Why was there more Work for Mother? Knowledge and Household Behavior, 1870-1945

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"Our House is clean enough to be healthy

and dirty enough to be happy."

Poster Inscription in American kitchens

"Until such time as science shall illuminate the housewife's path,

she must walk in the twilight of traditional opinion"

Wesley Clair Mitchell, 1912

The Problem

This paper makes two related points. The first is the rather commonplace observation that what people "know" -- that is, believe to be true about the natural world -- affects the efficacy with which they manipulate their physical environment and thus their material well-being. While economic historians have never really doubted this view, its significance is not always made explicit. "Useful knowledge", since Kuznets's classic formulation, has widely been understood to hold the key to economic progress in the modern era.[1] The set-up I will deploy below, outlined in more detail elsewhere, is that knowledge consists of a set of *useful knowledge* about nature, cataloguing natural phenomena and the relations between them, and a set of *techniques* utilizing this knowledge to formulate lists of instructions that manipulate nature to yield "production" in the widest sense of the word.[2]

The second is the seeming non sequitur that the allocation of resources and distribution of consumption *within* the households of the industrialized West in the past century and a half is an important example of this kind of connection. In particular, I wish to analyze what may well be called the Ruth Schwartz Cowan problem. In her classic book *More Work for Mother*, published in 1983, Cowan raised a fundamental conundrum: why did homemakers end up working longer hours in their homes in the century after 1870, despite the growing mechanization of household activities? Despite the obvious technological changes in household appliances (most of them presumably labor-saving), married women worked as long if not as hard in their homes and till World War II very few of them worked outside the home. It has been maintained that the number of hours worked by

[1]Kuznets, *Economic Growth*, pp. 81-92.

[2]See Mokyr, "Science, Technology, and Knowledge" and "Knowledge, Technology and Economic growth."

the housewife in U.S. households were around 52 hours a week in the beginning of the century, rising to 56 in the late 1960s, declining only in recent years to about 50 in 1987.[3] Strictly speaking, the uncertainties surrounding these numbers suggest that perhaps the "more" in Cowan's title should be interpreted cautiously as "not less." In view of the technological progress in household implements and declining fertility in industrialized countries, however, this is still rather amazing. This is not to say that labor-saving innovations in domestic technology had no beneficial effect. Cowan notes that the American housewife of 1950 produced single-handedly what her counterpart in 1850 needed a staff of three or four to produce: a middle class standard of cleanliness, health, and comfort for herself and her family. Cowan's observation holds, however, one of the keys to the paradox. The point is that when three or four servants were needed to attain this standard for one household, only a fraction of the population could enjoy it. The technological advances allowed a growing fraction of the population to enjoy these standards, thus substituting capital for labor.[4] At the same time we need to know what happened to these standards and why.

The Cowan problem, not much discussed by economic historians, is one of the more intriguing puzzles of modern economic history.[5] There are other persuasive explanations for the paradox. For one thing, when the effort required to carry out an activity is reduced (and possibly made less unpleasant), the volume of the activity may expand, offsetting the labor-saving effect. The decline in the supply of domestic servants forced housewives to carry out activities previously bought in the market. At the same time, if housework and market goods or services were close substitutes for each other, the invention of labor-saving devices may simply have meant an additional shift from market purchases toward home-production. Demand for female labor may have remained low, thus leaving women with little choice but to stay home and either consume leisure or engage in household

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[3]Cowan, *More Work*, p. 178; Vanek, "Time Spent in Homework," pp. 116-20, and Schor, *The Overworked American,* p. 87. Lebergott disputes these numbers and estimates that weekly chores fell from 70 hours in 1900 to 30 in 1970. See Lebergott, *Pursuing Happiness*, p. 58. A recent study finds a far more moderate decline (14 percent) in housework time between the 1920s and the 1960s, of which about one third can be attributed to composition effects. See Bryant, "A Comparison." Gershuny and Robinson, "Historical Changes" and Robinson and Godbey, *Time for Life*, pp. 103-120 show that from 1965 on, time spent in household work has declined in the US and UK, largely, they believe, on account of growing productivity in producing household work (as opposed to reducing its volume). Research by Roberts and Rupert shows a further decline in housework in more recent years. Roberts and Rupert, "The Myth."

[4]Cowan, *More Work*, p. 100. Formally, the problem is similar to the question whether labor-saving innovation reduces total employment. It is of course no paradox to note that by and large any innovation that increases the capital-labor ratio does *not* create unemployment in and of itself, because the total demand of labor depends on the demand for final goods.

[5]An exception, written before Cowan's book appeared, is Brownlee, "Household Values." The idea that home production of household services is an economic activity worthy of analysis has been widely accepted since Folbre's comprehensive analysis of the issue. See Folbre, "Cleaning House."

work. My argument adds another dimension to the question of why so few married women worked outside their homes: the *perceived* marginal product of housework increased sharply in the last third of the nineteenth century.

The changes in the participation rates of married women have long puzzled economic historians. The exact timing in the nineteenth century is not easy to establish because of the ambiguous meaning of statistics on "participation" in economies where much production is still carried out by self-employed workers in their homes. Yet two facts seem well-established: first, compared with the standards of our own time, these participation rates in the industrialized West were quite low.[6] Second, what little evidence we have is consistent with a decline in the participation rates of married women in the last third of the nineteenth century.[7] The leading specialist on the subject has recently stated that "what cries out for an explanation in these [female participation] data is not dramatic change over the period of the Industrial Revolution, but a retreat much later in the nineteenth century that is then maintained through the first 30 years of the twentieth."[8] As it turns out not surprisingly, the answer to that question is very much the same as the resolution of the Cowan paradox.

The literature on the topic has mostly abstracted from the most profound change that affected household behavior, namely a change in knowledge and beliefs, although recent research has begun to change this.

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[6]The evidence that only a small (if variable) proportion of married women worked outside the house is summarized for the United States by Brownlee, "Household Values." Goldin shows that for the cohort of women born between 1866 and 1895, participation rates of married white women did not exceed 10% over their lifetime. See Goldin, *Understanding*, p. 121.

[7]Data for England are difficult to interpret because of inconsistent census definitions. Whereas in 1851 about a quarter of all married women reported a "specific occupation" other than domestic work (not, of course, quite the same as working outside the house), the rate declined to 10% by 1901 and remains there till 1931. Hakim concludes from these data that in the mid twentieth century "women returned to work after almost a century of being primarily engaged in unpaid work at home and excluded from the labour market." Hakim, "Census Reports," p. 560. In France, things may have been different. Until 1931 the participation rates of French women did not decline and remained unusually high, and yet in 1931, only 19.4% of French married women outside agriculture were "active." One historian concludes that "French women were far less likely to leave their jobs upon marriage than English women." See Rollet-Echalier, *La Politique*, p. 491. In the Netherlands, budget studies show that the percentage of married women working fell from 55 percent in 1886/87 to 26 percent in 1910/11 and the contribution of the wife to total family income fell from 7.2 percent to 3.4 percent in the same period (unpublished data kindly supplied by Dr. Arthur Van Riel, University of Utrecht). The convincing evidence amassed for Ireland shows that female labor force participation in that nation declined quite significantly before 1914, indicating that the phenomenon was not confined to the industrialized countries. See Bourke, *Husbandry*.

[8]Humphries, "Women and Paid Work," p. 100. Brownlee's participation rates of married native white women in the U.S. increased from 2.2 percent in 1890 to 6.3 percent in 1920, but he notes that inconsistent definitions makes such comparisons hazardous and the actual participation rates of middle class women may have actually lower in 1920. In any event, even the higher rate in 1920 is one tenth of what it is today. Brownlee, "Household Values," p. 200. Recent research indicates that female labor force participation rates may have already started to decline by the middle of the nineteenth century. Humphries has recently reviewed the literature and confirms that the decline in the female participation rates from a plateau of 42-43 percent in 1851-71 to one of 32-34 percent (1881-1931). This "retreat" cannot entirely be explained away by changes in the definition of the labor force. It also reaffirms that married women's participation rates remained low from their mid-nineteenth century decline up to World War II. Horrell and Humphries, "Women's Labor"; and Humphries, "Women and Paid Work."

Households perform homework not only because they enjoy the outcomes directly but also because they have certain priors on how such services affect other aspects of consumption. For instance, individuals might want to live in cleaner homes, breast-feed a baby, and cook better quality foods because they enjoy doing so, or else they may spend time cleaning, nursing, and cooking because they believe cleaner homes and more labor-intensive foods are inputs into other ultimate objectives such as health or social status.[9] These are analytically distinct objectives, even if they are not always easy to separate in practice. Standard economic analysis suggests that if certain household services are produced because households enjoy them directly, any subsequent realization that these services also have a favorable impact on health will normally increase the quantities of them produced and thus increase housework. In what follows, I will treat household choices in a manner analogous to the economics of technological change in that they are affected by perceptions regarding the natural world around us, the very crux of technology. Such an approach has its pitfalls: households are not like firms. They do not compete with each other in the same way, and their behavior is more conditioned by persuasion than their concerns about profits.

The analysis below is by necessity oversimplified. I will ignore the obvious difficulty in separating leisure from homework, although the two overlap a great deal. Precisely because of the technological changes in the household, the nature of household labor changed considerably, and, in Ruth Cowan's words, eliminated drudgery, not labor. Yet in this regard, household labor is hardly unique and the blurring at the edges of the boundary between leisure and work is a general issue in post-1945 labor economics. There are also complex issues of changing degrees of substitutability between home production and market-purchased goods and services.[10] Most perplexing of all, perhaps, is the question of how we generalize from individual decision making to the household as a unit which makes collective decisions that maximize the composite utility of different individuals with possibly different preferences and perceptions. All the same, it represents a relatively minor

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[9]For a recent treatment, see Tomes, *The Gospel of Germs*. There is also a literature emphasizing a cultural dimension in cleanliness. An important early work is Mary Douglas, *Purity*, according to which cleanliness is culturally constructed as a rationalization to create order.

[10]Cowan, *More Work*, pp. 100-101. Laundering, to choose but one example, was an exceedingly hard chore in the nineteenth century, carried out once a week and consisting of endless scrubbing, wringing, drying, ironing, folding, carrying and heating water, disposing of the washwater and so on. Compare this with today's fully automated washing machines in which the labor input consists of some sorting and the pushing of a few buttons (without ironing) up to the point where the clean laundry is folded and put back in place (a process that has eluded mechanization so far). Changes in the substitutability between market goods and domestic production are at the heart of De Vries's ideas about the "Industrious Revolution." De Vries, "Between Purchasing Power" and "The Industrial Revolution."

extension of standard consumer theory and much of the work made by Becker and his students applies directly. Although the idea that time is allocated rationally among competing uses conditional on the prior beliefs of the decision-maker seems straightforward, it has eluded some scholars. Schor, for example, suggests that the main reason why housework has remained so time-consuming is because the market places no economic value on work inside the house. This cannot possibly be right: even when women have no outside jobs, the opportunity cost of housework is leisure, and elementary economics suggests than women who set their own schedules will work in their homes until the marginal utility of leisure equals the perceived value of the marginal product of housework.

