Opportunities for Revitalizing Stagnant Markets: An Analysis of Household Appliances

William A. V. Clark, Howard E. Freeman, and Dominique M. Hanssens

For many durable consumer products, the conditions needed for sustained growth in sales seem to have disappeared. Some of these products have reached saturation levels of ownership; others seem to have plateaued at lower levels of ownership. The authors of this article, Professors Clark, Freeman, and Hanssens, have taken a multidisciplinary approach to the analysis of one portion of the consumer durables market—household appliances—to detect the underlying components of demand. They speculate on how these demand components will fare in the coming years and draw implications for the way these markets can be stimulated.

Introduction

Low discretionary incomes, high interest rates, reductions in new housing starts, and a lack of consumer confidence during the early 1980s are realistic reasons for the plateaued sales curves of many consumer durables and the clear downward trajectories of others. At the same time, however, the sheer dollar volume of consumer durable markets—despite their softness—results in continued product investments by U.S. manufacturers and a target of opportunity perspective by international companies engaged in their production. But either for the former to prosper or the latter to successfully invade the marketplace requires product development and marketing strategies that do more than simply shift brand demand from one manufacturer to another. Thus a clear need exists to prospect for opportunities to redesign existing consumer durables in ways that stimulate sales, to implement marketing programs that provoke purchases from population segments now underrepresented, and to develop new products with high odds of consumer acceptance.

Despite the important need to revitalize stagnant consumer markets, there has been scant analytical attention paid in the marketing literature to the problem. For example, the *Journal of Marketing* in the Fall of 1981 published a special section on the product life cycle, but none of its articles addressed the issue of marketing stagnant products. Other important research [2, 13] and reviews [15] of the product life cycle only tangentially address the issue of stagnant markets. Given the extensive investments in mature products

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within the portfolios of major manufactors, there is a surprising gap in the analysis of the consumer durable market.

Utilizing the electrical appliance market as a case in point, we present a comprehensive, multidisciplinary analysis of major factors influencing electrical appliance demand in the United States, with special emphasis on *product life cycles, macroeconomic influence,* and *sociodemographic profiles* of appliance buyers. Then, we examine the findings from a behavioral perspective, using the concepts of *cost-to-gratification* and *structural readiness*. The former concept seeks to explain consumer purchases on the basis of the perceived advantages to consumers outweighing appliance costs; the latter refers to the incentives for product adoption created by the particular social structure arrangements found in a community or society. Finally, we use our empirical and behavioral insights to formulate predictions about changes in the U.S. market, leading to managerial recommendations for revitalizing old products and introducing new ones.

Are the Life Cycles of Household Appliances Uniform?

The first issue we examine is whether or not we are dealing with a homogeneous group of products. Clearly, if there is no uniformity in sales and penetration histories of appliances, generalizations about these products would be impossible, and any effort to examine them as a group would be limited. The product life cycle provides an organizing scenario for studying this issue.

The idea that inventions and new products pass through a series of stages—innovation, acceptance, persistance, and displacement—was set out by Rogers in 1962 [16]. Since then the concept has been examined and criticized in both the social sciences and the marketing field. For example, it has been held by Dhalla and Yuspeh [5] that it results in unwise decisions to terminate brands, but by Hayes and Wheelwright [6] as an important input for developing pricing and marketing strategies.

Analytically, it is possible to estimate product life cycle parameters and to make projections for the remainder of a life cycle, using the well-known model developed by Bass [1]. Technical details of this model are provided in Appendix A. In the spirit of Rogers, Bass examined the diffusion of innovation of consumer and industrial durables as a composite of *innovation* and *imitation* effects in the market. Customer innovation represents the strength of innovative buyers in the market, i.e., those who make a purchase decision regardless of the opinion of others. For example, in the motion pictures industry, it is important that some people view a new film strictly on its own perceived merit, independent of what the critics or the neighbors say. Second, customer imitation is the strength of "me too" buying, i.e., by those who are more likely to adopt a new product as more products have been sold. In movies, imitative buying occurs as a result of favorable reviews and word-of-mouth. Finally, the sum of customer innovation and imitation is called the "contagion level" of a new product, i.e., the higher contagion, the more this product "catches on" in the market, in a manner similar to the dissemination of contagious diseases among animals or humans. The practical aspect of Bass's model is that ordinary sales data can be used to find estimates of

