TRD Sales Simulator
In pursuit of sustainable innovation

CONTENTS

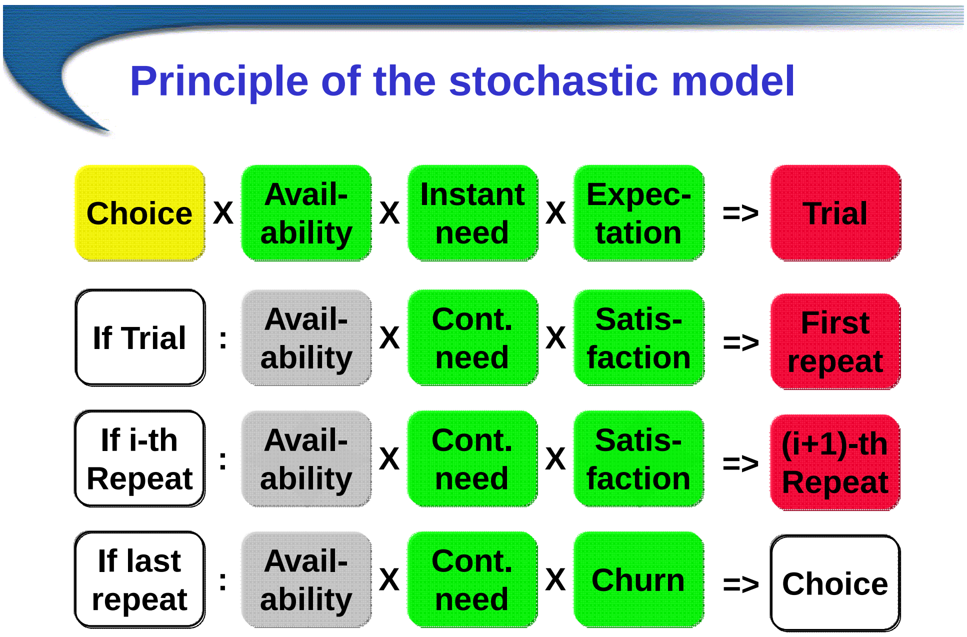
1. INTRODUCTION

The aim of this simulator is to provide a marketing engineer with a dynamic predictive tool possessing a 'what if' capability. The simulator is based on the TRD (Trial and Repeat Dissipation) model of the market.

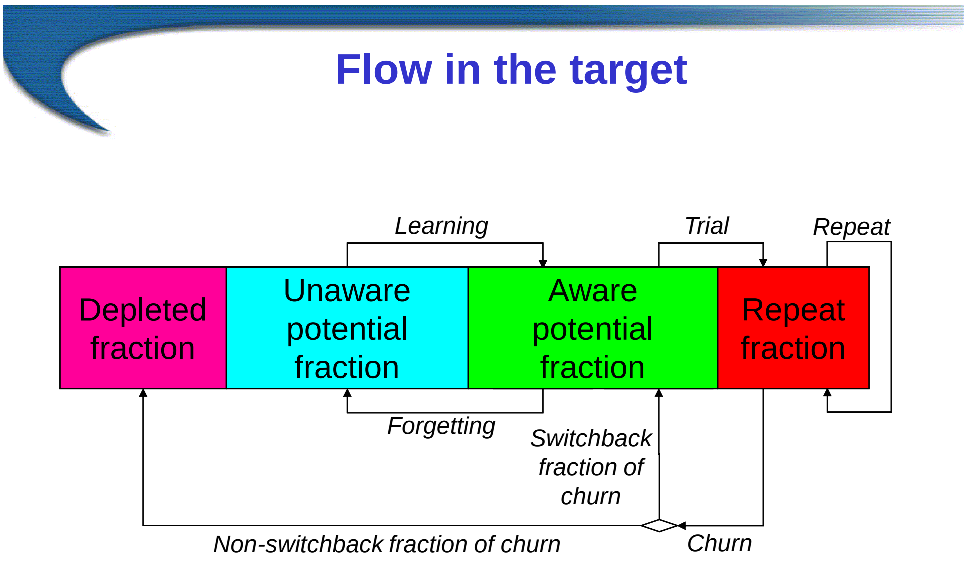
In making this document synoptic the use of some circularly dependent definitions could not be avoided.

1.1 Behavioral model

The TRD model reflects the stochastic nature of shopping behavior.



The choice of a product is made at the trial purchase stage alone. The purchaser continues with [no or] several repeats until the churn stage, with churn here representing the ending for any reason of the repeat spell, i.e., dissipation of the repeat. The new trial and repeat spell starts either with the product being included in the set of products from which the choice is to be made or with the product being abandoned. In the latter case, the purchaser becomes a member of the 'depleted' target for the product (see below). The flow diagram below defines the TRD model.



2. INITIAL PROPERTIES OF THE MARKET

2.1 Target

In the TRD model, the ‘target’ is defined as a set of potential, current, and former users of the product. It is assumed to be composed of four fractions.

- **The depleted fraction** is made up of those who will not purchase the product in the future. It can grow only by a fraction of the former users who do not become part of the aware potential fraction for the product. Awareness in this fraction is assumed to obey the same rules as in both ‘potential’ fractions of the target (see below).
- **The unaware potential fraction** is the source for the aware potential fraction by its members becoming aware of the product.
- **The aware potential fraction** is the part of the potential fraction aware of the product. Trials occur in this fraction, with the overall probability of trial being comprised of autonomous and epidemic purchase probabilities (see paragraph 3.4).
- **The repeat fraction** consists of current users of the product.

The total size of the target remains constant through all time periods of the simulation.

2.2 Total awareness

'Total awareness' is defined as the aware fraction of the complete target. For a definition of 'nominal awareness', see paragraph 3.2.

2.3 Sales rate

The 'sales rate' is an instantaneous sales rate in quantity units per time unit.

2.4 Mean purchase quantity

The 'mean purchase quantity', *Q*, is the average quantity of a product purchased and used (consumed) by a target unit per time unit over the period of repeated use – that is, throughout the repeat spell (see paragraph 3.5). Inter-purchase time does not figure in the TRD model.

N.B.1 For sake of simplicity, *Q* is a constant for all users in a given period of time. The TRD simulator cannot model effects such as promotion-induced stockpiling.

N.B.2 The mean purchase quantity, *Q*, size of the target, Tgt, and time unit are strictly linear quantities in the model. Their values can be arbitrarily scaled without changing any of the shape factors of the simulation.

3. PARAMETERS OF THE MARKET

The easiest way to describe controllable and/or predictable changes in the market is by using a table of parameters specific to each of the periods considered in a simulation.

3.1 Length of time period

The number of periods in the simulator is limited by the available number of columns in MS Excel. Setting the length of a period to zero ends the sequence of periods for simulation.

3.2 Nominal awareness

The 'nominal awareness' term means the awareness of the product only among potential triers, i.e. not including users and those in the depleted fraction of the target. This reflects the fact that users are always fully aware of the product and have zero learning and forgetting rates. Members of the repeat and depleted fractions of the target, by definition, will not try the product, and their awareness is irrelevant.

