. Wiley, New York

Rosen S, Willis RJ (1979) Education and self-selection. J Polit Econ 87(5):S7–S36

Roy AD (1951) Some thoughts on the distribution of earnings. Oxf Econ Pap 3(2):135–146

Schultz TW (1961) Investment in human capital. Am Econ Rev 51(1):1–17

Solberg A (1994) Negotiating childhood. Dissertation 12. NORDPLAN, Stockholm

Weymark JA (1985) Money-metric utility function. International Economic Review 25(1):219–232