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Model Building Tutorial 4

Multiple Products

Contents

Overview

The objective of this document is to elaborate on the model building process by creating a model that has two products.

In addition to the **Life** product specified previously we will also specify an **Annuity** product that pays a monthly annuity that escalates over time.

The **Instance Variables** required for the **Annuity** product are:

Name	Description
AgeAtInception	Policy holder age at inception, in years
DurationInforce	Number of months the policy is in force
Gender	Whether the policy holder is male or female
Smoker	Whether the policy holder is a smoker or not
Annuity	The monthly annuity payable to the policy holder
AnnuityEscalation	The amount by which the annuity escalates annually.

The **Single Variables** required for the **Annuity** product are:

Name	Description
Expense	The monthly expense incurred to maintain each policy

The **Series Variables** required for the **Annuity** product are:

Name	Description	Index By
Inflation	Forecast inflation rates, for each future time period	Time
Yield	Forecast yield curve, to be used to present value future cash flows	Time

The **Table Variables** required for the **Annuity** product are:

Name	Description	Index By
Qx	Life table, giving the probability of survival for a given policy holder age. We will use a table with 4 columns – the columns representing a combination of gender (male / female) and smoker status (smoker / non-smoker)	Policy Holder Age

Spreadsheet Structure

The spreadsheet structure is as before with the following changes within each sheet:

Model Sheet

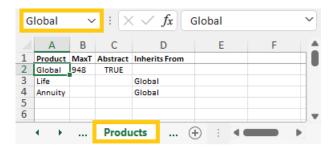There is no change to the **Model** sheet when defining multiple products.

Products Sheet

When declaring multiple products it is often useful to derive actual products from a common **base** product. This **base** product can define all of the variables that are common to all of the products in our model that will inherit from it. We will define a base product called **Global** and derive our **Life** and **Annuity** products from this **Global** product.

We have added some more information on the **Products** sheet to enable us to define the relationship between products:
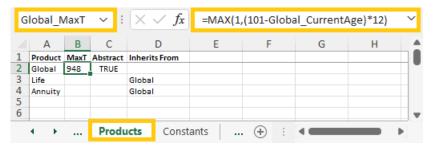
- **Abstract**. Specifies whether the product is a 'real' product (such as a life policy) or an 'abstract' product (such as Global). Abstract products are not 'real' products, i.e. we cannot have an instance of an abstract product – they are used for convenience when creating our product hierarchy. Products are NOT abstract by default.

- **InheritsFrom**. Specifies which other product a product inherits from. This allows us to specify the relationships between products in our product hierarchy.
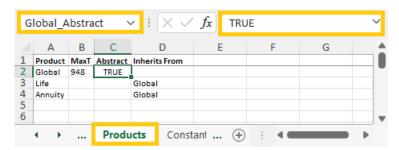
We will specify our **Global** product as follows:

- **Name**:

- **MaxT**: By specifying **MaxT** at the **Global** level will mean that any product that inherits from **Global** will use this **MaxT**. Note that we need to prefix **MaxT** with the product name in order to differentiate this **MaxT** definition from any other product **MaxT** definition, thus the name **Global_MaxT:**
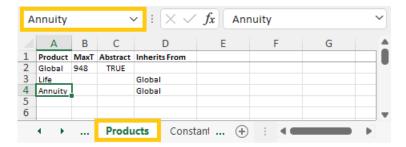

- **Abstract**: We specify that the product is abstract by entering TRUE into a cell named **Abstract** prefixed by the product name, thus the name **Global_Abstract**:
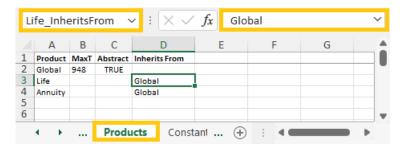

We will specify our **Annuity** product as follows:

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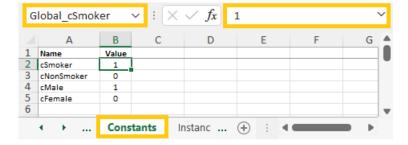
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- **Name**:

- **MaxT**: It is unnecessary to specify **MaxT** as it will be inherited from the **Global** product.