N.B.3 'Awareness' as used in this document refers to potentially purchase-stimulating awareness in the target. Dummy awareness should be handled as unawareness, or else such consumers should be excluded from the target.

Projected nominal awareness is the nominal awareness at a given intensity of promotional activity projected to the infinity time.

3.3 Half-projection time of nominal awareness

It is presumed that the rate of unaware potential users learning about a product, is directly proportional to the size of the unaware fraction and the intensity of the promotion (such as a number of exposures in the media, feature presentations, and other support actions). The rate at which aware potential users forget and become unaware users is proportional to the size of the aware fraction. The rate is expressed as fraction change per time unit.

Accepting these assumptions, the dynamics of awareness can be described in terms of the 'half-projection time of nominal awareness', or *HTA*. It is defined as the time that is required to attain one-half of the projected nominal awareness starting from an unaware potential target.

Some workers prefer a 'rate of awareness penetration', *w*, to the half-projection time definition. In this particular case, the projected nominal awareness is assumed to be 100%, i.e. $NAw = 1$, and the half-projection time can be estimated from equation (1).

$$HTA = \frac{\ln(0.5)}{\ln(1-w)} \cong \frac{-0.693147}{\ln(1-w)} \quad . \qquad \textbf{(1)}$$

3.4 Probability of trial

The trial of a product in the TRD model is defined in a substantially different way from the conventional one. Rather than the first purchase in a sequence of repeated purchases, it is understood as a ***hypothetical*** event of a current non-user having become a user of a product of a mean quantity *Q* per time unit for a time period of length *MTR* (mean time of repeat, see below). No trial quantity is related to the trial event. It is best understood as an act of becoming a user.

N.B.4 The TRD model takes account of the fact that an actual trial purchase lags behind a decision to purchase the product. It is put back to the time when the product is needed.

N.B.5 For $Q \geq 1$ and no switchback (see paragraph 3.6), the computed TRD trial rate is equivalent to the conventional trial rate. If $Q < 1$, the computed TRD trial rate is $1/Q$ times higher than the conventional trial rate.

The probability of the TRD trial is assumed to consist of two parts, the autonomous and epidemic trial probabilities.

3.4.1 Autonomous trial

In a situation where a potential purchaser has no or negligible awareness of (or is uninfluenced by) the extent to which the product is generally in use, the purchase decision is 'autonomous'. In other words, it is independent from the number of current product users. The probability p of an autonomous trial is defined as the fraction of the aware non-users who will become users of the quantity Q of the product in a time unit either for the first time or after having finished the repeat spell of a product from the category.

N.B.6 The latter case may be understood as a link in a chain of product substitutions (switches).

Estimation

In most cases, the data comes from mall scanners, STM (simulated test market) measurements, diary studies, or other experimental sources. If the mean used quantity of the product per time unit during the spell of repeated use is $Q \geq 1$, the TRD trial probability is identical to the conventional trial probability. It is the ratio between the number of trials in the time unit, and the size of the aware potential target. In the case of rarely purchased products, such as durables, the conventional trial probability must be modified.

If p_1 is the conventional (first-purchase-based) trial probability related to a single unit of the product with the mean use quantity $Q < 1$ units per time unit, one unit of a product is used in time $1/Q$. The TRD trial probability p of quantity Q in a time unit is then:

$$p = 1 - (1 - p_1)^{1/Q} \quad . \tag{2}$$

Evidently, if $Q < 1$, then $p > p_1$.

3.4.2 Epidemic trial

Where a product is heavily communicated among members of a social system over time, autonomous trial probability alone cannot explain market evolution. An 'epidemic' trial probability q can be understood as an additional (non-additive) increment p_{epid} to the trial probability given the fraction of current users in the target is R.

$$q = \left(p_{epid} \mid R\right) = \frac{p_{epid}}{R} \tag{3}$$

This formulation is closely related to the Bass model for trial probability (F. M. Bass, 1969). The Bass model parameters, however, are parameters of a differential model rather than probabilities. To rectify this for the present simulator, the probability of a 'socially influenced' purchaser trying the product has been defined as

$$p_{trial} = 1 - (1 - p) \times (1 - q)^R \, . \tag{4}$$

Hence the probability q can be understood as a contribution to the probability of a trial given that everyone in the target is using the product. It can be shown that the definition equation (4) is fully equivalent to the original Bass model.

Estimation

In the early stages of introducing a (breaking and/or innovative) product or technology onto the market, the autonomous trial probability is $p << 1$, and penetration $R << 1$. For a time period short enough so that change in R is small, equation (4) simplifies to expression (5).

$$p_{trial} \cong p + q \times R \qquad \textbf{(5)}$$

Let the aware segment of the target (that is, the aware potential plus current users) be taken as a complete set (100%). Let the fraction of users in this set be R at the beginning of a time unit, and $R + \Delta R$ at the end of that time unit. If the total change ΔR is separated into a portion made mainly by autonomous trials, ΔR_{auto}, and into a portion made with a dominant contribution of the epidemic influence, ΔR_{epid}, informed guesses at probabilities p and q can be drawn from equations (6) and (7).

$$p \cong \frac{\Delta R_{auto}}{1 - R} \qquad \textbf{(6)}$$

$$q \cong \frac{\Delta R_{epid}}{(1 - R)(R + \Delta R)} \qquad \textbf{(7)}$$

Dissipation of repeat (the churn rate) should be completely detached from the data.

3.5 Mean time of repeat

The usual approach to the repeated use of a product is to define an appropriate decay model, relying on either fixed or variable probabilities of successive purchases in different time periods.

In the TRD model, an individual is assumed to use a product at a constant rate during the spell of repeated use while the probability of every successive repeat decreases over time. When a certain threshold is reached, the individual stops using the product, i.e. the repeat dissipates.

As a measure of user repeat spell duration, the 'mean time of repeat', MTR, can be understood as the depth of repeat expressed in time units. The present model requires that $MTR \geq 1$.

Estimation

The MTR for a frequently purchased product is the average duration of the purchase repeat spell weighted by the usage quantity rate Q of individuals.

N.B.7 The available data on the repeat length are usually censored.

The MTR for durables or leased services is simply the average duration of the product's use.

When the probability r of a repeated purchase in a time unit is known (as used, for example, in the Fourt-Woodlock model), *MTR* can be roughly estimated as

$$MTR \cong 1/(1-r) \quad . \qquad \mathbf{(8)}$$

3.6 Switchback ratio

When a user finishes a repeat spell for a product he or she may or may not continue to consider the product in future choices. This implies two basic alternative behaviors, with a 'switchback ratio' z equal to either 1 (one) or 0 (zero).

In the first scenario with the switchback ratio z = 1, purchasers retain the product in their choice portfolio, and thus former users become members of the aware part of the potential target. This is typical of a frequently purchased product when the repeat spell finishes more-or-less because of a desire for a change.

