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New products do not grow into maturity at a steady rate. Rather, their sales pattern is marked by a long introduction period, when sales linger at low levels. At a certain point in time, the new product breaks into rapid growth, associated with a huge jump in sales. Academic literature and the business press refer to this point as the takeoff in sales.

The takeoff of new products is a vitally important phenomenon in the management of new products, and Europe—with a long history of developed capitalist markets and unification toward a single market with a single currency—offers an interesting context for its study. Some economists and non-Europeans suggest that the western half of the continent now constitutes a single European market, while nationalists and Europeans contend that these countries have distinct market identities.

In this study, authors Tellis, Stremersch, and Yin ask a number of questions about takeoff in the international realm, specifically in Europe:

- ❒ Does the phenomenon of takeoff occur as distinctly in other countries, especially in Europe, as it does in the U.S.?
- ❒ Do different product-categories and countries have consistently different times-of-takeoff?
- ❒ What economic and cultural factors explain the inter-country differences?
- ❒ Does takeoff in one country affect the probability of takeoff in other countries?

With data on 137 new products across 10 categories and 16 European countries, they found that:

- ❒ Sales of most new products display a distinct takeoff in various European countries, at an average of 6 years after introduction.
- ❒ Time-to-takeoff differs dramatically across product classes. The mean time-to-takeoff is 8 years for white goods (kitchen and laundry appliances) and 2 years for brown goods (entertainment and information products).

- ❒ Time-to-takeoff differs dramatically between countries (e.g., 3.3 years for Denmark and 9.3 years for Portugal). On average, time-to-takeoff is almost half as long in Scandinavian countries (4 years) versus Mediterranean countries (7.4 years).
- ❒ Culture partly explains these differences. In particular, the probability of takeoff increases with higher need for achievement and industriousness and lower uncertainty avoidance. The effects of economic factors are neither strong nor robust to model specification.
- ❒ The probability of takeoff of a new product in a target country increases with prior takeoffs in other countries.

Managerial Implications

The most important implication is that specific regions of Europe have distinct commonalities in terms of time-to-takeoff of new products, with sharp differences across regions. A second important implication is the distinct advantages to a "waterfall" strategy (the sequential introduction of new products) over a "sprinkler" strategy (the simultaneous introduction of new products across countries). A waterfall strategy is supported for three reasons. First, managers are under great pressure to pull the plug on a product that has not taken off. Thus, introducing in a few countries that are likely to show early takeoff can win internal support for continued marketing of the new product. Second, takeoff in one country increases the likelihood of takeoff in other countries. Third, an early takeoff generates revenues and profits for the company, which it can use to improve the product, market it more aggressively, and introduce it in other international markets. A third implication of our study is that managers can use the takeoff of products in one country to predict takeoff in other countries.

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Introduction

New products do not grow into maturity at a steady rate. Rather, their sales pattern is marked by a long introduction period, when sales linger at low levels. At a certain point, the new product breaks into rapid growth, associated with a huge jump in sales. Academic literature and the business press refer to this point as the *takeoff* in sales. It is the point of transition between the introduction and growth stage of a new product. The *time-to-takeoff* is the duration of the introductory stage, or the period from the introduction to the takeoff.

Takeoff is a vitally important phenomenon in the management of new products for several reasons. First, growth rate in sales at takeoff may exceed 400 percent (Golder and Tellis 1997). Such rapid growth requires extensive resources in terms of advertising, sales staff, manufacturing, distribution, and inventory support. Second, many new product managers are under extensive pressure to kill new products that show sluggish sales. However, research shows that the introduction period may be quite long and variable. Knowing when takeoff is likely to occur helps managers withstand the pressure to pull the plug and prevents premature cancellation of promising new products. Third, takeoff is often a signal of the mass adoption of a product and its ultimate commercial success. Knowing how company decisions affect the likelihood and timing of takeoff is important for effectively managing such success. Fourth, the introduction and takeoff of new products across various countries are critical events in international marketing strategies. This issue has gained importance with the world's increasing globalization and with increased unification among countries within trade zones (EU, NAFTA, GATT, etc.). Knowing how takeoff varies across countries is important for designing effective international strategies.

Recently, Agarwal and Bayus (2002) and Golder and Tellis (1997) modeled the takeoff of consumer durables in the United States. These studies raise a number of questions about takeoff in the international realm, which we attempt to address in the context of Europe:

1. Does the phenomenon of takeoff occur as distinctly in other countries, especially in Europe, as it does in the United States?

2. Do different countries and product-categories have consistently different times of takeoff?

3. What economic and cultural factors explain differences between countries in takeoff times?

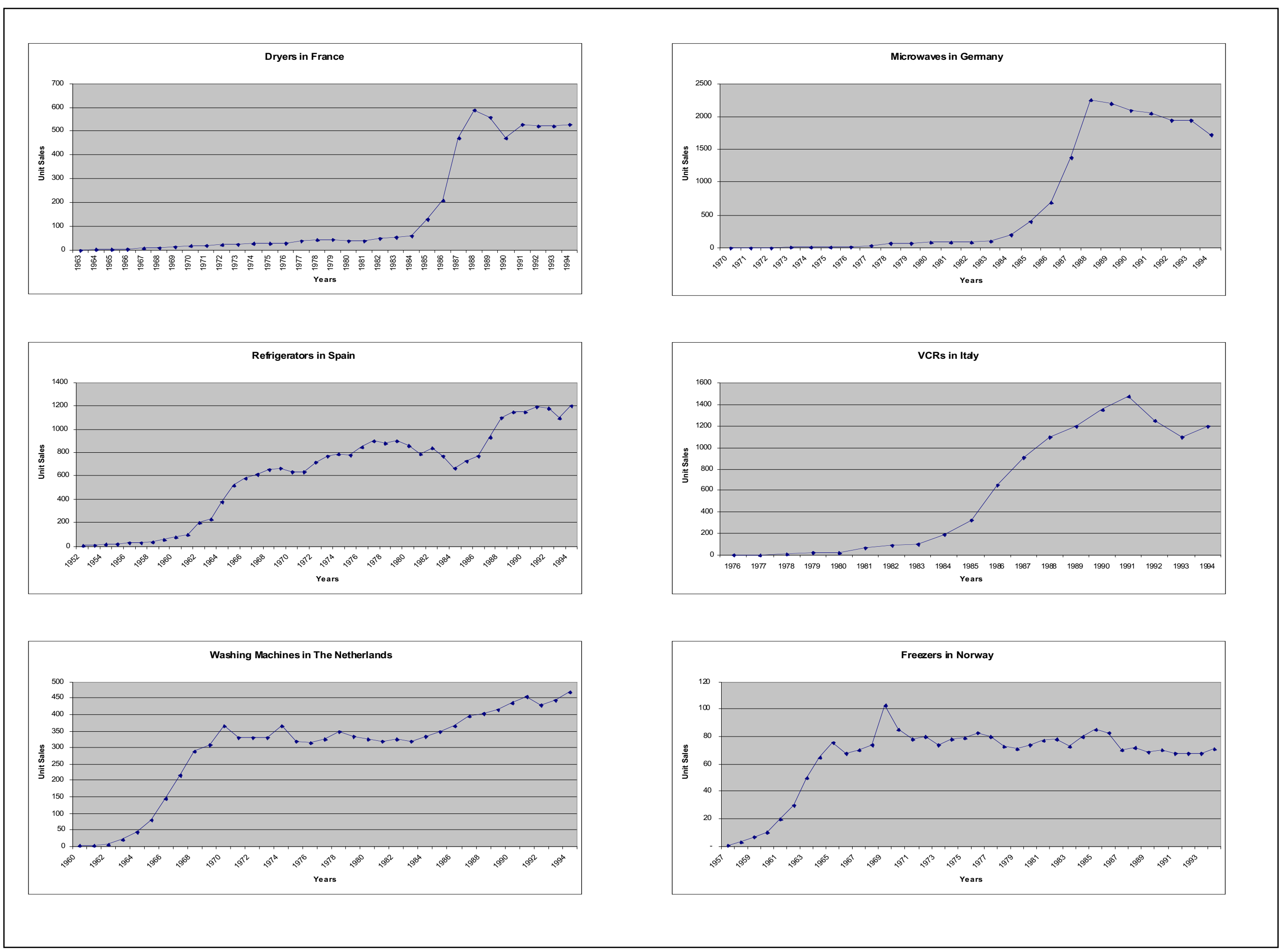
4. Should managers use a sprinkler strategy (simultaneous introduction of new products across countries) or a waterfall strategy (sequential introduction of new products across countries)?

