Modeling Internet Diffusion across Tourism Sectors

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Advances in Tourism Research: Perspectives of Actors, Institutions and Systems

Theoretical background (I)

- Some of our previous research focus on the diffusion of innovations (AIEST 2003, 2004, 2005), leapfrogger phenomenon and on the factors that affect its adoption such as
  - Size of the firm
  - Expectation of profit from the new techniques
  - Rate of growth of a firm
  - Firm profit levels
  - Age of the management
  - Liquidity of the firm
  - Firm profit trends

Perruchoud-Massy, M.-F., Scaglione, M., Schegg, R., & Murphy, J. (2005, 28th August -1st September 2005). *Adoption of Innovation by Swiss Hotels: Exploring Internet Strategies and Dynamics. Paper presented at the Proceeding of the 55th AIEST-Congress 2005. Innovation in tourism :Add customer value, Brainerd/Minnesota (USA).*

Theoretical background (II)

- Mansfiel (1971) pointed out the wide variation among firms in the intrafirm rate of diffusion. i.e. the adoption of Diessel locomotives. On the 30 companies under study which yielded, in average of 9 years to go from to the 20% up to 90% of adoption (complete conversion), there were 3 firms from which the process last 14 years and more and 6 where the process last only 3-4 years.
- Econometric analysis showed that the two third of this intrafirm variation can be explained by profit expectation, size of the firm, the age of the steam locomotives and the firm initial liquidity.

Theoretical background (III)

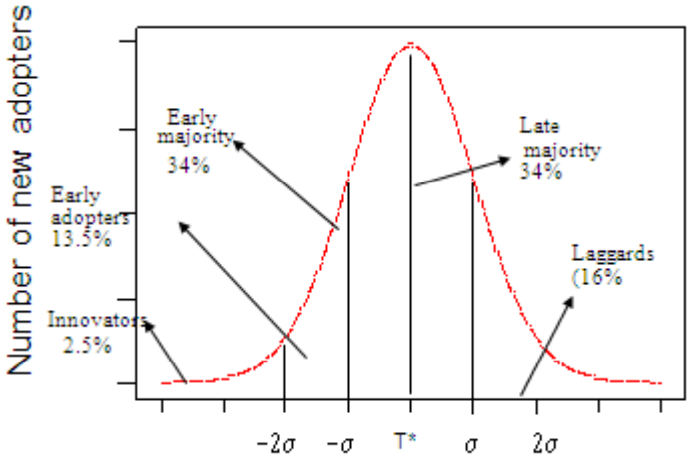
The present research program wants to transpose this theory to tourism sectors and focus on the intrasector variability of adoption of internet.

The first step is to show a model that can show the level of heterogeneity in the decision of the first-purchase, namely adoption of internet by tourism sectors.

Plan

- Bass model reinterpretation from the individual level of adoption to the aggregate one.
- Bemmaor general model that includes Bass model as a special case but allows the estimation of heterogeneity.
- Empirical part applied to tourism sectors
- Conclusion and future research track.

Adoption of Innovations Over Time



- Everett M. Rogers (1962) discusses innovation adoption at the individual and organisational level.
- Diffusion follows a normal distribution and as a consequence, there are fixed percentages for his five—innovators, early adopters, early majority, late majority and laggards—adopter categories.
- These fixed categories however, rarely hold across countries and innovations.

Bass model (I)

The basic premise of this model states that part of the adoption influence depends on imitation or learning and part of it does not:

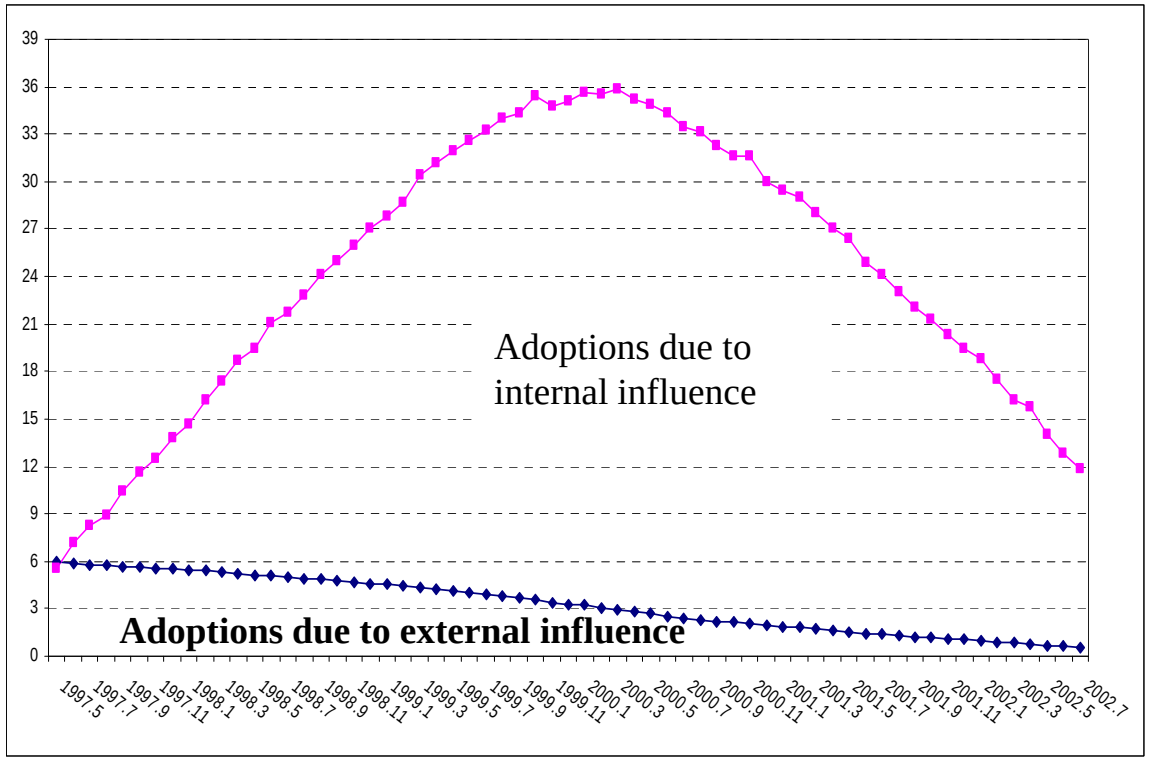
$$\frac{dN(t)}{dt} = \underbrace{p(m - N(t))}_{\text{adoption due to external influence or independent adoption}} + \underbrace{\frac{q}{m}(m - N(t))}_{\text{adoption due to internal influence or internal adoption}}$$

p: coefficient of innovation and proportion of buyers at time 0

q: represents the imitation influence and the weight of the cumulative proportion of buyers on the remaining potentials buyers.

m : final market

Bass Model (II)



Example :Diffusion of DNR in Swiss hotels

AIEST Congress 2006/ Pontresina : Dealing with volatile demand in tourism
Scaglione, Schegg & Murphy (2006) *Investigating website performance in Valais' hospitality industry* and Tecnovation (2007)

- Bass model does not formally break down the population into innovators and imitators.

- Assumes homogeneity of likelihood to purchase across buyers. All potential buyers operate under the same purchasing mechanism and experience the two influence in the same fashion

Bass model (III)

- Despite of the latter facts at the aggregate level of diffusion, does Bass model take into account the heterogeneity of adoption at the individual level? What happens if an interpretation of Bass model begins from the propensity to buy at the individual level?

Bass model reinterpretation (I)

For an individual consumer, the propensity to buy follows shifted Gompertz (SG) distribution.

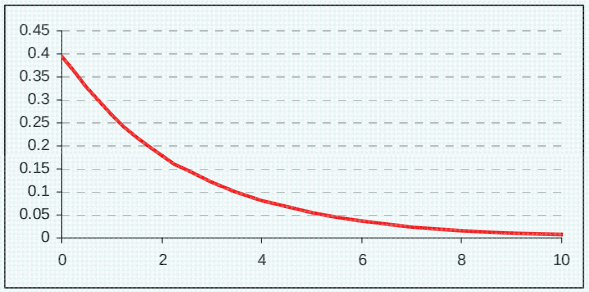
$$f(t \mid \eta) = be^{-bt} \exp\left\{-\eta e^{-bt}\right\}[1+\eta(1-e^{-bt})],\ t>0$$