Some Theoretical Considerations

To distinguish between the alternatives, it is useful to set up the problem a little more formally.[11] The advantage of this model, which is just a modification of standard consumer theory is that isolates with some precision the exact variables at play and their relationship with each other even if they cannot be measured directly in the historical record. As in standard theory, the consumer j maximizes a utility function:

(1) $U_j = U_j(X_{1j} \ldots X_{nj}, H_j, L_E, L_D)$

where H is a composite variable of family life expectancy and health, the X's are goods purchased in the market, the L's are time spent on leisure and domestic work respectively and consumption is subject to the usual budget constraints $\sum X_i P_i = Y$ and $L_E + L_D + L_W = L^*$ (time is allocated between leisure, housework, and work for income).[12] The special characteristic of this setup is that H is determined by the household production function:

(2) $H_j = E + f(X_{ij} \ldots X_{nj}; L_D)$

or in simple additive form

(2') $H_j = E + \sum_i f_i (X_{ij}, L_{Dj})$

E is a common factor independent of the consumption basket ("environment"), f is the vector of household production functions that transforms the goods consumed and time spent producing them into better health and

[11]For a more detailed exposition, see Mokyr and Stein "Science, Health and Technology." The approach here is a special case of home production, and I have not bothered to include most of the comparative statics results as they are well known. The seminal work here is Becker, *A Treatise*. For a recent good summary, see Cigno, *Economics*. For an early example, see Grossman, "On the Concept."

[12]Whether H measures life expectancy alone, "health" (the absence of morbidity) or some combination is a difficult issue. The issue seems more perplexing for today's medical environment in which morbidity and mortality are less closely connected. In the age in which infectious diseases were the main causes of death, the distinction seems less acute, though Riley ("Working Health") suggests that while mortality declined during the 19th century, morbidity was rising.

longer lives for the members of the household. Each good X_i is converted by household j into health using f_i and normally a dose of L_D into "health." The functions f are unobserved technical relationships. They tend to be complex to be beyond the household's full comprehension at almost any level of bounded rationality. The food component of the X's takes account not only of caloric intake but also of vitamins, minerals, fiber, substances combating free radicals such as anti-oxidants and so on. Home-heating, cleanliness, child- and medical care, and physical exercise are other examples of X's that enter equation (2). The function f describes such effects as exposure to harmful micro-organisms and chemicals, the impact of behavior and nutrition on the cardiovascular system, as well as the interaction between consumption and the human immune system. Moreover, f is assumed to satisfy the condition that the conversion is *efficient* (that is, no X's are wasted in the production process), though this assumption is not necessary for the present purpose.[13] The shape of f is, however, not fully known to best-practice science, much less to the household. Indeed its complexity is such that it seems safe to maintain that its precise form is *unknowable*. Behavior is therefore determined by the function:

(3) $H_j^e = E + \sum_i [A_i - \theta_{ij}] F_i(X_{ij}, L_{Di}) \quad \forall j$

where H_j^e is the prior that the consumer has over the determination of H, and E is an environment over which the consumer has no control. F_i is the best-practice knowledge on how the goods X and their associated household labor L_{Di} jointly produce H. The sum of all L_{Di} is total household labor, L_D. For my purpose here, it is important to realize that best practice knowledge could still be far from the accurate truth. A_i is a shift factor that measures the degree to which the "best-practice" grasps the true effects of good i on health. A = 1 means that best practice fully understands the impact of X on health. A = 0 means that nobody has any idea that X has any effect on health at all (and thus the only reason why it is consumed is because it conveys direct utility). Moreover, individuals lag in their knowledge behind best practice technique. θ_j is an individual-specific measure of the difference between this individual's technology and the best-practice technology regarding good i. The term $A_i - \theta_{ij}$ measures the degree to which consumer j is aware of and believes the mapping of L_D and X_i into H and is defined it here for simplicity as a multiplicative deviation from "ideal" priors. By substituting equations like (3) into (1), we obtain demand functions for each good X and for the L_D associated with it.

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[13] By this I mean that each X is directed toward the use where it can achieve the best effect on H. For instance, if the household purchases fruits and vegetables because it is believed that these product contain health-enhancing substances, the household does not proceed to then destroy these substances by overcooking them. This assumption is required so that for each set of X's and L_D there exists a unique level of H for each individual. This implies that the crucial part of each recipe is the quantity and quality of the ingredients and not the details of preparation -- clearly a simplifying assumption.

I will refer to terms measuring priors such as (A-,)F as *recipes,* and distinguish them from household technology which is embodied in the X's. Thus the introduction of labor-saving household electric appliances should be regarded as changes in *household technology*, while the growing awareness of the importance of fresh fruits and vegetables in a healthy diet due to the discovery of ascorbic acid in the early 1930s is an example of an improvement in *recipes*. A substantial portion of the resolution of the Cowan conundrum depends on substitution and income effects. Household labor had to go up in large part because with higher incomes consumption went up and required more work. Thus the vacuum cleaner might have saved household labor, but more upholstered furniture and wall-to-wall carpeting increased it. In general increases in consumption of the X's, whether driven by income, changes in prices, or innovation, will increase total household work if

$$\text{(4)} \qquad \int \left(\frac{\partial L_D}{\partial X_i}\right) dX_i > 0$$

In addition, however, increases in housework depended on what people knew and believed.

As noted, the term A-, measures the degree to which each consumer takes the indirect effect of the X's and L_D on H into account. Normally we would expect that term to be somewhere between 0 and 1 though it could be negative.[14] An increase in A - , within that interval means that a consumer can do better in terms of overall utility than before simply by redeploying the resources available. For the present purpose the possibility that $A\text{-}, > 1$ is especially interesting. This means that the consumer is exaggerating the perceived effect of the good on her health and thus *over*consuming it to the point where its quantity is superoptimal. In the multigood model, $A\text{-}, > 1$ for a particular good means that the consumer underconsumes other goods, and thus reduces her utility from those goods and in all likelihood even suffers lower health. If A_D - $,_D > 1$, households invest more in housework than is optimal under the mistaken belief that immaculately clean homes and other labor-intensive household services are more important than they really are. If this were the case, it would have a

[14]For example, the smoking of tobacco was widely prescribed by 17th century doctors as a cure for a variety of respiratory afflictions; marijuana, in our own age, may be an example of the reverse, namely a harmless and possibly benign substance (at least for some individuals) denounced and proscribed as unhealthy for moral reasons. In both cases A , and possibly A - ,, are negative.

number of important implications. First, if L_D replaces primarily leisure, there is a direct reduction in utility. Second, if it reduces both leisure and work time, it will also reduce utility through a lower consumption of the X's. Third, it is likely to lead to lower health.

The oversimplification is compounded by the nature of H itself: rather than a composite variable, it really is a matrix of variables, with a vector of health characteristics defined for each member of the household. How one trades off the health of one member against another remains an intra-household bargaining problem. Furthermore, "health" can be understood in two specific ways. As mortality, health is a fairly straightforward binary concept although households had to deal with it probabilistically. Morbidity on the other hand is subjective, variable, and socially constructed and hence may have moved in a direction different from mortality.[15] These different aspects of health may have had an impact on what housewives perceived they could accomplish through housework. The argument below relies on a generalized notion of "health" that women were trying to affect by household work. A more detailed analysis of its different components is beyond the scope of this paper.

Of central importance to the question of changes in housework is the effect of knowledge progress on the allocation of time. Note that the allocation of time could change in two ways. First, if the consumer just changes her appreciation of the impact of good i by raising A_i - $,_i$, the consumer would consume more of that good than she would otherwise. This will increase L_D if i is complementary with household labor.[16] Second, an increase in A_D- $,_D$ will bring to a redeployment of time in favor of household work so as to bring it closer to unity and it is on this effect that I will concentrate. Note that this could occur through "invention" (that is, improvement in best-practice technique A with constant $,$) or "diffusion" or "persuasion" (a decline in $,$, the lag between actual and best practice).[17] Assume for simplicity that the time worked outside the house, L_w, is

[15]The argument for a separation of mortality and morbidity in analyzing health issues is justified well by Riley (*Sick, Not Dead*) in his study of working class health in Britain. He offers up several useful ways to conceptualize and measure the difficult issue of "sickness."

[16]Thus, if the household decides that it wants to reallocate resources to housing and live under less congested conditions because it has been persuaded of the effect of congestion on its health, it may have to reallocate more time to household work just to keep the increased quantity of housing at a constant level of cleanliness even in the absence of a change in its appreciation of the effect of L_D on health.

[17]The term "persuasion" is used here to mean not whether the consumer "believes" that there is an effect of an X or L on his or her health but that she is willing to change her behavior in accordance.

fixed. Let A_D and $,_D$ denote the values of A and , with respect to time allocated to housekeeping labor.[18] Then the equilibrium allocation of time is given by the equation

$$(5) \qquad \frac{MU}{MH}\frac{MH}{ML_D}(A_D - ,_D) = \frac{MU}{ML_D} = \frac{MU}{ML_E}$$

The left hand side of equation (5) is total marginal utility of household labor, and the right hand side the marginal utility of leisure; for a given level of outside work, an increase in $A_D - ,_D$ will raise the right hand side of equation (5). To maintain equilibrium, the right hand side has to rise as well, meaning moving to a position where the marginal utility of leisure is higher which can only be achieved by consuming less of it.

Other elements also affected the allocation of time to household labor. A decline in the birth rate reduced the number of children the average household had to care for, but the rise in quality standards for child care, nutrition and education, and a decline in intersibling care may have more than offset this effect. One direct effect of the increase in child quality is the likely increase in the term MU/MH as far as children are concerned. In other words, when the emphasis shifted from child quantity to quality due to declining birth rates, mothers naturally became more concerned about the health of their children simply due to the fact that they had fewer of them. Furthermore, a possible exogenous increase in MU/MH due to a greater concern for children cannot be ruled out. A "changing concept of childhood" is a notion most often connected with the work of Philippe Ariès although he sees the turning point in attitude to children at an earlier time.[19] However, the idea that children were worth protecting and nurturing became central to reformers of the late 19th and early 20th century. Limiting children from work in the factory, providing them with a proper education, and keeping them healthy were intertwined with the fertility decline and the mortality trends. This trend may have been reinforced by ideological forces: the Eugenicists and Social Darwinists in the late 19th century propagated the belief that better

[18]Note that L_D can be spent on many different chores, and that the effect of each chore on H may be quite different. We are assuming here that the marginal effect of health work is equalized along the various chores, that is, housework is allocated efficiently.

[19]The literature on the emergence of a modern concept of childhood is summarized in Pollock, *Forgotten Children*, chs. 1-2. The upshot of this literature is that an acknowledgment of childhood as a unique phase in human development did occur, but scholars have been unable to agree on exactly when the transition occurred. It seems a consensus view that it occurred later for the working poor than for the educated and better-off urban classes. More recent writings have pointed toward a fundamental change in the last quarter of the 19th century. For example, see Steedman, "Bodies"; and Hopkins, *Childhood Transformed*. As working class children changed from being workers to being pupils, compulsory education laws and kindergarten movements combined with child labor law reform to enact a basic shift in what childhood was. In addition, Hopkins (*Childhood Transformed*, p. 315) sees evidence of a broader evolvement in the attitudes of parents towards their children within a decline in the brutality of child punishment, a process that has been described as the "sacralization" of children. See especially Zelizer, *Pricing the Priceless Child*.

children would improve their "race" (by and large whites, Anglo Saxon, middle class). This ideology pressured mothers to protect the health and mental well-being of their children at all costs. Fears of declining "national efficiency" were fueled by the realization that infant and child mortality rates in the closing decades of the nineteenth century were remaining high in the face of declining general mortality.[20]

The impact of such an increase is proportional to $[(A - ,)* MH/ML_D]$. That is to say, mothers who become more concerned with the health of their children will work harder at home *only to the extent* that they believe that such efforts will actually have an effect on the children's health. An increase in the productivity of household labor in producing health (MH/ML_D) is likely to increase the amount of labor allocated to it, as is a decline in the arduous nature of household work (a decline the absolute value of the negative term MU/ML_D in equation (5). Furthermore, as already noted, rising incomes and increased consumption do not lead to an unambiguous change in household work. Thus an increase in labor saving household technologies such as the microwave oven may actually increase housework if it leads to the purchase of microwaveable foods replacing take-out food rather than the substitution of easily-cooked food for more arduous recipes. The same may be true for washing machines and the use of personal computers in teenage education. It is also possible that homemakers increased their appreciation of cleanliness for its own sake, and that as a normal good the demand for it increased with income. But leisure was a normal good as well, and the net change in time allocation depended on the respective income and substitution effects. Moreover, an increase in women's market wages by itself would have affected the demand for both leisure and household work negatively (assuming substitution effects dominate income effects).