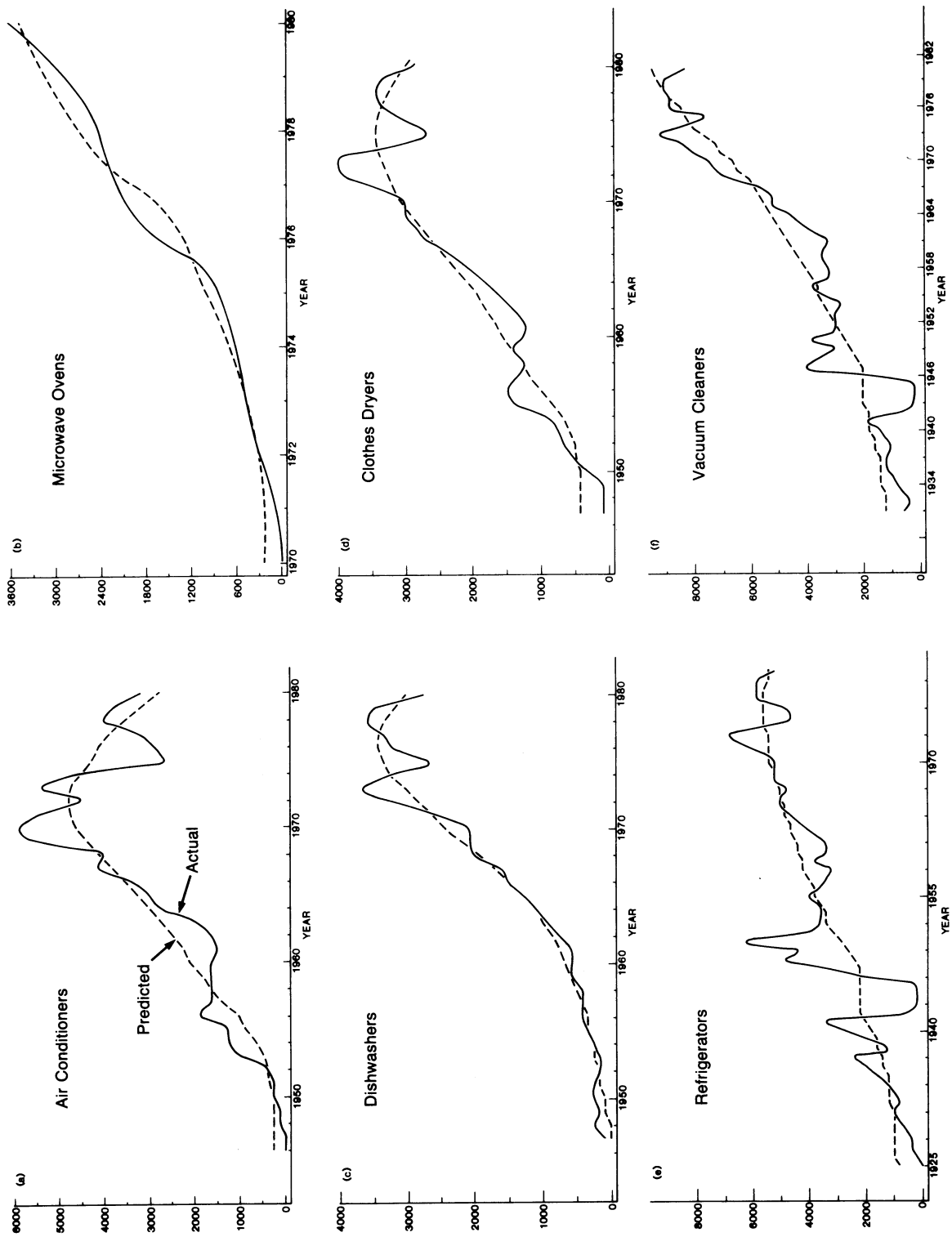

Figure 1. Actual and modeled unit sales.

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innovation and imitation strength, as demonstrated in Appendix A.

Annual unit sales and penetration data were used to fit product life cycle models, as proposed by Bass [1]. In the case of the seven products selected—window air conditioners, microwave ovens, dishwashers, clothes dryers, refrigerators, vacuum cleaners, and clothes washers—a fairly accurate model can be fitted to the historical data. (The models for six of these products are shown in Figure 1.)

The "contagion level" for each product (i.e., the sum of the innovation and imitation coefficients) was also estimated. These contagion coefficients, listed in Table 1, reflect the speed of the innovation process. The analysis suggests a secular trend: *contagion levels are generally higher for the most recently introduced appliances,* probably because of the speed and influence of the mass media, and particularly of television. It is noteworthy that the change in contagion levels is largely accounted for by the increased q coefficients (speed of acceptance). The rapidity of reaching maturity among the more recently introduced products apparently is not related to a higher level of innovativeness among consumers, but rather to faster acceptance or imitative purchasing. This finding is consistent with a study by Qualls, Olshavsky, and Michaels [14], in which the duration of the introductory and growth stages was shown to be shorter for postwar than for prewar consumer innovations (see also Table 1).

Thus, the life cycle analysis provides evidence of the homogeneity of appliances as a product class—at least when life cycle behavior is the criterion. Further, it suggests that life cycles are becoming shorter because imitative consumer purchase behavior is occurring more rapidly. Finally, in spite of the high level of fit with the data, there are considerable year-to-year deviations in sales from the life cycle predictions. The next step undertaken was to explain sales movements by economic factors.

What Does Economic Modeling Show?

Among the large number of macroeconomic indicators generally associated with demand for consumer durables, we selected four commonly used variables: real disposable personal income, real price of appliances, general unemployment rate, and number of housing starts (see, for example, [19]). The restriction of variables was based not only on the high levels of predictability they provided, but also on the collinearity between these and most other economic measures. For the case of air conditioners, we also included fans as an independent variable to examine the possible effect of air conditioners as substitutes for fans. Details of the economic models are shown in Table 2.