b is the scale parameter

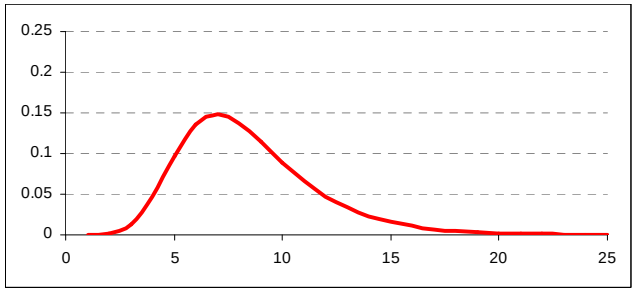
η is the shape parameter

b is suppose to be same across adopters but η, the shape parameter varies across them. If η tend to 0, then the propensity to buy tends to an exponential distribution, therefore, early adopters buy in a more random fashion that late adopters. The next slide shows the time of the f

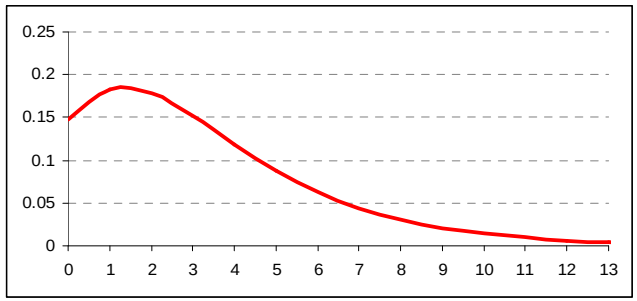
Shape of the shifted Gompertz density function for *b*=.4



$\eta = .01$
mean = 2.512
std dev=2.506
cv=.998



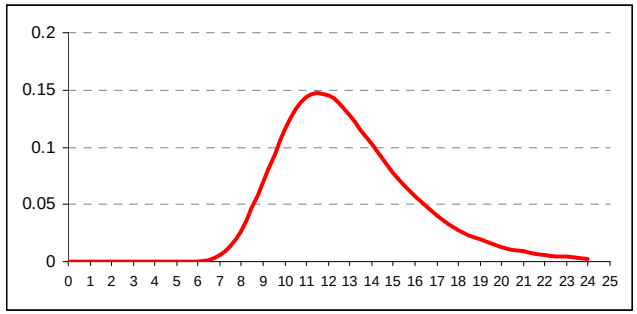
$\eta = 10$
mean = 7.449
std dev=3.197
cv=.429



$\eta = 1$
mean = 3.572
std dev=2.888
cv=.809

$\eta = .5$
mean = 3.077
std dev=2.741
cv=.891

$\eta = .1$
mean = 2.623
std dev=2.559
cv=.976



$\eta = 100$
mean = 12.981
std dev=3.206
cv=.247

Inspired by Bemmaor, A. C. (1994). fig. 1 page 205. Blue panels

When $\eta \leq 0.5$, then mode t=0.

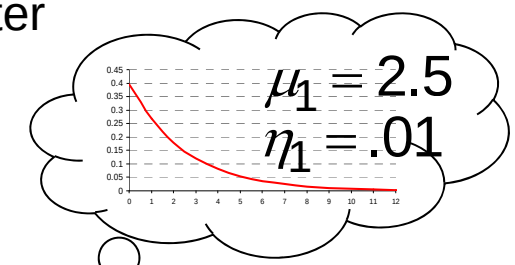
Bass model reinterpretation (II)

- Under which assumptions, if the individual propensity to buy follows a SG, we will have Bass model at the aggregate level?

The answer is lays on the distribution generating η, the parameter that varies across adopters, should drawn from an exponential distribution function.