Results from modern cross sections confirm that there is no clear-cut connection between time spent on housework and income, nor -- more surprisingly -- do they show any significant correlation between it and the ownership of labor saving household appliances. The only good predictors were whether there were small children in the family and the employment status of the mother. The conclusion drawn by that literature is that there is a causal relation running from outside employment to the number of hours spent on housework. On the

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[20] Indeed the blame intensified with doubts about the military capacity of British males in the Boer War. See Dwork, *War is Good*, ch. 1; and Lewis, "Family", p. 3. Lewis (*Women*, p. 81-85) concentrates on the effects of evolutionary theory in solidifying the role of women in housework in the late 19th century, and the implications of these intellectual trends on female education are tackled by Dyhouse, "Social Darwinistic Ideas." Reflecting this growing concern about infants and children was George Newman's work, widely read on both sides of the Atlantic. He was a key figure in shifting the blame for infant mortality from physical environment to the socio-economic conditions and the individual. For him, infant mortality as a *national* problem was based on the conditions of motherhood.. "This book would have been written in vain if it does not lay the emphasis of this problem upon the vital importance to the nation of its motherhood", he notes, though unlike some of his contemporaries he full-well realized that poverty and the lack of education constrained what individuals could do. Newman, *Infant Mortality*, p. 257. See also Meckel, *Save the Babies*, p. 99-101.

supply side of the labor market, the exogenous variable that may have mattered most was the beliefs and priors of individuals about the effect of housework on their health (and other variables not discussed here such as the approval of friends and neighbors) that determined the entire allocation of time between leisure, housework and wage labor.[21]

The framework described here is simplified in many ways. It abstracts from the historical reality in that it makes no distinction between the household and the individual. In the actual historical experience, households made decisions and allocations that affected its members in different ways, and complex bargaining may have been involved to determine how the X's would be allocated. This is especially important because the new recipes of cleanliness and good housekeeping tended to be costly in terms of time, but this time-cost was disproportionately born by women. There may be a difference in the identity of the person whose beliefs are incorporated in equation (3) and the person who carries out the work. In other words, the L_D may be supplied by a *different* person than this person whose , appears in equation (3). If different members of the household disagree about ,, it is far from clear how to aggregate the different values of the H^e 's and thus how the actual decisions are made.[22] This is compounded by the nature of H itself: rather than a composite variable, it really is a matrix of variables, with a vector of health characteristics defined for each member of the household. How one trades off the health of one member against another remains an intra-household bargaining problem.

There are, however, deeper difficulties with the neoclassical approach advocated here. The entire structure of the household decision-making model needs to be specified in probabilistic rather than deterministic terms. Consumption and housework affect the conditional probabilities of disease and mortality. Whether households can form accurate perceptions of these probabilities and can thus optimize their behavior if only provided with the correct knowledge is unclear. The work by Kahneman and Tversky, controversial as it may be among economists, suggests at the very least that there are serious psychological difficulties that individuals experience in assessing differences in conditional probability leading to consistent and serious biases in the assessment of the F's in equation 3 above. The probabilities remain subjective and have often alarmingly diffuse

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[21]Robinson, "Housework Technology." Vanek ("Time Spent") reports that non-employed women spent 55 hours weekly on housework compared to the 26 spent by women employed outside the home. It might be added that this model precludes "cleanliness" itself from being in the utility function, which is of course unrealistic. Accounting for it would add another term to the left hand side of equation 5. It seems difficult, however, to distinguish between a change in preferences favoring cleanliness and one that is induced by changes in information. The advantage of the latter is that there are good reasons to believe it happened, whereas changes in preferences are always a weak reed for profound historical changes.

[22]Interestingly enough, recent work on intra-household bargaining deal with cooperative and non-cooperative solutions to the consumption of common ("public") goods on which the members have different preferences, but do not deal with the possibility that they may have different views on *how* common preferences are to be achieved. See Lundberg and Pollak, "Bargaining."

prior distributions. Low probability events are often either under- or overestimated by consumers depending on how the matter is brought to their attention; large-probability risks are systematically underestimated. There is abundant evidence that most people use "judgmental rules" or "heuristics" to assess these probabilities, which at times lead to erroneous inferences.[23] Modern writers about household practices describe the state of knowledge among housewives about hygiene as "a general state of vague anxiety ...even the dismissive doubters are rarely absolutely confident of their position."[24]

A further difficulty in applying rational choice modeling to household work is that it involves dynamic decisions, that is, benefits (or the avoidance of pains) in the future are compared to costs at the present, and thus relies implicitly on discounted utility models. While such models are widely used in economics, they have weak empirical and theoretical foundations in psychology. It is well-known that time consistency requires very special (exponential) forms of discounting and that quite often discounting asymmetries are observed, that is, future benefits and future pains are discounted at time-dependent rates. Furthermore, as Thomas Schelling has noted, there is a universal problem of self management, to behave the way one has resolved to behave for the sake of future benefits, which must be all the more acute for homemakers who do not face acute competitive pressures to discipline them into best-practice choices.[25] Self-discipline for homemakers was reinforced through education, propaganda and other methods of persuasion. The issue is further complicated by the feedback from health to discount rates (as life expectancy went up, discount rates should have fallen). All the same, for many of the infectious diseases of the late nineteenth century, the lag between act and penalty was sufficiently short to make discounting a secondary issue -- in contrast with modern afflictions such as cancer and cardiovascular diseases.

Three Scientific Revolutions

In the past two centuries household behavior has been affected by science far more than has been

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[23]A good introduction can be found in the papers in Kahneman, Slovic, and Tversky, *Judgment Under Uncertainty*. Among those errors noticed in modern studies are the tendency to attach a higher probability to an explicit event than to a non-specified one and people's tendency to perceive correlations (and then infer causality) where none exists. See Redelmeier et al., "Probability"; and Redelmeier and Tversky, "On the Belief." For examples of systematic underestimation of risk, see Viscusi, *Smoking*, pp. 22-4 and sources cited there. In regards to the utilization of "judgement rules" and "heuristics" in making erroneous inferences, see Slovic, Fischoff, and Lichtenstein, "Facts vs. Fears." The psychological literature has long noted that individuals tend to overweight "salient" information that is conveyed to them in a particularly vivid and effective manner. Especially if the health effects of unsanitary behavior follow rather quickly (as is the case with many infectious diseases), the way the information about germs was communicated to the working classes may have led them to consistently err in the direction of over-cleaning and working harder in homework than is warranted. Ross and Anderson, "Shortcomings."

[24]Horsfield, *Biting the Dust*, p. 171.

[25]For details, see the essays in Loewenstein and Elster, eds., *Choice over Time*.

realized.[26] This is not necessarily because science is "right" but because scientists have increasingly influenced the way common people have thought about the natural world, and not just informed them of one fact or another.[27] Scientific knowledge was generated of course by a few men and women who pushed the best-practice technique *A* forward. Increases in *A* were followed by changes in individual behavior, that is, declines in , , the gap between best and average practice techniques. Describing what exactly households knew and believed and how they were persuaded to change their behavior through persuasion is of course a complex task. As a general proposition, however, the decomposition proposed in equation (3) suggests that two elements can be examined separately: the better knowledge that people in authority possessed about disease and health, and changes in the influence that they exerted on daily consumer behavior and household recipes.

Three major scientific revolutions affected the value of A in the past two centuries. The first was the sanitary and hygienic movement that began after 1815, picked up enormous momentum between 1830 and 1870 and swept the later Victorian era, leading to a widespread if unfocused war against dirt under the vague perception that dirt and disease were correlated.[28] The war against filth, which had of course eighteenth century roots, drew strength above all from the statistical revolution that grew out of the enlightenment and led to the development of nineteenth century epidemiology. It provided data supporting the close relation, long-suspected, between consumption patterns, personal habits, and disease. The statistical movement presented one way out of the household's logical dilemma: how can an individual verify that a given recipe affects the health of the members without being able to carry out an experiment in laboratory conditions? Even today, inferences from large samples have remained the logical foundation of much research in epidemiology and public health.

The roots of this movement went back more than a century, especially to the debates around the efficacy of the smallpox inoculation procedure, the beneficial effects of breastfeeding, and the bad effects of miasmas (putative disease-causing elements in the atmosphere). But its persuasive force was vastly extended by the

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[26]The Mitchell quote at the heading of this paper is one example. Margaret Reid's otherwise perceptive book notes that "Scientific guides are absent. Nor can one learn readily from experience... the effect of [the homemaker's] mistakes is not clear-cut and decisive and as a result they continue to be repeated...The housewife finds it impossible to evolve "best" methods for herself and almost if not quite impossible to keep informed of scientific findings which would aid her in her various tasks." Reid, *Economics*, pp. 173, 193. Modern scholars such as have taken exception to this view. Good examples include Tomes, "The Private Side" and *The Gospel of Germs*.

[27] As biologist Richard Lewontin has observed, "the reason that people do not have a correct view of nature is not because they are ignorant of this or that fact about the material world but that they look to the wrong sources in their attempt to understand it." See Lewontin, "Billions and Billions."

[28]For some insights in the emergence of the statistical method in post 1830 Europe, see especially Porter, *The Rise of Statistical Thinking*; Eyler, *Victorian Social Medicine*; Gigerenzer et al., *The Empire of Chance*; Coleman, *Death*; and Cullen, *The Statistical Movement*.

growing interest in statistics and the analysis of what we today would call "data" dating to the decades after 1815.[29] The founding of the Statistical Society of London in 1834 led to an enormous upsurge in statistical work on public health. In Britain, William Farr, William Guy, and Edwin Chadwick were the leaders of this sanitary movement, but it encompassed many others.[30] On the Continent, the leaders of the statistical movement included such notables as Adolphe Quetelet, René Villermé, and Charles-Alexandre Louis clustered around the *Annales d'hygiène Publique*. The connection between the sanitary movement and the statistical revolution was fundamental to the changes in the perceived health effects of consumption and behavior. Between 1853 and 1862 no less than a quarter of the papers read before the Statistical Society of London dealt directly with public health and vital statistics.[31]

Much of the statistical work of the sanitary movement was concerned with the correlates of the incidence and virulence of specific infectious diseases. As such they were meant not only to persuade (reduce ,) but also to increase knowledge (increase *A*). Statisticians looked for empirical regularities in the geographical, seasonal, and social patterns of major illnesses in an attempt to find the etiology and transmission mechanisms. Often they were led to blind alleys and clutched at statistical artefacts, but their search for regularities led to advances in epidemiology and public health with profound implications on the practice of preventive medicine. Among the great triumphs of this methodology were the famous discoveries of John Snow and William Budd in the 1850s that water was the transmission mechanism of cholera and typhoid, as well as much less renowned discoveries such as the incrimination of milk as a carrier of diphtheria in 1878 from correlating the incidence of the disease with milk-walks.[32] In Germany, the great founder of modern physiology, Rudolf Virchow, called for more medical statistics: we will weigh death and life and see where death lies thicker, insisted Virchow. Early Victorian Britain witnessed the transformation of 18th century Political Arithmetic into a body of knowledge which combined a quantitative approach with social reform. Systematic empirical observations allowed observers, notwithstanding erroneous theories, to draw the correct policy implications for the wrong reasons -- another parallelism between technological change and medical progress. Hudson indeed notes that

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[29]For the roots of the movement, see Rusnock, "The Quantification"; and Riley, *The Eighteenth-Century*. The growth of the movement's persuasiveness is well-documented in Headrick, *When Information Came of Age.*

[30]For details see especially Flinn, "Introduction."

