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ABSTRACT

The Demand for Variety: A Household Production Perspective

Economists have devoted substantial attention to firms' supply of variety, but little to consumers' demand for variety. Employing the framework of home production, we trace differences in demand to differences in the opportunity costs of activities, which are associated with investments in human capital. Schooling alters time costs and changes the variety of activities household members choose. In time budgets from Australia, Israel, and West Germany we find that higher own and spouses' incomes raise variety (suggesting positive income effects). Education increases variety independent of income and earnings; part of its impact goes beyond a correlation of educational attainment with preferences for variety.

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Variety is the mother of enjoyment. Benjamin Disraeli, *Vivian Grey*

I. Introduction and Motivation

Product diversity is a salient feature of every modern marketplace. It is therefore unsurprising that it has played an increasingly important role in economic theory. The emphasis in the literature, however, has generally been on supply factors—on firms' behavior (Chamberlin, 1933) and the optimal diversity of supply, with consumer demand for variety taken as given. It is assumed that the distribution of consumers' tastes in product space is given (uniform along a straight line in Dixit and Stiglitz 1977, circular in Salop, 1977). The implicit assumption is that this distribution reflects diversity of preferences (i.e., different tastes) and is unaffected by economic factors, implicitly ruling out the effect of the standard economic variables—prices and income—as sources of variation in consumer demand.[1]

This neglect is not surprising. To analyze product variety one has to define the nature of the product, something most economists tend to shy away from. Measurement creates additional problems, as the measure of product variety depends crucially on the level of data aggregation. The degree of detail in the data (consumption and production surveys) depends often on the cost of data collection. An observed increase in product variety over time can therefore at least partly reflect increased resources devoted to data collection. This forces the researcher to infer the factors affecting variety from differences in behavior among various socioeconomic groups in cross-section surveys. This is the path that we take here. Instead, however, of studying the demand for goods, we analyze the underlying demand for activities, where each activity is "produced" à la Becker (1965) using goods and time.

In the traditional model all consumers face the same money prices. The burden of explaining differences in consumption diversity lies with income and preferences. A revolutionary aspect of the home production model is its emphasis on the price mechanism: The prices of activities differ among consumers, depending on the price of time. Furthermore, in a world of home production, productivity at home may vary with schooling. Schooling, with its

strong links to wages (i.e., the price of time), income and productivity, therefore becomes a major determinant of the demand for variety. One of the challenges that we deal with is to separate the "economic" explanation from one that ties schooling to differences in preferences.

We use time-budget surveys from Australia 1992, Israel 1991/92, and West Germany 1991/92. We begin with a theoretical discussion of the demand for variety in a home-production context. After a brief description of issues in using time-budget data, we then discuss the amounts of time allocated among different types of activities. Most of the empirical analysis deals with aspects of the demand for variety, including the impacts of wages and incomes and the sources of any independent effects of education on the demand for variety.

II. A Model of Variety in Household Production

Standard consumption theory pays little attention to the question of variety. The theory of household production, however, creates the scope for a rich explanation of the demand for variety. In this scheme (Becker, 1965) the subject of utility is not the good but the activity (Z), which in turn is produced by combining goods and time (T) according to

(1) $Z_i = f_i(X_i, T_i)$.

Maximization of the utility function $U = U(Z_1,\ldots,Z_n)$ is subject to two constraints: the usual income constraint and the time constraint

(2) $$\sum_{i=1}^{n} T_i = \overline{T},$$

where $\overline{T}$ denotes consumption time, and income I consists of wages and non-labor sources of income $I = wL+V$, w denotes the wage rate, L market labor time, and V non-labor income. When the household is free to choose its labor time inputs (L), income (and the budget constraint) becomes an endogenous part of the model, and the household faces one ultimate constraint—the total time constraint (T_0):

(3) $$\overline{T} + L = T_0 .$$

Optimization leads to the choice of producing/consuming those m activities that satisfy the condition

(4) $u_i / \pi_i = \lambda$, $i = 1,\ldots,m$,

where $u_i = \partial U/\partial Z_i$ is the marginal utility of activity i, λ is the marginal utility of "effective time" $[T_0 + (V/w)]$, and π_i denotes the marginal time cost of producing activity i. The marginal cost of the activity consists of two parts: The market time required to purchase inputs used in producing it, and the home time required to produce it. The full price is then

(5) $\pi_i = (p_i / w)\, x_i + t_i$,

where $x_i = \partial X_i/\partial Z_i$ and $t_i = \partial T_i /\partial Z_i$ are the marginal goods and time inputs. The diversity of activities depends on the number of activities satisfying the condition

(6) $\overline{\pi}_i > \pi_i$, $i = 1,\ldots,m$,

where $\overline{\pi}_i$ is the reservation price $u_i(0)/\lambda$.

In this model the diversity of activities undertaken arises not merely from the dispersion of preferences and incomes, but also from the dispersion of prices. Whereas in the standard model all households face the same set of product prices p_i, this assumption does not hold for the activity prices π_i. Differences in investments in human capital lead to differences in activity prices and affect the variety of activities undertaken.

Here an increase in non-labor income V increases the "effective-time" constraint and has the usual positive income effect on (the superior good) variety. Assuming V = 0, a wage increase has a pure price effect. It lowers the market-time component $(p_i x_i/w)$ and changes relative prices in favor of goods-intensive activities. The time released from time-intensive activities may allow the expansion of the activity set and the incorporation of additional goods-intensive activities. An increase in the wage rate in a model where labor supply is exogenous increases the "shadow price" of time and has a similar effect. This yields the two crucial predictions that we use in our

empirical work: 1) There will be positive income effects on the demand for variety; and 2) More important, since it could not have been derived outside a model of household production, there will also be positive wage effects on this demand.