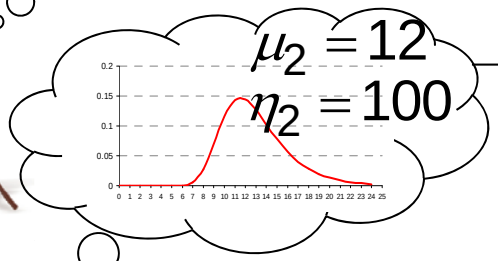
$$k(\eta) = (1/\beta)e^{-(1/\beta)\eta}$$

Density of the time adoption by adopter

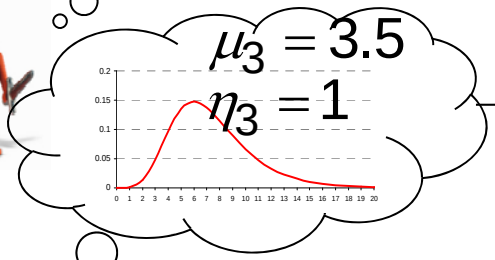


Time of Adoption T

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26



X



X

X

Shifted Gompertz

Exponential /Shifted Gompertz

Market size *m*

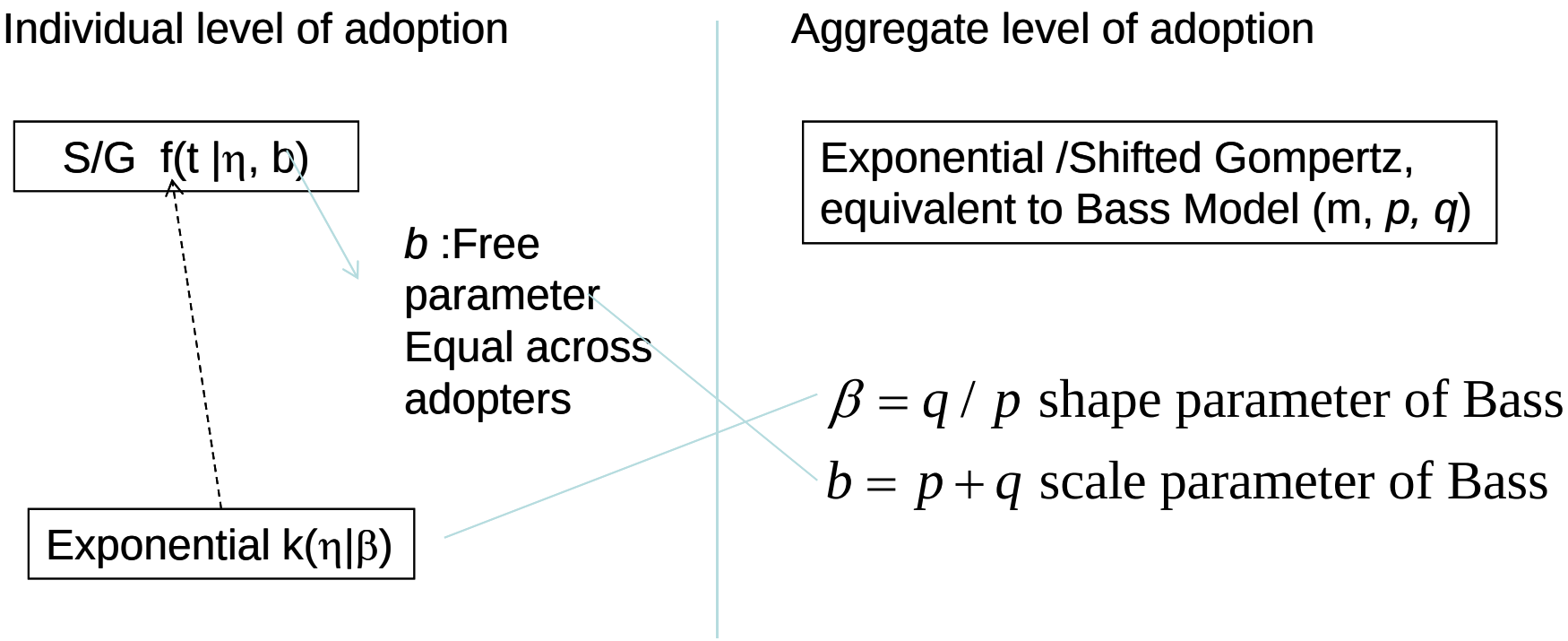
μ

n_1 $n_2 \cdots$ n_T

Population diffusion

At the aggregate level is equivalent to Bass model

Bass model reinterpretation (III)



- Which are the consequences of the fact that the shape (η) of the SG density function the models the propensity to buy at the individual level ?

