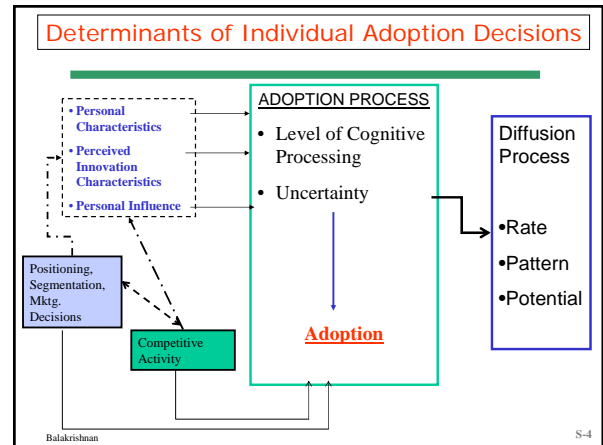
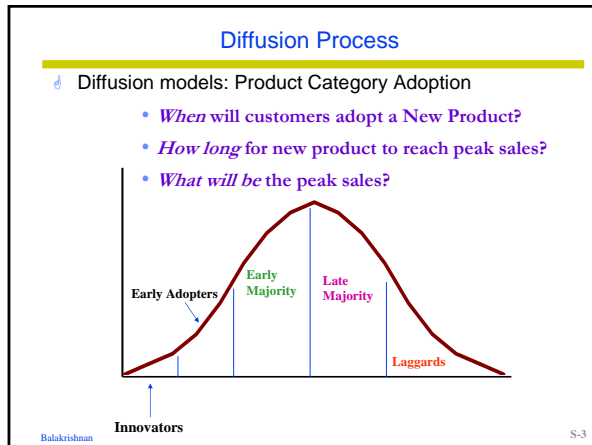
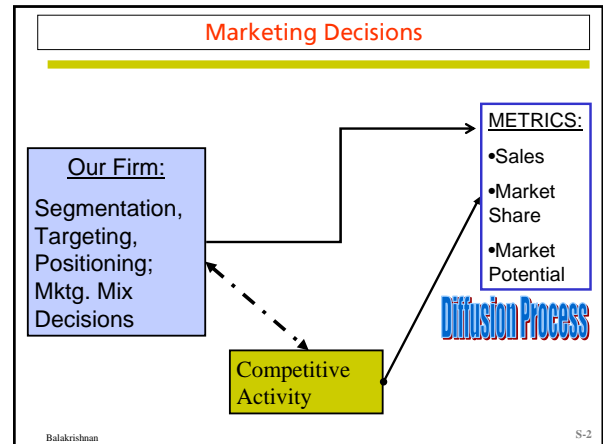


Diffusion of Innovations & The Consumer Adoption Process: Resistance to Innovations

by
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Need for Innovation

- A Terrible Killer
 - in the Navy: "...worse than accidents or warfare or all other causes of death together"
- 1497: Vasco Da Gama
 - Sailed around the Cape of Good Hope
 - 160 Sailors
 - Result: 100 died! =>
- Cause: Scurvy
 - Mosteller 1981, Science.

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A Lemon of an Innovation

- 1601: Captain Lancaster
 - Sailed -- England to India with 4 ships
 - Experiment:
 - 1 large Ship: 3 tsps Lemon Juice every day
 - 3 Ships: Control Group
 - Halfway to Cape of Good Hope
 - Result: In the CG 110 of 278 died.
- Status of Innovation
 - Nothing happened!

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Silence of the Lemon

- 1747: 150 years later
 - Dr. James Lind onboard HMS *Salisbury*
 - Knew about Lancaster's work.
 - Experiment: Six dietary supplements:
 - 6 spoons of Vinegar
 - ½ pint of Sea Water
 - Quart of Cider
 - 75 drops of Vitriol Elixir
 - 2 Oranges and 1 Lemon
 - Nutmeg
 - 2 ill patients were assigned to each treatment
 - Citrus fruit sailors were cured in a few days.
 - Fruit supply ran out in 6 days.
- Innovation: Nothing happened!