- **Abstract**: It is unnecessary to specify that the product is not abstract as this is the default.

- **InheritsFrom**: We will specify that the **Annuity** product inherits from the **Global** product. This is achieved by entering the name of the product we are inheriting from (**Global**) in a cell named **InheritsFrom** prefixed by the product name, thus the name **Life_InheritsFrom**.
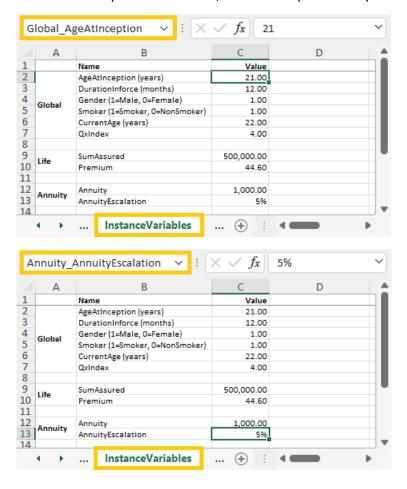
Constants Sheet

Constants are specified as before, but must be preceded by the name of the product they belong to:

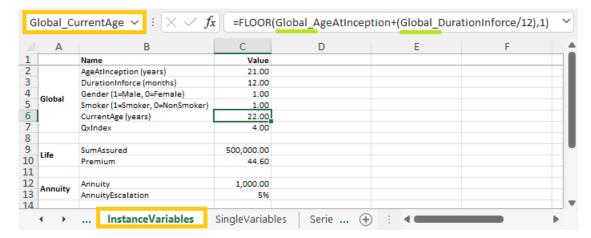| Name	Value
cSmoker	1
cNonSmoker	0
cMale	1
cFemale	0

Instance Variables Sheet

Instance Variables are specified as before, but must be preceded by the name of the product they belong to:

Derived Instance Variables are specified as before, but must be preceded by the name of the product they belong to. Remember that all variables names referenced in formulae must include a product prefix as well:

Single Variables Sheet

Single Variables are specified as before, but must be preceded by the name of the product they belong to:

Series Variables Sheet

Series Variables are specified as before, but must be preceded by the name of the product they belong to:
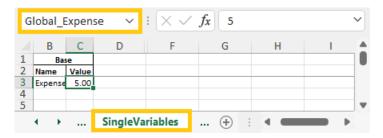

Derived Series Variables are specified as before, but must be preceded by the name of the product they belong to. Remember that all variables names referenced in formulae must include a product prefix as well:
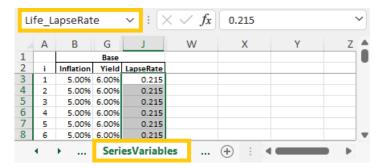
Table Variables Sheet

Table Variables are specified as before, but must be preceded by the name of the product they belong to:

| Global_Qx | | fx | 0.00024964 | |

	A	B	C	D	E	F	G
1					Qx		
2				Female		Male	
3		i	Non Smoker	Smoker	Non Smoker	Smoker	
4		1	0.000249640	0.000020806	0.000274604	0.000022887	
5		2	0.000249640	0.000020806	0.000274604	0.000022887	
6		3	0.000249640	0.000020806	0.000274604	0.000022887	
7		4	0.000249640	0.000020806	0.000274604	0.000022887	
8		5	0.000249640	0.000020806	0.000274604	0.000022887	