In the second scenario with the switchback ratio z = 0, former users exclude the product from their future choice portfolio, and become members of the depleted target. This is typical for products with short lifetimes (such as fashion items and products in areas affected by rapidly advancing technology), products which are purchased very infrequently (such as mortgages), and other such products.

The switchback ratio is essentially a binary variable. Where a mixed behavior can be expected any value from 0 to 1 can be set in the simulator (say, for loans, automobiles, and suchlike). However, no general instruction can be given for estimating the switchback ratio.

N.B.8 Some models define a ‘coefficient of adoption’ representing the fraction of trials followed by repeat purchases. To achieve the same result the target may be divided into two segments, one of potential users with full switchback and the other with zero switchback.

4. AWARENESS TOOL

This simulator has been equipped with a simplistic tool that allows the user to make a rough estimate of the projected nominal awareness when the intensity of advertising is changed. This tool has been based on the assumptions outlined in paragraph 3.2. When setting the relative advertising intensity coefficient, the relative efficiency of the promotion type should be taken in account.

N.B.9 Most values for non-advertising situations are subject to gross error and should be handled with caution. A synergy of all promotion means should be included.

5. PRE-SIMULATION CHECK

In the case of stable market conditions, a moderate, not overlong mean time of repeat (*MTR*), and full switchback, the market will tend to reach a dynamic equilibrium (a stationary state or steady-state). Properties at equilibrium, referred to as ‘projected’ in the present model, are calculated as a limit to the infinity time. The projected total awareness and sales rate for each defined time period may be used to check if the input data values are consistent.

The following comments should be noted.

1. The initial conditions and the half-projection time for the nominal awareness have no effect on the computed projected values.
2. If the switchback ratio is set to a value lower than 1, the projected values are not computed. The projected sales would be zero and the total awareness equal to the given projected nominal awareness.
3. If the autonomous probability of trial is zero ($p = 0$) and the epidemic probability of trial is positive ($q > 0$) the computed projected values are non-zero. The computation is being carried out as if there were a random initialization sale.
4. The computed projected total awareness is defined as the total awareness that would be achieved across the target (including users) at a given intensity of the promotion at infinitely long time.

N.B.10 The projected total awareness may not necessarily be the maximal awareness reached over the course of time.

If the epidemic trial probability can be neglected ($q = 0$) and the autonomous trial probability is small enough ($p << 1$), then the approximate value of sales S per time unit at the equilibrium will be

$$S \cong W \times \frac{p}{p + 1/MTR} \times Q \times Tgt \ , \qquad \mathbf{(9)}$$

where W is total (rather than nominal) awareness, Q is the average quantity of the product used in the repeat spell per target unit and time unit, *MTR* is the mean duration of the repeat spell, and *Tgt* is size of the target.

MTR is always finite. As it grows the influence of the trial probability p becomes smaller: this shows the importance of customer retention on the sales of all repeatedly purchased products and long-term services. On the other hand, the used quantity of durables is generally $Q = 1/MTR$. Increases in *MTR* (that is, in the durability of a product) results in decreasing sales.

N.B.11 An approximation for $MTR \to \infty$ in the equation (9) makes no sense. Humans do not live that long.
N.B.12 Unlike the equation (9), the TRD simulator check procedure uses an exact solution.
N.B.13 Note that product penetration is $S/(Q \times Tgt)$.

For most consumer products, $p << 1/MTR$, and the equation (9) simplifies to equation (10) equivalent to the Parfitt-Collins model.

$$S \approx W \times p \times MTR \times Q \times Tgt \ . \qquad \mathbf{(10)}$$

In the special case where only a single product is used by a target unit,

$Q \times MTR = 1$, and the sales rate can be expressed as

$$S \approx W \times p \times Tgt \quad . \tag{11}$$

This equation is an alternative formulation of the preference share model weighted by awareness.

6. SIMULATION

A simulation starts by clicking the button ‘Run simulation’. If there are a great many periods or the computer is slow, a progress bar will appear. The simulation can be stopped by clicking the ‘Close’ button in the progress bar window.

The computed rates are instantaneous values at the given time. Average rates can be obtained as differences between the computed cumulative sales.

N.B.14 The charts created in a simulation are built from points separated by one time unit. So that the curves are sufficiently smooth, time should be scaled so that the shortest time period is at least 10 time units long.

7. EXAMPLES

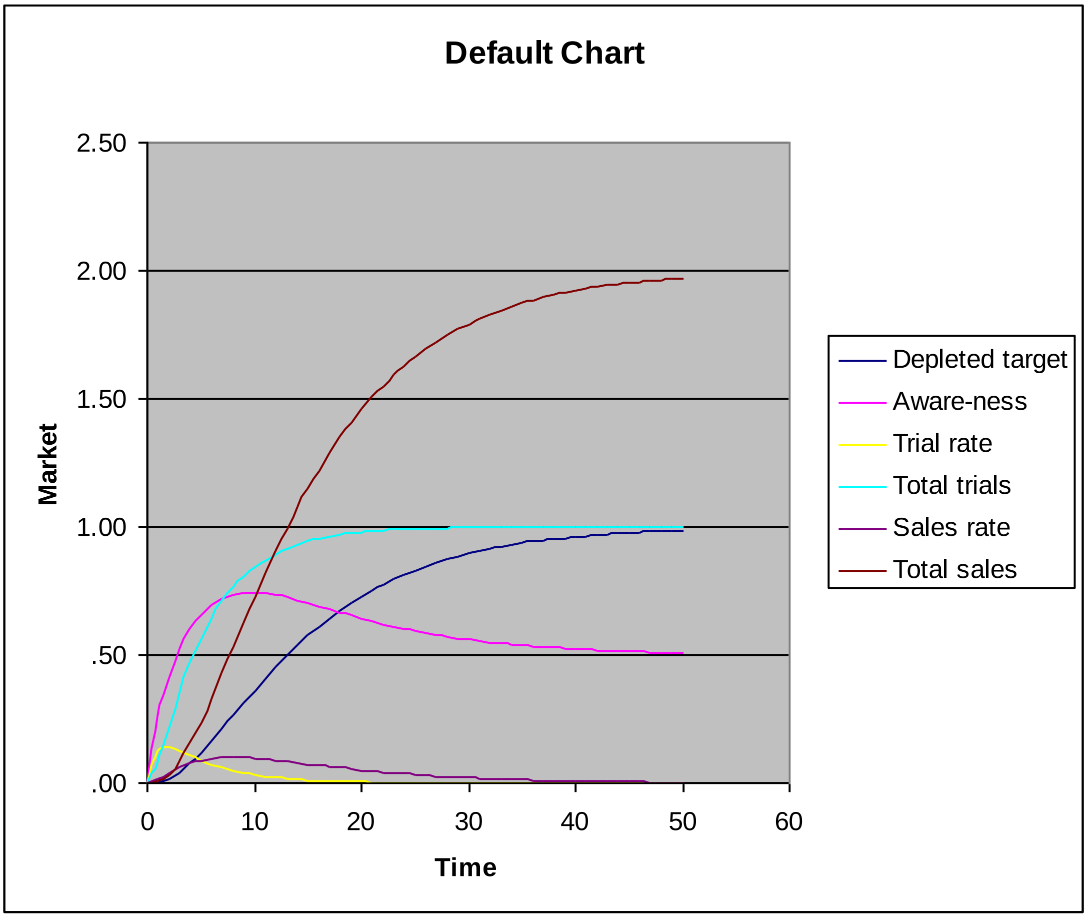
All examples have been generated so as to demonstrate basic features of the model.