The only relevant literature on this topic occurs in the related field of diffusion modeling. Although this literature is extensive, with over a hundred studies

(Mahajan, Muller, and Bass 1990), only a few of these studies address the international diffusion of new products. Most of them examine how the parameters of the Bass diffusion model vary by country (Ganesh, Kumar, and Subramaniam 1997; Gatignon, Eliashberg, and Robertson 1989; Heeler and Hustad 1980; Helsen, Jedidi, and DeSarbo 1993; Putsis and Sen 2001; Takada and Jain 1991; Talukdar, Sudhir, and Ainslie 2002). Putsis, Balasubramaniam, Kaplan, and Sen (1997) model the influence of "mixing" between countries on cross-country diffusion patterns. Dekimpe, Parker, and Sarvary (2000) examine the sequential adoption of a technological innovation by various countries. None of these studies addresses the takeoff of new products across multiple countries.

The present study focuses on the variation in time-to-takeoff of 10 new consumer durables across 16 European countries (see Figure 1 for examples). As such, it is the most extensive study ever conducted on the growth of new products in Europe. Besides country-specific differences, the study also examines how underlying economic and cultural characteristics explain the variation in time-to-takeoff across countries.

Figure 1. Illustrations of Takeoff in Selected Countries



We chose Europe as a domain of analysis for two reasons. First, European countries have a relatively long history of developed capitalist markets, and therefore data on new product introductions are available in these countries, although they are not necessarily complete or easy to obtain. Second, since World War II the trend in Europe has been toward a single market, through institutes such as the European Council, the Benelux, the West-European Union, the North American Treaty Organization, the Organization for Economic Cooperation and Development, the European Free Trade Association, the European Union, and the European Monetary Union.[1] With the introduction of a single European currency (the euro), seen by some as the culmination of the unification movement, there is a growing perception among some economists and non-Europeans that the western half of the continent constitutes a single European market. Yet at the same time, these countries differ substantially in economic strength and cultural identity. Thus there is an equally strong perception among nationalists and Europeans that these countries have distinct market identities. The takeoff of new products is an important context in which to test some of these rival perceptions.

Modeling International Takeoff

As Golder and Tellis (1997) explain, takeoff is a time-dependent binary event that is best modeled by the hazard model. However, where Golder and Tellis use a proportional hazard model, we use a parametric hazard model. We modify the threshold rule they use and use raters to identify the takeoff. We explain our approach below.

Model Development

The hazard model is often used in medicine and biology, where the focal event, failure, typically corresponds to accident, death, or reoccurrence of disease. For us, the focal event, takeoff, although in actuality a success, corresponds to failure in the hazard literature. Similarly, remaining in the introductory stage, while undesirable for a new product, corresponds to survival or success in the hazard literature.

Since the model for international takeoff we propose includes both time-varying covariates (such as market penetration and gross domestic product) and time-invariant covariates (such as cultural characteristics), a fully parametric hazard model is most appropriate (Helsen and Schmittlein 1993; Kalbfleisch and Prentice 1980). In our treatment of the parametric hazard model and the derivation of the likelihood, we draw heavily upon Petersen (1986a, b). Let T be a non-negative continuous random variable that denotes duration in a given state. In the presence of time-varying covariates—which we denote as $X(t)$—the hazard function, or the rate of transition from one state to another (e.g., introduction to growth), is:

$$h(t \mid X(t)) = \lim_{\Delta t \to 0} P[t \le T < t + \Delta t \mid T \ge t, X(t)] / \Delta t \qquad (1)$$

Let t_k be duration in a given state at the time when either the state is left or censoring occurs. We divide t_k into k non-overlapping but adjacent segments of time, which need not be of the same length. Let $t_0 = 0$ and $t_0 < t_1 < \ldots < t_{j-1} < t_j < \ldots < t_k$. We obtain the following probability of surviving beyond duration t_j given survival at duration t_{j-1}, conditional upon the path taken by $X(t)$ up to duration t_j:

$$P[T \ge t_j \mid T \ge t_{j-1}, X(t_j)] = \exp\left[-\int_{t_{j-1}}^{t_j} h(s \mid X(t_j))ds \right] \qquad (2)$$

The survival function for duration of t_k can then be written as:

$$S[t_k \mid X(t_k)] = \prod_{j=1}^{k} P[T \geq t_j \mid T \geq t_{j-1}, X(t_j)] \tag{3}$$

$$= \exp\left[-\int_0^{t_1} h(s \mid X_0))ds\right] * \ldots * \exp\left[-\int_{t_{k-1}}^{t_k} h(s \mid X(t_{k-1}))ds\right]$$

$$= \exp\left[-\sum_{j=1}^{k} \int_{t_{j-1}}^{t_j} h(s \mid X(t_{j-1}))ds\right]$$

The probability density function becomes:

$$f(t_k| X(t_k)) = h(t_k \mid X(t_k))S[t_k \mid X(t_k)] \tag{4}$$

We propose to test a log-logistic function because it allows for non-monotonic baseline hazards. The hazard function (*h(t)*) and survival function (*S(t)*) for a logistic distribution can be written in general forms as:

$$h(t) = \frac{\lambda p(\lambda t)^{p-1}}{1 + (\lambda t)^p} \tag{5}$$

$$S(t) = \frac{1}{1 + (\lambda t)^p} \tag{6}$$

where:

$$\lambda = e^{-\beta' x_i}; p = \frac{1}{\sigma} \tag{7}$$

The log likelihood is:

$$\ln L_i = \delta_i \ln h(t_k \mid x_k) - \sum_{j=1}^{k} \int_{t_{j-1}}^{t_j} h(s \mid x_j)ds \tag{8}$$

An interpretation of this model is that the hazard function is adjusted by the independent variables of each individual product-category in each country at each time period. This adjustment is made by the hazard ratio, which is defined as $e^{-\beta}$. Positive β coefficients decrease the probability of takeoff and negative β coefficients increase it. The parameter σ characterizes the distribution of the hazard rate. δ_i is a right-censoring indicator.

Similar to Helsen and Schmittlein (1993) and unlike Jain and Vilcassim (1991), we do not include a term for unobserved heterogeneity. We capture heterogeneity across product-categories and countries by including theory-based product-category and country variables in our model.

Conceptual Framework and Hypotheses

We develop a theory to explain takeoff around two broad groups of factors, country characteristics and product-category characteristics. We can further classify country characteristics into economic, cultural, and information access variables. The subsequent discussion develops specific hypotheses for each of these variables.

Country Characteristics

Economic Variables

Five economic constructs are likely to play an important role in the takeoff of new products: a country's wealth, income inequality, participation in economic unions, economic roles in the household, and openness of the economic system.

Wealth. Prior research posits that wealth strongly influences the speed with which inhabitants of a specific country adopt a new product (Helsen, Jedidi, and DeSarbo 1993), so we expect that wealth will have a strong effect on time-to-takeoff. A well-known conclusion of the diffusion literature is that innovators generally are wealthier than later adopters (Rogers 1995). Wealthier people attach a lower utility to money, a fact economists call the wealth effect. The lower utility of money has two consequences. First, wealthier people can better afford the risks of adopting a new product early (Dickerson and Gentry 1983). Risk is an important determinant of timing of adoption (Sheth 1968). Second, because prices of new products tend to start high and drop steadily (Golder and Tellis 1998), wealthier people are the ones who can afford new products early, when prices are still high. In sum, wealthier people are expected to adopt a new product earlier than less wealthy people. So we hypothesize:

> H_1: New products take off faster in countries with higher average wealth than in those with lower average wealth.

Income Inequality. Income inequality is the condition of wealth being distributed unevenly within countries. Even when a country has high average wealth, it may be concentrated in a few homes. In such a case, the vast majority of people may still be poor and unable to afford the new product. Thus if there is high disparity in wealth, such that many people cannot afford a new product, then that product's takeoff will come later than it would in a country with a more even wealth distribution.

> H_2: New products take off faster in countries with a more even distribution of wealth than they do in countries with greater income inequality.

Participation in Economic Unions. The extent to which countries participate in economic unions may affect takeoff. Such participation facilitates the movement of capital, labor, suppliers, and goods between countries. Such unions reduce economic disparity among countries and encourage the formation of a common market. This economic atmosphere is likely to promote the dispersion and growth of new products in countries that belong to the union. Thus, sales of new products may grow more rapidly in countries that are members of such unions. This argument is also in line with the finding of Mahajan and Muller (1994) that a borderless Europe leads to faster diffusion. We hypothesize:

H_3: New products take off faster in countries that participate in economic unions than they do in countries that do not belong to economic unions.