Bass model reinterpretation (IV)

- Given that in exponential density …
  1. the coefficient of variation of exponential density is 1, the degree of heterogeneity in Bass is constraint to an *a priori* given value, as a consequence this constraint speeds up de diffusion when the population is more homogenous that the models assumes. This creates some very know problems in the estimation of *p* and *q.* (Bemmaor, 1994, Bemmaor&Lee, 2002)
  2. mode is 0, then Bass model assumes that the individual first-purchase times density is most likely to be exponential (SG when η close to 0). As a consequence, consumer are more likely to buy at the launch time-> questionable assumption,

Getting more heterogeneous possibilities

Individual level of adoption

Aggregate level of adoption

S/G f(t |η, b)

b :Free parameter Equal across adopters

Exponential /Shifted Gompertz, equivalent to Bass Model (m, *p, q*)

$\beta = q / p$ shape parameter of Bass

$b = p + q$ scale parameter of Bass

Exponential k(η|β)

Gamma /Shifted Gompertz, Where Bass Model is an special case when α=1

Gamma distribution Γ(α, β), instead of exponential density. Exponential density is a special case of Gamma distribution when shape parameter α=1.

$$F(t) = \frac{(1 - e^{-bt})}{(1 + \beta e^{-bt})^{\alpha}}$$

Beammaor model

$$F(t) = \frac{(1 - e^{-bt})}{(1 + \beta e^{-bt})^{\alpha}}$$

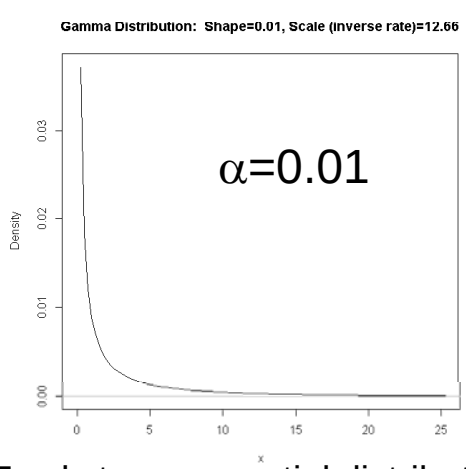
• For fixed values of b and β, gamma distribution function depends on the parameter α.The coefficient of variation of a Gamma function is $\alpha^{-1/2}$ (standard deviation=b$\alpha^{1/2}$ over the mean=bα).

•Homogeneity has a direct relationship with α,

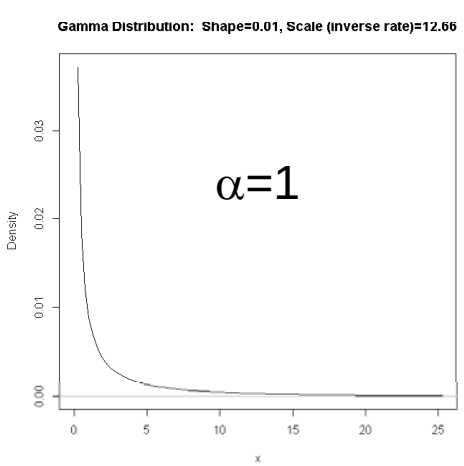
1) when α tends towards $\propto$, the population is homogenous. The propensity to adopt is roughly the same across potential adopters.
2) when $\alpha \approx 1$, the model is the Bass model.
3) When $\alpha \approx 0$, potential adopters' acceptance rates differ across strata population. Bemmaor (1994, p. 220) suggests that the propensity to adopt will differ across the BR adopter categories.

Shapes of absolute distributions de Bemmaor for *p*=0.03 and *q*=0.38

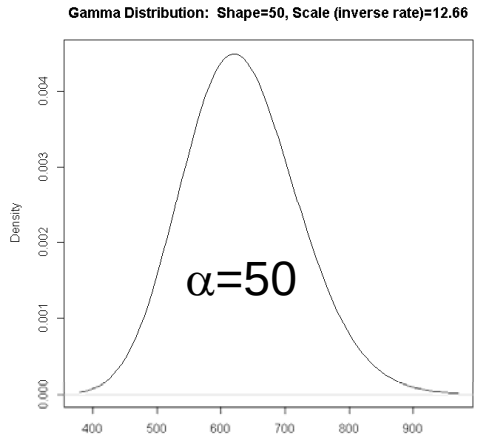
Row above: $\Gamma(\alpha, \beta)$ generating η parameter of the Shifted Gompertz propensity to by at the individual level