The four economic variables are significantly associated with sales, although, of course, there are variations in predictive power from one product to the next. More important is the finding that occurs when the regressions are run separately for the innovation-imitation and the maturity periods of the life cycle. This was done for all products except for the microwave oven, which does not have a sufficiently extended maturity period.

Table 1. Product Life Cycle Analyses

Product	Database	1980 Household penetration	Duration of introductory stage[a]	Duration of growth stage[a]	Life cycle parameters[b]			
					p	q	p + q	R^2
Air-conditioner	1946–80	55.6%	16 years	19 years	0.007	0.355	0.362	0.92
Microwave oven	1970–80	8.2	NIA	N/A	0.006	0.420	0.426	0.97
Dishwasher	1947–80	43.9	11	16	0.024	0.201	0.225	0.94
Dryer	1947–80	62.5	5	21	0.005	0.322	0.327	0.91
Refrigerator	1925–80	99+	7	44	0.005	0.215	0.220	0.85
Vacuum cleaner	1931–80	99+	18	40	0.022	0.184	0.206	0.77
Clothes washer	1929–80	99+	12	37	0.020	0.115	0.135	0.55

[a]From [14].

[b]Based on data until 1940 for the prewar products, until 1961 for the postwar products (except microwave oven, where all data were used). The results for dishwashers exclude 1947–1953 because no sales growth occurred. The coefficients p and q are adjusted for discrete-interval bias (see [1]). They represent the strength of consumer innovation (p), imitation (q), and total contagion (p+q).

Table 2. Economic Models on Unit Sales

		First period	Second period
Air-conditioner	Time Sample	1946–1960	1961–1980
	Estimation Method	C-O	OLS
	R-Squared	0.93	0.88
	Intercept (T)	57.17 (2.8)[b]	17.80 (6.4)[a]
	Disp. Pers. Income (T)	−3.47 (−1.6)	−0.07 (−0.2)
	Unemployment (T)	−0.06 (−0.1)	−0.97 (−5.0)[a]
	Housing Starts (T)	0.54 (0.8)	0.37 (2.0)[c]
	Real Price (T)	−4.59 (−3.1)[b]	−1.93 (−7.7)[a]
	Fans (T)	0.74 (3.2)[b]	0.53 (0.9)
Microwave oven	Time Sample	1970–1980	N/A
	Estimation Method	OLS	
	R-Squared	0.98	
	Intercept (T)	36.49 (6.0)[a]	
	Disp. Pers. Income (T)	−1.91 (−1.9)	
	Unemployment (T)	1.41 (2.2)[c]	
	Housing Starts (T)	1.94 (4.6)[a]	
	Real Price (T)	−5.60 (−6.6)[a]	
Dishwasher	Time Sample	1947–1960	1961–1980
	Estimation Method	OLS	OLS
	R-Squared	0.54	0.97
	Intercept (T)	33.25 (1.0)	27.70 (14.2)[a]
	Disp. Pers. Income (T)	−0.85 (−0.2)	0.16 (0.6)
	Unemployment (T)	0.40 (0.9)	−0.37 (12.7)[b]
	Housing Starts (T)	−0.14 (−0.2)	0.23 (1.7)[c]
	Real Price (T)	−3.56 (−1.9)[c]	−4.24 (−15.5)[a]
Clothes dryer	Time Sample	1947–1960	1961–1980
	Estimation Method	C-O	C-O
	R-Squared	0.72	0.88
	Intercept (T)	128.43 (1.9)[c]	14.62 (4.5)[a]
	Disp. Pers. Income (T)	−9.12 (−1.1)	−0.33 (−0.7)
	Unemployment (T)	−0.43 (−0.4)	−0.27 (−1.1)
	Housing Starts (T)	1.03 (0.8)	0.37 (2.0)[c]
	Real Price (T)	−10.08 (2.1)[c]	−1.25 (−2.5)[b]
Refrigerator	Time Sample	1929–1941	1946–1980
	Estimation Method	OLS	C-O
	R-Squared	0.94	0.69
	Intercept (T)	−27.80 (−1.8)	13.69 (4.4)[a]
	Disp. Pers. Income (T)	4.76 (3.4)[a]	−0.66 (−2.5)[b]
	Unemployment (T)	0.08 (0.5)	−0.09 (−0.7)
	Housing Starts (T)	−0.21 (−1.2)	0.52 (3.8)[a]
	Real Price (T)	−0.56 (−0.7)	−0.65 (−2.3)[b]
Vacuum cleaner	Time Sample	1929–1941	1946–1980
	Estimation Method	OLS	C-O
	R-Squared	0.99	0.94
	Intercept (T)	−13.02 (−2.9)[b]	20.01 (8.7)[a]
	Disp. Pers. Income (T)	1.90 (3.1)[b]	−0.63 (−2.2)[b]
	Unemployment (T)	−0.50 (−2.9)[b]	−0.12 (−1.0)
	Housing Starts (T)	0.10 (1.3)	0.15 (1.2)
	Real Price (T)	1.06 (4.2)[a]	−1.69 (−8.7)[a]
Clothes washer	Time Sample	1929–1941	1946–1980
	Estimation Method	OLS	C-O
	R-Squared	0.93	0.59
	Intercept (T)	−41.25 (−5.5)[a]	7.10 (2.9)[a]