Economic Roles in the Household. Over the second half of the 20th century, there was a steady change in work roles in the family. Where earlier families had depended on one income earner, in the second half of the century they relied increasingly on two income earners (with the woman, in addition to the man, working outside the home). Such households are intensely pressed for time; the family has less time for housework, relaxation, and entertainment. Such families put a high value on any appliances that help them save time. Most new products have at least some time-saving features. For example, dryers and washers free up the hours that would have been spent on manual washing and hanging clothes to dry. VCRs enable families to watch movies at home rather than spending time traveling to movie theaters. Home computers save time in word processing and home accounts.

Thus, we expect that countries in which more women work outside the home are likely to adopt durables faster than those in which fewer women do so. This position is consistent with that of Gatignon, Eliashberg, and Robertson (1989). We hypothesize:

H_4: New products take off faster in countries in which more women are economically active than they do in countries in which fewer women are economically active.

Openness of the Economic System. The openness of a country's economic system is indicated by the degree to which the country is involved in international trade. Because of increasing international free trade between countries, this may be an important and increasingly relevant factor in the international takeoff of new products. Open economic systems may speed the takeoff of new products for two reasons. First, economic openness encourages the development or opening of unified infrastructure between countries, such as freeways, phone lines, railways, television broadcasting, and so forth. Such infrastructure may facilitate the faster spread of new products through observation or word of mouth. Economic openness also fosters greater competition, which increases production and distribution efficiency (Talukdar, Sudhir, and Ainslie 2002). Savings from these efficiencies should make new durables more affordable for consumers, with a faster takeoff as a consequence. So we hypothesize:

H_5: New products take off faster in countries that have a more open economic system than in countries that have a less open economic system.

Cultural Variables

Prior research suggests that a country's culture strongly affects the speed at which its citizens adopt a new product (Dekimpe, Parker, and Sarvary 2000; Gatignon, Eliashberg, and Robertson 1989; Takada and Jain 1991). We identify four cultural variables that can affect time-to-takeoff across countries: uncertainty avoidance, masculinity,[2] need for achievement, and industriousness.

Uncertainty Avoidance. Uncertainty avoidance refers to the level of anxiety about the future (Hofstede 1980; Hofstede 2001). Societies that are high in uncertainty avoidance continuously feel the inherent uncertainty in life as a threat that must be fought, while societies low in uncertainty avoidance more easily accept uncertainty and take "each day as it comes" (Hofstede 1980, p. 183).

We expect countries that are high in uncertainty avoidance to show later takeoffs than those that are low in uncertainty avoidance, for two reasons. First, societies that are low in uncertainty avoidance are more willing to take risks. Therefore, they will more readily accept new products (Rogers 1995). Second, societies high in uncertainty avoidance consider novel ideas to be dangerous and are more intolerant toward change than societies low in uncertainty avoidance (Hofstede 1980). Thus, countries that are low in uncertainty avoidance will embrace a new product more easily than countries that are higher in uncertainty avoidance.

Our expectation is also consistent with prior research. For example, Lynn and Gelb (1996) find a negative correlation between a country's uncertainty avoidance and the penetration of six consumer durables. Steenkamp, ter Hofstede, and Wedel (1999) find that consumers in countries high in uncertainty avoidance are less innovative than consumers in countries low in uncertainty avoidance.

> H_6: New products take off faster in countries low in uncertainty avoidance than in countries high in uncertainty avoidance.

Masculinity. In most cultures men tend to be more assertive than women, who tend to be more nurturing than men. Male behavior is associated with autonomy, aggression, exhibition, and dominance, while female behavior is associated with nurturance, affiliation, and humility (Hofstede 1980; Hofstede 2001). Masculinity and femininity refer to the sex role pattern in society at large, to the extent it is characterized by male or female characteristics. We expect masculinity to affect the speed of takeoff for two reasons.

First, masculine societies attach more value to recognition and wealth, while feminine societies attach more value to human contacts and living environment (Hofstede 1980). The adoption of new products allows consumers to exhibit their wealth and success, which may be more compatible with masculine societies. Consumers in masculine societies may thus show more innovativeness than consumers in more feminine societies (Steenkamp, ter Hofstede, and Wedel 1999).

Second, in masculine societies people tend to make decisions independently and admire those who are strong and independent (Hofstede 1980). When a new product first emerges, adoptions are few and require independent decisions by innovators. This trait of masculine societies may lead to better acceptance of new products. In contrast, in feminine societies, the tendency to make group decisions may lead to less acceptance of a product. For all these reasons, we expect masculine countries to show faster takeoff than feminine countries. So we hypothesize:

H_7: New products take off faster in countries high in masculinity than in countries low in masculinity.

Need for Achievement. In one of the earliest discussions of need for achievement, Murray (1938) describes it as the tendency or desire to do things as rapidly and/or as well as possible. The need for achievement leads people to overcome obstacles successfully and independently and to compete with and surpass others, and it is characterized by high self-regard. Veroff, Feld, and Gurin (1962) associate a high need for achievement particularly with working harder, being less satisfied with current success, and being more oriented to the future fruits of work. All these traits may lend themselves to greater eagerness to adopt new products and greater willingness to experiment with new products as soon as they are available. Thus we expect:

H_8: New products take off faster in countries whose inhabitants have a high need for achievement than in countries whose inhabitants have a low need for achievement.

Industriousness. Industrious people are inclined to work and tend to value the fruits of work more than less industrious people. The industriousness of a population can affect the speed of takeoff for supply-and-demand reasons. Industrious people realize that innovations can make both work and leisure more productive, so they tend to be more receptive to innovations and to work harder to develop innovations. Thus when a new product is available, industrious entrepreneurs, retailers, and distributors are likely to work harder to make this product available to the general population. At the same time, the people themselves are more likely to search for, try out, and adopt the new product. Thus, the new product is likely to take off faster in an industrious culture than in one that is not industrious. So we expect:

H_9: New products take off faster in countries with more industrious cultures than in ones with less industrious cultures.

Information Access Variables

Prior research suggests that people's access to information strongly affects the speed with which they adopt a new product (Rogers 1995). We may expect a new product to take off faster in countries in which inhabitants have easy access to information than in countries where information is harder to obtain. We identify three factors that capture different dimensions of information access: media intensity, mobility, and education.

Media Intensity. Mass media, such as newspapers, radio, and television, play an important role in creating awareness of a new product among potential adopters (Beal and Rogers 1960) and influencing acceptance of a new product (Katz and

Lazarsfeld 1955). Mass media may also lead to greater ability of consumers to detect superior new products, and thus increase the rate at which and the likelihood that consumers will adopt them. Mass media also contribute to cosmopolitanism of consumers of a country, especially if it concerns "cosmopolite channels" (Rogers 1995). Through cosmopolite channels, consumers in a target country can access information about innovations that have been introduced in other countries, even before the innovation is introduced in their own country (Gatignon, Eliashberg, and Robertson 1989). Such information can hasten the takeoff of the innovation in the target country. For all these reasons, we hypothesize:

H_{10}: New products take off faster in countries high in media intensity than in countries low in media intensity.

Mobility. Interpersonal communication affects the rate at which consumers learn about new products. An important facilitator of such communication is mobility. Gatignon, Eliashberg, and Robertson (1989) have shown that the more mobile a country's inhabitants are, the more rapidly new products penetrate the social system. So we hypothesize:

H_{11}: New products take off faster in countries whose inhabitants have high mobility than in countries whose inhabitants have low mobility.

Education. Education involves the exposure of people to a constant stream of new ideas, which makes them more receptive to innovations. Education also sensitizes people to the importance of technology in human progress, which also makes them more receptive to innovations. Indeed, a general finding in diffusion research is that educated people tend to adopt new products earlier than uneducated people (Rogers 1995). So we hypothesize:

H_{12}: New products take off faster in countries whose inhabitants have received higher education than in countries whose inhabitants have not received higher education.

Product-Category Characteristics

We identify four product-category characteristics that may affect the probability of takeoff: product class, market penetration, number of prior takeoffs, and year of introduction. (Although these variables are intrinsically product-category characteristics, some, such as market penetration, number of prior takeoffs, and introduction year, can also vary by country.)

Product Class

Product class may affect the probability of a new product's takeoff (Gatignon, Eliashberg, and Robertson 1989; Golder and Tellis 1997). In particular, we distinguish between white goods, such as kitchen and laundry appliances, and brown goods, such as entertainment and information products. We expect brown goods to take off earlier than white goods because they appeal to all members of a household, provide more instant gratification, and are more visible to guests. Thus we hypothesize:

H_{13}: Brown goods take off faster than white goods.