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Innovation Adoption

- Citrus Fruit for Scurvy:
 - British navy adopted this 48 years later in 1795
 - The British BOT: only 70 years later in 1865!
 - Scurvy is wiped out.
- Why this Resistance?:
 - Misleading accounts from Captain Cook's voyages
 - Competing "remedies"
 - Stature:
 - Lind's lack of prominence
- 1980: similar situation with submariners
 - Lowered plasma Vitamin C
 - "Let us not repeat mistakes of 400 years."

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BASS MODEL

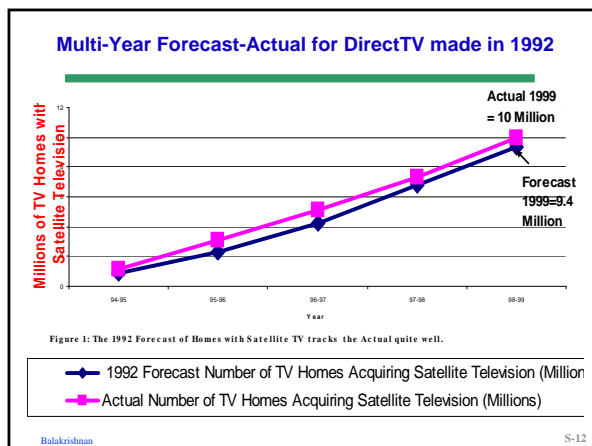
- ♣ New Durable Goods
- ♣ Objectives:
 - ◆ 1: Forecast penetration curve $X(t)$ and product life cycle sales rate curve $S(t)$
 - ◆ 2: Provide diagnostic information
 - ❖ Time to peak sales
 - ❖ Capacity needed at peak sales

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Bass Model Applications

1. Companies,
 - a) Eastman Kodak.
 - b) Dow Chemicals
 - c) IBM.
 - d) Sears.
 - e) AT&T etc.
2. Applications,
 - a) Retail Service.
 - b) Industrial Technology.
 - c) Educational.
 - d) Pharmaceutical.
 - e) Consumer Durable Goods

