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Minitutorial: Forecasting New Product Adoption Using S-Curves

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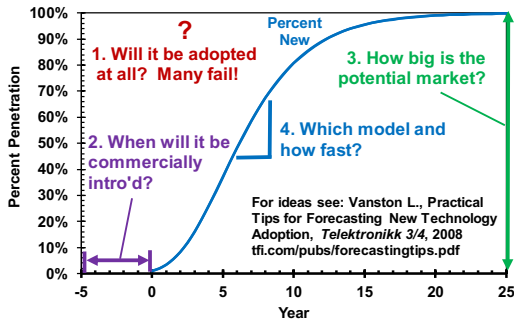*forecasters.org/foresight/*

Forecasting New Product Adoption Using S-Curves

LAWRENCE VANSTON

• S-Curves reflect the fundamental nature of adoption and technology change, proven over decades of use.
• They apply to new products, services, and technologies that use a fundamentally new approach, usually substituting for an old one.
• With enough historic data, we can use linear or nonlinear regression to estimate the 2-3 curve parameters.
• Without it (the usual case), we must rely on analogies, judgment, and analysis of underlying factors to estimate them.
• We usually forecast market *penetration* by all firms from which sales and share can be derived.

The S-shape's slow start reflects the fact that this type of new product must overcome constraints such as needed improvements, uncertainty, unfamiliarity, and high prices (due to low economies of scale, R&D costs, or lack of competition) often against entrenched existing products. Usually, a niche market or a community of innovators gives the new product its start. Once improvements are made, the new product's advantages becomes clear and the curve steepens dramatically. It flattens out as niches favorable to the old products are reached, including late adopters in the case of consumer products.

The Four Big Questions - They don't answer themselves!

?
1. Will it be adopted at all? Many fail!
2. When will it be commercially intro'd?
3. How big is the potential market?
4. Which model and how fast?

For ideas see: Vanston L., Practical Tips for Forecasting New Technology Adoption, *Telektronikk 3/4*, 2008 tfi.com/pubs/forecastingtips.pdf

The Basic S-Curve Models

Logistic Model

$$y(t) = \frac{1}{1 + e^{-b(t-a)}}$$

a = year 50% penetration is reached
b = penetration rate

Good for industrial or commercial adoptions

Symmetric, Inflection pt. at 50% penetration

AKA the Fisher-Pry model of technology substitution or the Mansfield diffusion model

Gompertz Model

Asymmetric, Inflection pt. at 37% penetration

Long tail makes Gompertz good for consumer adoptions

$$y(t) = e^{-e^{-b(t-a)}}$$

a = year 37% penetration is reached
b = penetration rate

Bass Model

$$y(t) = \frac{1 - z(t)}{1 + (q/p)\, z(t)}$$

where

$$z(t) = e^{-(p+q)(t-a)}$$

p = .100
q = .250

p = .050
q = .250

p = .010
q = .400

Popular with market researchers

a = Start year
p = penetration rate for early adopters
q = penetration rate for followers

*Bass can model steep new product takeoffs with the **p** parameter*

SELECTED CLASSIC REFERENCES

Bass, F. (1969). A New Product Growth for Model Consumer Durables, *Management Science*, Vol 15, 215–227.

Fisher, J. & Pry, R. (1971). A Simple Substitution Model of Technological Change, *Tech. Forecast. & Soc. Change*, 3, 75-88.

Mansfield, E. (1961). Technical Change and the Rate of Imitation, *Econometrica*, 29 (Oct), 741-766.