The third prediction relates to schooling. Michael (1973) argued that schooling contributes to productivity at home. If more educated people are better at planning, coordinating and streamlining their tasks, then marginal time inputs t_i will decline with schooling. Schooling will, therefore, be negatively correlated with shadow prices π_i and will increase the variety of activities undertaken independent of its indirect effect through wage rates. Admittedly, tastes for acquiring schooling and preferences for variety may be related, so that it is hard to distinguish the role of preferences from those of productivity or ability. In the empirical work we devise some tests designed to make this distinction.

III. Time-Budgets in Three Countries

Full-scale time-budget surveys go back at least to Sorokin and Berger (1939). Such data are based on daily diaries, but usually rely on the respondents recollecting 24 hours, which limits the length of period covered by the surveys. Most samples are relatively small (not much more than 10,000 respondents) and cover relatively short time periods. Given these data constraints and the large variability in survey methods, we adopt a research strategy based on width rather than depth, using surveys covering three countries. The data constraints allow us to examine the robustness of most of the results by comparing them under the different definitions of variety imposed by the surveys' methods.

The Australian Time Use Survey of 1992 (ABS, 1993) is a random stratified sample of roughly 7000 individuals on two, typically successive days each, so that the hebdomadal distribution of observations is nearly uniform. Individuals listed when they began a new activity, with responses then coded into 280 categories of activities. The activities could encompass as

few as 5 minutes, with the upper bound being the full 24 hours. The diary provided space for the respondent to list up to two other activities in which he or she was engaged.

The Israeli Time Use survey, conducted in November 1991-April 1992 (*CBS*, 1995), covered 3081 Jewish Israelis who reported their activities on 4840 days. It was based on self-recorded diaries (covering about one-quarter of the days) and recall diaries based on interviews. Days were divided into fifteen-minute intervals (except for thirty-minute intervals between 12:30AM and 4AM), and respondents were asked to report the main activity (out of a list of 87) during each interval.

The 1991-92 German *Zeitbudgeterhebung* (Statistisches Bundesamt, 1999) covered both West and East Germany and was structured similarly to the Australian survey. It allowed for 230 possible activities in time units disaggregated to five-minute intervals, as well as for secondary activities. The sample is slightly larger than the Australian sample. Because the survey was undertaken very shortly after the German reunification, we use only observations from the former West Germany.

The theoretical discussion focused on three key economic variables: resources, prices and productivity/tastes. To separate their effects one needs accurate and detailed data on unearned incomes, wage rates and factors that might affect household productivity or tastes for variety. Time-budget surveys regrettably channel most of their effort to the collection of the time diaries, and relatively little is done to assure the quality of the income and earnings data, measures that are prone to substantial response errors even in the best of circumstances (Bound *et al*, 1994). Many time-budget surveys have no useful information even on incomes, and none of them contains direct observations on wage rates.

For Israel we use each respondent's "family income, personal earnings excluded," which should provide estimates of pure income effects. The wage is computed as earnings divided by working hours. The Australian sample provides good measures of family income, but the data on personal incomes include both earnings and non-labor income. We form measures similar to

those for Israel, except that these include all income accruing to other household members. In the West German data information on both spouses' incomes is available, so that we use spouse's income to proxy the other income available to the respondent, and own income per work hour to proxy the price of time.[2]

Not all the "completed" time diaries are complete for our purposes. To avoid contaminating the results we discarded any diary-day that included a time interval for which no activity was coded, which never disqualified more than one percent of the observations. We restrict the basic samples to individuals ages 19 through 69. Because marital status is likely to be crucial in determining behavior; because it is central to our ability to identify income and price effects using these data, and because the samples of unmarried individuals are quite small, we restrict the analyses to married persons. Educational systems differ among the countries, and even years of schooling are not always comparable across the samples. Accordingly, we rely on the respondents' reports of schooling attainment and divide each sample into three categories, with the sizes of the low-, middle- and high-education groups varying across the samples.[3]

In the regression analyses we control for the ages and numbers of children in the married persons' households. The measures of the age of the youngest child differ in definition across the samples; but we can classify them as indicating whether the youngest child is pre-school, pre-teen or a teenager (although in Australia youths over age 14 are not included as children). Where meaningful additional demographic information is available, it is also included. In the Israeli data indicators of health problems are included; and in that and the Australian samples indicators of country of origin and metropolitan residence are available. In Australia information on whether the respondent speaks a foreign language at home is also included.

Given the short time spans covered by the surveys, the observations on time allocation are susceptible to nonrandom variation. The major sources of such variation are institutional arrangements relating to work schedules. Except in Israel behavior on Saturdays and Sundays is likely to differ from that on weekdays. (In Israel Saturday is a "free" day and Friday is at most a

"short" workday, so that we treat Friday and Saturday as the weekend there.) Because of these differences we use differences in behavior on weekdays and weekends to shed light on the theoretical discussion.

The discussion dealt with consumption activities. The distinction between work and consumption (i.e., non-work) activities is not always clear, especially where home work is concerned. An activity was considered to be a "consumption activity" if it was assumed to yield considerable direct utility. Hence child-care activities were included in the consumption set. We excluded from the analysis work activities: market work, cleaning and cooking at one's residence, and shopping.