Market Penetration

We define market penetration in terms of the percentage of households that have purchased the new product. Prior research posits that product categories reach takeoff at an average market penetration of 2.5–3 percent (Golder and Tellis 1997). The diffusion literature also suggests that market penetration may be an important correlate of takeoff (Sultan, Farley, and Lehmann 1990). Thus an increase in market penetration increases the likelihood of a takeoff. To avoid problems of simultaneity, we include the lagged value of market penetration as an independent variable in the model. Thus we hypothesize:

H_{14}: The greater the market penetration, the higher the probability of takeoff.

Prior Takeoffs

A new product's prior takeoffs in other countries can stimulate takeoff in a target country for at least four reasons. First, as the product takes off in other countries, the media are more likely to report its use or popularity, increasing its attractiveness in the target country. Second, on seeing a new product take off in other countries, manufacturers or retailers are more likely to promote sales in the target country, thereby triggering a takeoff. Third, takeoff in other countries implies more adopters, which means that a consumer in the target country has a higher probability of coming in contact with an adopter. Such contact can increase acceptance of the new product and thus the chance of takeoff in the target country. Fourth, when a product takes off in other countries, potential adopters in the target country are more likely to perceive the new product to be a success. This perception is likely to reduce the perceived risk associated with adopting the new product, increasing acceptance of the new product and the chance of takeoff in the target country. Thus we hypothesize:

H_{15}: The greater the number of prior takeoffs in other countries, the higher the probability of takeoff in a target country.

Year of Introduction

The literature is ambiguous about the effect of the year of introduction on takeoff. Golder and Tellis (1997) argue that due to the faster speed of technological innovation in more recent years, new products improve faster. Thus they are likely to appeal to consumers and take off sooner than products introduced in prior decades. On the other hand, Bayus (1992, 1994) argues that technological change is not occurring any faster in more recent decades than it did in earlier decades. By this logic, takeoff should not occur any faster in more recent decades than in earlier decades. Recently, Van den Bulte (2000) showed that although, on average, there has been an increase in diffusion speed, this effect disappears when one controls for economic and demographic evolutions as well as for the nature of products studied. Therefore, we will not posit a hypothesis for this effect, but merely include it as a control variable.

Data

This section describes our data collection and measures.

Data Collection

The data collection was difficult and slow. It took the periodic efforts of several research assistants and authors over four years to assemble, prepare, and analyze all the data. In searching for data, the authors had to pursue numerous leads (many of them futile), including contacting dozens of sources through hundreds of emails and phone calls and traveling to various international cities.

We hoped to gather data for 10 consumer durables (refrigerator, washing machine, freezer, dishwasher, color television, dryer, VCR, computer, CD player, and microwave oven) across 16 European countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom). In effect, we succeeded in obtaining data on 137 of these 160 country-categories, for about an 86 percent achievement rate.

For data on product sales, we turned to Euromonitor International, GfK Group, the Economist Intelligence Unit (EIU), TableBase (a database from Responsive Database Services, Inc.), the archives and publications of associations of appliance manufacturers in various European countries, and William P. Putsis Jr., who generously sent us data on a few product-categories.

Some of the data series from these sources overlapped. When sources overlapped, sometimes the figures were identical and sometimes they differed. Even when figures from two sources did not match, they were highly correlated. When figures did not match, we used the figures from the source that provided all observations for a series and the greater amount of overall data across series. These protocols ensured that a particular series was unlikely to have a sudden increase or decrease in sales attributable to a change in the source of data; they further ensured that a maximum consistency existed in the underlying process that generated various series of data, given that we had to tap multiple sources. Note that the use of multiple sources increases the noise in the data and thus would decrease the probability of finding the patterns that we expect.

- To gather data on our explanatory variables, we primarily used publicly available sources because these are generally acknowledged to be more reliable (Golder 2000). Our key sources of data were the *Statistical Yearbook* of the United Nations, the Penn World Tables (a collection of international data comparisons), World Bank statistics, Eurostat reviews, and individual sources, such as Parker (1997) and Hofstede (1980, 2001).

Measures

This subsection explains the measures for year of introduction, takeoff, and the independent variables in our model.

Year of Introduction

For most country-categories we have data from the year of introduction with sales as low as one thousand units per year. However, for some country-categories we were unable to get data from the early years, especially during or before World War II. To avoid left-truncation bias we dropped such country-categories. In the interests of consistency, we formulated a rule that for country-categories for which penetration in the first year of our data is more than .5 percent, the early years are missing. Consequently, we also dropped those country-categories from the analysis. (In addition, we dropped four countries in VCRs because sales for those countries started quite high relative to the others.) By using these conservative rules, we are relatively confident that we have the correct year of introduction for 120 of the 137 country-categories. The average first-year sales per country (across categories) ranges from 1,000 units for smaller countries to 20,000 units for the largest one.

Takeoff

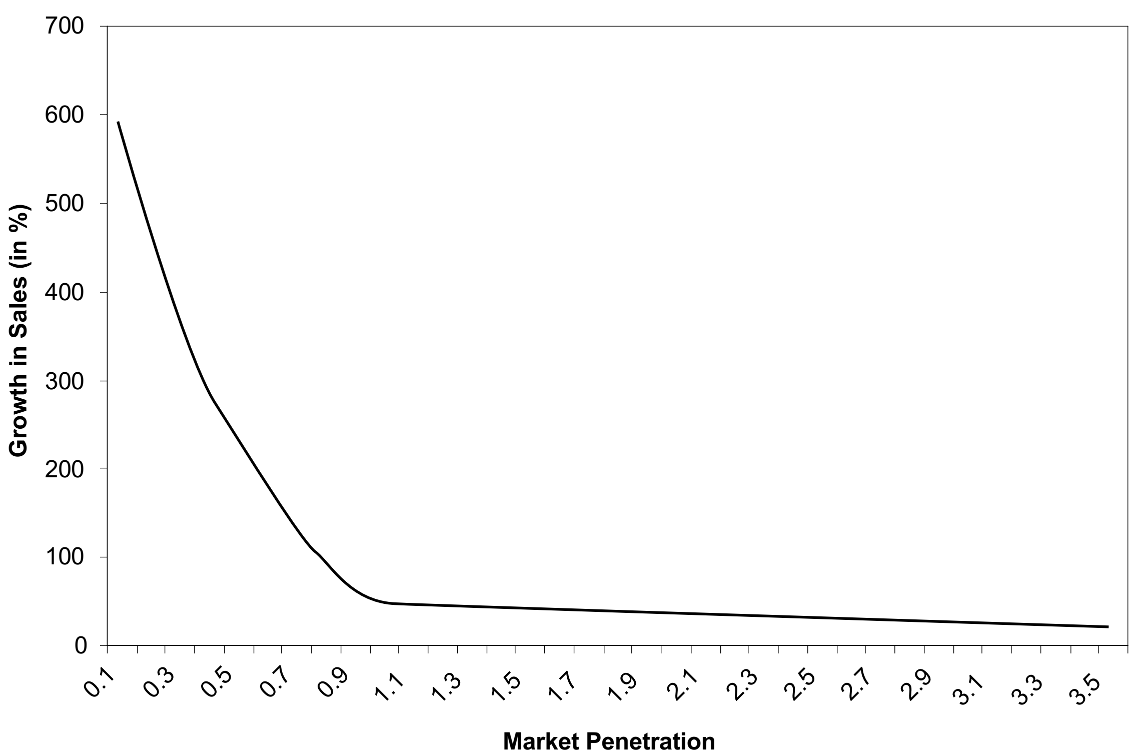
Recall that takeoff is the start of the growth stage of the life cycle characterized by a rapid growth in sales. A heuristic to identify takeoff is very important because it provides a basis for empirical analysis as well as a simple rule that practicing managers can use. However, when the base sales are small, a relatively large percentage growth in sales may occur without signaling takeoff. On the other hand, when the base sales are large, takeoff may occur at a relatively small percentage growth in sales.

So, Golder and Tellis (1997) defined a threshold rule for takeoff. The rule identifies a particular growth rate for each level of cumulative sales, above which takeoff is said to have occurred. They inferred the threshold growth rates from empirical data, such that it would give the best prediction of takeoff with visual identification. They refer to the locus of these threshold growth rates plotted against cumulative sales as the threshold curve. The advantages of the threshold rule are that it is simple to use, is interpersonally certifiable, and has predictive validity. That is, the rule enables one to predict the year of takeoff as it occurs, without the need for all the data. However, the Golder and Tellis (1997) threshold did not easily fit our multinational application because of the great diversity of base sales across the 16 countries in our sample.