(*continued*)

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Table 2. *(Continued)*

	First period	Second period
Disp. Pers. Income (T)	5.06 (7.7)[a]	−0.61 (−2.7)[b]
Unemployment (T)	0.09 (0.7)	−0.10 (−1.0)
Housing Starts (T)	−0.41 (−3.5)[a]	0.39 (3.5)[a]
Real Price (T)	1.69 (2.6)[b]	0.63 (2.3)[b]

Notes: 1) As many of the variables have either upward or downward trends over time, the economic models were estimated on the first differences (i.e., changes from one year to the next). Also the regressions were run on logarithmically transformed data so that the coefficients can be conveniently interpreted as elasticities. Ordinary least-squares estimation was used, except where the residuals were autocorrelated, in which case the models were re-estimated by the Cochrane-Orcutt method. The parameters are accompanied by t values in brackets and significance levels a ($p < 0.01$), b ($p < 0.05$), and c ($p < 0.1$). Data before 1929 were not available.
2) The time periods used for the analysis were based on the following judgments: (a) the first and second periods were designed to correspond roughly with the introductory and early growth stages and the late growth and maturity stages of the product life cycle respectively, (b) to achieve adequate ns for the regression analysis, and (c) to recognize the disruption of World War II. The first period is designed to capture mostly first purchases and the second period to capture replacement purchases.
3) Data for unit sales from *Merchandising Week*.
4) Appliance prices are real prices.

While there are variations between products it is clear that two economic measures, housing starts and unemployment, *have a stronger influence on predictors of sales during maturity than in earlier periods,* in some cases overshadowing price as a determinant. Thus, replacement purchases are more sensitive to macroeconomic conditions than first purchases. An important finding is that the "displacement" phenomenon does not operate, at least in the case of window air conditioners. In fact, sales of fans vary positively with air conditioners.

Pricing strategies, then, do have an impact on sales as others have documented (see, for example, [4]). But, clearly for mature products, depressed economic conditions are strong constraints on sales, suggesting that in these economic times a new manufacturer would be foolish to enter the appliance market to compete with existing brands unless his product is either dramatically cheaper or highly innovative in its features. This conclusion is consistent with Day's [3] finding that replacement is the dominant feature of maturity in the product life cycle.

Consumer Characteristics and Sales

The results so far have indicated that the life cycle concept does operate for appliances as a product class, that life cycles are getting shorter possibly because of faster consumer imitative purchasing, and that economic conditions such as unemployment and housing starts primarily affect the *maturity* stage of appliances. How can these findings be interpreted from a consumer profile perspective, in particular for the results for the earlier stages in an appliance life cycle? To investigate these issues, we used data from the surveys of Consumer Finances (1947–1971) [18] and the Target Group Index (1973–1979) [20]. These data on consumer purchases are reported by measures of income, occupation, and family demographics, and can be compared with available Census data. Consumer profile analyses were undertaken for the four products for which there were consistent data available—air conditioners, refrigerators, dishwashers, and washing machines.

In Figure 2, we provide illustrative findings for income, occupation, and homeownership, variables for which data are available in the Surveys of Consumer Finances. For all products, the early purchasers are drawn from professional and managerial households; as products mature, purchasers resemble the general population distribution in occupation (Figure 2). Measures of homeownership, however, show importantly different results. On the one hand, homeowners are the early purchasers of air conditioners and dishwashers, but on the other hand, washing machines and refrigerators (more essential products from a homeowner standpoint) are purchased from their early acceptance periods in rough proportion to the general population distribution. For all products, the proportion of the early purchasing population with incomes over $15,000 was higher than expected, compared to the general population. This finding is clearest for air conditioners and