For each respondent-day the central concept in this study is the number of different non-work activities in which the individual engages. We focus on the variety of non-work activities and present all results for this set of activities. Using broader or narrower definitions of variety does not qualitatively alter any of our conclusions.[4] The minimum number of non-work activities that we observe in the samples on a diary-day is one, while the maximum possible is the total number that could be coded (202 in Australia, 64 in Israel and 128 in West Germany).

IV. First Impressions

A. The Allocation of Time among Activities—the Background to Variety

We cannot understand the production of variety unless we know the context of time use in which it is produced. Although a substantial sociological literature has generated tabulations of the amounts of time spent on different activities, with much of the focus on sex differences, many studies examine only one country's data, obviating the chance to discern general, possibly universal patterns.[5] Table 1 lists the mean minutes per day allocated to market work, home work, and non-work (childcare, personal care and leisure) separately by sex and schooling level for each of our samples. Each statistic is presented for a "representative day"—a weighted average of the observations reflecting the average allocation of time across weekdays and weekends.

Consider first the sex differences in time allocation. The data replicate most of the well-known differences, including greater market work, less homework and less childcare by men. In all three countries men spend less time in homework, but this is more than compensated for by their greater market work, so that total non-work time is less among these married men. Much less well known are the differences in leisure time and personal care between men and women. The greater allocation of time to personal care by women reproduces findings for the U.S. by Biddle and Hamermesh (1990) on sleep, by far the largest component of personal care. In Australia the differences in leisure time by sex are essentially zero; but in the other two countries married men consume more leisure than do married women. Sex differences in leisure time are opposite those in time spent on personal care, so the total of leisure time and personal care is typically only slightly lower among married men.

The effect of schooling on market work, mainly through its effect on wages, is one of the best-established facts in labor economics. It is replicated here for all countries and both sexes. Among women a negative relation between homework and schooling accompanies the positive relation between schooling and market work. Among men the homework-schooling relationship is slightly negative, so that for both sexes the effect of schooling on total work is less than is indicated by its effect on market work alone. As a result, in Australia and Israel, but not in Germany, for both sexes there is a positive schooling—total work gradient. This means that the total amount of time available for non-work activities, and thus the possibility of generating more variety in non-work activities, is less among more educated people in Australia and Israel, but is the same in Germany.

B. Variety of Activities

Table 2 presents the means and their standard errors of the number of non-work activities undertaken on a representative day by the married respondents in our samples. Remembering the international differences in the number of possible activities in the surveys, these tables make it quite clear that, where more activities are possible, more are coded as having been undertaken.

Australia and West Germany, which have at least twice as many possible non-work activities as Israel, show higher mean numbers of activities performed. The international differences, however, are not huge and are far smaller than the differences in the number of possible activities. Comparing men and women, the most striking difference is that women engage in more non-work activities than do men. Looking at the sources of variety, the gender difference stems from women's undertaking more child-care related activities. The greater variety undertaken by women may explain the finding (Hamermesh and Lee, 2007) that women are more likely than men to state they are rushed or pressed for time.

As we noted in Section II, education can affect the amount of variety produced in a number of ways—indirectly through its effects on the price of time and on incomes, and directly through its relation to the efficiency of household production and through its possible correlation with preferences for variety. For both sexes we find a general rise in the number of different non-work activities as the level of education rises (even though, as the previous Subsection demonstrated, in Australia and Israel more educated people have less time available in which to undertake non-work activities). Whether because of the income and wage-increasing effects of education, because of a causal relation between schooling and efficiency in household production, because educated people are more able, or because people with a greater taste for variety that is not captured by observable characteristics invest more in human capital, is unclear from these descriptive statistics. A positive simple correlation between schooling and variety is, however, abundantly clear from this three-country analysis.

The Australian and West German data also contain information on secondary activities. Including them would hardly affect our results, raising the number of different activities in Australia (Germany) to 9.51 (10.51) for men and 10.30 (11.77) for women. Very little waking time in Australia is coded with secondary activities, while in Germany around 90 percent is. The variety of secondary activities coded in Germany is uncorrelated with education level, so that the schooling-variety gradient is in main activities only.

V. The Roles of Income, Time Prices and Schooling

The central empirical question is whether income, time prices and schooling have independent effects on the demand for variety, as was hypothesized in Section II. To address this issue we use the measures of spouse's income and own income per hour that we outlined in Section III. Admittedly these variables are noisy, but there is no way of separating pecuniary from non-pecuniary effects without them. To circumvent selectivity issues, problems of corner solutions in labor supply, and the possibility that much of each spouse's income is unearned, we restrict these regression analyses to two-earner couples under age 60.[6]

Table 3 lists the estimated coefficients of schooling, hourly earnings and spouse's income for the reduced samples of pre-retirement age working couples. The equations also include a quadratic in age, measures of the number of children and the age of the youngest child, indicators of the day of the week on which the diary was kept, and the several extra variables for Australia and Israel, including self-assessed health status in the latter.[7] The results are surprisingly strong. All but one of the six income effects is positive, with four of them significantly so. In most instances individuals who are in households where the spouse has a higher income generate more variety. The effects are not very large: Doubling spouses' incomes in the Australian sample leads to an 11 percent increase in the number of activities among men, and a 1 percent increase in the number of activities undertaken by wives. In the Israeli samples the income effects on the consumption of variety by husbands and wives are 5 and 6 percent; in West Germany they are 1 and 10 percent for men and women respectively.