So, we modified the rule, using market penetration rather than sales as a base with which to evaluate growth. We define the locus of the critical growth rates plotted against penetration level as the *threshold for takeoff* (see Figure 2). We operationalize takeoff as the first year a product's growth in sales crosses the corresponding growth rate on the curve in Figure 2. Like Golder and Tellis (1997), we inferred the shape of the curve so that identification of takeoff by the rule matches with the visual determination of takeoff in a maximum number of cases.

This simple rule for international takeoff corresponds very well with a visual inspection of the sales curve in 132 of 137 country-categories. In two country-categories growth failed to cross the threshold, though a takeoff did occur. In three other country-categories, we did not have enough data to determine the takeoff.

Figure 2. Threshold for Takeoff



We also developed an entirely different method for defining takeoff that relied on a multi-rater visual identification of takeoff without raters having any knowledge of the threshold rule (see Appendix 1). To ascertain the robustness of the threshold rule, we repeated the entire descriptive and hazard analysis using the alternative method. The main results proved to be robust.

From our identification of the introduction and takeoff, we calculated time-to-takeoff as the number of years between introduction and takeoff. By using this rule, we have time-to-takeoff for 120 of the 137 country-categories.

Independent Variables

We measured economic wealth by gross domestic product (GDP) per capita in thousands of U.S. dollars. We also included real GDP per capita in constant dollars, adjusted for changes in the terms of trade (we used the 1985 international prices for domestic absorption and current prices for exports and imports). This measure gave similar results.

Recall that we operationalized a country's economic progressiveness in terms of income inequality and participation in economic unions. A well-established measure of income inequality is the Gini index. We extracted our measure of the Gini index from the database of Deininger and Squire (1996), which can be accessed on the website of the World Bank. To maximize consistency across countries, we selected the Gini coefficient based on net income (not expenditure or gross income), number of households (not population), and national coverage. We selected the Gini coefficient that was closest to 1980 to be consistent with the time of the Hofstede measures on culture.

For participation in economic unions, we used a dummy that indicated if the country was a member of the European Union (EU) or one of its predecessor organizations, such as the European Coal and Steel Community (ECSC) or the European Economic Community (EEC), in a given year. The EU (then called ECSC) was founded in 1951 by Belgium, France, Germany, Italy, Luxemburg and the Netherlands. Later, Austria (1995), Denmark (1973), Finland (1995), Greece (1981), Ireland (1973), Portugal (1986), Spain (1986), Sweden (1995), and the United Kingdom (1973) all joined.

We measured a country's economic openness by its level of international trade, which encompasses exports (fob) and imports (cif) per capita in thousands of U.S. dollars. As a composite measure for economic openness or international trade, we used the sum of exports and imports per capita in thousands of U.S. dollars. We also used exports and imports as a percentage of GDP per capita as a measure for openness. Subsequent analyses revealed results for the latter measure that were similar to the former.

We measured economic roles in the household through the economic activity rate of women, which refers to the percentage of women that are employed in the workforce or who are unemployed but actively seeking work.

For the cultural variables of uncertainty avoidance and masculinity, we used Hofstede's measures. Readers may refer to Hofstede's original work (1980) or its most recent edition (Hofstede 2001). Weber (1958) established the high correlation between need for achievement and religious denomination. The major religious divide among European nations is between Protestants and Catholics. There is strong evidence in sociology that Protestant denominations are more supportive of a high need for achievement than is Catholicism (McClelland 1961; Weber 1958). Therefore, we operationalized need for achievement by the percentage of Protestants in the population (see Parker 1997). We used climate as a proxy for industriousness (reverse scaled). This operationalization is based on the argument that climate plays a strong role in human mood, work ethic, and productivity. A hot climate discourages hard work and leads to lethargy. On the other hand, in cold climates the need to keep warm stimulates individuals to undertake physical activity. Over time, these influences may lead to work ethics and attitudes in cool climates that encourage more industry and enterprise than the work ethics and attitudes in warm climates. We measured climate by monthly high temperatures (max C), as inventoried by Parker (1997).

We measured media intensity in several ways. A first measure is the country's total circulation of newspapers—the number of newspaper copies printed—per 100 inhabitants. A second measure is the number of radios (receivers) per 100 inhabitants. Note that this series has the disadvantage that the United Nations switched in the 1980s from inventorying the number of radio licenses to estimating the number of receivers in use. A third measure is the number of televisions (receivers) per 100 inhabitants. A fourth measure is the number of telephones per 100 inhabitants. As a composite measure for media intensity, we use the sum of these four measures. Since in post–World War II Europe the most important factor in mobility is car possession, we measured a country's mobility by the number of cars per 100 inhabitants. For education, we used the number of tertiary-degree (university) students as a percentage of total population.

To account for differences between brown and white goods we included the product class as a dummy variable, coded 1 for white goods and 0 for brown goods. For market penetration, we used the average possession of the product by households in the country. One of our sources provided us with the market penetration for the white goods. For brown goods, we calculated the market penetration as follows:

$$\text{penetration}_t = \text{penetration}_{t-1} + \{(\text{sales}_t - \text{sales}_{t-r}) \,/\, (\text{number of households}_t)\}, \quad (9)$$

where r is the average repurchase time for a product in a particular category. For example, assume a country has 10 million households and sales of the durable in question in the first three consecutive years are 10,000, 25,000, and 75,000 per year. Also assume that the durable has a short replacement cycle—for instance, of one year. Then our rule would say that penetration in the first year is 0.1 percent (= 10,000/10,000,000), penetration for the second year is 0.25 percent (= 0.1 percent + (25,000 – 10,000) / 10,000,000), and penetration for the third year is 0.75 percent (= 0.25 percent + (75,000 – 25,000) / 10,000,000).

Note that because takeoff typically occurs at a low level of penetration, adjusting the penetration to the ceiling values (Dekimpe, Parker, and Sarvary 1998) in each category is not critical.

For the number of prior takeoffs in other countries, we used two measures. One was a generic measure that counts the total number of prior takeoffs across all the countries of Europe. The second is a region-specific measure that counts the total number of takeoffs in the cultural-geographic region to which a country belongs (Scandinavian, mid-European, or Mediterranean; see below). Both measures gave similar results, and we report those for the second measure.

Since the variables in our model include both time-varying and time-invariant measures, we need to point out clearly which measures are of which type:

- Time-varying measures are market penetration; number of prior takeoffs; GDP; EU membership; exports; imports; number of radios, televisions, telephones, and cars; circulation of newspapers; and education.

- Time-invariant measures are product class, introduction year, income inequality (Gini), economic activity rate of women, uncertainty avoidance, masculinity, percentage of Protestants, and maximum temperature.

Empirical Results

We first present some descriptive statistics, then the estimates of the model, and finally, an assessment of the model's performance.

Descriptive Statistics

Recall that the first two goals of this study are to determine if the phenomenon of takeoff generalizes to Europe and whether there are country-specific differences in takeoff across European countries. The descriptive statistics help to answer these questions. They cover the time-to-takeoff and the mean leads and lags in takeoff across countries.

Time-to-Takeoff

On average, new products in Europe take 6 years to take off (see Table 1a). This average is statistically different from 0, having a standard deviation of 3.3 years. At the same time, some significant differences in this average exist across key countries and categories.

Each product-category has a particularly distinct time-to-takeoff, which is often significantly different by product-category (Table 1a). A more dramatic, albeit related, result is the difference in time-to-takeoff between product classes (see Table 1b). As we expected, white goods (kitchen and laundry appliances) generally have a longer time-to-takeoff than brown goods (entertainment or information products). The mean time-to-takeoff is eight years for the former and two years for the latter—white goods take, on average, four times longer to take off. The reason could be the greater visibility of, prestige associated with, and immediate satisfaction all family members derive from brown goods as opposed to white goods. However, other variables also affect time-to-takeoff, so we need to evaluate this result in the multivariate analysis using the hazard model.

Another categorical variable that affects takeoff is the country. Each country seems to have a distinct time-to-takeoff (see Table 2a). One of the most striking results is the dramatic difference between geographic regions of Europe (see Table 2b). The Scandinavian countries (Denmark, Sweden, Norway, and Finland) have the shortest time-to-takeoff. It is a mere 4 years (even shorter if Finland is excluded). This number is almost half that for Mediterranean countries (France, Greece, Italy, Portugal, and Spain), which have a mean time-to-takeoff of 7.4 years. The time for the rest of Europe (United Kingdom, Ireland, Germany, Austria, Belgium, Netherlands, and Switzerland) is in between, at 6 years. These differences are based on such a large number of different products and time periods that the results are unlikely to be due to chance.