[31]Many social reformers and activists such as Henry Mayhew and Florence Nightingale were life-long and enthusiastic members of the Statistical Society. See especially Wohl, *Endangered Lives*.

[32]Hardy, *Epidemic Streets*, p. 90.

the "Great Sanitary Awakening" after 1840 was a remarkable but not unique example of doing the right thing for the wrong reasons.[33]

The second breakthrough of the nineteenth century, or in terms of our notation, increase in *A*, was the germ theory of disease. It is important to stress that bacteriology was more than just a way of attributing certain symptom to certain microorganisms. The germ theory provided an entirely new concept of what disease was, how it was caused, how to differentiate between symptom and cause, and how infection occurred. As is well-known, the germ theory was not quite "invented" in the decades after Pasteur's famous work on silkworm disease. It had been proposed repeatedly since the sixteenth century, and in 1840 Jacob Henle revived the theory in Germany. The theory remained, however, on the fringes of medical science and in the following decades Henle was regarded by the medical profession as fighting a "rearguard action in defense of an obsolete idea."[34] The emergence of the germ theory after 1865 should be regarded above all as a victory of scientific persuasion in which a number of brilliant scientists were able to combine scientific insights with considerable academic prestige and a good understanding of how power and influence in the scientific community work.[35] Most important, it was largely based on an experimental method widely touted to be a failsafe way of unearthing "truth" and thus accepted by increasing numbers of people with the same blind faith previously reserved for religion. Rhetorically, then, it was knowledge that powerful and persuasive even if many of the details remained highly controversial for many decades.

In terms of its direct impact on human physical well-being, the victory of the germ theory must be counted as one of the most significant technological breakthroughs in history. The bacteriological revolution heralded a concentrated and focused scientific campaign to once and for all identify pathogenic agents responsible for infectious diseases. Between 1880 and 1900 researchers discovered pathogenic organisms at about the rate of one a year, and gradually established many of the transmission mechanisms, though many mistaken notions survived and a few new ones were created. The age-old debates between contagionist and anticontagionists and miasma vs. anti-miasma theories slowly evaporated, although the belief that "bad air" was some-

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[33]Virchow cited in Rosen, "What is Social," p. 684. Hudson, *Disease and Its Control*, p. 179. Even those who resisted the new science often made life-extending recommendations: the influential German physician Max Pettenkoffer fought the microscopic theory of disease tooth and nail, yet advocated radical public health measures to prevent the spreading of infectious disease in the city of Munich. As late as 1900, eighteen years after the discovery of the tubercle microorganism, a prominent British physician recommended improving the homes and living conditions of the working classes to reduce the incidence of tuberculosis, yet added that "the insane hunt after the tubercle bacillus is the insanest crusade ever instituted on illogical lines" (cited by Wohl, *Endangered Lives*, p. 131).

[34]Rosen, *A History*, p. 277.

[35]Latour, *The Pasteurization*.

how responsible for diseases such as diarrhoea was still prevalent in the 1890s. The refutation of the Aristotelian notion of "spontaneous generation" of life from lifeless matter by Pasteur demonstrated that bacterial infection was contracted exclusively from a source outside the body. Control the transmission channels, and one can control disease. Tomes points out that perhaps the most shocking discovery was Koch's identification of the tubercle bacillus (1882), which changed the outlook on one of the great scourges of Western civilization, which had hitherto believed to be hereditary and beyond the control of humans.[36] A middle class belief in cleanliness and hygiene was not novel, but the new bacteriology provided it with focus and accuracy, and because it *was* effective it was persuasive and the recipes it implied spread to large segments of the population.

In terms of our model, we can regard the discoveries as a sudden leap in the value of *A*. Best practice techniques change when the nature of a particular disease and its transmission is clarified. To be sure, there is a difference between the discovery of a pathogenic microorganism responsible for a disease and the recipes implied by it. However, once it is clear which microbe causes a disease and how it is transmitted, the means of prevention become easier, and the recommended adjustment in behavior can be inferred.[37] The discovery of the HIV virus in 1984 had a comparable effect. Yet recall that in terms of earlier notation any discovery in and of itself initially leaves A-, unchanged (that is, , rises at first to match the increase in *A*). It is only when the new knowledge is disseminated to the population and when the public is sufficiently persuaded by it to alter its behavior, that the value of , starts to decline, consumption and time-allocation behavior is modified, and mortality declines.[38] The decline in , is closely related to the persuasiveness of knowledge, that is, people's willingness to act upon it. The experimental methods deployed by the bacteriologists coupled to the tabulations of the statisticians created a powerful assault on age-old prejudices and customs about what made people ill. Moreover, the paternalism of the educated classes and the greed of commercial salesmen created an apparatus that diffused the new knowledge rapidly among the working classes in the industrialized West. While the

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[36]Tomes, *The Gospel of Germs*, p. 113. It is precisely this aspect of the germ theory that refutes Latour's (*The Pasteurization*, p. 23) view that without the Pasteur revolution the "hygienists" would still have achieved essentially the same results. Indeed one scholar puts it well when he says that whereas "Miasma was entirely concerned with breath and fetidity, the microbe ... became a more precise cause which could be both located and logged ... the microbe thus materialized the risk and identified it. Hence the new role of cleanliness." Vigarello, *Concepts*, p. 201.

[37]A powerful example of this is the idea that diseases were transmitted by vectors. Like the germ theory itself, the model itself had been proposed a few times before, but the work of Patrick Manson, Ronald Ross, and G.B. Grassi demonstrated the culpability of the *anopheles* mosquito in the 1890s and in 1909 Charles Nicholl discovered the louse vector of typhus, five years before the causative germ itself was isolated. These discoveries were decisive in persuading households how such diseases were contracted and focus the efforts to prevent them on insect control. See Rogers, "Germs with Legs."

[38]See Mokyr and Stein, "Science, Health and Household Technology"; and Mokyr, "Technological Progress," "La tecnologia," and "Technological Selection."

absorption of the full behavioral implications of the germ theory took decades to complete, what is surprising is how relatively quick and complete its triumph was by 1914, delivering sharp declines in infectious disease decades before the introduction of antibiotics.

The long-run implications of the new bacteriology were first outlined by George Rosen but are worth re-stating: responsibility for the health of household members was shifted from Providence or "fate" to the homemaker. Diseases were controllable and preventable provided households changed their behavior and infant morbidity or mortality, if it occurred, was to blame on the homemaker.[39] While it was recognized that because of certain imperfections such as local public goods and the externalities associated with epidemics there remained a role for the public sector, this role was from now on circumscribed: public health shifted from an environmental view of health and disease to a behavioral one in which the habits of the individual became the focus of health policy.[40] Proper childcare, domestic and personal cleanliness, and adequate nutrition were properly regarded part of household choice and were not incompatible with poverty. The poor did not get sick because they were poor, but because germs infected them. Eliminate the germs and you will have healthy poor (as long as their incomes does not fall below a level where their physical well-being cannot be supported, hence the idea of a poverty line). Homemakers had to be persuaded that they were the primary guardian at the household gate, armed with mop and sponge, charged with keeping out the microscopic enemy. Mrs. Plunkett spoke for a new set of beliefs when she wrote in 1885 that "the full acceptance of the germ theory of contagious disease shows exactly where to combat it. Destroy the seed, you prevent the crop, and where this is impossible the next best thing to do is the neutralize the conditions of their growth."[41] Yet by 1885 the new knowledge was still concentrated among a few educated men. How to spread this knowledge to the masses so as to reduce their lag behind "best-practice knowledge" and have them implement the recipes implied by the new bacteriology?

To bring this about, a new science had to be invented, domestic science, and its lessons taught to the masses. Home economics became committed to the home as a microbial environment and the need to teach

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[39]Rosen, "What is Social Medicine?" p. 675. This point is made in some detail by Ball and Swedlund, "Poor Women." It should be stressed, however, that without the changes in medical knowledge it is hard to understand why this sudden change in the assignment of responsibility. Proper childcare, domestic and personal cleanliness, and adequate nutrition were no longer the domain of policy measures since they were not incompatible with poverty and were regarded part of household choice. The poor did not get sick because they were poor, but because germs infected them. Eliminate the germs and you will have healthy poor. The responsibility of homemakers to keep the domestic environment germ-free is the main logical pre-requisite to "blaming" inadequate maternal care for the high infant and child mortality rates that still plagued the United States and Britain by the late nineteenth century. See also Meckel, *Save the Babies*, pp. 92-123 and Tomes, *The Gospel of Germs*, pp. 65-66, 150-54.

[40]Rogers, *Dirt and Disease*, p. 16. See also Brown, "Coping with Crisis?"

[41]Plunkett, *Women*, p.164.

women to control it. Ellen Richards, the pioneer of home economics in the United States pointed out that “when a pinpoint of dust could yield three thousand living organisms, not all malignant but all enemies of health, cleanliness was a sanitary necessity of the twentieth century whatever it may cost." To be sure, this rhetoric, as Ehrenreich and English point out, meant that science acquired a certain moral force.[42] But at bottom, the transformation was not moral or religious but about perceptions and understanding how the world worked and how and why people got sick. The moral and religious force behind it became part of the persuasion mechanism although it acquired a life of its own, eventually intersecting with related social movements such as temperance.

The speed of the transition should not be overstated. Many of the exaggerated nineteenth century recommendations to avoid odors and to maximize sunlight and ventilation survived for many decades. Mrs. Plunkett's book provided an example of a work well-aware of the bacteriological advances of her age, yet at the same time reproduces advice inconsistent with it and recounts tales reflecting miasma theory. As late as the 1920s, household manuals railed against "sewer gas" as much as they did against deadly germs.[43] The triumph of the new recipes in displacing less effective older ones at the household level was not nearly as fast and thorough as we imagine happens in production technology when a truly superior technology comes up. Indeed, the survival today of "alternative" medical paradigms such as homeopathy, chiropractice, herbal medicine, and similar approaches suggests that the victory of "modern" medicine is far from complete even today and that there remains considerable uncertainty about best practice recipes. It was a lot worse in the years 1870-1914. In part, the problem was with the science itself. Bacteriology took decades to become a coherent body of knowledge and until the insights of immunology came along, it remained unclear why some infected people did not get sick, as Shaw’s *The Doctor’s Dilemma* illustrates.[44]

Furthermore, the slow rate of adoption and the disagreement reflects the further difficulty in the practical application of bacteriology to household decisions. Even when it was wholly understood how impure drinking water could transmit disease, it was not clear how to define standards for purity and how to go about achieving those. Even more difficult was the issue of clean milk: while the dangers of possible infection through

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[42]Tomes, *The Gospel of Germs*, p. 136. Ehrenreich and English, *For Her Own Good*, p. 66. Ellen Richards cited by Hoy, *Chasing Dirt*, p. 153. For some insightful papers on the evolution of Home Economics, see Stage and Vincenti, *Home Economics*.

[43]Tomes, "The Private Side," p. 538.

[44]B.B. *Though the germ is there, it's invisible...can you for instance show me a case of diphtheria without the bacillus?*
Sir Patrick. *No, but I'll show you the same bacillus without the disease, in your own throat.*
B.B. *No, not the same, Sir Patrick. It is an entirely different bacillus; only the two are so exactly alike that you cannot see the difference.* Shaw, *The Doctor's Dilemma*, p. 23.

milk were increasingly understood, the "right" choices (boiling, pasteurization, breast- vs bottlefeeding) were a source of great confusion deep into the twentieth century.[45] It is also worth stressing that acceptance of the germ theory was not a necessary condition for a belief in hygiene: from Florence Nightingale to Max von Pettenkoffer, leading sanitarians rejected the new gospel of germs and yet preached cleanliness.