All the wage effects are positive, with five of the six significantly positive.[8] Holding the major measurable determinants of a person's price of time constant—his/her age and education—a higher time price increases the amount of variety that is consumed. This regularity corroborates our prediction in Section II that a person whose time is more valuable will engage in more goods-intensive household production, freeing up time to enjoy more different activities. The wage elasticities are 0.07 and 0.04 in Australia for men and women respectively, in Israel 0.03 and

0.001 respectively, and 0.01 for both men and women in West Germany. Thus while the effects are generally statistically significant, they are in all cases fairly small. The purely economic variables do matter in the directions we expect, but their impacts are not very large.

Table 3 also presents the coefficients on the indicator variables for schooling level. Additional schooling has generally positive and usually statistically significant partial effects on the number of different activities undertaken each day. This is true for each transition to a higher education group for both men and women in the Australian and German samples, and in Israel except for the comparison of the low and middle levels of education among men. Given the negative correlation between schooling and total non-work time, the schooling effect on diversity is even more pronounced when we control for the amount of non-work time available.[9]

Table 3 also includes a decomposition of the gross schooling effect (i.e. the schooling coefficients obtained when the regressions exclude the wage and income variables) into its components: the net schooling effect and the wage and income effects.[10] The schooling effects are obtained by differencing the coefficients of high- and low-level of schooling. The wage and income effects are the products of the respective coefficients in Table 3 and the schooling coefficients obtained when wages and spouses' incomes are regressed on the other explanatory variables used here.[11]

The decomposition is illuminating. The net effect of schooling constitutes only two-thirds of the gross effect among Australian and Israeli males (but is almost identical to the gross effect among West German males). It constitutes about 85 percent of the gross effect among all three groups of women. The wage effect constitutes about one quarter of the gross effect in the case of Australian and Israeli males, but is relatively unimportant in the case of females. (Australian women are a slight exception.) Among women in Israel and West Germany income effects are far more important than wage effects. The results are consistent with the notion that wages generally affect men's demand for variety more, whereas spouse's income affects women's demand more.

VI. Exploring the Role of Schooling

Schooling seems to be a major determinant of the demand for variety. We have also established that schooling has a direct effect on the variety of activities undertaken, independently of its indirect effects through earnings and income. To many readers this finding may not come as a surprise, being consistent with everyday observation. It is not clear, however, whether the association between schooling and variety is due to greater efficiency in home production, due to the possibility that people who have a greater "taste" for variety obtain more schooling, or is merely an artifact of reporting—people with greater schooling find it easier to provide a detailed report of their activities. To separate these three factors is not an easy task. Unlike market productivity, productivity at home does not carry financial rewards, making the separation of home productivity from preferences a difficult task.[12] Still, we try in this Section to produce some tentative answers.

A. Reporting and Variety

The results on schooling are not an artifact stemming from the ingenuity of more educated respondents in listing more activities in their diaries. If that were true, we would see bigger effects of schooling in samples where more non-work activities might be listed (Australia and West Germany). That the marginal effects of moving to a better-educated group are roughly the same in the Israeli samples (where the time diaries provided no more than half as many possible non-work activities) as in the other two samples suggests the result is not spurious.[13]

One might also argue that the requirement that an activity lasts at least 15 (or 5) minutes for it to be recorded causes us to underestimate the amount of variety consumed. Extremely short-duration activities may not be included in the data. There is no reason for their exclusion to affect reporting differentially by level of education. Indeed, if our theory is correct, underreporting will be greater among the more educated, since it will be easier for them to produce the extremely short-duration activities that may not be recorded.[14]

B. Home Efficiency and Variety

To explore the issue of home productivity further, one has to examine how more educated people can squeeze more activities into their limited time budgets in the face of an inflexible time constraint. Theory predicts that variety will increase with schooling due to two effects: 1) Higher wages result in relatively lower indirect "time costs" involved in obtaining the goods inputs into the activity, leading to substitution from time-intensive to goods-intensive activities; and 2) Increased home productivity allows the more educated to economize on the direct time inputs going into each activity. In either case the more educated will engage in shorter-duration activities, allowing them to increase the number of activities at the expense of length.

Table 4 presents the distribution of activities by duration and educational attainment for men and women.[15] The prominent feature of this distribution is its skewness: About half the activities last under an hour, between 30 and 40 percent last between 1 and 4 hours, and one activity, usually sleep, lasts more than 6 hours. Sleep is the most time-intensive activity and offers little opportunity to substitute goods for time. It is, therefore, the prime candidate for cuts when wages increase (Biddle and Hamermesh 1990). The percentage of people who sleep more than 8 hours on an average day declines with schooling. Similarly, in the 1–4 hour activity group the number of long activities (2-4 hours) diminishes and the number of short activities (1-2 hours) increases with schooling. The time saved allows a 30-40 percent rise in the number of very short-duration activities (less than one hour).[16]

The large fraction of time spent by the less educated on the more time-intensive activities—sleep, rest and TV watching—that have only a very small (variable) goods component indicates the presence of slack time. The less educated have enough time at their disposal, but lack the material resources that allow them to diversify their activity set. The opposite holds for the more educated—they have already conserved on time-intensive activities, and the major constraint on the diversification of their daily activities is the time constraint. With a more tightly

binding daily time constraint, the only way open to the more educated to expand their activity set still further is to diversify among days. Thus, if we compare the daily activity sets across days, we should expect a greater similarity among the less educated than among the more educated.