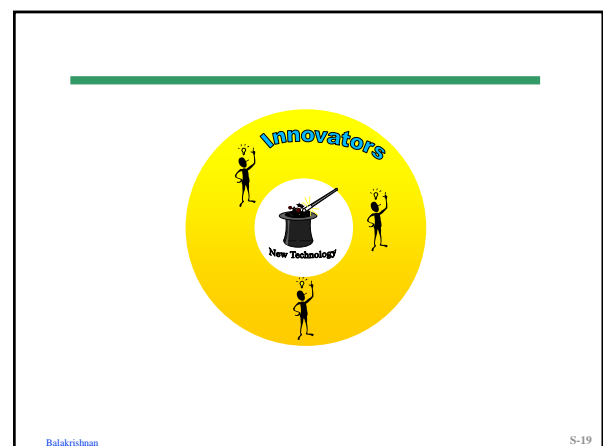
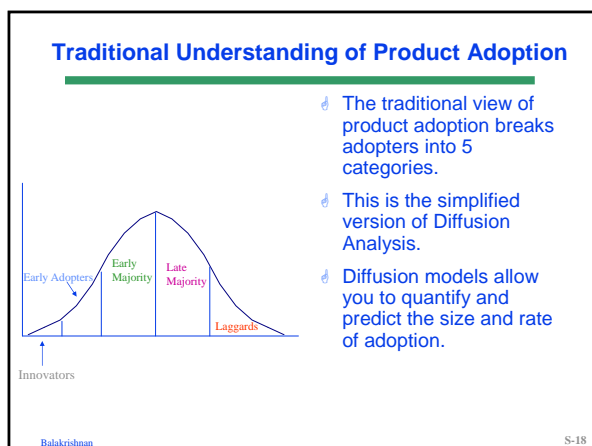
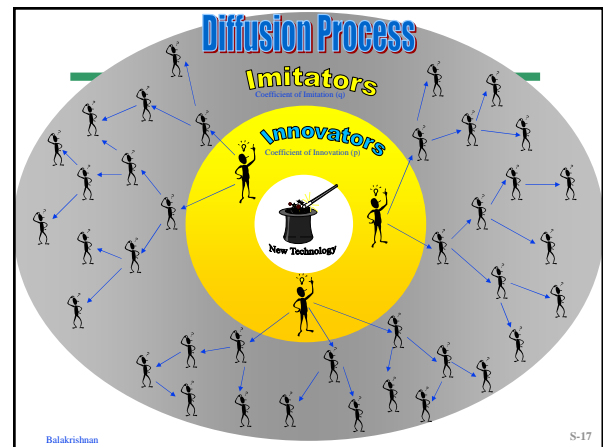
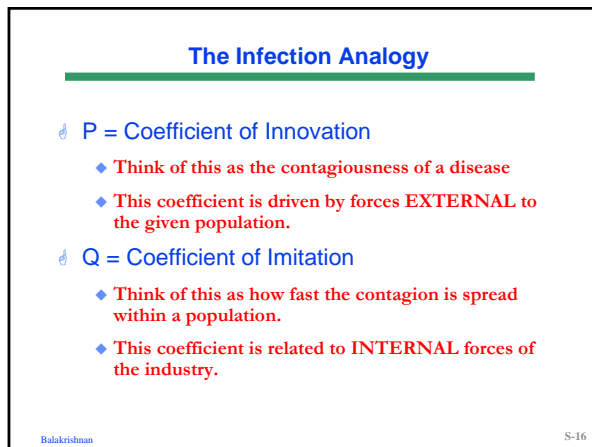
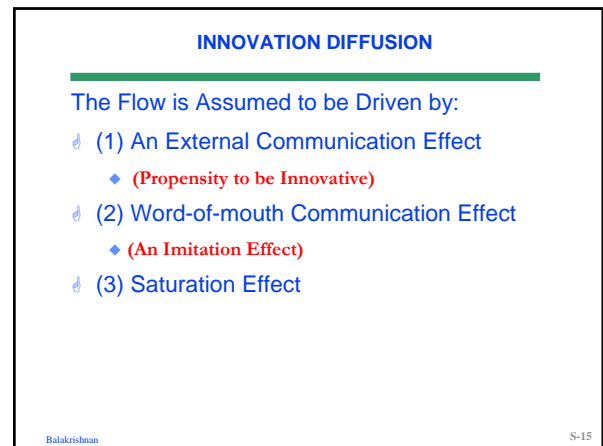
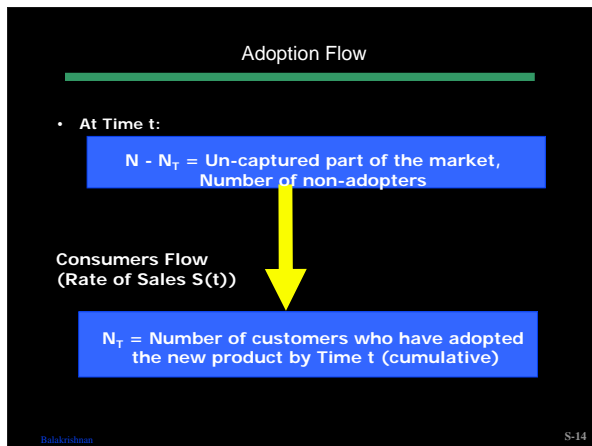
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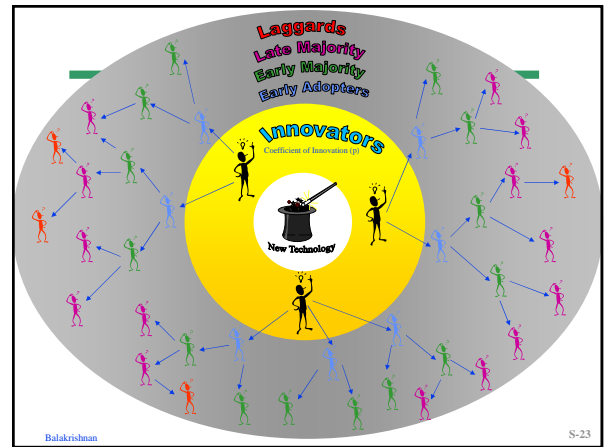
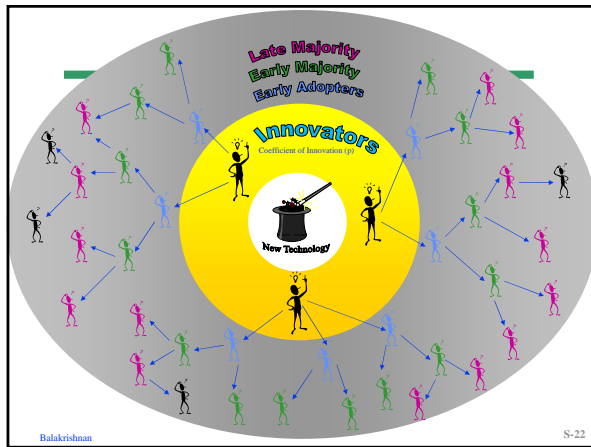
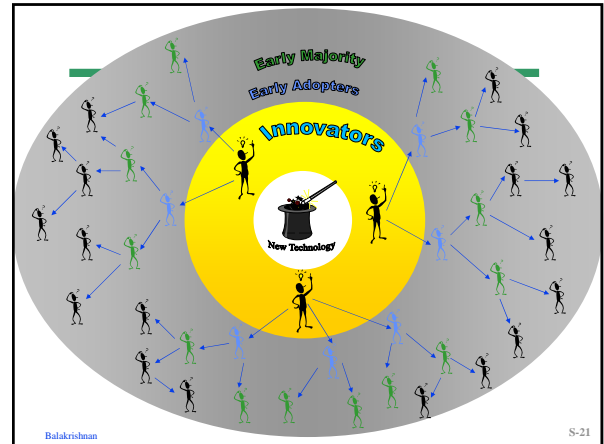