7.1 Example 1 A new product with a short market lifetime

The size of the target has been set to 1. By setting a zero-time length for the second period, the simulation has been limited to only one-time period. The *HTA* has been set very low, meaning that the target learns about the product very quickly. The trial probability [of purchasing 0.2 quantity units per time unit] has been set high to make the simulation curves and their implications clear. The zero-epidemic probability and switchback ratio correspond to the Fourt-Woodlock model.

Time period parameters	Limitations	Period	
		1	2
Lengths of period ***L*** [time units]	***L*** > 0	50	0
Projected nominal awareness ***NAw*** [fraction]	0 ≤ ***NAw*** ≤ 1	0.5	
Half-projection time of nominal awareness ***HTA*** [time units]	***HTA*** ≥ *1*	1	
Probability of autonomous trial ***p***	0 ≤ ***p*** < 1	0.5	
Probability of epidemic trial ***q***	0 ≤ ***q*** < 1	0	

Mean time of the repeat spell ***MTR*** [time units]	***MTR*** ≥ 1	10	
Mean purchase quantity ***Q***	***Q*** > 0	0.2	
Switchback ratio ***z***	0 ≤ ***z*** < 1	0	



Since *MTR* = 10 and *Q* = 0.2, the final total sales at an infinite time must be 10 × 0.2 = 2 quantity units. This value has nearly been reached in just 50 time units.

The instantaneous sales lag behind [hypothetical] trials because of the low mean consumption of the product (Q = 0.2). The curve of total awareness has a maximum due to the increased fraction of current users of the product.

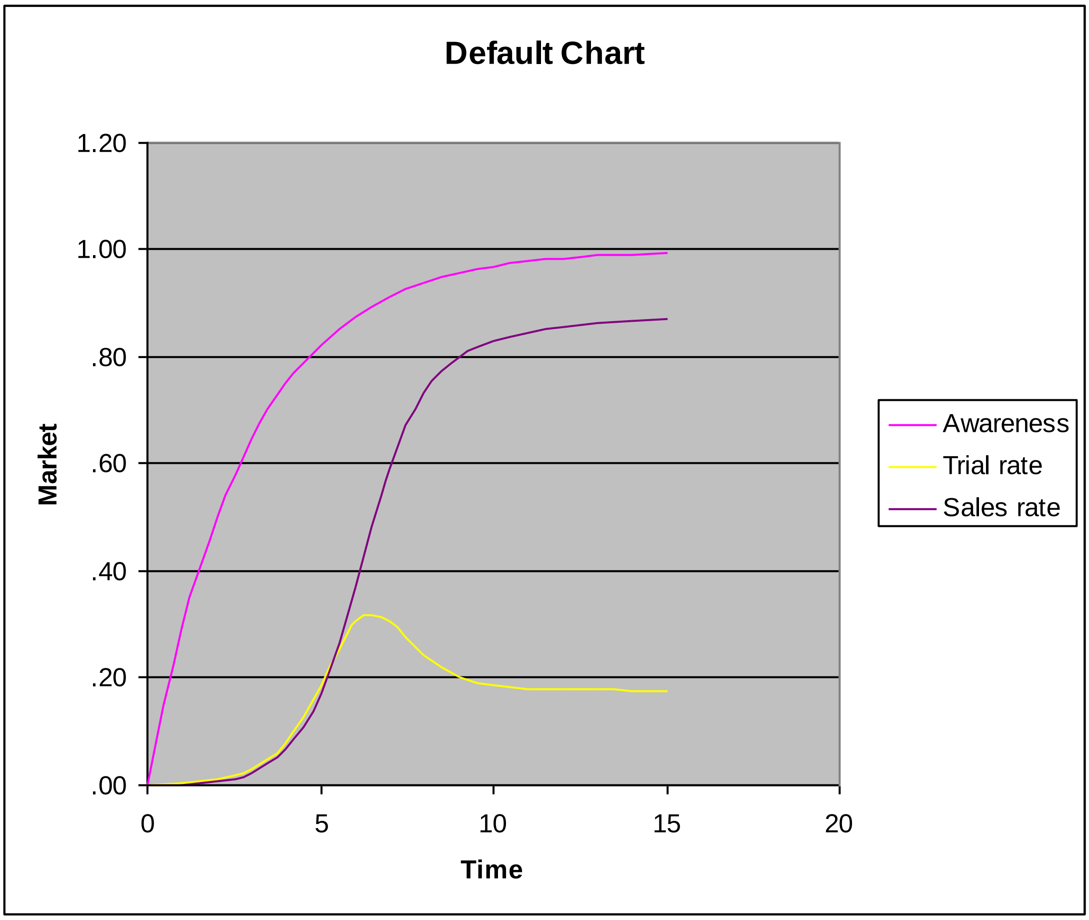
N.B.15 This example is very unrealistic. The trial probability of a unit quantity in 5-unit period is $(1 – (1–0.5)^5) = 0.96875$, a value that is unlikely to be found on the real market.

7.2 Example 2 Adoption of advanced technology through epidemic mechanism

In this simulation, we start with the premise that the technology was introduced 2 years ago. A guess is to be made for the next 13 years (*L* = 15). The following data is known.

The attractiveness of the technology allows us to expect it to become commonly known (*NAw* = 1) to the target (*Tgt* = 1) in the long run. Current awareness among the target is about 50% (*HTA* = 2 years). To date, adoption has been about 1 in 100 aware potential users in a year (*p* = 0.01, innovators). Eight in ten potential users claim they will use the technology if everybody else in their social neighborhood uses it (*q* = 0.8, imitators). The inherent problem with the technology adoption is a relatively expensive gadget required to be purchased. It will become obsolete in about 5 years, and will have to be replaced with a more advanced one (MTR = 5). As our interest is mainly in penetration and the services adjoined to the technology, we set the quantity used by an individual as *Q* = 1. The gadget sales can be estimated as trials. We assume no one will give up using the technology (*z* = 1).

Time period parameters	**Limitations**	**Period**	
		1	**2**
Lengths of period ***L*** [time units]	***L*** > 0	15	0
Projected nominal awareness ***NAw*** [fraction]	0 ≤ ***NAw*** ≤ 1	1	
Half-projection time of nominal awareness ***HTA*** [time units]	***HTA*** ≥ *1*	2	
Probability of autonomous trial ***p***	0 ≤ ***p*** < 1	0.01	
Probability of epidemic trial ***q***	0 ≤ ***q*** < 1	0.8	
Mean time of the repeat spell ***MTR*** [time units]	***MTR*** ≥ 1	5	
Mean purchase quantity ***Q***	***Q*** > 0	1	
Switchback ratio ***z***	0 ≤ ***z*** < 1	1	



This simulation predicts that 15 years from introduction, an actual adoption would be 87% (the ‘Sales rate’ curve). Maximum adoption rate will be reached about six years after introduction (the ‘Trial rate’ curve). Stabilization of the market is forecast to about 10 years after introduction.