For all those respondents who reported their time allocations for two days we define routine activities as those that were undertaken on both survey days, and non-routine activities as those undertaken on only one of the two days. Let $NACT_i$ denote the number of different activities on day i, and NACTW be the number of different activities in which the respondent engaged over the two reported days. The number of routine activities is

(7a) $ROUTINE = \Sigma NACT_i - NACTW$.

The number of non-routine activities is:

(7b) $NONROUTINE = NACTW - ROUTINE = 2* NACTW - \Sigma NACT_i$.

Estimates of the mean numbers of routine and non-routine activities by level of education in each of the three samples are shown in Table 5. For both men and women the number of non-routine activities rises with education. Variety in routine activities increases with education in the Australian and West German samples, and among Israeli women, but those increases are much less pronounced than the increases in non-routine variety. The schooling gradient on non-routine activities is steeper than that on routine activities—schooling matters more in those areas over which there is more choice.

C. Efficiency vs. Preferences

It may still be argued that people with different schooling levels have different preferences, with more educated people preferring shorter-duration activities. Those with a greater thirst for diversity may also opt for diversity in schooling, i.e., spend more time in school. If this hypothesis were true, we should expect two disjoint sets of activities, some dominated by the less schooled and some dominated by those with more schooling. Alternatively, if schooling

affects efficiency directly, we will observe that the activities of the less educated are a subset of those undertaken by individuals with more education.

One way to make this comparison lets A_M denote the mean number of activities undertaken by members of the more educated group, and A_L the mean among the less educated group. If the two groups chose activities independently, the fraction of activities in which representation by the more educated group predominates would be:

$$p = A_M/[A_L + A_M].$$

On the other hand, if the more educated were to choose all the activities chosen by the less educated plus some additional ones, we should expect all the activities to be dominated by the more educated. To reject the hypothesis of randomness of choice we test whether the fraction of activities in which the more educated group is dominant exceeds the ratio p. The test treats the process as a binomial with the probability p and the number of realizations equal to the number of non-work activities possible in the survey.

The fractions of activities in which the more educated group participates more than the less educated group are shown in Table 6 for each sex and country, and for each of the three possible two-way comparisons. Listed in parentheses below each fraction is the probability that we would observe at least this many activities in which the more educated group dominates, given the average numbers of activities engaged in by members of the two groups. In all but three of the eighteen comparisons the fraction of activities in which representation by the more educated group predominates significantly exceeds the fraction p. The evidence thus suggests that more educated people tend to include the activities of the less educated as a proper subset of their activities.[17]

If the correlation between schooling and variety were due exclusively to preferences, one would expect the schooling effect on the demand for variety to be insensitive to the amount of time available (or perhaps even more pronounced when there is more time to indulge one's taste

for variety). On the other hand, when variety is affected by home productivity we should observe that the impact of schooling is negatively related to the amount of non-work time available. To test whether home productivity affects variety we therefore compare the schooling effect on weekdays, when people's schedules are constrained by their market work, to its effect on weekends, when they are not so tightly constrained.

We define the intensity of non-work activities in educational category j on day d (I_{jd}) as the number of consumption activities per hour of non-work time on that day (d denoting either weekday D or weekend E). Let $\Delta^{d}_{jj'} = I_{j'd} - I_{jd}$ denote the mean difference between any two schooling groups (j'>j) on day d. Our test is based on the double difference $\Delta^{2}_{jj'} = \Delta^{D}_{jj'} - \Delta^{E}_{jj'}$ for every pair of schooling groups, where $\Delta^{2}_{jj'}$ measures the difference in the education gradient of the consumption of variety on weekdays compared to weekends. If education affects variety because it enhances household productivity, we will observe $\Delta^{2}_{jj'} > 0$.

Table 7 first lists I_{jd} for each education category for both sexes. It then also lists the three possible double-differences that measure the relative education gradients between weekdays and weekends, and presents t-statistics testing the hypothesis that they equal zero. Of the 18 possible double differences 16 are positive. The two negative double differences are insignificantly different from zero, while the majority of the positive ones are significantly nonzero. Thus schooling is not just a proxy for "taste," but rather at least to some extent reflects the greater ability of the more educated to cope with the constraints of working time in their production of greater variety.[18]

VII. Conclusions and Implications

We have constructed a model of household production focusing on variety in household members' undertakings. Driving the model are differences among households in the time costs of different activities and differences in reservation prices. The time costs differ with the households' efficiency in home production and with the market time it takes to acquire the

required market inputs. The reservation price varies with income. Since all three factors—productivity, wages and income—are positively correlated with education, we expect variety in activities to increase with schooling. Using time-budget surveys from three countries we have demonstrated that this is exactly what occurs: More educated individuals undertake more different activities in a day. In the case of employed married men the wage effect, independent of the impact of schooling differences, is positive but not large. Among employed married women the income effects of their husband's earnings, independent of their educational attainment, are positive but also not large.

It is tempting to dismiss the correlation between schooling and variety as an artifact of heterogeneity. Heterogeneity, however, should be reflected in the less educated and the more educated engaging in different activities. The more educated engage in the same home activities as the less educated, but in additional ones as well. Similarly, that education matters more on weekdays, when people's schedules are more rigid, than on weekends suggests that at least some of the impact of education arises from its (household) productivity-enhancing effects.