Assumptions of the Basic Bass Model

- ♣ Diffusion process is binary
 - ◆ consumer either adopts, or waits to adopt
- ♣ Constant maximum potential number of buyers (N)
- ♣ Eventually, all N will buy the product
- ♣ No repeat purchase, or replacement purchase
- ♣ The impact of the word-of-mouth is independent of adoption time
- ♣ Innovation is considered independent of substitutes
- ♣ The marketing strategies supporting the innovation are not explicitly included

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Theoretical Basis for the PLC: the Diffusion Model

- Qualitatively, Sales depend on purchases by
 - Innovators and by Imitators
 - Innovators' decision = f(inherent benefits, risks, info. availability)
 - Imitators' decision = f(word-of-mouth by innovators)
 - = f(# of innovators)

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Sales Growth Model for Durables (The Bass Diffusion Model)

$$S_t = p \times \text{Remaining Potential} + q \times \text{Adopters} \times \text{Remaining Potential}$$

Innovation Effect
Imitation Effect

where: S_t = sales at time t

p = "coefficient of innovation"
 q = "coefficient of imitation"

Adopters = $S_0 + S_1 + \dots + S_{t-1}$
 Remaining Potential = Total Potential - # Adopters

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Theoretical Basis for the PLC: the Diffusion Model

I.e., Sales at any point come from two types of consumers:
Innovators and Imitators

$$S_t = p(N - N_T) + q(N_T/N)(N - N_T)$$

where:
 S_t = sales (number of buyers) in period t
 N = ultimate number of buyers (market potential)
 (NOTE: L&R use m)
 N_T = cumulative number of buyers to date
 p = innovation effect (individual conversion rate without adopters' influence)
 q = imitation effect (effect of each adopter on each non-adopter)

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Parameters of the Bass Model: Product Categories

Product/ Technology	Innovation parameter (p)	Imitation parameter (q)
B&W TV	0.028	0.25
Color TV	0.005	0.84
Air conditioners	0.010	0.42
Clothes dryers	0.017	0.36
Water softeners	0.018	0.30
Record players	0.025	0.65
Cellular telephones	0.004	1.76
Steam irons	0.029	0.33
Motels	0.007	0.36
McDonalds fast food	0.018	0.54
Hybrid corn	0.039	1.01
Electric blankets	0.006	0.24

A study by Sultan, Farley, and Lehmann in 1990 suggests an average value of 0.03 for p and an average value of 0.38 for q.