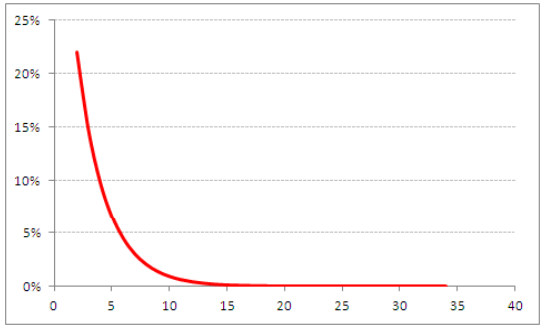
Tends to exponential distribution

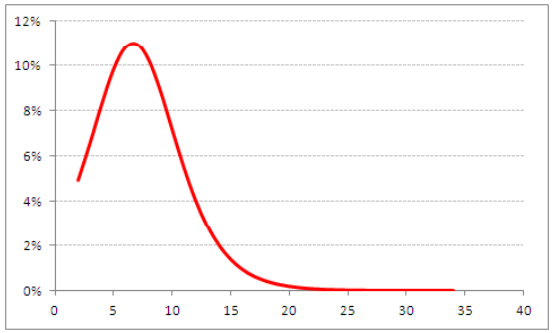


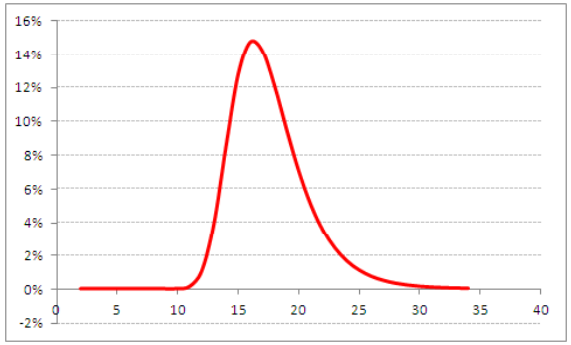
Bass Model



Gompertz Model







Row below: Beammaor model for the values of α row above

High heterogeneity → Low heterogeneity

Data sample

Acronym	Sector	Age source	Market size (base year)	Source	Website age/n (URL)	*Observed* penetration rate respect to 1)
DMO CH	**Swiss DMOs**	WM	155 (2005)	myswitzerland.ch	149/155	100%
DMO AU	**Austrian DMOs**	WM	na	Klimek, K., Scaglione, M., Schegg, R. & Matos, R. (2011)	96/96	Na
DMO DE	**German DMOs**	WM	na	Klimek, K., Scaglione, M., Schegg, R. & Matos, R. (2011)	182/188	Na
Rest CH	**Swiss restaurants**	WM	18,867(2005)**	Swisscom Directories	1573/1858	10%
Cable CH	**Swiss cable car companies**	WM	370 (2010)	Seilbahnen Schweiz (seilbahnen.org)	190/190	51%
Hotel Chain	**International hotel chains**	WM	325(2010)	hotelsmag.com (July 2006)	267/276	85%
TO Europe	**European tour operators**	WM	na	etoa.org, european-travel-market.com	117/121	na
Malays. hotels	**Malaysian hotels**	WM	530	(Hachim, Scaglione & Murphy 2012)	305/315	60%
Non affiliate Hotel CH	**Unaffiliated Swiss hotels**	Softbot	1133 (2003)	Swisscom Directories	780/780	69%
Hotelleriesuisse CH	**Affiliated Swiss hotels**	Softbot	2122 (2003)•	(Scaglione, Trabichet, Johnson, 2010)	1677/1733	82%
Hotel CH	**Swiss hotels**	WM	3255 (2003)•	(Scaglione, Trabichet, Johnson, 2010)	2467/2513	77%
Guesthouse CH	**Swiss guesthouses**	Softbot	3463 (2003)•	(Scaglione, Schegg, Steiner & Murphy, 2004)	2250/2269	65%
TA CH	**Swiss travel agencies**	WM	272(2008)	Schweizerischer Reisebüro-verband (www.srv.ch)	244/232	90%