Education produces a remarkable variety of benefits, from direct effects on earnings (Becker, 1964), to the externalities that it creates in production and the spillover to economic growth (e.g., Romer, 1986), to impacts on non-economic outcomes such as criminal activity (e.g., Grogger, 1998). We have suggested that education may generate yet another welfare-enhancing outcome—additional variety in the activities in which people engage. We cannot measure the magnitude of the gain in welfare that is generated by the greater diversity in activities that comes with education.[19] All that can be concluded at this point is that there are gains along this dimension, with the impact of education on variety not small: The estimates suggest that each extra year of schooling yields is related to a two-percent increase in variety.

Having demonstrated that there are systematic differences among households in the production of variety, one wonders how this realization might affect the theory of product demand. The first thing to do here is to analyze whether greater variety in time use is associated

with greater variety in the kinds of goods used in household production. Even without that analysis, however, our results suggest that, as its citizens acquire more skills, an economy will generate a greater demand for variety in the activities that its consumers undertake and will provide incentives for greater differentiation of the products that its firms offer. This development will in turn affect the structure of product markets.

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Table 1. Time Allocation of Married Persons by Schooling Level (Minutes per Representative Day)

	MEN			WOMEN		
	Australia[1]	**Israel[2]**	**West Germany[3]**	**Australia**	**Israel**	**West Germany**
Low Schooling Third						
Market work	299	242	345	104	82	114
Home work	143	105	145	293	304	325
Total non-work	1000	1093	950	1043	1054	1001
Childcare	20	20	21	63	34	49
Personal care	625	674	628	628	699	657
Leisure	355	399	301	352	321	295
Middle Schooling Third						
Market work	343	394	359	154	138	129
Home work	143	71	127	263	230	308
Total non-work	954	975	954	1025	1072	1003
Childcare	22	29	29	82	91	82
Personal care	599	584	621	606	630	639
Leisure	333	362	304	337	351	282
High Schooling Third						
Market work	359	409	367	234	213	130
Home work	136	67	129	219	201	290
Total non-work	945	964	944	986	1026	1020
Childcare	35	38	31	91	100	95
Personal care	578	560	613	587	595	637
Leisure	332	366	299	308	331	288
All Respondents						
Market work	329	382	356	133	164	122
Home work	141	74	135	276	229	312
Total non-work	969	984	948	1031	1047	1006
Childcare	23	32	26	71	86	69
Personal care	605	584	621	617	624	647
Leisure	341	368	301	343	337	289

NOTE: The total minutes allocated may differ slightly from 1440 due to rounding.

[1]Low if secondary or no qualifications; middle if a certificate, diploma or trade qualified; high if a bachelor's degree. The distribution is: 38 percent, 46 percent and 16 percent among men, 58 percent, 33 percent and 9 percent among women.

[2]Low if 0-8 years; middle if 9-12 years; high if 13+ years. The distribution is: 13 percent, 43 percent and 44 percent among men, 17 percent, 39 percent and 44 percent among women.

[3]Based on sums of years of schooling and formal training. The distribution is: 41 percent, 23 percent and 36 percent, 47 percent, 30 percent and 23 percent among women.

Table 2. Number of Non-work Activities of Married Persons on a Representative Day, by Schooling Level*

Schooling Level	Australia	Israel	West Germany
		MEN	
Low Schooling Third	8.77	7.04	8.13
	(0.09)	(0.24)	(0.05)
Middle Schooling Third	9.18	7.14	8.71
	(0.09)	(0.14)	(0.08)
High Schooling Third	10.11	7.72	9.32
	(0.17)	(0.13)	(0.06)
All Respondents	9.17	7.40	8.68
	(0.06)	(0.09)	(0.04)
		WOMEN	
Low Schooling Third	9.48	6.83	9.31
	(0.09)	(0.19)	(0.05)
Middle Schooling Third	10.32	8.13	10.23
	(0.12)	(0.13)	(0.07)
High Schooling Third	11.10	8.61	11.02
	(0.23)	(0.13)	(0.09)
All Respondents	9.90	8.15	9.97
	(0.07)	(0.09)	(0.04)

NOTE: Standard errors of the means are in parentheses. The educational categories are defined in the notes to Table 1.

Table 3. Determinants of the Demand for Variety: Schooling, Hourly Earnings and Spouse's Income

	Australia		Israel		West Germany	
EMPLOYED HUSBANDS						
Schooling: Low	-0.024	0.055	0.001	0.090	-0.438	-0.430
	(0.22)	(0.26)	(0.00)	(0.17)	(2.32)	(-2.28)
High	1.078	0.758	0.577	0.469	0.657	0.626
	(3.76)	(2.57)	(9.82)	(5.94)	(3.28)	(3.15)
Income/1000		0.224		0.049		0.010
		(1.97)		(2.14)		(0.14)
Wage		0.044		0.003		0.004
		(2.71)		(7.35)		(2.45)
Sample size (N)	480		593		855	
R^2	.132	.152	.177	.185	.083	.092
Schooling effect	*1.102*	*0.703*	*0.576*	*0.379*	*1.095*	*1.056*
Income effect		*0.128*		*0.035*		*0.004*
Wage effect		*0.272*		*0.162*		*0.035*
EMPLOYED WIVES						
Schooling: Low	-0.432	-0.433	-0.720	-0.664	-0.522	-0.487
	(1.80)	(-1.82)	(-0.86)	(-0.78)	(2.72)	(-2.56)
High	0.695	0.543	0.330	0.252	0.956	0.753
	(2.12)	(1.62)	(1.61)	(2.04)	(4.22)	(3.25)
Income/1000		-0.004		0.058		0.171
		(-0.04)		(3.56)		(3.26)
Wage		0.030		0.000		0.002
		(2.85)		(0.03)		(2.54)
Sample size (N)	438		510		857	
R^2	.310	.319	.195	.203	.183	.198
Schooling effect	*1.126*	*0.976*	*1.050*	*0.916*	*1.478*	*1.240*
Income effect		*-0.003*		*0.132*		*0.218*
Wage effect		*0.153*		*0.004*		*0.020*