7.3 Example 3 A new financial product

A bank is considering launching a new financial product aimed at a particular segment of the target. The fact that the new product is clearly distinguishable from existing products in the category is anticipated as a competitive advantage. The aim is to estimate the future sales of the new product based on a choice-based concept test.

7.3.1 Current product

This simulation assumes that the size of the existing market is 5.6; the total penetration of the category (including the competition) is 0.15; the uninterested fraction of the market is 0.24; and the bank’s current standard product share is 0.09. There is common awareness of the current product category among the target, so we set $W = 1$. The market in the category is very inflexible. As the true product switch rate is unknown, we make a guess at the mean time of repeat as 3 product-validity periods of the usual length 3 time units, that is, $MTR = 9$ time units.

The bank’s current sales of the standard product are assumed to be close to the market equilibrium. Its penetration stands at 0.15 × 0.09 = 0.0135. Restating equation (9) and noting that $S/(Q \times Tgt)$ is penetration, we can obtain an expression for the probability of TRD trial of the bank's current product:

$$p \cong \frac{S/(Q \times Tgt)}{MTR \times (W - S/(Q \times Tgt))} = \frac{0.0135}{9 \times (1 - 0.0135)} = 0.00152 \ . \qquad \textbf{(12)}$$

The actual target size is 5.6 × (1 – 0.24) = 4.256. Assuming the market equilibrium, we guess that the bank is attracting (and, due to an equilibrium, losing at the same time) about 4.256 × 0.00152 = 0.00647 users of the current product per time unit. If this is far from being true then our estimate of the MTR value is wrong.

7.3.2 New product

The new product has shown a 2.2-times higher preference share than the standard product of the bank in a simulated market. This result has been obtained from a conjoint study carried out on a sample selected from the particular target segment under consideration. The initial trial probability of the new product can be estimated as p = 2.2 x 0.00152 = 0.003344.

N.B.16 This is a rather simplistic approach. No corrections have been made for the current and future distribution of sales, or for whether the new product is to be a complement to the standard product.

Since the considered target accounts for a fraction 0.27 of the target for the standard product, its size is *Tgt* = 0.27 × 4.256 = 1.149.

Users in the given target segment are expected to be less loyal to a product than the rest of the target are to the standard product. As we do not have any experimental data, we will guess the mean time of repeat as *MTR* = 6.

The bank is planning to promote the new product with an intensity likely to result in a projected nominal awareness *NAw* = 0.7 with a half-projection time *HTA* = 2 time units. Projected awareness in a non-advertising situation is expected to be 0.05. After *L* = 3 time units of the first period the advertising is scheduled to be halved, and the second period is planned to last *L* = 6 time units. Based on the specifications for the first period, the awareness tool in the TRD simulator predicts a projected awareness of *NAw* = 0.544 and a half-projection time of *HTA* = 3.04 time units for the second period.

Projected nominal awareness estimation tool		
Relative advertising intensity	1.00	0.50
NAw for no advertising	0.05	0.05
NAw for advertising	0.7	0.544
HTA for advertising	2	3.04

As we are mainly interested in penetration, we set the size of the target to *Tgt* = 1, and the mean quantity per time unit as *Q* = 1. Full switchback and no epidemic behavior are expected. The input parameters for the model are shown below:

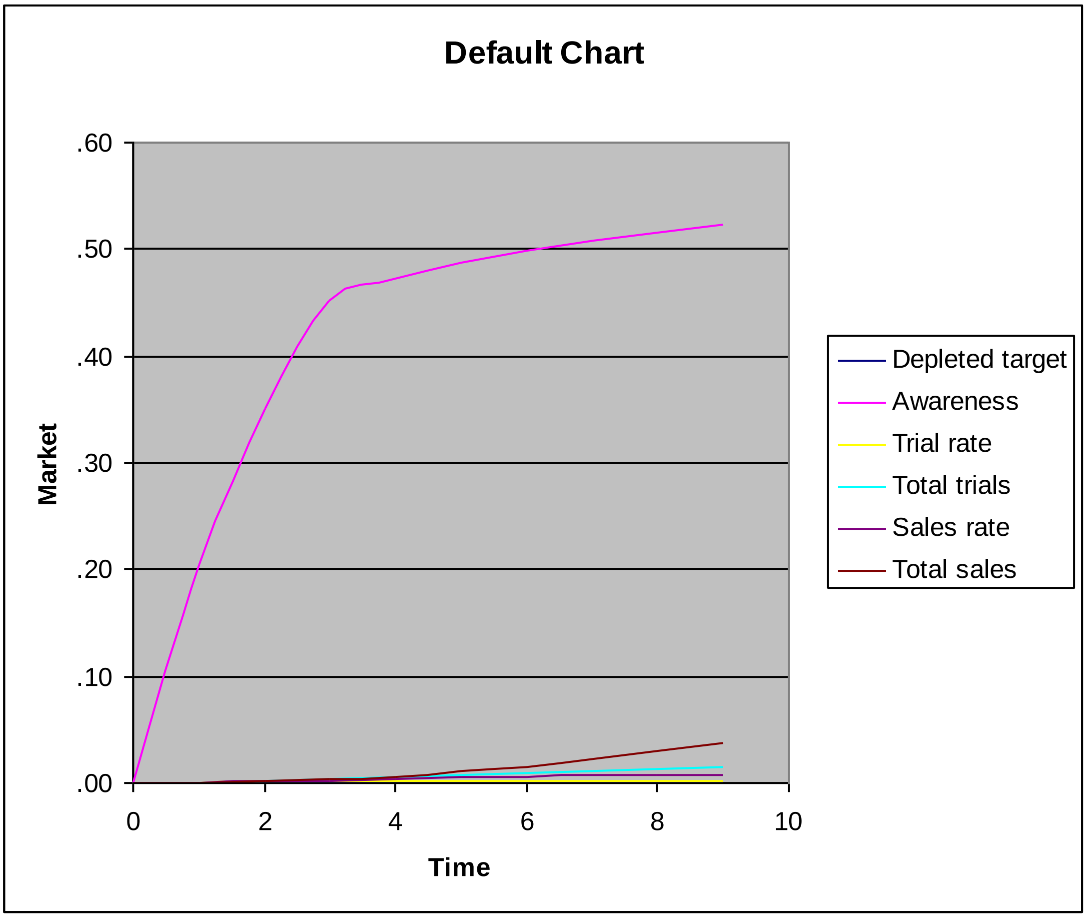
Time period parameters	**Limitations**	**Period**	
		1	**2**
Lengths of period ***L*** [time units]	***L*** > 0	3	6
Projected nominal awareness ***NAw*** [fraction]	0 ≤ ***NAw*** ≤ 1	0.7	0.544
Half-projection time of nominal awareness ***HTA*** [time units]	***HTA*** ≥ *1*	2	3.04
Probability of autonomous trial ***p***	0 ≤ ***p*** < 1	0.003344	0.003344
Probability of epidemic trial ***q***	0 ≤ ***q*** < 1	0	0
Mean time of the repeat spell ***MTR*** [time units]	***MTR*** ≥ 1	6	6
Mean purchase quantity ***Q***	***Q*** > 0	1	1
Switchback ratio ***z***	0 ≤ ***z*** < 1	1	1

The result of checking the parameters is as follows:

Pre-simulation check results			
Projected total awareness ***UAw*** [fraction]	**UAw** (t → ∞)	0.704162	0.548932
Projected sales rate ***S***	***S***(*t* → ∞)	0.013873	0.010815

The check results suggest that launching the new product is questionable. The projected product penetration (0.013873) in the particular target segment is about the same as the current penetration (0.0135) of the standard product in the [whole active] target.