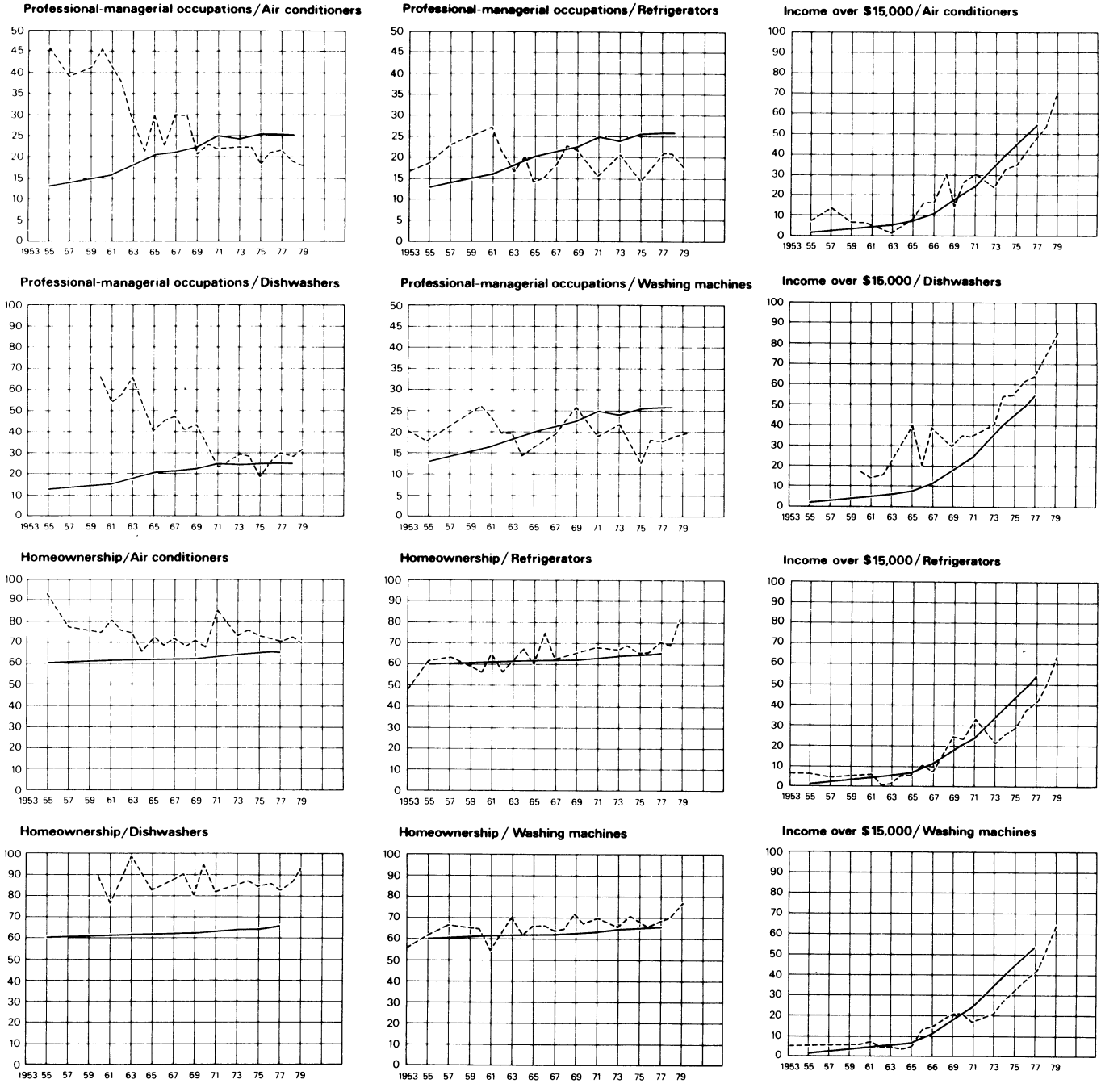

Figure 2. Profiles of the consumer population purchasing refrigerators, air-conditioners, dishwashers, and washing machines (dashed line) in comparison with total U.S. population (solid line). In each case, the graphs represent the percent of the surveyed population in managerial occupations; with incomes over $15,000; or who owned homes and who bought a particular product, compared with the percent of the total U.S. population in that category. If the lines are close together, there is little difference between the purchasing population and the total population. A wide difference (as in the first block of Figure 2) indicates that professional managerial households were buying a greater proportion of air-conditioners (up until the late 1960s) than the population as a whole.

dishwashers—related, of course, to the association between income and home ownership. By the time products reach sales maturity, however, wealth no longer is a critical predictor of purchasing behavior.

For household appliances, then, a strong case can be made that *during the introduction or innovation stage, consumers typically have distinguishable profiles. Subsequent to introduction, the personal characteristics of purchasers become less significant as determinants of sales and their profiles begin to approximate the gener-*

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al population structure. The analysis of consumer profiles and of macroeconomic predictors suggests that products are sensitive to individual family wealth in their early stages of penetration, but to conditions in the economy as a whole as they mature.

Speculating on Consumer Behavior in the Future

The post-hoc analyses undertaken indicate that (1) appliances do have orderly life-cycle histories which are becoming shorter, (2) economic conditions explain sales in the maturity phase to a considerable degree, and (3) early, compared with mature, purchasing is understandable in terms of individual socioeconomic characteristics of consumers. To identify future marketing prospects for household appliances, it is necessary to speculate about future economic and social conditions for the next decade. These speculations will be based on two causal views on consumer appliance purchasing: cost-to-gratification and structural readiness.

Examining Purchasing Behavior: Cost/Gratification

Underlying virtually all views on consumer behavior is the idea that a product is adopted because it serves a necessary function. The seven appliances studied, the sales of which represent the bulk of dollar volume in household appliances, clearly meet the criterion of being functional. Of importance, however, is that they are functional not because they have displaced other products, but because they substitute for otherwise labor intensive activities.