Resutats

						Bass model (Equation 1)						G/SG
						T1	***peak***	***T2***	***p***	***q***	***q/p***	
	Type of model	**Drivers**	**Final market size**	**Final market size respect to 1) table 1**	**initial & final obs.' dates**	*inflection point*	*maximum*	*inflection point*	*innovation*	*imitation*	***q/p***	***alpha***
DMO CH	Bass p=0 (Logistic)	imitation	150.1 (1.69)	96.77%	Dec-96-Feb-05	Feb-98	Jul-99	Jan-01	0	0.0661	∝	0.230 (0.023)
DMO AU	Bass	innov./imitat.	96.78 (7.02)	na	Dec-96 - Jul-10	Jun-97	Sep-99	Jun-03	0.0079	0.0232	2.94	1.97E8 (1.34E7)
DMO DE	Bass	innov./imitat.	181.63 (19.83)	na	Nov-96 - Oct-10	Dec-97	Dec-00	May-04	0.0050	0.0503	10.14	0.81 (0.09)
rest CH	Bass	innov./imitat.	1647.35 (70.04)	8.73%	Nov-96-Jun-08	Dec-97	Jan-99	Sep-01	0.0035	0.0392	11.19	171.6 (3.37)
cable CH	Bass p=0 (Logistic)	imitation	194.5 (1.30)	52.70%	Dec-95-Feb-05	Jan-00	Jan-01	Jan-02	0	0.0875	∝	0.61 (0.07)
hotel chain	Bass	innov./imitat.	269.2 (38.56)	82.77%	Dec-96-Nov-06	Feb-98	Jan-99	Apr-04	0.0099	0.0376	3.80	0.51 (0.056)
TO Europe	Bass	innov./imitat.	119.18 (9.39)	na	Oct-96-Feb-06	Aug-98	Aug-99	Nov-01	0.0076	0.0399	5.28	0.98 (0.28)
Malays. hotels	Bass	innov./imitat.	316.9 (12.8)	59.81%	Nov-96-Jun-08	Oct-98	Jul-01	Apr-04	0.0037	0.0364	9.85	0.35 (0.02)
No affiliate hotel CH	Bass	innov./imitat.	796.4 (12.0)	70.26%	Dec-95-Feb-04	Sep-98	Dec-99	Apr-01	0.0029	0.0799	27.39	0.74 (0.04)
Hotelleriesuisse CH	Bass	innov./imitat.	1716.6 (22.0)	81.93%	Dec-95-Feb-04	Feb-98	Jun-99	Jan-01	0.0028	0.0718	25.56	1.16 (0.07)
hotel CH	Bass	innov./imitat.	2525.5 (25.2)	77.57%	Oct-96-Feb-04	Jan-97	Feb-02	Nov-01	0.0022	0.0775	35.03	1.27 (0.08)
Guesthouse CH	Bass p=0 (Logistic)	imitation	3131.0 (235.5)	90.41%	Dec-95-Dec-03	Jul-01	Oct-03	May-06[f]	0	0.0521	∝	No convergence
TA CH	Bass	innov./imitat.	235.13 (39.04)	98.72%	Nov-96-May-06	Sep-00	Apr-02	Dec-03	0.0063	0.0676	10.70	0.60 (0.08)