Table 1a. Time-to-Takeoff by Product-Categories

Category	Time-to-Takeoff		
	Number of Countries	Mean	Standard Deviation
CD player	8	1.8	1.5
Color TV	3	1.7	0.6
Computer	12	1.3	0.6
Dishwasher	14	8.1	4.5
Dryer	15	10.4	6.6
Freezer	15	7.7	5.0
Microwave	16	10.1	2.5
Refrigerator	7	2.9	2.2
VCR	12	3.3	1.8
Washing machine	15	4.7	3.2
Overall	**117**	**6.0**	**3.3**

Table 1b. Time-to-Takeoff by Product Class Groups

Group	Time-to-Takeoff		
	Countries	Mean	Standard Deviation
Brown goods	35	2.0	0.4
White goods	82	8.2	2.4
Overall	**117**	**6.0**	**3.3**

Leads and Lags in Takeoffs

Because of the differences across product-categories and because product-categories are not evenly distributed across countries, we computed the intercountry differences in the calendar year of takeoff after correcting for product-category differences. To do so, we first computed the mean year of takeoff for each product-category across all countries. We then subtracted the mean of a product-category from each country's year of takeoff for that category. The result gives us the lead or lag time for a product's takeoff in a given country relative to the average in Europe. If the takeoff occurs in a country before the average, that country leads. If it occurs

Table 2a. Time-to-Takeoff by Countries, Sorted by Increasing Time-to-Takeoff

		Time-to-Takeoff	
Country	**Number of Product-Categories**	**Mean**	**Standard Deviation**
Denmark	9	3.8	3.3
Norway	7	4.0	2.4
Sweden	8	4.3	3.5
Finland	8	4.6	3.8
Ireland	5	4.8	4.0
Belgium	9	5.1	3.4
Switzerland	3	5.3	3.5
Austria	7	5.9	4.5
Netherlands	7	5.4	4.7
Germany	8	6.4	4.8
Italy	10	6.7	8.0
Spain	8	7.1	5.4
France	9	7.4	6.0
U.K.	8	8.5	7.3
Greece	5	9.0	6.8
Portugal	6	9.3	5.0
Overall	**117**	**6.0**	**3.3**

Table 2b. Time-to-Takeoff by Country Groups

		Time-to-Takeoff	
Region	**Number of Product-Categories**	**Mean**	**Standard Deviation**
Scandinavia	32	4.0	5.3
Mid-West Europe	47	6.0	4.4
Mediterranean	38	7.4	4.4
Overall	**117**	**6.0**	**3.3**

after the average, the country lags. The means of these leads and lags across product-categories for each country are given in Table 3a. Note that positive numbers imply overall leads, while negative numbers imply overall lags. The countries are listed in decreasing order of lead times.

Here again, after controlling for product-category differences, there is a very clear difference in leads and lags in year of takeoff across countries. Although we expected some difference across European countries, the variation, displayed in Table 3a, is huge. Note especially the dramatic 11-year difference between Denmark, which tops the list, and Greece, which is at the bottom. The difference in mean leads and lags in year of takeoff carries over to the differences among the country groups in Table 3b.

Table 3a. Lead and Lags in Year of Takeoff by Countries, Sorted by Lead Time

Country	Number of Product-Categories	Mean Lead (+) or Lag (–) in Takeoff (Years)
Denmark	9	3.1
Switzerland	4	3.0
Sweden	9	2.8
Norway	8	2.1
Germany	9	2.3
Austria	8	2.0
Belgium	9	1.8
Netherlands	10	0.9
Ireland	7	0.7
U.K.	9	0.4
Finland	8	–0.2
France	10	–0.4
Italy	10	–2.1
Portugal	7	–3.9
Spain	9	–4.8
Greece	6	–8.1
Total	**132**	

Table 3b. Leads and Lags in Year of Takeoff by Country Groups

Country Group	Number of Country-Categories	Mean Lead (+) or Lag (–) in Takeoff
Scandinavia	34	2.0
Mid-West Europe	56	1.5
Mediterranean	42	–3.4

Estimates of the Hazard Model

Are the differences in the countries and these country groups due to economics, culture, information access, or the product-category characteristics? Our assumptions were that economic variables would be the prime factor that explained differences between countries. Cultural variables would be the next important factor. Most people with whom we discussed the study and most audiences before whom we presented felt likewise. Subsequent empirical analysis with the hazard model enables us to test these expectations. The hazard analysis allows for multiple explanatory variables and thus is a convenient framework for such a test. We next discuss the parameter estimates we obtained; the results of the model's performance are given in Appendix 2.

Table 4 contains the parameter estimates. Note that positive β coefficients decrease the probability of takeoff and negative β coefficients increase the probability of takeoff (as specified in equations 5–7). Because of the large number of variables and the potential for multicollinearity, we ran the model with each independent variable alone as well as with all the independent variables together.

The analyses with individual independent variables show that 10 of the 14 hypothesized effects are significantly different from 0 and in the expected direction. The hypotheses not confirmed are income inequality (H_2), participation in economic unions (H_3), roles in the household (H_4), masculinity (H_7), and market penetration (H_{14}). In particular, we find that:

- ❒ Brown goods take off faster than white goods (H_{13}).
- ❒ The higher the prior takeoffs in other countries, the higher the probability of takeoff in a target country (H_{15}).
- ❒ Products take off faster in wealthier countries than in poorer countries (H_1).
- ❒ Products take off faster in countries with more open economies, as compared to countries with less open economies (H_5).
- ❒ Products take off faster in countries low in uncertainty avoidance, as compared to countries high in uncertainty avoidance (H_6).

- ❒ Products take off faster in countries high in need for achievement, as compared to countries low in need for achievement (H_8).
- ❒ Products take off faster in industrious countries, as compared to less industrious countries (H_9).
- ❒ Products take off faster in countries high in media intensity, as compared to countries low in media intensity (H_{10}).
- ❒ Products take off faster in countries high in mobility, as compared to countries low in mobility (H_{11}).
- ❒ Products take off faster in countries high in education, as compared to countries low in education (H_{12}).

We also find that products that were introduced more recently took off faster. However, when we include all these variables in the full model, many of the effects are not significantly different from 0. One reason for this result is multicollinearity. The condition index takes on a value of more than 2200, which by far crosses the threshold of 30 (Belsley, Kuh, and Welsh 1980). Nonetheless, while all the country characteristics seem susceptible to this problem, the effects of the three product-category variables are strong, have the right sign, and are very robust to model specification: product class (H_{13}), lagged market penetration (H_{14}), and prior takeoffs (H_{15}).

To deal with the multicollinearity problem, we conducted a factor analysis to extract orthogonal, higher-order constructs. We extracted factors using principal components, which we rotated using Equamax, an orthogonal rotation method (to avoid collinearity among factors). On the basis of a scree plot, we retained three factors (explaining 71 percent of the variance), which we named, in order of importance:

1. *Economic wealth* (43 percent of variance): GDP (0.909), number of telephones (0.915), number of cars (0.885), number of televisions (0.908), exports (0.860), imports (0.854), and education (0.647) load heavily on this factor.
2. *Venturesome culture* (19 percent of variance): uncertainty avoidance (–0.777), need for achievement (0.839), and industriousness (0.799) load heavily on this factor.
3. *Economic progressiveness* (9 percent of variance): income inequality (–0.734) and EU membership (0.679) load heavily on this factor.

Note that the factor analysis was unable to discriminate between economic wealth and information access as separate factors. This result may not be surprising when one considers that information access is largely dependent on the wealth of a country. We then included these factors together with the product-category characteristics as independent variables in the hazard model. Table 5 presents the results of this estimation. In the last column of Table 5, we also present the percentage change in the hazard ratio given a one-unit change in the independent variable.