The simulation run with *Tgt* = 1.149 is even less convincing. The predicted acquisition rate of users of the new product is very slow, as revealed in the following graph:



7.4 Example 4 Imitation of the Fourt-Woodlock model

In deciding upon a strategy for its new product a company has chosen to employ a diffusion model of the product penetration to forecast sales for the first 10 time units after the introduction of the product.

The projected market penetration has been estimated as *Tgt* = 2 units. The 'rate of market penetration of untapped potential' is expected to be 10% per time unit.

The rate of repeated purchases was estimated as 16%.

There are basically two ways of imitating the Fourt-Woodlock model in the TRD simulator:

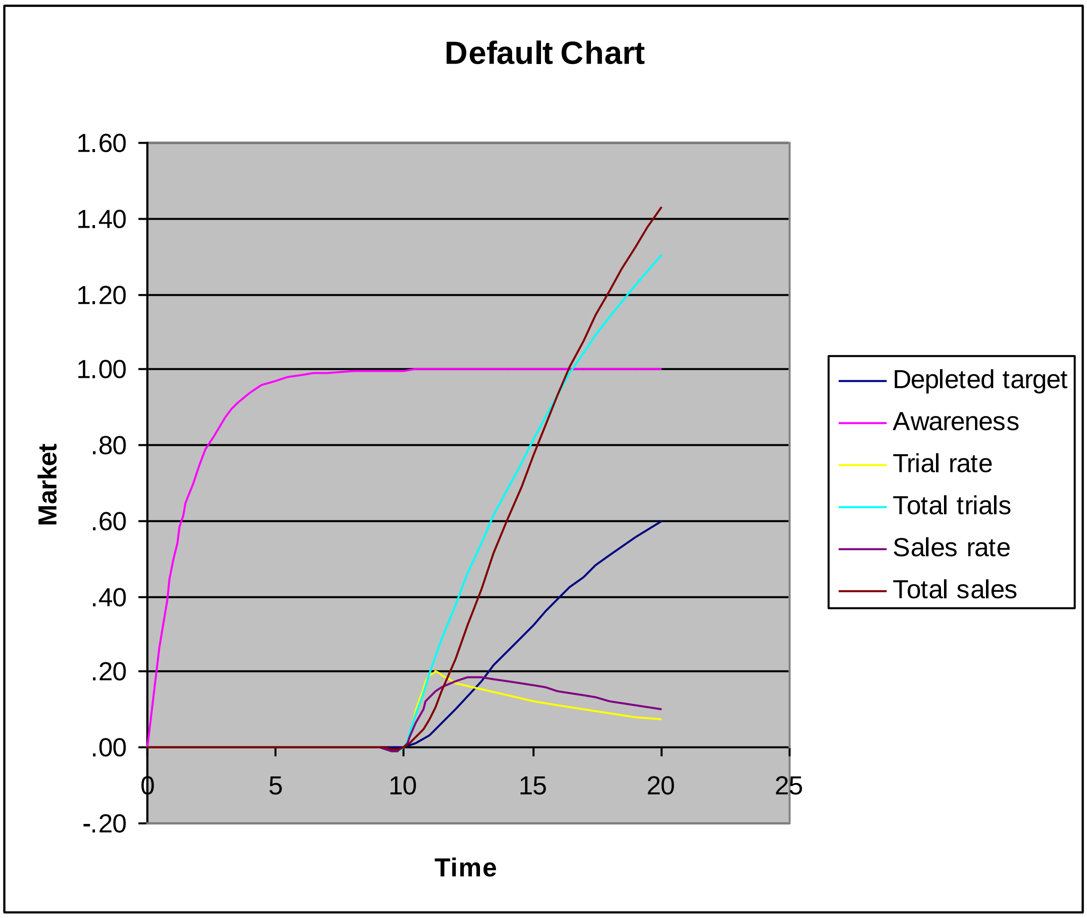
Imitation 1: First, the 100% awareness is let to be developed in the target with the probability of trial set to zero in the first time period. In the second period, the probability of trial is set to a non-zero value.

Imitation 2: Awareness is allowed to develop at the rate of the expected market penetration with the probability of trial set to a value as close to 1 (one) as the numerical precision of the simulator allows. Only one time period is required.

7.4.1 Imitation 1

By using the equation (8) for *r* = 0.16, the equivalent mean time of repeat is found to be *MTR* = 1.190476.