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Estimated Parameters of 'q' Across Countries

Products	U.S.A.		South Korea		Taiwan		Japan	
	Years Covered	q	Years Covered	q	Years Covered	q	Years Covered	q
Electric Refrigerators	1921-54	.16	1970-82	.69	1966-80	.29	1956-65	.76
Black and White TV	1946-58	.39	1966-83	.52	1968-75	.75	1953-65	.59
Electric Washing Machines	1927-52	.13	1975-82	.61	1968-82	.36	1953-75	.19
Room Air Conditioners	1949-61	.38	1970-81	.50	1972-81	.65	1957-81	.28
Passenger Cars	1901-31	.29	1965-81	.49	1969-82	.45	1952-74	.39
Vacuum Cleaners	1932-54	.15	NA	NA	NA	NA	1956-75	.23
Calculators	1970-81	.43	NA	NA	1975-86	.46	1963-81	.39
Radios	1922-45	.38	1971-80	.48	1966-75	-	NA	NA

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Number of Cellular Subscribers

Source: Cellular Telecommunication Industry Association

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Estimating the Parameters of the Bass Model Using Regression

The discretized version of the Bass model is:

$$s(t) = a + bN_{(t-1)} + cN^2_{(t-1)}$$

a, b, and c may be determined from ordinary least squares regression. The values of the model parameters are then obtained as follows:

$$\bar{N} = \frac{-b - \sqrt{b^2 - 4ac}}{2c}$$

$$p = \frac{a}{\bar{N}} \quad (\text{Note from above: } c = -q/N)$$

$$q = p + b$$

To be consistent with the model, $N > 0$, $b \geq 0$, and $c < 0$.
Can also use EXCEL to solve these parameters.

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No prior data available

- Parameter Estimates Obtained from,
 - Management Judgment:**
 - Potential Market Size (N).
 - Number of Adoptions in the First Time Period.
 - Diffusion History of Analogous Products,**
 - Establish Similarity and Dissimilarity Relationships Between the New Product and Various Analogous Products.
 - Historical Empirical Relationship Between Innovation and Imitation Coefficients and Product or Market Attributes.
- Start with estimates and update parameters as initial sales data comes in.

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ODI Case: Using the Bass Model

	Time	Sales(farms)	Cumulative Sales
Market Size = 87	0	0	0
	1	3	3
	2	3	6
Innovation Rate= 0.03 (Parameter p)	3	5	11
	4	6	17
Imitation Rate = 0.38 (Parameter q)	5	7	24
	6	8	32
	7	9	41
	8	10	51
	9	9	60
	10	8	68

87 in prd.18

Example computations:
 Sales in Yr1 = $0.03 \times (87-0) + 0.38 (0/87) (87-0) = 2.61$
 Sales in Yr2 = $0.03 \times (87-2.61) + 0.38 (2.61/87) (87-2.61) = 3.49$

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Innovation and Diffusion and Market and Market Entry Decisions

Two frequently observed diffusion patterns:

Exponential (C-Curve)

Propensity to innovate dominates the propensity to imitate

$\alpha > \beta$

Logistics (S-Curve)

Propensity to imitate dominates the propensity to innovate

$\beta > \alpha$

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Predictive Performance (Life Cycle Curves)

Power Lawnmowers

Clothes Dryers

B & W TV

Home Freezers

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Diagnostic Prediction

Time to Peak Sales=

$$T^* = \frac{1}{p+q} \ln(q/p);$$

$$S^*(t) = \{N(p+q)^2\}/4q$$

At the point of "Takeoff", typically

- Price is 2/3rd the Launch Price;
- We have achieved 1.7% penetration;
- 6 years since Introduction (This time is shrinking).
- Two of these three criteria tend to be operative.