Table 4. Estimate of the Hazard Model (Standard errors in parentheses)

Variables	Individual Models																
Intercept	1.009‡	2.052‡	3.266‡	2.226‡	2.058‡	0.634	1.742‡	1.956‡	2.008‡	1.306‡	1.526‡	1.847‡	–0.107	2.301‡	2.094‡	2.103‡	–1.446
	(0.125)	(0.176)	(0.422)	(0.115)	(0.106)	(0.900)	(0.099)	(0.251)	(0.097)	(0.194)	(0.147)	(0.096)	(0.834)	(0.157)	(0.132)	(.137)	(2.056)
Product-Category																	
Product class	1.034‡																
(1: white goods, 0: brown goods)	(0.143)																1.712‡
																	(0.405)
Market penetration		–1.044															–0.688
		(0.637)															(0.414)
Introduction year			–0.023‡														0.022
			(0.006)														(0.027)
Number of prior takeoffs				–4.39‡													–0.263‡
				(0.084)													(0.102)
Economic Variables																	
GDP					–0.079‡												0.042
					(0.020)												(0.085)
Income inequality (Gini)						0.034											0.003
						(0.028)											(0.044)
European unification							–0.046										–0.083
							(0.145)										(0.246)
Roles in the household								–0.008									0.009
								(0.008)									(0.016)
International trade									–0.126‡								–0.049
									(0.033)								(0.077)
Cultural Variables																	
Uncertainty avoidance										0.006†							0.007
										(0.003)							(0.007)
Masculinity											0.005						0.005
											(0.003)						(0.005)
Need for achievement												–0.357*					0.286
												(0.191)					(0.533)
Industriousness													–0.050†				0.004
													(0.023)				(0.047)
Information Access																	
Media intensity														–0.052‡			–0.037
														(0.013)			(0.040)
Mobility															–0.020‡		0.023
															(0.006)		(0.022)
Education																–0.313‡	0.005
																(0.096)	(0.154)
LL	**–299.321**	**–326.388**	**–326.023**	**–305.507**	**–321.108**	**–330.554**	**–331.361**	**–330.945**	**–319.884**	**–328.674**	**–330.169**	**–329.631**	**–328.885**	**–322.848**	**–326.194**	**–325.474**	**–268.176**

N = 117 (product-country series) and 826 (observations)

Significance levels (one-sided): *: $p < 0.10$; †: $p < 0.05$; ‡: $p < 0.01$.

Table 5. Results of the Hazard Model with Factors

Variables	Coefficient	Standard Error	Change in Hazard Ratio (in %)
Intercept	–1.327	1.695	
Product-category (1: white goods, 0: brown goods)	1.924***	0.453	–85.4
Market penetration	–1.172**	0.521	222.8
Introduction year	0.038	0.023	–3.7
Number of prior takeoffs	–0.380***	0.113	46.2
Economic wealth	0.047	0.164	–4.6
Venturesome culture	–0.189*	0.098	–20.8
Economic progressiveness	–0.065	0.112	6.7
LL	**–271.31**		

Significance levels (one-sided): *: $p < 0.10$; **: $p < 0.05$; ***: $p < 0.01$.

This value is equal to 100*($e^{-\beta}$–1) (see Equation 7). Note that this hazard ratio cannot be straightforwardly compared across variables, since it is not unit-free.

Here again we find that the product characteristics are highly significant. Consistent with our hypotheses, takeoff occurs earlier for brown goods, as lagged market penetration increases, and with more prior takeoffs in neighboring countries. Counterintuitively, we now find that takeoff occurs later for more recently introduced categories. The reason for this result may be the omission of old product-categories from our data. We do not have data prior to 1950. As a result, we do not have information on old product-categories that were introduced very early and which we suspect took a long time to take off. If we had these data, the effect may have been insignificant, as Golder and Tellis (1997) found, or may have had a sign opposite to what we obtained.

Of the country factors we extracted, we find that only the venturesome culture (p = .054) has a significant effect on time-to-takeoff. The sign is consistent with our hypothesis, in that takeoff occurs faster in countries with a more venturesome culture. Economic wealth and economic progressiveness do not have a significant effect on time-to-takeoff. This is a surprising result, since many observers credit economics as having a predominant influence on time-to-takeoff.

Discussion

While the takeoff of new products is an important phenomenon, it has received limited attention, all of which focuses on the U.S. market. Because Europe has had 55 years of successful evolution of free consumer markets, that arena constitutes a good context in which to test the generalizability of takeoff. The post–World War II economic boom in Europe, together with Europe's growing economic unification, has led to a perception among some that all of Europe has become or is steadily becoming one market. The takeoff of consumer durables across Europe is a suitable context in which to test the validity of that perception.

We analyzed the takeoff of 10 consumer durables across 16 western European countries. While still limited in scope, this is one of the largest studies on international new product growth. Our analysis leads to some clear conclusions:

- Sales of most new products display a distinct takeoff in various European countries, at an average of 6 years after introduction.
- Time-to-takeoff differs dramatically across product classes. The mean time-to-takeoff is 8 years for white goods (kitchen and laundry appliances) and 2 years for brown goods (entertainment and information products).
- Time-to-takeoff differs dramatically between countries (e.g., 3.1 years for Denmark and –8.1 years for Greece). On average, time-to-takeoff is almost half as long in Scandinavian countries (4 years) as in Mediterranean countries (7.4 years).
- Culture partly explains these differences. In particular, the probability of takeoff increases with higher need for achievement and industriousness and lower uncertainty avoidance. While economic factors individually affect the probability of takeoff in the expected direction, their effects are neither strong nor robust to model specification.
- The probability of takeoff of a new product in a target country increases with prior takeoffs in other countries.

These results have important implications for international entry and marketing of new products. The most important implication is that specific regions of Europe have distinct commonalities in terms of new products' time-to-takeoff, with sharp differences across regions. While we expected some differences, we were surprised by the size of the differences. We were also surprised by the fact that Scandinavian countries tend to have the shortest time-to-takeoff of all European countries. In contrast, the large economies of Europe, France, Germany, Italy, Spain, and the United Kingdom turned out to have longer time-to-takeoff than the Scandinavian countries. When we presented these results to audiences of managers and researchers in the United States and Europe, they were also surprised, yet found the results believable. They had suspected that Scandinavian countries are relatively innovative, while Mediterranean countries are much less so.

A second important implication that follows from our results is that there are distinct advantages to a waterfall strategy as opposed to a sprinkler strategy when it comes to marketing new products. A waterfall strategy entails sequential introduction, while a sprinkler strategy entails simultaneous introduction of new products across countries. Our results support a waterfall strategy for three reasons. First, because managers are under great pressure to pull the plug on a product that has not taken off, introducing the product in countries that are likely to show early takeoff can win internal support for continued marketing of the new product. It can help to convince critics within the company of the new product's potential and prevent its premature withdrawal. Past studies on diffusion have typically not emphasized this perspective, which is unique to a focus on takeoff. For example, Putsis et al. (1997) even suggest introducing first in Germany, France, Italy, and Spain, for "seeding the diffusion process" (p. 354).

Second, takeoff in one country increases the likelihood of takeoff in other countries, as indicated by our empirical results and by past research (Gatignon, Eliashberg, and Robertson 1989; Kalish, Mahajan, and Muller 1995). Moreover, quick takeoffs in some countries can convince distribution channels in countries with slower takeoffs to carry the new product and support it adequately. Third, an early takeoff generates revenues and profits for the company, which it can use to improve the product, market it more aggressively, and introduce it in other international markets.

Have managers of new products adopted such a strategy in Europe? Our empirical analysis suggests not. Apparently firms do not take expected time-to-takeoff into account much when they introduce their products in different countries. This is a third important implication of our study. We arrived at this conclusion from an analysis of intercountry leads and lags in year of introduction for each product-category. A lead or lag in year of introduction for a target country is the difference between the mean year of introduction for a product-category across all countries minus the year that it was introduced in the target country. This analysis is based on only 120 country-categories because for 17 country-categories we were unable to determine the precise introduction date. We can compare the average leads or lags in year of introduction (see Table 6) to those in year of takeoff, shown in Table 3a.

Note first that there are considerable differences in mean leads and lags in year of introduction across countries. These leads and lags do not correspond exactly to the leads and lags in year of takeoff. In particular, large, developed economies, such as the United Kingdom, Germany, and France, show early product introductions but late product takeoffs, while Scandinavian countries, such as Sweden and Norway, show relatively late product introductions and early takeoff. (Note that this effect for the Scandinavian countries occurs even after the inclusion of prior takeoffs that account for potential spillover due to takeoff in other countries). This lack of correspondence could occur for several reasons.

One, managers of new products may not be aware of these results and may not have analyzed the success of past introductions along these lines. Two, managers of new products may be introducing products in economically advanced countries, assuming that these countries are likely to see product take off quickly. If so, our results are the opposite. Three, managers of new products may be focusing purely on sales and not on the profits or signaling value that accrues from an early takeoff.

A fourth implication of our study is that managers can use the takeoff of products in one country to predict takeoff in other countries. For this purpose the hazard model is useful and convenient. Even without using the model, managers can use the consistent inter-country differences in takeoff as a heuristic to gauge the likelihood and timing of takeoff in other countries. Similarly, public policymakers can use the results of the study to ascertain the likelihood and timing of takeoff of a new product in their own country, given its performance in other countries. Such a determination may play a role in encouraging or supporting investments in production and marketing so as to encourage timely local manufacturing of new products.