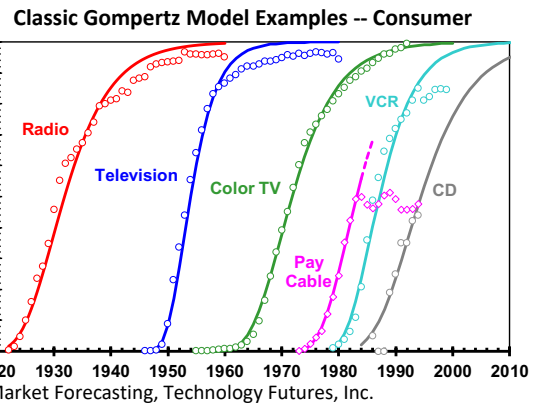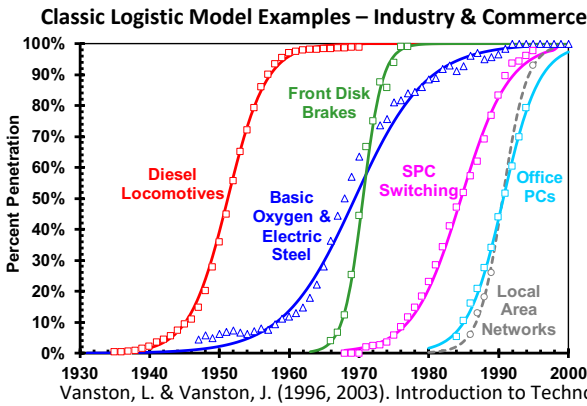Martino, J. (1983). *Technological Forecasting for Decision Making, 2nd Ed.*, North-Holland Publishing.
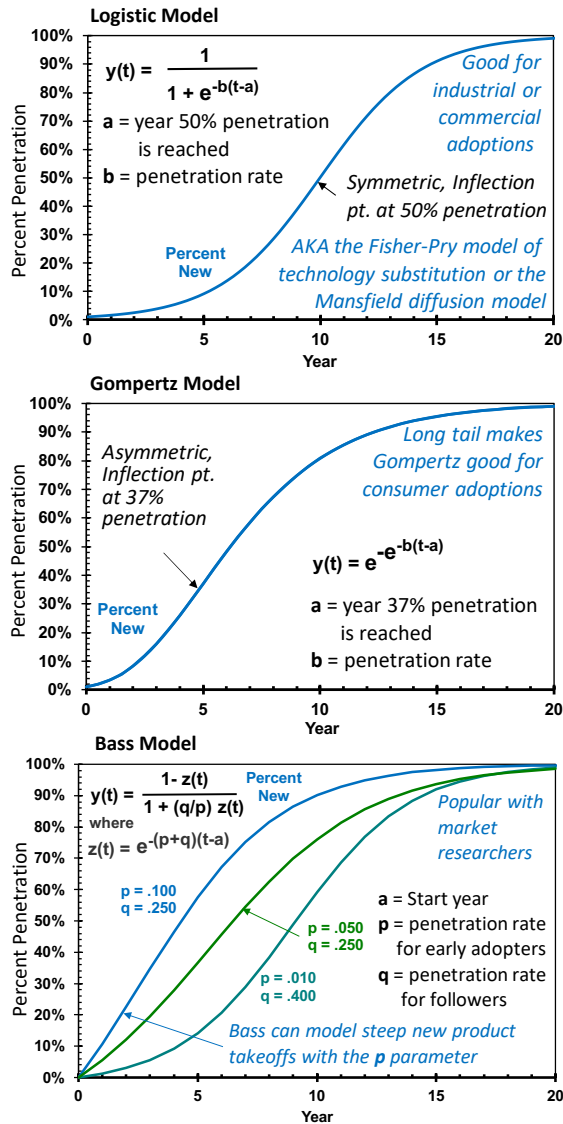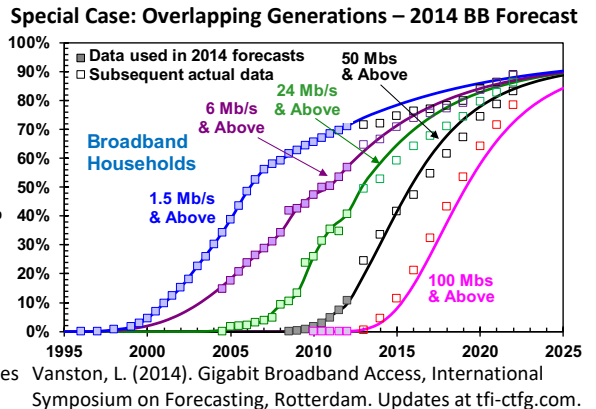
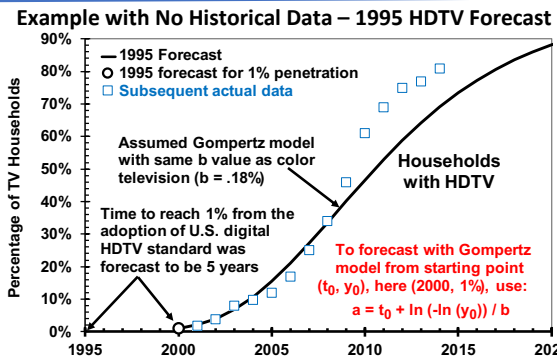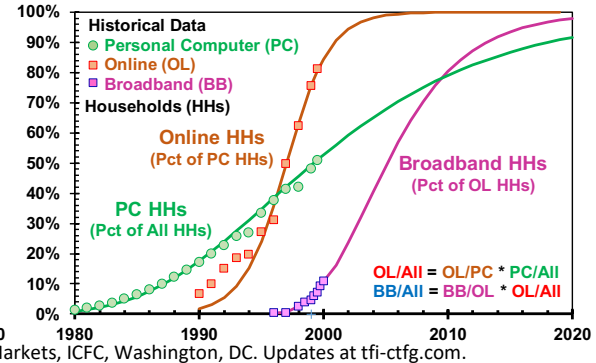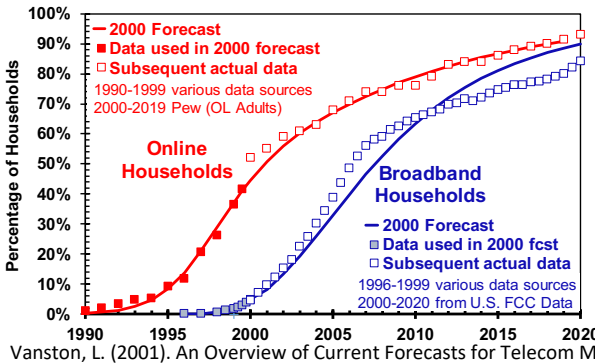### REFERENCES ON USING ANALOGIES