The third revolution consisted of scientific advances in nutritional science. The discovery of vitamins and minerals and their effects on the body and the growing awareness of health benefits and risks in various consumer goods and environmental factors.[46] The increase in the demand for fresh fruits and vegetables, for example, was in part fueled by the realization of the beneficial effects of "an apple a day." Some crippling diseases such as rickets, pellagra, and scurvy were shown in the years around World War I to be related to trace elements in the diet. The realization that a "good diet" did more than just preventing bacterial infection by preventing nutritional deficiencies, and that the best defense against infectious disease -- the human immune system -- was sensitive to diet and temperature, heaped even more responsibility on the homemaker's already overburdened shoulders. Later on, however, the possibility of supplying the necessary nutrients through such market-purchased goods as cod liver oil and multi-vitamin pills worked in the other direction. With the decline of infectious and nutrition-deficient disease in the 1930s, non-infectious diseases took their place as the main causes of morbidity and mortality and as they are almost as poorly understood as infectious diseases before 1860, empirical regularities -- albeit backed up by larger samples and far more sophisticated statistical techniques -- are once more becoming a major selection mechanism between competing recipes.

Antibiotics completed the war against infectious disease by the invention of effective cures against them. The introduction of antibiotics after World War II removed the responsibility for health partially from the household and transferred it to experts who exercised a monopoly on the wonder substances that took over the war against microbes. From an economic point of view this meant that H increasingly became a function of a set of "pure" health goods that conveyed health exclusively rather than as a by-product of the consumption of other goods and the production of cleanliness. The loss-function of contracting an infectious disease shifted: whereas

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[45]On the debate around impure drinking water, see Hamlin, *The Science of Impurity*. On milk, important works are Dwork, *War is Good*; and Apple, *Mothers and Medicine*.

[46]Of particular interest to the kind of argument I am trying to make here is the example of scurvy. The empirical regularities that pointed to its cause were already unearthed by Edward Ives and James Lind in the mid eighteenth century. Yet scurvy kept reappearing during the Irish Famine, the Crimean War and the Russian army during World War I. Infantile scurvy was prevalent among wealthier families in which weaning occurred at a relatively early age. The discovery of the germ theory led to decades of futile search for a causative microorganism. Only after the seminal papers by Holst and Fröhlich after 1907 did it become clear that certain diseases were *not* caused by infectious agents but by nutritional deficiencies, and only in 1928-32 was the crucial ingredient isolated. See Carpenter, *The History of Scurvy*; and French, "Scurvy."

in the 1920s and 1930s contracting an infectious disease could have serious consequences and therefore should be avoided at all cost, in more recent times standards of cleanliness may have been allowed to slip to some extent because it gradually became clear that infectious disease could be cured with antibiotics. In this regard, of course, changes in medical technology could partially explain the recent decline in housework.[47]

Changes in Household Behavior

How did these three breakthroughs in best-practice knowledge affect household recipes and persuade homemakers to change their choices and allocations? In a set of pioneering papers, feminist writers such as Ehrenreich and English, Strasser, and Carol Thomas explained what they saw as the increase in housework (which Thomas regards as an important source of reduced mortality) through the internal dynamics of changes in capitalist production during the second Industrial Revolution. With rising wages and a reduced work week, she argues, women were increasingly relegated to home-making as the result of an increasingly rigid sexual division of labor. The assumption underlying this interpretation is that following the gradual disappearance of domestic production in the nineteenth century, women had lost their economic function.[48]

This argument has been effectively challenged by Bourke who has pointed to the growing economic significance of housework at this time, which in her view was seen as a way of improving living standards. She insists that the growing specialization in the household was a conscious choice made at a cost, but the benefits perceived were "cheap at the price." In any event, such an explanation would be incomplete without noting the rapidly changing notions of disease and health driving the perceived benefits.[49] Industrialization happened to coincide with a major revolution in the way individuals in the Western World came to think of their health and the interaction of their bodies with their environment. The revolution was not just in the way physicians thought about disease, but in the growing awareness that households could control their destinies by their own actions, and prevent disease by avoiding certain well-understood sources of infection. Women were, from the beginning, to be in charge not so much because there was nothing else for them to do, but because it was inherent in the

[47]It is not possible to test rigorously Hoy's answer to the question: "are we as clean as we used to be?" which is "probably not." Hoy, *Chasing Dirt*, p. 179).

[48]Strasser suggests that during the "transition to industrial capitalism" women had no clearly defined role in the new order and Ehrenreich and English propose the fanciful concept of a "domestic void" created by commercialization of consumer good production. Ehrenreich and English, "The Manufacture of Housework"; Strasser, "An Enlarged Human Existence"; and Thomas, "Domestic Labour," especially p. 339 where she discusses the increased rigidity of the sexual division of labor.

[49]Bourke, "Housewifery," p. 177.

nature of the concept of gender in Western societies that they would become the protectors of health. In the early 1880s, the President of the British Medical Association said that “It is the women on whom full sanitary light requires to fall. Health in the home is health everywhere; elsewhere it has no abiding place” and while “the men of the house come and go, the women are conversant with every nook of the dwelling...and on their knowledge, wisdom and skill the physician rests his hope."[50] The existing domestic functions of women and the growing perception of the importance of housework on health mutually reinforced each other to produce a growing specialization of the genders within the household.

The contribution to the resolution of the Cowan conundrum proposed here is that the health-related demand for L_D rose, through either a rise in MU/MH (the marginal utility associated with good health and longevity) or a rise in A-, in equation 3. The rise in the marginal utility of H was in part an income effect, because health and longevity are more appreciated in richer societies. The primary effect, however, was that large segments of the population in the past century acquired more knowledge and understanding about the connection between what they consume and their health. As a consequence homemakers spent more time cleaning, nursing, laundering, cooking, and looking after their children because they had become convinced that the health of the members of their household was under their control and part of their responsibility. They had been persuaded that wholesome food, clean clothes and bedsheets, breastfeeding, and a hygienic environment were critical variables in the determination of good health and longevity.[51]

In any event, the demand for domestically produced health increased significantly in the past century because of big changes in household knowledge: there can be no demand for a germ-free house or germ-free clothes unless people know and believe that germs cause disease. In that regard the three revolutions affected household behavior directly. It would be naive to recount it in terms of a Whiggish tale of growing enlightenment and rational choice of recipes following the triumphs of science. The relation (3), which defines household behavior, is determined by its *priors*. Consequently our story has to be about more than just the changes in A, which are recounted in competent histories of medicine and public health. Instead, we need to look at , ,

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[50]Cited by Plunkett, *Women*, pp. 10-11. This revolution in the way people thought of health is advanced in Easterlin, *Growth Triumphant*. The gender-specificity of the burden created within these developments is discussed by Cowan, *More Work*; and Thomas, "Domestic Labour."

[51]It would also explain an increase in breastfeeding, although the improvements in baby formula and milk quality since the early 1900 tended to offset this. It should be realized that most of the early breastfeeding campaigns emphasized the clean nature of mother's milk and were not aware of its additional immunological and psychological benefits. Dwork (*War is Good*, p. 36) maintains that as late as the early twentieth century, while it had been recognized for many decades that breast-feeding was the most effective preventive measure against lethal attacks of childhood diarrhoea, "the precise reason for this was absolutely unclear." The statistical evidence seemed irrefutable, but the mechanisms poorly understood.

that is, focus on the question of how individuals, especially women, were persuaded by outsiders to change their behavior and allocate more time to housework than they would otherwise have. Persuasion of this kind took many forms, of course. Some of it was simply imitation, either horizontal (through looking at neighbors and relatives) or vertical (through the emulation of one's social superiors). Some of it was social pressure to conform to certain customs and social standards that had taken root. Middle class notions of a culture of respectability were a subtle means by which concepts of proper housekeeping were diffused through the working class.[52] But quite a bit occurred through the direct and deliberate brainwashing of the population at large after a small elite of educated, politically powerful and socially influential people had persuaded itself it knew the right way or stood to gain from it.

The statistical revolution came first. Much of the sanitary movement was persuaded and motivated by its findings. It is easy to underrate the rhetorical power that statistics lent to the spread of hygiene. Literally hundreds of tracts, newspaper articles, pamphlets, lectures and government reports on the new quantitative approach to health were published in the nineteenth century, all pointing to the direction of improved health if the consumer chose to practice the rules of cleanliness. Statistics were used to persuade the masses directly, but more commonly, they persuaded people of authority in key positions to influence others. Statistical regularities were disseminated by influential people: the Metropolitan Health of Towns Association was founded in 1844 to "diffuse among the people the valuable information elicited by recent inquiries and the advancement of science [and] the physical and moral evils that result from the present defective sewerage, drainage, supply of water, air, and light, and construction of dwelling houses."[53] The rhetorical impact of statistical knowledge was considerable. Chadwick's famous 1842 report, "a masterpiece of persuasion, subtly blending fact and fiction" is only one example of this power. Although Chadwick's work may have been theoretically flawed, his use of statistics lent his report persuasive weight.[54] The nature of statistics and data of an aggregative nature should not be judged by today's more exacting standards. Much of the statistics

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[52]See Lewis, *Women in England*, pp. 30-31.

[53]Among its early members were T.R. Malthus, Charles Babbage, Earl Grey, Disraeli, Bulwer Lytton and the Earl of Shaftesbury, a leader of the factory reform movement. Wohl, *Endangered Lives*, p. 144. The Manchester Statistical Society (founded in 1833) contained primarily members of the industrial and commercial bourgeoisie, people who in many ways were social models, to be followed and emulated by their lessers.

[54] Chadwick cited by Cullen, *The Statistical Movement*, p. 56. Statistical fallacies were not of great import, and some of the finer points were lost in the rhetorical noise. Thus, Chadwick used average age at death to drive home his point that poorly drained and congested urban areas had far higher mortality rates than other regions. Cullen points out that already at the time it was realized that this particular statistic is sensitive to the age structure and thus a poor proxy for life expectancy at birth; yet this fine point ignores the more important one that Chadwick was able to drive home a clear-cut association of health with sanitary conditions.

consisted of tabulations in which "numerators came from the registration materials and the denominators from the census."[55] There was little consciousness that correlation did not imply causation, that there was a need to hold some factors constant to isolate the net effect of each variable, no awareness of the problems of multicollinearity, omitted variables, and specification bias. Yet it allowed inferences, however crude, by increasing the sample size beyond the individual experimentation space. Faced by this growing sense of statistics, medical practices and household decision makers began to re-examine age-old beliefs and practices, including childcare, drinking water purity, hygiene, and nutrition. Chadwick was clearly aware that "domestic mismanagement" as he called it was a "predisposing cause of disease." He cited with approval a set of reports that maintained that workers's wages would have been sufficient to supply the domestic comforts that would keep them in good health, but that these funds were spent "viciously or improvidently" and that "thoughtless extravagance" prevailed in their consumption habits.[56]

The empirical regularities discovered by the statisticians reinforced earlier middle class notions that cleanliness enhances health.[57] By the middle of the nineteenth century, these notions were filtering down vertically through the social layers of society. Once the scientists and statisticians had persuaded the literate and educated public, well-meaning organizations run by middle-class ladies such as the British Ladies' National Association for the Diffusion of Sanitary Knowledge (founded in 1857) took over the task of persuading the masses of the merits of the new domestic sanitary science. Between 1857 and 1881 this Association distributed a million and a half tracts loaded with advice on pre- and postnatal care, made millions of house-visits, and spread the gospel of soap and clean water, and the evidence is that in the late Victorian period the poor were receptive to these volunteers. The Association also published tracts on diet, and taught cooking classes and campaigned to have cooking taught in elementary schools. At a later stage, statistics and numbers were used with powerful effect on the masses directly. Contemporary pamphlets used statistical rhetoric to underline

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[55] Eyler, *Victorian Social Medicine*, p. 68. William Farr, one of the founders of the statistical movement in Britain, wrote to Florence Nightingale in 1861, "We want facts ... the statistician has nothing to do with causation, statistics should be the dryest of reading." Cited in Porter, *The Rise of Statistical*, p. 36.