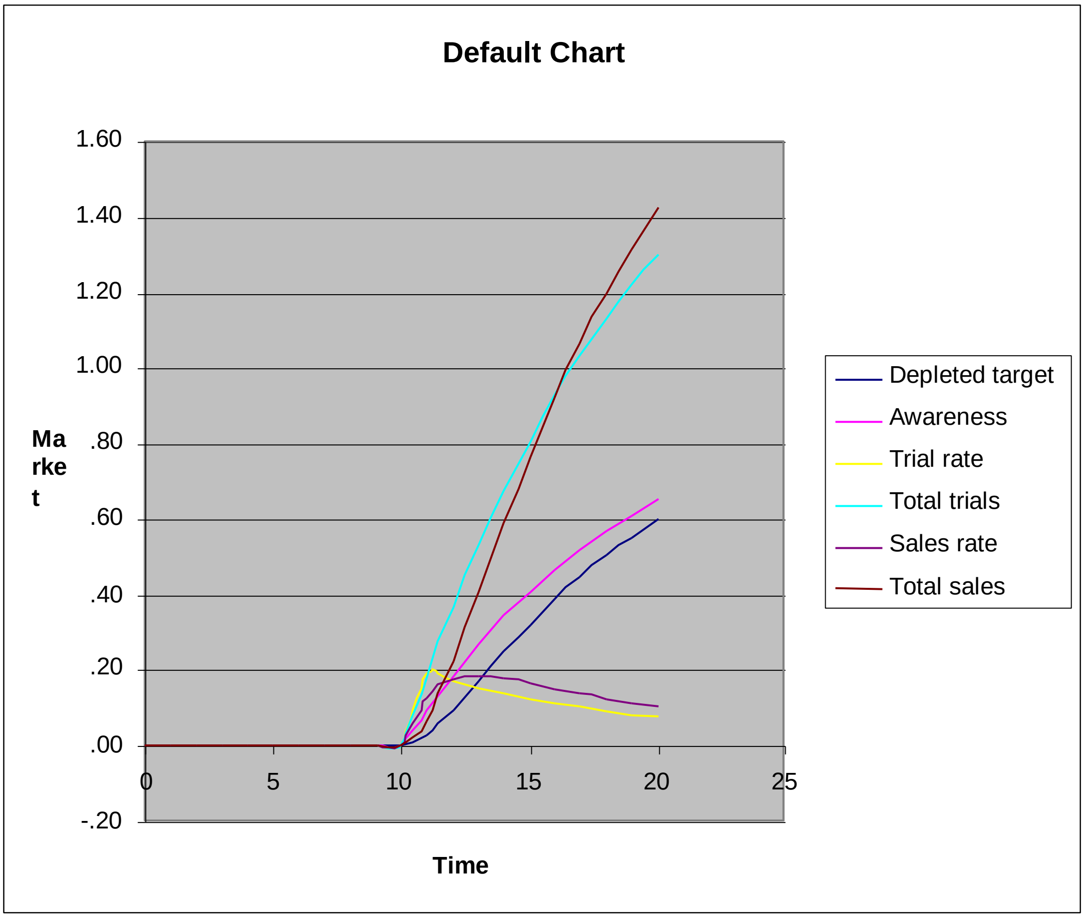
Time period parameters	Limitations	Period 1	Period 2
Lengths of period ***L*** [time units]	***L*** > 0	10	10
Projected nominal awareness ***NAw*** [fraction]	0 ≤ ***NAw*** ≤ 1	1	1
Half-projection time of nominal awareness ***HTA*** [time units]	***HTA*** ≥ *1*	1	1
Probability of autonomous trial ***p***	0 ≤ ***p*** < 1	0	0.1
Probability of epidemic trial ***q***	0 ≤ ***q*** < 1	0	0
Mean time of the repeat spell ***MTR*** [time units]	***MTR*** ≥ 1	1	1.190476
Mean purchase quantity ***Q***	***Q*** > 0	1	1
Switchback ratio ***z***	0 ≤ ***z*** < 1	0	0



7.4.2 Imitation 2

Using the equation (1) we can establish that if *w* = 0.1, then *HTA* = 6.578813. The first period is configured as a dummy one to obtain a picture similar to the previous simulation.

Time period parameters	Limitations	Period	
		1	2
Lengths of period ***L*** [time units]	***L*** > 0	10	10
Attainable nominal awareness ***NAw*** [fraction]	0 ≤ ***NAw*** ≤ 1	0	1
Half-projection time of nominal awareness ***HTA*** [time units]	***HTA*** ≥ *1*	1	6.578813
Probability of autonomous trial ***p***	0 ≤ ***p*** < 1	0	0.999999
Probability of epidemic trial ***q***	0 ≤ ***q*** < 1	0	0
Mean time of the repeat spell ***MTR*** [time units]	***MTR*** ≥ 1	1	1.190476
Mean purchase quantity ***Q***	***Q*** > 0	1	1
Switchback ratio ***z***	0 ≤ ***z*** < 1	0	0



Both simulation imitations lead to identical results. However, compared to the original Fourt-Woodlock model (the results are not shown) the sales computed by the TRD model are delayed. This is due to the TRD model definition where the trial is a decision to purchase rather than an actual purchase, and the actual sales are realized in the repeat cycle.

7.5 Example 5 Promotion of FMCG/CPG

A short-time price discount and/or a massive advertising are popular ways for consumer goods sale promotions.

The first simulation shows the influence of a price discount for an established, commonly known (projected nominal awareness *NAw* = 0.5 with the half-projection time of nominal awareness *HTA* = 20), but not very popular product (choice probability *p* = 0.1). The size of the target has been formally set to 1.

We assume that the good is purchased by a single piece and we are interested in actual purchase rates, that is, in the rate of trials. So that trial and steady-state sales rates are numerically identical for the given mean time of the repeat spell *MTR* = 20, we set the mean purchase quantity to *Q* = 1/20 = 0.05. The initial total awareness *W* = 0.756525738 and sales rate *S* = 0.025652574 has been obtained as results of the check procedure. Three time periods are simulated. The first one as a steady-state equilibrium, the second with price discount (p = 0.9) and massive advertising (*NAw* = 0.9), and the third with the parameters of the first one.

Time period parameters	**Limitations**	**Period**		
		1	**2**	**3**
Lengths of period ***L*** [time units]	***L*** > 0	10	10	30
Projected nominal awareness ***NAw*** [fraction]	0 ≤ ***NAw*** ≤ 1	0.5	0.9	0.5
Half-projection time of nominal awareness ***HTA*** [time units]	***HTA*** ≥ *1*	20	20	20
Probability of autonomous trial ***p***	0 ≤ ***p*** < 1	0.1	0.5	0.1
Probability of epidemic trial ***q***	0 ≤ ***q*** < 1	0	0	0
Mean time of the repeat spell ***MTR*** [time units]	***MTR*** ≥ 1	20	20	20
Mean purchase quantity ***Q***	***Q*** > 0	0.05	0.05	0.05
Switchback ratio ***z***	0 ≤ ***z*** < 1	1	1	1

The simulation shows marked post-promotion dip usually met after an established good promotion action. The real dip will be probably even greater if we simulate the stock piling behavior of consumers by four-fold increase of the mean time of the repeat spell to *MTR* = 80 during the promotion time period.