NOTE: t-statistics in parentheses. The educational categories are defined in the notes to Table 1. Robust standard errors that account for the duplication of observations are presented. All the equations include a quadratic in age, and measures of the number of children present and the age of the youngest child. The equations for Australia also include indicators of residence in the urban part of a metropolitan area, of immigrant status, and of whether English is spoken at home. Those for Israel also include indicators of residence in the urban part of a metropolitan area, of ethnic origin, of health problems, of the age of the youngest child, and continuous measures of the number of children and of number of persons in the household.

Table 4. Number of Non-work Activities by Duration on a Representative Day

Duration (in minutes)	1-59	60-119	120-239	240-359	360-479	480+	Total No. of Activities
Australia:							
Men: Low Schooling	4.42	1.76	1.02	0.37	0.50	0.71	8.77
Middle Schooling	4.86	1.84	0.98	0.31	0.55	0.64	9.18
High Schooling	5.72	2.03	0.89	0.31	0.62	0.54	10.11
Women: Low Schooling	5.17	1.98	0.99	0.27	0.42	0.65	9.48
Middle Schooling	6.02	2.01	0.96	0.26	0.47	0.60	10.32
High Schooling	6.79	2.05	0.90	0.25	0.61	0.50	11.10
Israel:							
Men: Low Schooling	2.37	1.91	1.20	0.53	0.45	0.59	7.04
Middle Schooling	2.91	1.83	1.05	0.42	0.48	0.46	7.14
High Schooling	3.41	1.96	1.04	0.40	0.55	0.37	7.72
Women: Low Schooling	2.40	1.76	1.28	0.34	0.37	0.68	6.83
Middle Schooling	3.25	2.26	1.23	0.39	0.44	0.59	8.13
High Schooling	3.82	2.28	1.23	0.36	0.46	0.46	8.61
West Germany:							
Men: Low Schooling	4.35	1.70	0.87	0.25	0.50	0.47	8.14
Middle Schooling	4.86	1.82	0.81	0.23	0.52	0.47	8.71
High Schooling	5.46	1.91	0.78	0.21	0.56	0.41	9.32
Women: Low Schooling	5.18	2.01	0.92	0.18	0.45	0.56	9.31
Middle Schooling	6.06	2.14	0.88	0.18	0.48	0.50	10.23
High Schooling	6.73	2.28	0.86	0.16	0.51	0.48	11.02

NOTE: Except for rounding the row-sum equals the entry in the last column, which is copied from Table 2. The educational categories are defined in the notes to Table 1.

Table 5. Number of Routine (R) and Non-routine (NR) Non-work Activities of Married People, by Schooling Level

	Australia		Israel		West Germany	
	R	**NR**	**R**	**NR**	**R**	**NR**
			MEN			
Low Schooling Third	6.18	5.17	5.23	4.08	5.44	5.39
	(0.07)	(0.12)	(0.53)	(0.62)	(0.03)	(0.06)
Middle Schooling Third	6.34	5.73	5.03	4.36	5.72	5.97
	(0.07)	(0.12)	(0.18)	(0.27)	(0.05)	(0.08)
High Schooling Third	6.74	6.71	5.03	4.89	6.04	6.55
	(0.12)	(0.20)	(0.15)	(0.27)	(0.04)	(0.07)
			WOMEN			
Low Schooling Third	6.42	6.12	4.74	4.04	6.14	6.33
	(0.06)	(0.10)	(0.29)	(0.57)	(0.03)	(0.04)
Middle Schooling Third	6.74	7.26	5.89	5.15	6.63	7.21
	(0.09)	(0.15)	(0.20)	(0.29)	(0.04)	(0.08)
High Schooling Third	7.52	7.14	5.83	5.49	7.16	7.73
	(0.16)	(0.16)	(0.18)	(0.27)	(0.06)	(0.09)

NOTE: Standard errors of the means are in parentheses. The educational categories are defined in the notes to Table 1.