[56] Chadwick, *Report*, pp. 204-05.

[57] Sheila Johansson ("Death and Doctors") has argued that the decline in the mortality rates of the British aristocracy after 1700 indicates that some of the knowledge that helped prevent infectious diseases preceded the sanitary movement. This could be the case for smallpox, and possibly childhood diarrhoea, as well as for the ability of the very wealthy to choose better values of E in equation (3) -- that is, to choose to live in low exposure environments.

especially one crucial recipe, the importance of breast feeding.[58]

All the same, even when the statistical evidence is so abundant as to be overwhelming (as is the case with smoking in our own time), the rhetorical strength of statistical logic is limited. Statistical evidence is potentially unpersuasive because of the well-known pitfalls of sampling biases, omitted variables and identification errors.[59] For that reason, other forms of rhetoric were needed. The sanitary movement declared hygiene to be virtuous in the "cleanliness is next to Godliness" mode. Such campaigns, much like the Temperance movement, were as often based on moralistic and pious arguments as on empirical and logical reasoning, and as such their impact remained limited to those susceptible to this type of rhetoric. As Tomes points out, heavy handed appeals to guilt did not apply to both sexes equally and women were expected to be in charge of housekeeping and carried greater responsibility for preserving health.[60] Arguably, the sanitarian movement needed an ally that would also appeal to the men.

The rhetorical support provided to the movement by bacteriology was enormous. As emphasized by Latour, the microbial theory came in the wake of the sanitary movement which had prepared the ground for many of its recommendations.[61] The propaganda value of the germ theory was based on two components. One was that the experimental method and the scientific aura around the discoveries made the new knowledge more persuasive and difficult to challenge. The other was the powerful rhetorical image that microbes provided, an image that is hard to replicate with more elusive pathogenic substances like ozone or cholesterol. Microbes were an invisible, omnipresent evil agent, a live monster threatening with infinite malice to attack the most

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[58]For discussion of the Association's propaganda and publications, see Wohl, *Endangered Lives*, pp. 36-37; and Williams, "The Laws of Health," p. 70. The underlying assumption was that a "principal cause of a low physical condition is ignorance of the *laws of health"* Williams, ("Laws of Health", p. 65). These laws, Williams points out, were the laws of "physiology and chemistry" as well as the ethical commandments of a divine lawgiver. The importance of the propaganda of these organizations is that households should take responsibility for their own health and well-being rather than accept their misfortunes fatalistically. Home economics textbooks such as Hitching (*Home Management*, p. 148) emphasizes the fact that babies fed on mother's milk have a ten times larger chance of surviving than bottle fed children. One of the most effective rhetorical tools of the authorities in England was to persuade the population that working mothers jeopardized the lives of their babies on account of a strong correlation between working mothers and infant mortality -- which received an official imprimatur from the 1904 "Physical Deterioration Committee" established after the Boer Wars although the absence of any serious evidence caused it to become more controversial in subsequent years. See Dyhouse, *Girls Growing Up*, p. 96.

[59]These were often mercilessly exposed by contemporaries, e.g. Shaw's cantankerous introduction to his *Doctor's Dilemma*, pp. lxii-lxvii; or Rumsey, *Essays and Papers*.

[60]Tomes, "The Private Side," p. 527.

[61]Latour, *The Pasteurization*. As Tomes notes, "popular hygiene writers had little trouble ... in associating dirt, infection, and germs... The ability of microorganisms to produce dangerous toxins or poisons could be easily assimilated into older notions of decay and putrefaction as sources of infection." Tomes, "The Private Side," p. 529.

vulnerable members of society.[62] Because they were alive and omnipresent, they lent themselves like nothing before to the demonization of dirt and dust. As one author, Ferdinand Papillon, wrote in *Popular Science Monthly* in 1874, “these baneful toilers for disease lie ever in wait to pierce the internal machinery of living beings to create disturbances”. After 1890 an anti-bacterial obsession took shape. Samuel Hart, MD, wrote in 1890 that “pathogenic microbes cause four fifths of all diseases and destroy more lives than war, famine, fire, murder, ship wreck and all casualties... they actually abbreviate the average natural term of human life by three fourths.” (*Popular Science Monthly*, 1890). Home economics textbooks, aimed at women, pulled out all stops: "a dirty house is full of poison germs...Try to imbue the children with a *horror* of dirt in any shape or form..." exhorted one author in a handbook for teachers in girls' schools. Another volume published at about that time warned students that “dirt ... is the soil in which plants grow... some very small kinds of colorless plants grow in dirt... known as microbes” and the obvious conclusion “our safest course is to keep all the things we have anything to do with very clean."[63] In his masterful analysis of the impact of the bacteriological revolution on the idea of cleanliness in France, Vigarello speaks of the “emotional power of the discoveries of Pasteur” which led to the change in the meaning of cleanliness -- “to be clean meant primarily to be free of bacteria...to cleanse was to operate on these invisible agents.”[64] In full cooperation with statistics and moralizing, the rhetoric of the germ persuaded the masses that the new recipes it implied were truly beneficial. It was by such imagery and language and the authority of science that civil servants, educators, and medical people were able to reduce ,, made large segments of the population *act upon* their new knowledge and alter their recipes and thus time and budget allocations.

Cleanliness no longer was *next to* Godliness, it became almost the same thing. Health is the birthright of every individual, proclaimed the new handbooks in home economics. Yet health was now neither a matter of divine intervention nor social evils but rather one of individual responsibility: informed by the science of bacteriology, instructed by home economics, and intimidated by scary advertisements, households now realized to an ever-growing degree that it was largely responsible for its own health, and the burden of that

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[62]Campbell, *Household*, p. 196.

[63]Hart, "Invisible Assailants," p. 808. Hitching, *Home Management*, pp. 26, 33, 64; and O'Shea and Kellogg, *Health*, p. 6.

[64]Vigarello, *Concepts*, p. 207.

responsibility placed squarely on the shoulders of the woman because she spent most of her time at home.[65] Marketing and product innovation capitalized on this trend, and an unprecedented expansion occurred in the demand for cooking stoves, disinfectants, soap, washing and cleaning equipment, toilets, water filtration methods, and safer foods. Tomes notes that many of these goods had been available before 1875, yet the revelations about the existence of microscopic life greatly increased their appeal.[66] The growing demand for consumer goods that would combat infectious disease led to a further development: the generation of *new* consumer goods whose invention was induced by the growing need felt by consumers to live in germ-free homes. The net effect of these changes in consumer demand on household labor are indeterminate and depend on the degree to which they were complements to or substitutes for household labor. The increased demand for such goods as water heaters and flush toilets did not mean necessarily an increase in household labor because while more of them were demanded, the labor requirements to produce "one unit" of cleanliness fell as new technology was developed responding to the increasing demand.

The diffusion mechanisms of the new anti-infection movement to the mass of lower middle- and working class consumers were of course diverse. The persuasive powers of bacteriology were especially effective when the authority of science was combined with fear, guilt, and old-fashioned moral authority. But teaching and advising were as important. As babies were particularly vulnerable victims of infectious disease, much of the campaign was directed toward new mothers, in such organizations as *goutte de lait* and the *consultations de Nourissons* in France, infant consultation clinics in Germany, and the Mothers and Babies Welcomes in Britain that were patterned after them. These organizations specialized in distributing free clean milk and instructing mothers in infant care. They also attacked infectious disease on every front they could think of. In Ireland, the Women's National Health Association sent out caravans with slogans to fight "bad air, bad food, bad drink and dirt."[67]

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[65]Elliot, *Household*, pp. 1-3. Adrian Forty (*Objects*, p. 169) compares the condition of total cleanliness to that of a religious state of grace, and just as unattainable. A 1916 schoolbook represented dirt, flies, impure air and spitting as parts of the forces of evil and germs were depicted looking like German soldiers. Williams ("The Laws of Health," p. 80) argues that with the increasing adoption of the germ theory of disease the importance of women's sanitary work became severely diminished. Perhaps in terms of persuasion and propaganda there is some truth to this view, as lay preventive medicine was gradually replaced by that of professionals, but clearly in terms of household work the effect was quite the reverse.

[66]Tomes, "The Private Side," p. 535. For a discussion of innovation and the increase in demand for household goods in this period, see Mokyr and Stein, "Science, Health and Household Technology."

[67]Bourke, *Husbandry*, p. 238. Dr. Josephine Baker, head of the newly created New York City Health Department, organized a "Little Mother's League" among school girls who is many poor families were in charge of their siblings' hygiene. These girls, in Rosen's words, "served as missionaries of the new gospel." See Rosen, *A History*, p. 334.

Furthermore, ignorance of good household practices due to deficient education and indoctrination of the working classes was increasingly being blamed for poor health conditions and infant mortality, indicating an instinctive sense of a growing ,, that is, a perception of a growing gap between the best possible and average practices. One consequence of these breakthroughs was a furious debate on the effects on health of working class mothers being employed outside the home. Books and magazines on the dangers of germs and good housekeeping proliferated, repeating ad nauseam the gospel of cleanliness.[68]

Education systems after 1880 increasingly came to enforce stricter cleanliness standards on children while indoctrinating them in the need to avoid germs and infection.[69] School curricula in Britain aimed at girls began to move away from traditional subjects such as needlework and to include home economics, nutrition science, infant care, with cleanliness and avoidance of infection the highest priorities. Courses in domestic science taught in American schools and YMCA's to working class girls an important vehicle by which "middle class home values" were transmitted to working people. Lectures and meetings provided hygiene education for adults, often clothed in scientific terms such as the *cours de puériculture pratique* taught to mothers in France which was supposed to "persuade mothers by exposing them to the fact."[70]

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[68]The debate on working mothers is ably summarized by Dyhouse, "Working-Class Mothers." In addition to the already cited *Popular Science Monthly*, mass circulation magazines such as *Good Housekeeping* and *Ladies Home Journal* soon became effective outlets for the new knowledge, full of advice and recipes on disinfectants, insecticides, food preservation and so on. A typical example of a domestic science textbook is Campbell's who stressed the dangers of "flourishing colonies of bacteria" and stressed how keeping the house clean was the best way to deal with this "enemy." See Campbell, *Household Economics*, pp. 198-201. Another example is *The Woman's Book* (1911) which filled no less than 734 pages with helpful hints on cleaning.