With the exception of the refrigerator being a substitute for the ice box (when first marketed 50 or more years ago), there are no substitute products among major appliances. Even with the refrigerator, however, it could be argued that the reduced "work" of proper food storage, and not such matters as the slower deterioration of foods and fewer health risks, leads to its adoption. Major appliances cannot properly be conceptualized as substitute products, but rather as replacements for labor-intensive activities (for example, the washing machine for the tub, the dishwasher for handwashing, and so on). The hardest product to fit into this labor-saving categorization is the microwave oven. But if time involved in performing a function is equated with labor intensity (and this is the way it is advertised), even this appliance can be so identified. *Successful new appliance development has been a consequence of labor deintensification, and this phenomenon to a large extent will continue to explain adoption of modified versions of existing products and acceptance of new ones.*

For a manufacturer to invade the appliance market successfully with a new product, then, or to spur sales of a modified model, the advantage of ownership by prospective purchasers must outweigh its costs. Advantage of ownership, of course, may be defined in either economic or psychological terms. In economic terms, adoption can be seen to be the result of a subjective cost/benefit analysis by the consumer. For example, microwave ovens when first introduced in 1955 had an approximate price of $1200, or more than $2500 in today's dollars, and few persons' time was worth enough to argue for their purchase in terms of a monetary calculation. Popular articles in the early 1960s ascribe the beginning of adoption of this product to sharp price reductions; rapid acceleration of sales began only when prices were reduced to about 20% of their initial level.

From a social psychological standpoint, the explanation is usually put in terms of relative values, i.e., psychological trade-offs, given limited consumer resources. An example is the anticipated gratification of the convenience of a garbage compactor compared with the output of energy the consumer estimates is required to earn its costs. The difference between the two explanations, then, is that the psychological one holds that *consumers use subjective cost-to-gratification rather than strictly economic cost-to-benefit analyses in deciding on purchases.*

Examining Purchasing Behavior: Structural Readiness

An equally compelling explanation is that changed social structural circumstances provide readiness for innovation; that is, new or modified social and demographic conditions provoke different or altered functional behavior. The idea of structural readiness is the common sociological explanation for the conversion of discoveries and inventions into adopted products and activities [11]. This perspective holds that everything from the wheel to the airplane has been discovered many times, but that inventions remain unadopted until

there is structural readiness. It can be argued, for example, that the window air conditioner could not have been promoted except in circumstances of dense housing and dense population concentration, and that the decline of the full-time homemaker role is related to adoption of the microwave oven. So, too, breakdown in reciprocal peer protection of property and limited effectiveness of police in the containment of crime can be seen as prerequisites for adoption of comprehensive home security systems. The congruence between structural conditions and a product may be mostly a matter of R&D. For example, developing dishwashers so that they fit under counters in small kitchens was a necessary requirement to widespread adoption.

Of course, marketing strategies may stimulate structural readiness by legitimizing the need, and, consequently, stimulating the purchase of innovative products. This strategy is a successful approach in the marketing of electronic products (for example, in video-technology where first the market opportunity was black and white television, then color television, and then TV recording equipment). In the electronic product area, each product is promoted as an "invention," as a "new" item for which consumers are persuaded they are ready. In the appliance field, where recent history has been one of relatively minor modifications and virtually no "new" products, the major emphasis has been on legitimizing new models mainly in terms of benefits-to-costs and gratifications. Thus, the time-saving of microwave cooking, the energy-dollar savings of new dishwashers, and the convenience of outside icemakers on refrigerators are the marketing foci.

Ideally, of course, new and modified products are likely to be adopted and diffused rapidly if concurrently there is a high degree of structural readiness, if their costs-to-benefits and/or gratification are persuasive, and if there are effective strategies available to mobilize consumers' perspectives about both "structural readiness" and the benefits and gratifications.

The Future for Appliances in Stagnant Markets

To speculate about future markets and about the appliance market in particular, requires at least basic predictions about future economic, social, and demographic conditions and their implications for social structural change and the related product adoption. We provide a "profile" of the United States for the next decade (see Table 3). From these predictions, we derive ideas on new and modified products. All of the projections are debatable individually, of course. In general, however, we believe they properly characterize the features of U.S. living in the next decade or so. Although the projections were made during the analytic phase of the study (late 1982), they remain reasonably consistent with later outlooks, albeit later projections are more optimistic [10]. (For examples of sources see Masnick and Bane [9]; Pitkin and Masnick [12]; and Soloman [17].) We examine both existing and new products.

Consequences for Penetration and Sales of Existing Products

At best, for products beyond the acceptance stage such as those reported on in the previous section, one can expect limited increases in penetration and replacement sales, certainly not at rates common in the 1970s. If our social, demographic, and economic predictions are correct, there will be minimal increases in penetration and a moderate to sharp reduction in replacement sales for existing products.

For mature appliances, as we have stressed, increased penetration depends on a considerable degree on wealth and a particularly strong economy. All indications suggest at best no marked increase in disposable income and a stagnant or slowly growing economy. Since most existing appliances are past the imitation stage, it is doubtful that any first-purchasers typically will allocate the required proportion of reduced and unstable income for items without essential functions. Thus, in temperate regions, window air conditioners are likely to have a softer first purchase market than before. Also, for essential appliances, such as refrigerators, price may become more important than convenience features in reaching purchasing decisions.