Table 6. Variation in Year of Introduction across European Countries

Country	Number of Product-Categories	Mean Lead (+) or Lag (–) in Introduction (Years)
U.K.	8	3.4
Germany	8	2.8
France	9	1.7
Belgium	10	1.5
Denmark	9	1.4
Sweden	8	1.2
Austria	8	0.8
Switzerland	3	0.6
Netherlands	7	–0.4
Norway	7	–0.4
Italy	10	–0.5
Ireland	6	–1.1
Finland	8	–1.6
Portugal	6	–1.6
Spain	8	–2.8
Greece	6	–9.1
Total	**120**	

This study has many obvious limitations, some of which we need to mention. First, we were unable to obtain data from before 1950. Thus we had to drop product-categories if they were introduced in a country before 1950. This was a problem particularly for refrigerators. The mean time-to-takeoff for refrigerators might have been longer than the 2.9 years we obtained if data for this product-category in all countries were included. Fortunately, this omission biases one of our results in the direction opposite to our major findings and hypotheses. If we had all the data, we would probably find that takeoff time is longer for white goods than we presently find.

Second, we were unable to get consistent measures of price and distribution in all the categories and countries. We were thus unable to assess the role of important variables that managers can control to trigger takeoff. Also our measure for need for achievement, namely the religious background of a country (Protestant versus Catholic), is weak. Although prior research since Weber (1958) has shown that the two are highly interrelated, a measurement closer to the definition of the construct would be more reliable. Such a measure is hard to obtain, however, especially from secondary data.

Third, we did not include U.S. data. In many cases, the products in our sample may have taken off in the United States before taking off in any European country. It would be interesting to compare and relate takeoffs in Europe with takeoffs in the United States or other North American countries.

Fourth, our measures of cultural differences may not directly assess peoples' readiness to adopt new products (see, for example, Parasuraman 2000). However, until such measures are available, the intercountry time-to-takeoff itself could serve as a surrogate of the innovativeness of countries.

Despite these limitations, we hope that researchers and academics will find value in our findings. We trust our effort will stimulate further research to overcome these limitations.

Appendix 1. Measuring Takeoff

In addition to the threshold rule we developed, we developed a procedure for visual identification of takeoff. This visual identification can provide additional validity for our threshold rule and model results. To avoid arbitrariness in implementing the rule, the year and type of takeoff was determined by pooling the input of three raters, as explained below.

We first graphed each product-category's sales history on a single page. We then used the following operational rule for identifying the takeoff: *The takeoff is a sharp turn in the sales curve that follows an introductory period of low, relatively flat or slowly increasing sales, and precedes a growth period of rapidly (exponentially) increasing sales. It forms an elbow in the sales curve. The* year of the takeoff *is the first year following the sharp turn*. We ascertained the validity and robustness of the visual determination of takeoff by the degree of consensus among the three raters. The three raters independently identified the year of takeoff, then met to discuss their identification. The discussion was meant to clarify misunderstandings but not to persuade or pressure raters into reaching a consensus. The greatest difficulty they had in identifying takeoff was with the product-category of dishwashers and the country of Ireland. They had the easiest time with microwave ovens and computers.

We measure the robustness of the takeoff as the degree of consensus among the three raters on the following 4-point scale:

- ❐ Very clear = unanimous agreement among the three raters
- ❐ Quite clear = one to two years' difference between one or more raters
- ❐ Fair = three to four years' difference between one or more raters
- ❐ Unclear = more than four years' difference between one or more raters

Of the 127 categories, 79 show a very clear takeoff. In 27 cases, takeoff is quite clear, in 9 it is fair, and in 12 it is unclear. In other words, 115 cases, or 90 percent of all categories, show a fair to very clear takeoff.

We repeated the entire descriptive and hazard analysis using this alternative measure of takeoff. The main results are robust; in particular, in the hazard model the same four variables are highly significant and are the main predictors of takeoff: product-category, prior takeoffs, market penetration, and country innovativeness.

Appendix 2. Model Performance

This second appendix discusses the stability of the parameters, the baseline hazard, and the model's fit.

Robustness of Results

To assess the robustness of our results, we checked the sensitivity of our results to alternative distributional assumptions, unobserved heterogeneity, and the method for determining takeoff. First, to check if our distributional assumption toward the baseline hazard (logistic) affected our results, we estimated a Weibull specification of the baseline hazard. A Weibull hazard model is a flexible form that allows for monotonically increasing or decreasing hazards and also nests an exponential hazard model, which has a constant hazard. The logistic specification we adopted also allows for non-monotonic hazards. We found that it did not significantly affect our point estimates, nor did it affect the standard errors of these estimates.

Second, we checked if unobserved heterogeneity was a problem. We modeled unobserved heterogeneity through the often-used gamma mixing distribution. We found unobserved heterogeneity to be very weak. Also the point estimates and standard errors we obtained in the model without heterogeneity were very close to the ones we found in a model with gamma mixing. We conclude that our model performs satisfactorily, as compared to a more complex parametric hazard model with gamma mixing, and thus retain our more parsimonious specification.

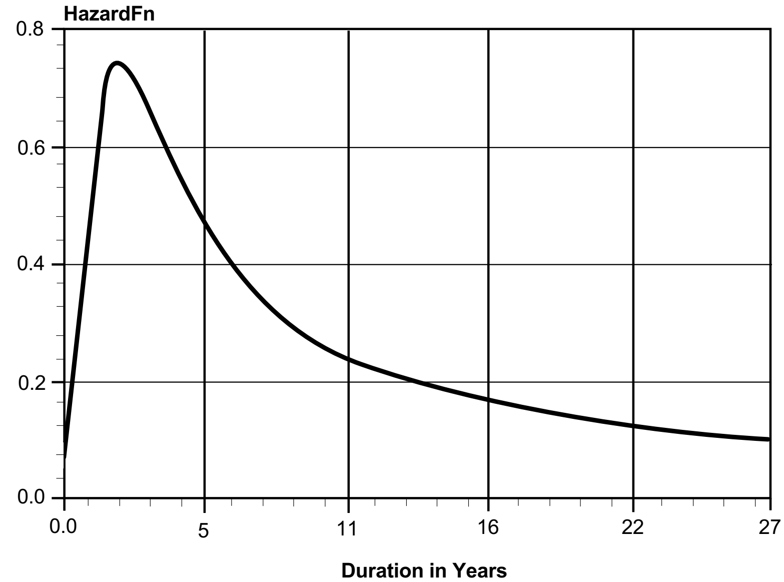
Third, we stated before that we also calculated takeoff years using visual inspection to check for the validity of our findings. That method resulted in findings that are not significantly different from the findings we obtained through the use of our threshold rule.

In sum, we find our estimates to be very stable with regard to the assumed distribution of the hazard, unobserved heterogeneity, and alternative takeoff rules.

Baseline Hazard

The distribution of the hazard function is modeled through the parameter σ. For the model with the factor scores of which the results are presented in Table 5, the σ parameter is equal to 0.37 and is significant at the 0.01 level. We display the baseline hazard function of this model in Figure 3. Note that the x-axis represents time in years and the y-axis represents the hazard function of Equation 7. This figure shows that the likelihood that takeoff will occur, given that it has not occurred yet, initially increases very rapidly to a maximum at around 3 years. After about 3 years the hazard gradually declines. In our data set, there were no products that took longer than 27 years to take off in a specific country.

Figure 3. Hazard of Takeoff Using Log-Logistic Function



Measures of Fit

To assess the model's performance, we use the likelihood ratio index (LRI, McFadden 1974). This index is a measure of how much the model reduces uncertainty and is similar to Hauser's (1978) U^2. It is analogous to the R^2 of multiple regression, although low values of LRI relative to R^2 still represent relatively good fits. A first model against which to evaluate the fit of our model is a proportional hazard model, which only includes a constant. Evaluated against this model, the model with the three factors (Table 6) has an LRI of 0.55. This value is excellent; the model proposed by Golder and Tellis (1997) had an LRI of 0.31 when evaluated against this base model. We also calculated the reduction in uncertainty as compared to a log-logistic model that only includes a constant. The LRI we obtained compared to this model is 0.18. Taking into account that our null model to calculate LRI includes a constant and, most importantly, already fits a log-logistic distribution to the hazard function, we can assess this LRI as satisfactory compared to results from prior takeoff research in marketing (Golder and Tellis 1997).

Notes

1. These institutions have changed names over the course of their existence; we use the most recent ones.
2. We found neither theoretical support nor empirical evidence in our data for including the two other Hofstede dimensions, power disparity and individualism, as explanatory variables.

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