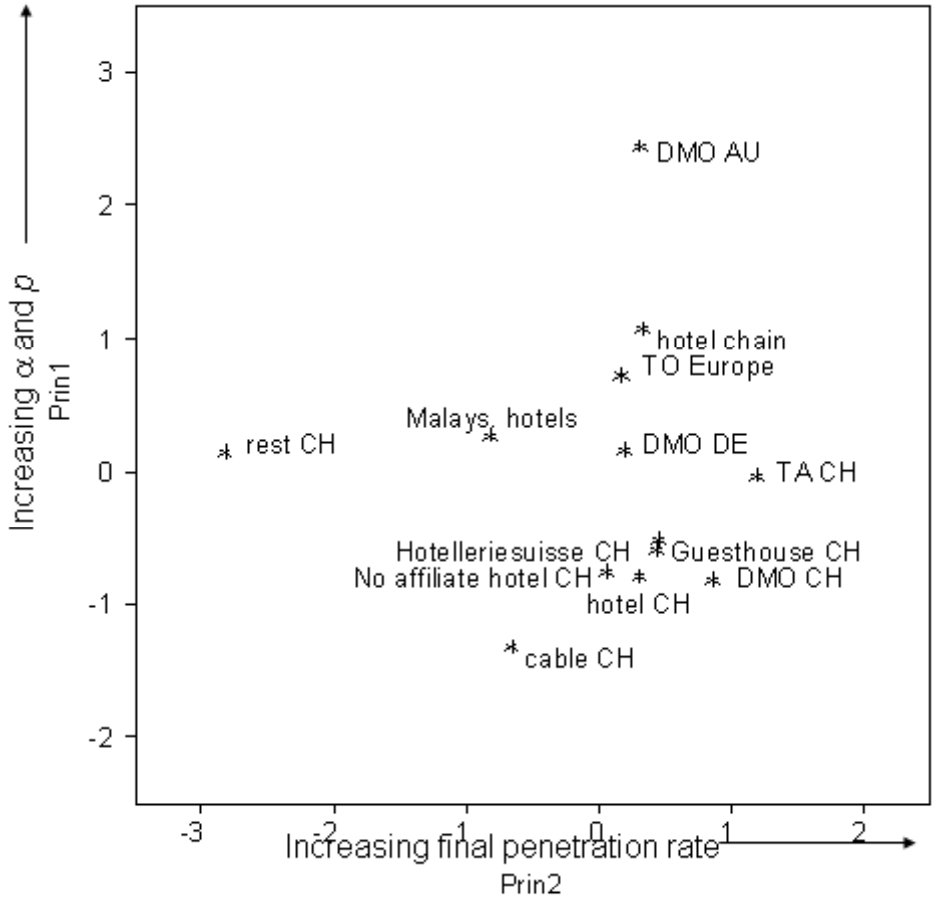
Results and comparison with other researches

SECTORS	ALPHA	Heterogeneous
DMO AU	1.97E+08	Low
rest CH	171.60	
hotel CH	1.27	Bass model
Hotelleriesuisse CH	1.16	
TO Europe	0.98	
DMO DE	0.81	
No affiliate hotel CH	0.74	High
cable CH	0.61	
TA CH	0.60	
hotel chain	0.51	
Malays. hotels	0.35	
DMO CH	0.23	

Cases	Product or Services	Estimate of alpha
Cases alpha > similar to 1	Accelerated program	3756.94
	Compulsory school	3144.28
	CT Scanner	2500.62
	Color TV	571.5
	Clothes dryer	261.68
	Air Conditionner	232.68
	Facebook on mobile China*	3.60
Cases with alpha<1	Tetracycline	0.97
	Corn (1943)	0.7
	Mammography	0.4
	Foreign language	0.37
	Untrasound	0.3
	Corn (1948)	0.3
	Facebook on mobile USA*	0.37

Bemmaor&Lee(2002) except for *
Hamoudia&Scaglione(2012)

Comparing adoptions



Academic conclusion

- The concept of heterogeneity gives some inside for the introduction of other innovations in the same market.
- This is particular important because Bass model is useless during the takeoff phase.

Managerial conclusions and future research (II)

- Tourism sectors varied across innovation and imitation parameters, homogeneity, critical mass and final market size.
- Almost all Swiss sectors showed a high sensibility to critical mass.
- Possible organizational and cultural factors include resistance to innovation and aversion to risk.

This diverseness aligns with the country's different linguistics/cultural factors and organizational differences such as the size—local, regional or national—budget and intensity of the tourism they represent.

Managerial conclusions and future research (I)

- Unlike the other Swiss sectors, Swiss DMOs showed high heterogeneity. Possible organizational and cultural factors include resistance to innovation and aversion to risk. This diverseness aligns with the country's different linguistics/cultural factors and organizational differences such as the size—local, regional or national—budget and intensity of the tourism they represent.

Managerial conclusions and future research (II)

- As future research, quantitative and qualitative studies should continue ferreting out the drivers and barriers to both technology adoption and organizational implementation of that same technology.
- Thus, this research can enlighten the adoption of Web 2.0 and Social Medias such as Facebook. Moreover, they can a bring a bases for the forecasting of diffusion of them.

Getting more heterogeneous possibilities

Individual level of adoption

Aggregate level of adoption

S/G f(t |η, b)

b :Free parameter
Equal across adopters

Exponential /Shifted Gompertz,
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