Table 6. Fraction of Activities Dominated by the More Educated Group (and p-value Against Randomness)

	Australia	Israel	West Germany
		MEN	
High vs. Low Education	.604 (.021)	.672 (.006)	.681 (<.001)
High vs. Middle Education	.667 (<.001)	.750 (<.001)	.766 (<.001)
Middle vs. Low Education	.633 (<.001)	.609 (.035)	.637 (.003)
		WOMEN	
High vs. Low Education	.465 (.993)	.781 (<.001)	.714 (<.001)
High vs. Middle Education	.518 (.452)	.797 (<.001)	.718 (<.001)
Middle vs. Low Education	.653 (<.001)	.594 (.174)	.692 (<.001)

Table 7. Number of Non-work Activities Per Non-work Hour, Married People by Schooling Level, Weekdays (Day) and Weekends (End)

		Australia		Israel		West Germany	
				MEN			
Schooling:		Mean	Δ^2	Mean	Δ^2	Mean	Δ^2
Low Third;	Day	.606	.027	.408	.048	.537	-.008
Δ_M- Δ_L	End	.458	(1.76)	.370	(2.10)	.456	(0.94)
Middle Third:	Day	.664	.033	.486	.038	.556	.027
Δ_H- Δ_M	End	.490	(1.58)	.400	(2.29)	.482	(3.32)
High Third:	Day	.739	.059	.542	.084	.610	.020
Δ_H- Δ_L	End	.532	(2.83)	.420	(3.68)	.509	(2.62)
				WOMEN			
Low Third:	Day	.593	.018	.415	.002	.575	.030
Δ_M- Δ_L	End	.478	(1.28)	.354	(0.11)	.492	(4.03)
Middle Third:	Day	.665	.039	.482	.022	.630	-.020
Δ_H- Δ_M	End	.532	(1.53)	.419	(1.48)	.516	(0.04)
High Third:	Day	.753	.056	.630	.024	.635	.011
Δ_H- Δ_L	End	.582	(2.37)	.516	(1.26)	.541	(3.95)

NOTE: Absolute t-statistics of the double differences are in parentheses. The educational categories are defined in the notes to Table 1.

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[1]Perhaps the only exception is Jackson (1984), who analyzed the effect of income on variety. In the now quite large literature on home production (summarized in part by Gronau, 1986 and 1997), none has analyzed the variety of activities.

[2]The data only measure gross incomes and earnings, not net after-income tax incomes. So long as income taxes are progressive in these countries, this measurement problem imparts a negative bias to the estimates of the impacts of these variables on variety.

[3]For each country we inferred the appropriate aggregations from conversations with people who were familiar with the educational system. For Israel we relied on one of our own experiences. We are thankful to Damien Eldridge for information on Australia, and John Haisken-De New for West Germany.

[4]On the Israeli data we estimated equations describing variety along these other dimensions, first including all activities, then dropping market work activities, homework activities, and child and family care activities sequentially. For the total of all activities the results were somewhat stronger than those presented in the text, mainly because additional schooling is associated with a greater likelihood of market work. Excluding child and family care activities also does not alter the results qualitatively, nor does excluding transportation activities.

[5]See the articles in Merz and Ehling (1999) and the references therein.

[6]Confining the sample to the employed may introduce a censoring bias into our measurement, but we expect it to be small compared with the measurement bias involved in using a sample that includes the non-employed.

[7]A measure of the presence of various medical conditions was in the Australian data. Adding that measure to the equations in the first two columns of Table 3 hardly changed the estimated coefficients.

[8]Nor are these effects due to common behavior by husband and wife. None of the estimated impacts reported in Table 3 is changed qualitatively when the spouse's variety of activities undertaken is added to the regressions.

[9]When we include secondary activities, re-estimates of the equations in Tables 3 including secondary activities look almost identical to those presented in the Tables. The impact is almost entirely on the estimated intercepts. The schooling and other estimated parameters change very little.

[10]The estimated impact of education is qualitatively unchanged as one moves to the more restricted sample in the West German case and for Australian males, but is somewhat smaller in the restricted Israeli sample and for Australian women.

[11] $b_{ns} = b_{ns.w} + b_{nw.s}b_{ws}$, where n denotes the number of activities, s is schooling, and w is the wage rate (or alternatively, spouse's income).

[12]A prime example is the interpretation given to the independent effect of schooling in women's labor supply (controlling for wage and income): Is it that the more educated have a greater preference for market work, or is it that they are more productive at home, which allows them more time to work in the market?

[13]Each of the surveys was extensively pre-tested, in part to ensure that respondents could express their activities consistently. This provides some additional assurance that questionnaire biases are small.

[14]In the Netherlands, whose time-use data had as many categories as Germany and Australia, but with time intervals recorded in quarter-hours, the differentials by education level were the same as in Australia and West Germany (Gronau and Hamermesh, 2001).

[15]Extensions of the estimates presented in Table 3 showed that excluding earnings and spouse's income does not greatly affect the estimated impacts of differences in educational attainment. Consequently, to enlarge the sample sizes in this Section we use data on all couples in the age range.

[16]A more detailed examination indicates that two other time-intensive activities—rest and TV watching—are (besides sleep) responsible for the release of time that allows the proliferation of short-duration activities among the more educated.

[17]This method is just one of many possible. As one alternative, we adapt Stewart's (2006) weighted Szalai index for our purpose and apply it to participation rather than time spent in each activity. Our modified index accounts not only for whether one group is more likely to engage in an activity, as did the calculations in Table 6, but also for the magnitudes of the differences between the two groups, and it weights more heavily those activities that are engaged in by more people. We calculated the indexes for Australia and West Germany, the two countries with the largest numbers of possible activities. In five of six cases in Australia, and in all six in West Germany, the estimated indexes were positive (showing that the less-educated group's activities tend to be a subset of those of the more-educated group), reinforcing the conclusions from Table 6.

[18]Testing for the existence of an "ability bias" in home production is clearly outside the scope of this study.

[19]The issue is somewhat similar to that of valuing new goods (see Hausman, 1997), although these welfare effects of increased variety are generated endogenously rather than by exogenous product innovation.