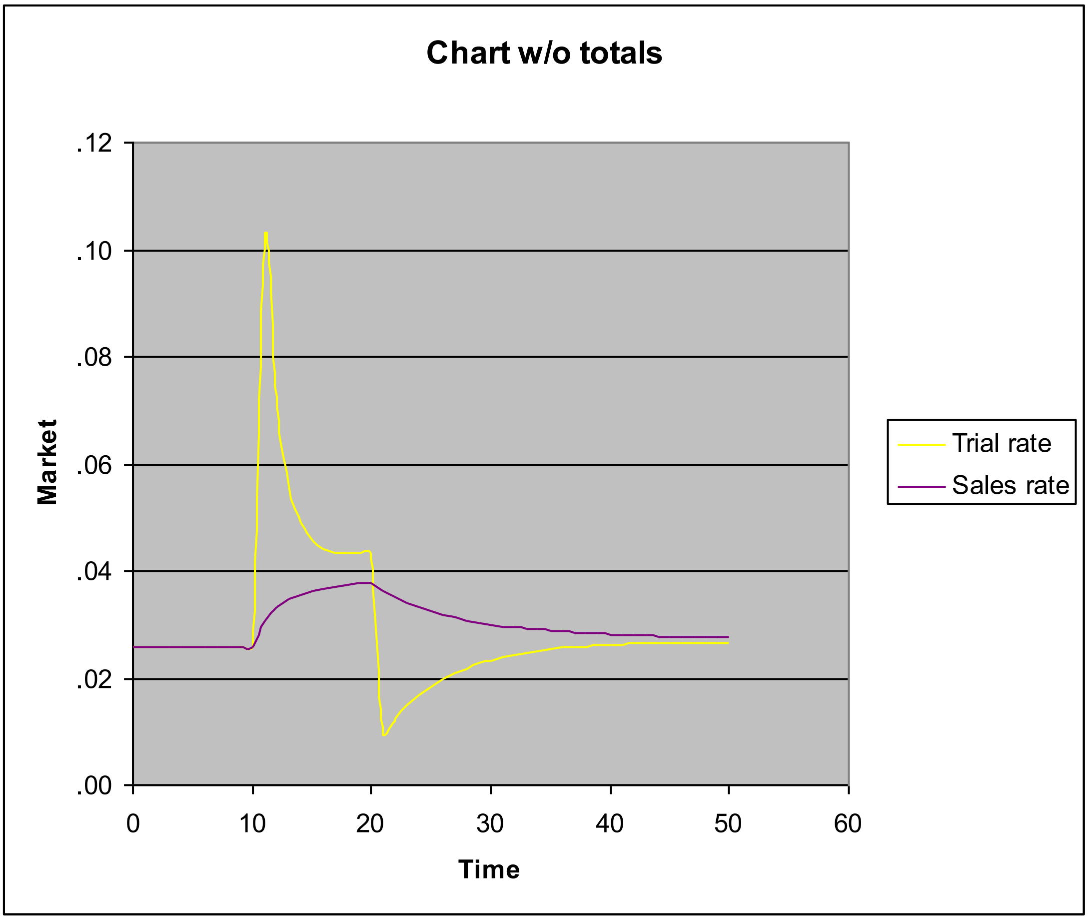
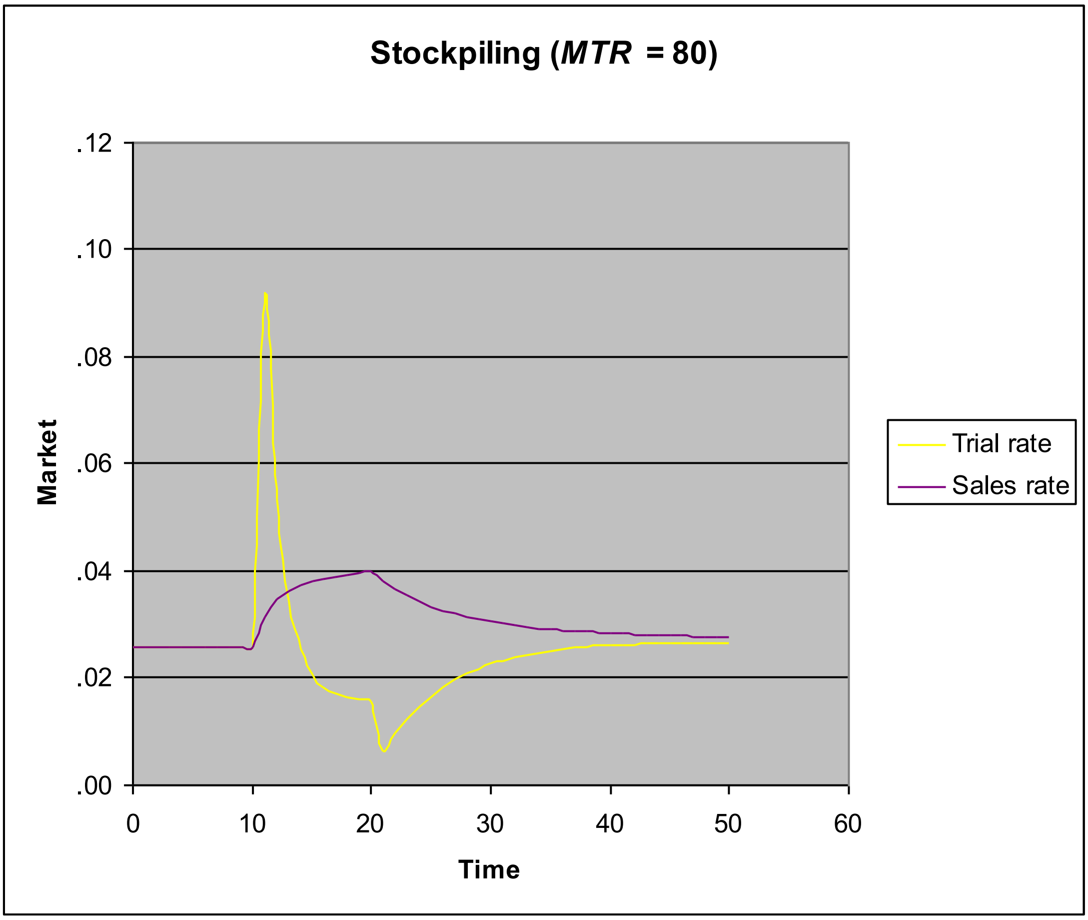


Chart w/o totals
Market
.12
.10
.08
.06
.04
.02
.00
0
10
20
30
40
50
60
Time
Trial rate
Sales rate


Stockpiling (*MTR* = 80)
Market
.12
.10
.08
.06
.04
.02
.00
0
10
20
30
40
50
60
Time
Trial rate
Sales rate

8. APPENDIX

8.1 Technical specifications

The ‘Simulation’ sheet is unprotected. The input and output data are organized into named rectangular ranges of cells that should not be deleted or disintegrated and the names of which should not be changed. The ranges can be moved anywhere on the sheet. Any number of rows or columns can be inserted between the named ranges. Only the address in the upper left cell of a range is significant. The only exception is the range named `Plot_Area`, which determines the plot area for the default chart.

The names of the six named ranges are self-explanatory:

```
Awarness_tool
Check_results
Initial_values
Param_values
Plot_area
Simul_results
```

It is recommended to choose market and parameter units that allow the results of a simulation to be shared in the default plot with the fixed title `Default Chart`.

The computed results are stored in the cells under the named header range `Simul_results`. Any number of columns containing formulas pointing to the default columns can be added.

N.B.17 In some cases, an inaccuracy may be noticed in the third significant digit of a result. This is due to the numerical algorithms used in order to achieve a reasonable speed of simulation computations.

N.B.18 Line smoothing is used in the default chart. An unexpected dip or bump on a curve at a period boundary may signal an overly abrupt change to a parameter between the adjoined time periods.

Hints

The default chart may be copied (as an object) to any place on the Simulation sheet. If the title of the copy is changed to anything other than `Default Chart` the settings of the copy will be kept intact in future simulations. This may be useful in generating custom-formatted charts.

To make a chart hardcopy, it should be pasted from Windows clipboard as a picture using ‘Edit/Paste Special/Paste Picture’ menu command.

If you run MS Vista or newer Windows, do not forget to enable macros immediately after opening the Excel file.

8.2 Program internal settings

The upper limit for number of periods is set to 105 (2 years in weeks). The number of integration steps over the total length of all effective periods is 1048576.