Green, K. & Armstrong, J. (2007). Structured Analogies for Forecasting, *International Journal of Forecasting*, 23, 365-376.

Goodwin, P., Dyussekeneva, K. & Meeran, S. (2013). The Use of Analogies in Forecasting the Annual Sales of New Electronics Products, *IMA J. Management Mathematics*, 24, 407-422.

Wright, M. & Stern, P. (2015): Forecasting New Product Trial with Analogous Series, *Journal of Business Research*, 68, 1732-1738.

Classic Logistic Model Examples – Industry & Commerce

Classic Gompertz Model Examples -- Consumer

Vanston, L. & Vanston, J. (1996, 2003). Introduction to Technology Market Forecasting, Technology Futures, Inc.

Forecasting Example - We made this early broadband forecast (left) in 2000, combining three related forecasts (right). We worried that slow home PC adoption might cause a pure Gompertz model to over-forecast. Such judgment calls are usual.

Vanston, L. (2001). An Overview of Current Forecasts for Telecom Markets, ICFC, Washington, DC. Updates at tfi-ctfg.com.

Example with No Historical Data – 1995 HDTV Forecast

Vanston, L., Rodgers, C. & Hodges, R. (1995). Advanced Video Services – Analysis and Forecasts for Terrestrial Service Providers, TFI.

Special Case: Overlapping Generations – 2014 BB Forecast

Vanston, L. (2014). Gigabit Broadband Access, International Symposium on Forecasting, Rotterdam. Updates at tfi-ctfg.com.

Other Special Cases: Market segmentation (e.g., consumer-business), geographic segmentation, multiple technologies, capital and other constraints, regulation and government action, etc. All require variations of the basic models.

REFERENCES ON EXTENSIONS AND OTHER MODELS

Mahajan, V., Muller, E. & Bass, F. (1990). New Product Diffusion Models in Marketing: A Review & Directions for Research, *Journal of Marketing*, 54 (1), 1-26.

Meade, N. & Islam, T. (2006). Modelling and Forecasting the Diffusion of Innovation – A 25-year Review, *International Journal of Forecasting*, 22 (3), 519-545.

Sharif, M. & Kabir, C. (1976). System Dynamics Modeling for Forecasting Multilevel Technological Substitution, *Technology Forecasting and Social Change*, 9:1-2, 89-112.

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