In addition to new purchasers, the consumer market consists of replacement sales. The replacement market depends to a considerable extent on disposable income and economic conditions as well. Owners of appliances, in the face of poor economic conditions, can be expected to prolong the lives of existing appliances by repairing them. Also, convenience becomes less of a rationale for appliance replacement in the face of reduced disposable income. Moreover, the housing market in the short term will be relatively stagnant, and this will have an impact on moves from one house to another within the existing stock of homes. Demographic predictions also indicate a proportionate reduction in "established" middle-aged families, at least for the

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Table 3. Projected Trends during the 1980s

Projections	Reasons for projections	Implications
Monetary Conditions:		
limited prospect for economic growth	decline in productive labor force	increased competition amongst product brands
stable or reduced family disposable income	international competition	reduction in replacement purchases
	lag effects from inflation	reduced credit purchases
	Federal deficit	
Employment:		
continued high or moderate unemployment	technological obsolescence of workforce	consumer unwillingness to take on long term debt for major durables
continued episodic employment and layoff periods for production workers	reduction in labor intensive employment	reduction in number of innovators
saturation of professional occupations	increased women in the work force	increase in two-worker households with high disposable income and reassignment of household responsibilities
	oversupply of professional school graduates	
Population & Family Structure:		
reduced proportion of child raising families in first part of decade	current demographic profile	reduced use of some consumer durables
zero population growth for U.S. born population	increased longevity	increased demand for products that reduce physical exertion
continuing high immigration	economic conditions in lesser developed countries	increased population segment with minimal discretionary income
increase in one person households		
Housing:		
gradual increase in housing starts	deterioration in current housing stock	resurgence of secondary appliance market
reduced size of dwelling units	decrease in family size	demand for smaller appliances
population decline in major metropolitan areas	high tax rates and urban deterioration	
	industrial decentralization	
Public Services:		
decline in public services and social programs	negative public reaction to increased taxation	reduction in discretionary income of civil service labor force
reduced retirement and social security benefits	reduced commitments of tax revenues stemming from fluctuating economic conditions	reduced discretionary income of aged population
		opportunities for technological innovations to replace public services
Natural Resources and Energy Conservation:		
increase in energy costs	increase in costs of production	opportunities for energy saving replacement appliances
decrease in energy supplies	international pricing activities	
decrease in natural resources (water)	population growth and dispersal	acceptance of energy-saving new appliances

first half of the decade. By the end of the 1980s, however, these features are expected to change, when increased housing starts and a greater number of middle-aged families may result in a spurt of new and replacement sales. Broadly speaking, for most of the next decade, brand choice within products will depend on *relative prices and perceived durability.*

For existing appliances, perhaps the most promising marketing strategy is a modification of design that takes into account the reduced sizes of families and the smaller amount of living space. For the typical urban family of middle income with one or two children, the dwelling unit of the future will probably be less than 1000 square feet. One possibility is to reduce the size of some appliances to only one-half to two-thirds of the current models. A second possibility would be to have appliances serve dual functions. The one that most readily comes to mind would be a combination clothes washer–dryer. For example, a clothes washer that took up more height (space which is usually wasted) but less width; or perhaps a different approach to agitating clothes is possible in order to reshape the appliance.

The other plausible strategy is to focus on the market segment of two-adult-earner households, which generally have the highest proportion of discretionary income. For this group, both convenience and labor dein-

tensification are valued. Being able to wash and dry clothes without shifting them from one appliance to another is an illustration. A refrigerator with an automatic, time-controlled defrosting compartment is another possibility. Yet another is an automatic ironer built into a dryer, or a clothes washer that also dry-cleans. Such appliances should be designed with the recognition that purchasing decisions and use are almost as likely to be made by the male as the female. A key market for convenience-oriented products would be the growing phenomenon of adults living alone and single parents (male or female) with children.

Consequences for Innovation in the Appliance Market

At the same time that existing products will face difficult market conditions, there are areas in which it can be speculated that changed structural requirements will result in opportunities for new products. These changed structural requirements include changes in the provision of public services and increased resource conservation, both of which provide opportunities for revitalizing the stagnant consumer appliance market. A simple illustration of the power of such changes involves modifications in the provision of public safety resources.

It is unlikely, for example, that public safety resources will be maintained at current levels; in most U.S. cities police protection now is inadequate, particularly in terms of crimes against property. Thus, there will be an increasing need for personal effort at property protection. So, too, as is now taking place in some cities, there is reduced garbage collection and we would anticipate further reductions in this public service. While in some areas public services will be replaced by for-profit equivalents (e.g., private police), technological substitution also is a viable alternative.

For middle- and upper-income residents, there already is a structural readiness for products that reduce both the property loss and bodily risks of crime and a growing security market system. Any system to gain widespread acceptance and penetration would have to avoid the current relatively high installation costs. R&D developments that minimize false alarms also are essential for high penetration. Certainly, a mass produced system with a one-time policy, say, under $1000, would have a significant market.

As another illustration, although garbage compactors have been on the market for a number of years, they have had a low rate of acceptance and limited penetration. Most are bought by builders of new homes. Structural readiness for them is overshadowed by the current costs-to-gratification ratio, since they are marketed primarily as a convenience product. While a sharp reduction in price would increase penetration now, structural readiness certainly will increase with decreases in the frequency of garbage pickups.