[69]Most of the research carried out confirms strongly a connection between literacy or education on the one hand and "health", however measured, on the other. The best statistical works on the period before 1914, Preston and Haines for the United States and Woods, Patterson, and Woodward for England and Wales, confirm this finding. These results do not lend themselves, however, to a distinction between alternative interpretations: did schools simply "drill" students in the habits of hygiene, or did they improve their ability to absorb logical and statistical arguments on preventive medicine? Ewbank and Preston suggest that the relative importance of *female* education in the mortality revolution suggests that the mechanism operating worked through the enlightenment of women in charge of hygiene and child care in the home. See Preston and Haines, *Fatal Years*; Woods, Patterson, and Woodward, "The Causes of Rapid Infant Mortality Decline"; and Ewbank and Preston, "Personal Health Behavior," p. 119. Modern research suggests that even the persuasiveness of recommendations based largely on empirical regularities such as abstaining from smoking and eating a full breakfast are strongly correlated with education. For an example, see Evans and Montgomery, "Education and Health."Caldwell (1979) has argued that the education of women has strong implications for familial balances and power relations. With more schooling, mothers gain control of resources within the family and more will be expended on child care with positive effects for child health. Cf. Caldwell, "Education as a Factor." Research in labor economics suggests that higher educated people have an advantage in adopting innovation in part because education and schooling improved the ability of individuals to reason statistically and distinguish between systematic and random elements. This relation is complicated by the fact that well educated people also tend to have lower rates of time preference and therefore more likely to invest in their health. See e.g., Bartel and Lichtenberg, "The Comparative Advantage."

[70]See Dyhouse, *Girls Growing Up*, pp. 87-91; and Rosen, *A History*, p. 392. The effectiveness of the formal schooling system in inculcating the new knowledge among the working class was probably modest, judging from oral history which indicates that the transmission of knowledge occurred largely within families. All the same, the British Education Code of 1882 recognized cooking as a subject of instruction and allocated funds to its teaching. By 1911, when the teaching of domestic science was further expanded, the majority of English schoolgirls were attending domestic education classes. Roberts, *A Woman's Place*, pp. 33-34; and Bourke, "Housewifery," p. 183. Domestic Science education in the United States is discussed in Ehrenreich and English, "The Manufacture of

Another agent of diffusion was the medical profession. The Pasteur Revolution, despite some pockets of resistance, had by 1890 been embraced by the majority of the medical profession and led to a re-definition of the tasks of medical personnel.[71] Physicians and nurses could now assume a new role of household consultants, advising families on how to avoid disease by following new sets of recipes in the preparation of food, cleaning, and child-care. These professionals, most of whom had fully bought into the germ theory by 1890, insisted on home-visiting and teaching the working class about matters of health and hygiene in their kitchens and bathrooms. At least some of those health visitors were drawn from the same social class they were to teach and persuade, but their training and background often varied.[72] In every industrialized country some intrusive form of such domestic counseling by "sanitary missionaries" (as Tomes has termed them aptly) was set up, in which professionals imposed themselves on working class families to instruct them in the ways of prevention and health.[73] Not all of the advice given out was sound, and certainly not all of it was followed; but there was enough to alter the perception of the role of homemakers permanently. While the cure of infectious disease was still elusive, prevention became a reality. Many of the old prescriptions such as ventilation (to avoid miasmas) and bleeding were abandoned. Instead, asepsis and hygiene became the watchwords. The gradual realization of the existence and working of an immune system led to more controlled environments ("avoid drafts") to prevent opportunistic diseases. The definitive realization that contagion could occur and how it did so meant that living space and privacy became more valued and age-old habits such as putting children in the same bed and inter-family sharing of facilities came under fire.

The idea of maternity and the responsibility of mothers for the health and well-being of their children became one of the most effective tools of persuasion to the new faith. In 1899, the school superintendent of Georgia told the National Education Association that if he were asked what is to be accounted the great discovery of this century "above and beyond [all inventions] the index finger of the world's progress (sic)

Housework," p. 159; and Stage and Vincenti, *Home Economics*, passim. Hygiene education in France is described by Rollet-Echalier, *La Politique*, p. 364.

[71]Latour, *The Pasteurization*. Tomes describes the long struggle between proponents and opponents of the germ theory as a "virtual civil war." Tomes, "The Private Side," p. 28. Much like the theory of evolution, the germ theory took about a generation to be fully accepted.

[72]Rosen, *A History*, p. 354. The "army of middle class visitors" became at times so numerous that according to one anecdote a woman busy at her washtub called out to her visitor "you are the fifth here this morning." Cited by Lewis, *Women in England*, p. 36.

[73]A detailed description of the characteristically state-run system of child protection and mother education in France between 1875 and 1939 is provided by Rollet-Echalier, *La Politique*, ch. VIII.

would point unerringly to the little child as the one great discovery of the century." Looking back to a fall of British infant mortality rates by more than two thirds between 1899 and 1942, Eric Pritchard attributed the achievement to the "discovery of the Mother."[74] What really had been 'discovered' was neither "the child" nor "the mother" but that mothers could, by their actions, affect the life and well-being of their offspring. This was the message science had taught, and as mothers were persuaded that the physical well-being of children was a function of their actions, they had to re-think their most basic time-allocation decisions.

In the 1920s and 1930s domestic science changed course somewhat. The emphasis on controlling dust and sewer gas was weakened, and nutritional science received a greater emphasis.[75] Rising incomes in the 1920s and the expansion of consumer durables and electrical appliances increased the number of items to keep clean but also the tools to keep them clean with.[76] Among the latter, running water in the house and hot water boilers were at the top of the list. At the same time, however, the influenza pandemic of 1920/21 and the appearance of polio once again increased germ awareness.[77] Homemakers behavior may not have followed suit right away. Education produced "vintage effects" that delayed the overall decline in ,: women may have stuck to the principles they learned from their mothers or as young girls at school. All the same, even adults were open to persuasion and behavior modification.

The role of advertising in this respect was crucial. Schor states that "businesses subjected women to a barrage of advertising and social pressure, in order to sell more products... they spread the message that a woman who did not purchase the growing array of consumer products was jeopardizing her family." The fundamental message sent to homemakers by advertisers was one of personal responsibility. If her children did not develop properly or became sick, if her husband was unhappy, if she herself grew old and tired before her time, the housewife was to blame. Perhaps she was not cooking the right meals, not scrubbing the bathroom floors enough, or did not insist that her family members clean their teeth.[78] The ironic fact remains that no

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[74]School superintendent quoted in Ehrenreich and English, *For Her Own Good*, p. 165. Pritchard cited by Dwork, *War is Good*, p. 216.

[75]For a good discussion of these changes, see Babbitt, "Legitimizing Nutrition Education."

[76]As Bourke notes, people not only had more clothes, they also washed them more frequently, and their income and location determined what equipment they could use and whether they had to carry the washing water themselves. An interesting labor-saving response to the bacteriological revolution is the change in home design, replacing the heavy upholsteries of the Victorian home with easier to clean surfaces, tiles and glass in the early twentieth century. Bourke, *Husbandry*, p. 225.

[77]Tomes, *The Gospel of Germs*, pp. 245-46; Rogers, *Dirt and Disease*, pp. 9-29.

[78]Schor, *The Overworked American*, p. 97. Cowan, *More Work*, pp. 187-89.

advertiser stood to gain from an increase in housework in and of itself. But the relentless use of fear and guilt in persuading women to keep their homes cleaner and their diets better in order to sell them a range of goods -- always reinforced by other agencies -- had precisely that effect.

Perhaps the best example of such unscrupulous marketing can be found in the soap industry, always strapped for markets because of the economies of scale in soap production and its highly competitive nature. Aggressive advertising campaigns for such brands as Sapolio and Ivory in the United States and Sunlight Soap in Britain took off in the 1870s and 1880s and kept hammering home relentlessly soap's role in fighting germs and dirt. The Cleanliness Institute, established by the American Association of Soap and Glycerine products in 1927, embarked on an unprecedented campaign to sell soap at all cost and in the process all but brainwashed Americans that "microbes were everywhere, omnipresent, ever-ready to spread disease, debility, and death."[79] The institute worked through the most effective means of persuasion: selling or giving away hundreds of thousands of storybooks, pamphlets, flyers, teachers' guides, and free samples to schools and children. It also advertised at an unprecedented scale, aiming its resources at women rather than at men, and using fear, guilt, and hope to sell soap. Advertisers pictured germs as "an enemy" which was to be kept outside the home by means of the "armor of cleanliness."[80] In the process of trying to sell soap they may have also helped to bring about millions of overworked housewives, even if that was not their intention.

All the same, the net effect of advertising on L_D is not clear. Soap happens to have a low elasticity of substitution with household labor; it does not clean but in conjunction with labor. A large proportion of advertising, however, was aimed at *replacing* domestic labor. The fast-food industry, for instance, must have saved housewives all over the world trillions of hours of cooking and cleaning. Schor's flat statement that industry has had no incentive to come up with labor saving devices in the household (Schor, 1991, p. 102) is contradicted by endless innovations that did just that: disposable paper products and cellophane, self-cleaning refrigerators and ovens, cake mixes, pressure cookers, and chemical toilet cleaners are just a few examples.[81]

Yet there remained a budget constraint, and some obvious health-enhancing products (such as less crowded housing conditions) remained outside the reach of the working classes for many decades after their effects were realized. Moreover, for households with fewer resources, the substitutability of labor for capital

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[79]Cited by Vinikas, *Soft Soap*, p. 85.

[80]Ibid., pp. 79-94. See for instance soap advertisements in *The Survey*, June 1 and Sept. 1, 1930.

[81]Schor, *The Overworked American*, p. 102.

may have been limited. As Tomes (1998, p. 204) notes, "without running water or sanitary toilets, even superficial cleanliness could be obtained only with backbreaking labor."[82] Wealthier households found it easier to substitute some market-purchased goods for labor, especially hot water, indoor toilets, and easier to clean kitchens and bathrooms. At the same time, however, poor families had simply fewer possessions and less space to keep clean. Income and substitution effects run counter to each other, and Tomes's suggestion that somehow increased household labor demand hit the poorer classes the worst is not easy to prove.

The more difficult question is not why there was no more substitution of household capital for household labor but why it took so long for markets selling commercial health-enhancing goods and services to emerge? As Cowan points out, we do not have a good theory explaining why certain household tasks are farmed out and others carried out by the homemaker. It is likely that labor-saving devices such as washers and dryers replaced market-provided substitutes for household labor (such as commercial laundries) as often as they replaced household labor itself. Not until the 1970s did consumers resort to take-out and pre-cooked food on a large scale. Commercial laundries and vacuuming services existed but never got close to controlling a large share of the output.[83] One reason, I suggest, is that households did not regard the market-purchased goods and the home-made goods as good substitutes because quality monitoring in the production of H is difficult and expensive. If the household has a certain prior over A-, , hiring someone else with different priors may have created serious principal-agent problems. It was felt that there was no room for error as the very health and survival of the members of the family was at stake, and strangers could never be trusted as much as the women of the family. De Vries argues in a similar vein that the new standards of health and education for children necessitated withdrawal of the housewives from the paid labor force because "there were no real *substitutes* for intensive home labor."[84] Yet such substitutability depended entirely on how it was perceived by the housewives, and one cannot understand their lack of demand for substitutes without the influence of the new

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[82]Tomes, *The Gospel of Germs*, p. 204.

[83]Cowan, *More Work*, p. 110. British working class households often used the "bag wash" in which the laundering of clothes was farmed out of the household but returned damp and unironed, so that the homemaker still had to dry, iron and fold it. The main reason for the bag wash was the absence of adequate laundry facilities in working class households. See Daunton, *House and Home*, pp. 243-44. In the United States, commercial laundries were well-developed in cities yet in 1919 even well-to-do families making up to $2,100 spent only $2.00 a month on laundry. Fundamentalist germ warriors such as Christine Frederick advised that commercial laundries may have been unsanitary because of contaminated clothing of others or unclean workers. See Cowan, *More Work*, p. 107 and Hoy, *Chasing Dirt*, p. 156. It is also telling that there is evidence that the time spent on home laundry in the US increased from about 5 ½ to over six hours a week between 1925 and 1964. Vanek, "Time Spent in Homework", p. 119.