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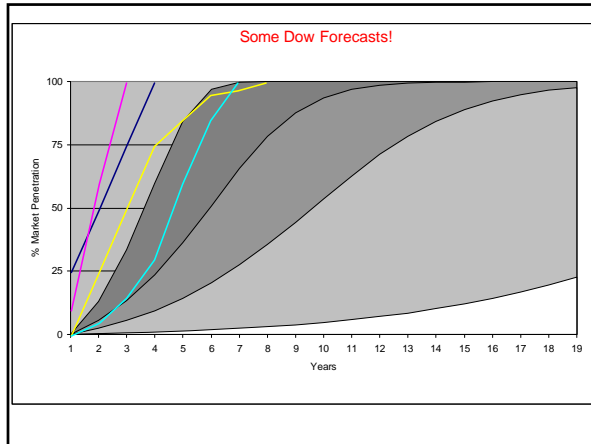
Application: Bass Model at Dow

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The Real Value: Understanding Diffusion is understanding what's possible!

Empirical Diffusion Percentile Rank for All Diffusions

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Diffusion Modeling: Can Put Expectations In Line With Reality!

“We may be as much as ten years too optimistic about the time needed to reach our ambition of capturing 16% to 17% of the target market.”
Pete Deal, NBG, after running a diffusion curve.

- ### The Myths:
- Innovations are Advantageous.
 - Less than half are.
 - Advantageous Innovations Sell themselves.
 - Most fail.
 - The Advantages are easily recognized
 - Try explaining one to Grandpa.
 - They diffuse easily across potential adopters, i.e., spread like wild fire
 - DVORAK vs. QWERTY
 - Most fall into the Chasm.
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- ### Some Negative Lessons
- Characteristics associated with a slower rate of adoption:
1. Complexity
 - high learning requirements
 2. Discontinuity from the consumer's existing experience base
 3. Perceived Risk
 4. Cost of the Innovation
 5. Marketing comes late into the game
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- ### Some Positive Lessons
- Characteristics of the innovation associated with a faster rate of adoption
1. Perceived relative Advantage by consumers
 2. Compatibility with existing consumption patterns.
 3. Communicability & Observability of the innovation and its benefits.
 4. Trialability: ability to demonstrate the innovation on a small scale.
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- ### New Products Innovators
- THE CHARACTERISTICS OF INNOVATORS MAY VARY BY PRODUCT CATEGORY. THERE IS NO GENERALIZED INNOVATOR.
 - VARIABLES MOST LIKELY TO CHARACTERIZE INNOVATORS ARE:
 - HIGHER INCOME
 - HIGHER EDUCATION
 - YOUNGER
 - GREATER SOCIAL MOBILITY
 - FAVORABLE ATTITUDE TOWARDS RISK (VENTURESOME)
 - GREATER SOCIAL PARTICIPATION
 - HIGHER OPINION LEADERSHIP
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Some Marketing Actions Implications

- THE LOWER THE PRICE THE FASTER THE RATE OF ADOPTION
- THE GREATER THE LEVEL OF ADVERTISING AND SALES EXPENDITURES, THE FASTER THE RATE OF ADOPTION
- THE GREATER THE SAMPLING OR DEMONSTRATION LEVEL, THE FASTER THE RATE OF ADOPTION
- THE MORE WIDESPREAD THE DISTRIBUTION LEVEL, THE FASTER THE RATE OF ADOPTION
- THE MORE THAT THE INNOVATION IS POSITIONED IN LINE WITH MARKET SEGMENT NEEDS, THE FASTER THE RATE OF ADOPTION

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Factors Affecting the rate of Diffusion

Product-related

- High relative advantage over existing products
- High degree of compatibility with existing approaches
- Low complexity
- Can be tried on a limited basis
- Benefits are observable

Market-related

- Type of innovation adoption decision
 - (eg, does it involve switching from familiar way of doing things?)
- Communication channels used
- Nature of "links" among market participants
- Nature and effect of promotional efforts

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Some Extensions to the Basic Bass Model

- Varying market potential
 - As a function of product price, reduction in uncertainty in product performance, and growth in population, and increases in retail outlets.
- Incorporation of marketing variables
 - Coefficient of innovation (p) as a function of advertising
 - $p(t) = a + b \ln A(t)$.
 - Effects of price and detailing.
- Incorporating repeat purchases
- Multi-stage diffusion process
 - Awareness → Interest → Adoption → Word of mouth

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