Introduction of new products in line with structural changes, however, should be approached cautiously. Given our analysis of the characteristics of innovators, we believe that with reasonable sales prices, such appliances could be successfully innovated. However, the movement to sales maturity would depend upon a marked shift upward in the country's economic conditions.

Conclusions

Our analysis suggests that the appliance industry in the post-World War II period grew in response to a need or demand for labor deintensification in household tasks. Appliances have somewhat regular and reasonably predictable life cycles. Their regularity suggests that while refinements in products may spur replacement sales to some extent, such modifications have not discernably had impacts on their life cycles. An important point to be noted about life cycles, however, is that the period of early acceptance has become shorter, probably related to increased speed of communication because of the power of mass media and related features of urbanization. It is a reasonable hypothesis that these observations hold for many other consumer durables as well.

Analysis of the life cycles of products and consumer characteristics during different life cycle periods suggest that early penetration is a function of social characteristics of innovators—wealth and education. During product maturity, consumer characteristics mirror population profiles and sales generally become most sensitive to general economic conditions. Prices of products seem to be related to early adoption, but during maturity, price becomes less important as a predictor of penetration. In general, given our projections about social and economic conditions, the appliance market for existing products will remain relatively stagnant. Additional refinements, unless truly radical, are not likely to spur penetration significantly and both new

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and replacement sales will primarily be determined by economic conditions.

From the standpoint of existing products, product modification that is in line with the trends toward smaller households (in terms of both number of occupants and space) may be a successful strategy to increase penetration. New housing starts are bound to accelerate during the decade and could enhance the market for smaller-size dual-function appliances. Also, segmented marketing that recognizes the importance of catering to two-breadwinner families and to the increased participation of males in household activities may have some payoff. But the highly competitive nature of the existing appliance marketplace suggests comparatively short-term gains from such efforts. More successful, perhaps, would be efforts to promote additional convenience and labor deintensification appliances.

In summary, a manufacturer interested in invading or increasing participation in the appliance market is likely to achieve only minimal payoff from either minor product improvements or price and quality competition. Rather, either fairly radical redesign of existing products to meet changing family housing specifications or products with new functions, are the far-sighted strategies.

Appendix A: The Bass New Product Growth Model

When a new product is launched, it will be adopted by innovators (who have a constant purchase probability), and imitators (whose purchase probability increases with cumulative sales). Formally, at any point in time T, the probability of an adoption, given that no previous purchase was made, is:

$$Pr(T) = p + \frac{q}{m} Y(T),$$

where p = coefficient of innovation (which is also the probability of purchase at time T = 0); q = coefficient of imitation (strength of imitative purchasing); Y(T) = cumulative sales at the beginning of time T, i.e.,

$$Y(T) = S(0) + (S(1) + S(2) + \cdots + S(T - 1),$$

where S = unit sales; m = market size, or total number of adoptions over the life cycle.

Now, the *sales* level at T can be viewed as the probability of adoption *times* the potential number of adopters [i.e., the size of the untapped market: m − Y(T)]:

$$S(T) = Pr(T)\,[m - Y(T)],$$

or, after some algebra:

$$S(T) = pm + (q - p)\,Y(T) - \frac{q}{m} Y^2(T),$$

which is a simple regression equation relating unit sales to cumulative sales and its square. Using historical sales data for a product, one can fit the regression line:

$$S(T) = a + b\,Y(T) + cY^2(T) + u_t$$

and then compute the life cycle parameters p, q, and m from least-squares estimates of the regression parameters a, b, c:

$$m = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2c},$$

$$p = \frac{a}{m},$$

$$q = -mc.$$

Among the two solutions for m, the positive one is chosen. Also, an adjustment of these parameters for discrete-interval bias is given in Bass [1].

It can also be shown that the peak time of the life cycle, T*, is predicted as:

$$T^* = \frac{\ln (q/p)}{p + q},$$

with a corresponding peak sales level S(T*):

$$S(T^*) = \frac{m(p + q)^2}{4q}.$$

The Bass model can also be applied to *penetration* data, as opposed to sales data. In penetration format, the model is:

$$DPEN(T) = p + (q - p)\,PEN(T) - q\,PEN^2(T),$$

where DPEN = penetration increase, PEN = (cumulative) penetration at the beginning of each period. In this case, the interpretation of regression results is even simpler, because p is given by the regression intercept, and q is the negative of the squared penetra-

tion coefficient. Notice, though, that the penetration coefficient is a linear combination of the other two parameters, so that a constrained least-squares method should be used (see also [21].

Since the Bass model refers to the first-purchase market only, one must be careful in selecting an appropriate data base. Note that we have applied the Bass model only to the introductory stage (Table 1, footnote b). Unless exact data on first- and replacement-sales are available, one should use only time periods for which the amount of replacement purchasing can be assumed to be negligible.

The Bass model has been applied in a large number of domestic and international industries. While it appears to be strong in describing actual life cycles, its forecasting value may be questionable (e.g., Heeler and Hustad [7]). Recent research has focused on extending the model by incorporating such factors as price and advertising (see [8] for an excellent review).

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