[84]De Vries, "The Industrial Revolution," p. 263, emph. in original. Cowan points out that experts brainwashed mothers into believing that "the child raised by nursemaids was to be pitied." Infant care became more complex when mothers "in an effort to combat infant mortality ... were watching scrupulously over their children's diets." Cowan, *More Work*, pp. 179-80.

domestic science and thus, indirectly, the New Medicine. It is thus likely that some income elastic services such as shopping, decoration, and intensive child-care are beset with principal-agent problems and could only be sub-contracted out with difficulty. Furthermore, there remains the question of *who* in the household made the decisions. The allocation of time between housework and leisure was by and large up to the homemakers. Switching from household-produced services to market-purchased substitutes, however, required cash outlays and thus needed the consent of other household members.

The notion that women were naive and credulous victims of a conspiracy run by greedy commercial interests or jealous males ignores the free will of women, conditioned as it was on what they believed was best-practice science.[85] Domestic science of course at times gave erroneous or unproven advice, and for decades spurred women to perform more housework than before, possibly more than they should have. But given how high the stakes were in the age before antibiotics, it is not surprising that women, when in doubt, chose to clean too much rather than risk disease. The powerful and often overwhelming propaganda barrage used by the crusaders of cleanliness biased behavior toward overexertion. Risk aversion, as well as biased processing of information, thus may have led to an excessive reallocation of household resources toward homework.

In our earlier notation, this scenario implies that the perceived value of A_D - $,_D$ exceeded unity and that far more cleaning and cooking were carried out than necessary, because households had been made to believe that household labor was more health-enhancing than it really was. One result of "overshooting" in the case of housework would be for married women to drop out of the labor force altogether (or, more likely, to never join it) in order to "keep house." The problem of course is that because the historian does not know the true value of A either, such a statement is difficult to quantify. Without actually estimating the *perceived* marginal impact of scrubbing and sweeping on health and comparing it to the *true* value, we cannot be sure that health production is overusing L_D. However, it is surely false to maintain that *just* because household labor is not a traded market good, as Schor maintains, it would be oversupplied. Some overshooting is suggested by the fact that today there is a marked difference between the level of L_D in households in which women have outside employment and those in which they do not without any known costs in terms of health. This might suggest at least that the marginal product of housework in terms of H is -- at least in contemporary households -- low. Yet

[85]Bourke, “Housewifery.”

this does not by itself constitute evidence of overshooting in the pre-1945 period.[86]

In terms of our model, overenthusiastic rhetoric and brainwashing by soap commercials may have led to some *negative* values of , , thus consuming more of some X's than best practice techniques called for, that is, when A < 1 if , < 0 and 1+ , < A. These conditions could lead to "overworked housewives" if there was low substitutability between the "overconsumed" X's and L_D (e.g. because the application of toilet cleaner detergent required labor), or that they somehow caused overshooting conditions to apply *directly* to A_D and $,_D$ (e.g. commercials persuaded women sweep the floors or wash sinks more often than necessary).

Moreover, in some instances best-practice medicine of the first decades of the twentieth century itself tended to exaggerate the effects of cleanliness (A > 1), so that homemakers following their prescriptions would tend to overexert themselves.[87] This was reinforced by the compulsive propaganda of some of the later domestic scientists such as Christine Frederick who was "so hell-bent on establishing a new 'science' of housework, that their rhetoric became an appalling jumble of exaggeration." The belief that household dust was the carrier of dangerous germs (especially tuberculosis), through dangerous "fomites" (dried contagious matter) stimulated an attack on household dust far beyond anything we would believe today necessary.[88] The popular diffusion mechanisms through which science disseminated often added to the distortion.[89] Without a more precise notion of how the body defended itself against germs, households fell into the belief that even the smallest traces of micro-organisms could be lethal. The fear of germs led homemakers to try to sterilize (rather than just clean) their pots and pans, a laborious and quite redundant endeavor. Manufacturers of goods from wallpaper to Lysol exacerbated science's exaggerations. One conclusion we can draw here is an affirmation that a "little knowledge can be a dangerous thing" or in the more technical language of economics, that there is no monotonic

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[86]For a comparison of housework by employed and non-employed women, see Vanek, "Time Spent in Housework." The concept of oversupply is further complicated by the fact that in the presence of uncertainty, a certain margin of "unnecessary" cleaning may be regarded as an insurance premium against low-probability but high-cost events.

[87]One example of this exaggeration was the notion of "calorific accumulation" which held that immunity was conveyed by an "invisible fire" needed to resist disease which required a high degree of cleanliness to operate property, presumably to allow oxygen to penetrate through the pores of the skin into the body. This gave cleanliness, by the end of the nineteenth century, an unsurpassed legitimacy. Vigarello, *Concepts of Cleanliness*, pp. 210-11.

[88]Horsfield, *Biting the Dust*, p. 101, 120, 183-185. Hardy, *The Epidemic Streets*, p. 14. The source of this belief was one of the first American bacteriologists, T. Mitchell Prudden whose *Dust and its Dangers* became, in Tomes's words, "a foundation of turn of the century domestic hygiene." Tomes, *The Gospel of Germs*, p. 97. Tuberculosis can be spread by dust, but only a small percentage of the infected patients become symptomatic, depending largely on interaction with other diseases which weaken immunity.

[89]Between 1900 and 1904, popular magazines published articles with titles such as "Books spread contagion," "Infection through Postage Stamps," and "Menace of the Barber shop." Ehrenreich and English, *For Her Own Good*, p. 142. As late as 1932, *Good Housekeeping* provided information on how to disinfect picture frames.

relationship between the acquisition of knowledge and welfare improvement.[90] After 1945, it was increasingly realized that the marginal benefits of housework may have been, after all, larger than its marginal costs. It is therefore possibly misleading to argue that household labor has declined because women are busier with market activities. Arguably, the causality runs in some part in the other direction: the values of A_D - $,_D$ today have fallen back to a level closer to unity, after having exceeded unity for many decades, and the decline in the perceived value of household labor has increased the supply of female market labor.

Conclusions

The Cowan problem has important ramifications. One, of course, deals with the entire set of problems related to the role of women in the household and in the economy. Given the statistical difficulties with female participation rates, it would be rash to argue that their newly perceived social role after 1850 or so actually caused a *decline* in married female participation.[91] But it can be safely concluded that by keeping the perceived benefits of housework at high levels, the new knowledge delayed widespread labor force participation of married women by many decades, perhaps close to a century. As Brownlee has also noted, both market (decline in domestic industry) and demographic forces (fall in fertility) would have indicated that the increase should have been much faster.[92]

It remains to be seen how much of the low labor force participation rates of married women in the first half of the twentieth century could be accounted for this way. It is suggestive that when families had a high marginal utility of money, the need to generate cash was reconciled with preserving the married woman's role as the guardian of the gates of health by taking in boarders, laundry, sewing, and other such activities rather than seek employment outside. It is also suggestive that the preachers of home economics such as Christine Frederick pontificated against "the unnatural craving [of women] for careers."[93] More accurate inferences seem

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[90]For a formal demonstration of this conclusion, see Mokyr, "Technological Selection."

[91]As maintained by Thomas, "Domestic Labour," p. 340; and De Vries, "The Industrial Revolution," p. 263.

[92]See Brownlee, "Household Values."

[93]Domestic industry had, by the end of the nineteenth century, enjoyed something of a revival in urban Britain, with homeworkers producing such items as matchboxes, artificial flowers, umbrellas, safety pins and tennis balls. Lewis, *Women in England*, p. 55. It might be noted that homes with boarders tended all the same to have higher infant mortality rates. See Preston and Haines, *Fatal Years*, p. 168. Frederick cited by Horsfield, *Biting the Dust*, p. 117. The great economist William Stanley Jevons in 1882 railed against "the employment of child-bearing women away from home" and asserted that "the very beasts in the field tend and guard their whelps ... only human mothers ...systematically neglect to give them nourishment." Quoted in Ball and Swedlund, "Poor Women," p. 37.

hazardous in view of the poor statistical material available and the difficult definitional issues concerned with nineteenth century female labor participation rates. The pertinent question is not whether the growth in knowledge led to a decline in the number of married women working outside the home, but whether it prevented it for many decades from rising and thus reduced economic growth to a lower rate than it could have. It is not until the late twentieth century, when the exaggerated notions of wife- and motherhood could be dispensed with, that levels of housework may be a bit closer to optimal. No doubt there were contributing factors to the recent decline in housework: an ever growing substitution of labor-saving goods and services bought in the market, and antibiotics weakening the paralyzing fears of infection. Beyond that, the solution to the Cowan conundrum suggested here is consistent with the decline in mortality, and especially infant mortality, in the early decades of the twentieth century. Regardless of its costs, the realization that household work and certain health-enhancing goods could help prevent infectious disease was without doubt, a major factor in the sharp decline in mortality after 1870.[94]

Yet above all I should like to point out that in addition to the material forces that determine the allocation of resources and time in a market economy, there were autonomous forces altering existing equilibria based on changes in *knowledge* and *perceptions* and originating from the sphere of science, discoveries, experiments, and were diffused by education, imitation, and persuasion. It is easy to dismiss domestic science as a tool devoid of much scientific content, intended to keep women in their proper place and leave it at that. Such a class-and-gender based analysis neglects the crucial role of *knowledge* and *beliefs* in the determination of behavior.[95] The radically novel concepts of disease and the human body, and the concomitant domestic sanitary science and home economics in the late nineteenth century, were, as has noted, as dramatic a change as the First Industrial Revolution and may have had implications that were as profound.[96] It is, of course, true that notions of dirt and defilement are hardly an invention of the enlightenment or nineteenth century science. Dirt as a notion of “matter out of place” is as old as notions of order and system in society, as Mary Douglas

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[94]Important works which discuss this relationship include Ewbank and Preston, "Personal Health Behavior"; Preston and Haines, *Fatal Years*; and Easterlin, *Growth Triumphant*.

[95]Such an argument is made in Ehrenreich and English, "The Manufacture of Housework"; and Thomas, "Domestic Labour." Ehrenreich and English remark that the domestic scientists knew little about the destruction of germs and erroneously believed that it was mostly carried by dust. This ignores the huge advances in cooking and child care where the advice of “domestic scientists” helped eliminate a host of dirt diseases, leading to a sharp decline in infant mortality rates after 1900 in the industrialized world. Oddly enough, they themselves explain the sharp decline in child mortality with improvements in sanitation and nutrition. Compare Ehrenreich and English, "The Manufacture of Housework," p. 19 with *For Her Own Good*, p. 167.

[96]See especially Easterlin, *Growth Triumphant*.

pointed out. What the past two centuries changed is the *understanding of* the direct correlation between dirt, nutrition, child care, and other variables controlled by homework on the one hand and the health of members of the household on the other. As Bourke points out for Ireland, "The *purpose* of cleaning changed. [It] became less of a ritual... and more of a 'scientific' dirt-control movement."[97]

The errors and exaggerations in this understanding and the unnecessary and wasteful housework they implied, lamented by today's feminist critics, were real, but probably largely unavoidable. The new knowledge embodied in the three revolutions was so radical that it had to be continuously fine-tuned and its applications to household recipes inevitably had to slide down a long and bumpy learning curve.[98] The fine-tuning has by no means ended in our own time. If we are to make progress on the new and exciting frontier of the economic history of the household and the family, economic historians need to ask again and again "what did women know, and when did they know it"?

[97]Douglas, *Purity and Danger*, p. 35; Bourke, *Husbandry*, p. 213.

[98]Douglas herself concedes that "the bacterial transmission of disease was a great nineteenth century discovery. It produced the most radical revolution in the History of Medicine. So much has it transformed our lives that it is difficult to think of dirt except in the context of pathogenicity." Douglas, *Purity and Danger*, p. 35.

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