◄ ► … **TableVariables** … ⊕ ⋮ ◄ ━━

Derived Table Variables are specified as before, but must be preceded by the name of the product they belong to. Remember that all variables names referenced in formulae must include a product prefix as well:
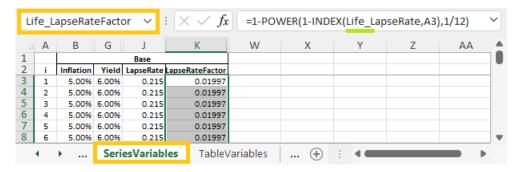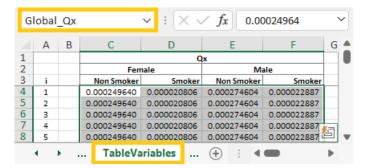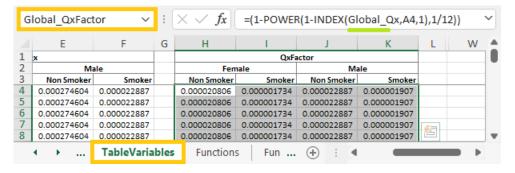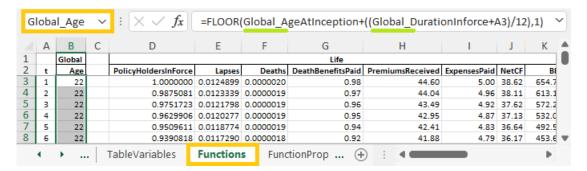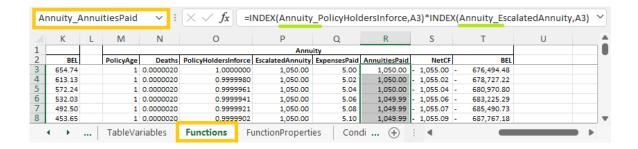
| Global_QxFactor | | fx | =(1-POWER(1-INDEX(Global_Qx,A4,1),1/12)) | |

	E	F	G	H	I	J	K	L	W
1	x					QxFactor			
2		Male			Female		Male		
3	Non Smoker	Smoker		Non Smoker	Smoker	Non Smoker	Smoker		
4	0.000274604	0.000022887		0.000020806	0.000001734	0.000022887	0.000001907		
5	0.000274604	0.000022887		0.000020806	0.000001734	0.000022887	0.000001907		
6	0.000274604	0.000022887		0.000020806	0.000001734	0.000022887	0.000001907		
7	0.000274604	0.000022887		0.000020806	0.000001734	0.000022887	0.000001907		
8	0.000274604	0.000022887		0.000020806	0.000001734	0.000022887	0.000001907		

◄ ► … **TableVariables** Functions Fun … ⊕ ⋮ ◄ ━━━━━ ►

Functions Sheet

We will define the functions required to calculate **Best Estimate Liability** (**BEL**) for our **Annuity** product as follows:

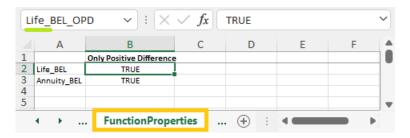| Function	Formula
Age(t)	FLOOR(AgeAtInception+((DurationInforce+t)/12))
PolicyAge(t)	FLOOR((DurationInforce+t)/12)
Deaths(t)	PolicyHoldersInforce(t) * QxFactor[Age(t),QxIndex]
PolicyHoldersInforce(t)	IF(t=1, 1, PolicyHoldersInforce(t-1) - Deaths(t-1))
EscalatedAnnuity(t)	Annuity * POWER(1+AnnuityEscalation,PolicyAge(t))
AnnuitiesPaid(t)	PolicyHoldersInforce(t) * EscalatedAnnuity(t)
ExpensesPaid(t)	PolicyHoldersInforce(t) * EscalatedExpense[t]
NetCF(t)	- ExpensesPaid(t) - AnnuitiesPaid(t)
BEL(t)	IF(t=MaxT, NetCF(t), NetCF(t) + (BEL(t+1) * DiscountFactor[t]))

Functions are specified as before, but must be preceded by the name of the product they belong to. Remember that all variables and other function names referenced in formulae must include a product prefix as well:
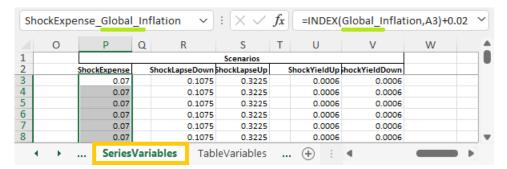
Function Properties Sheet

Function Properties are entered as before except a product prefix must be used:

Scenarios Sheet

There is no change to the **Scenarios** sheet as scenarios are not product specific.

Scenarios Adjustments are entered as before except a product prefix must be used:

Conditions Sheet

Conditions are entered as before except a product prefix must be used:

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