```
% This script file computes the optimal investment levels TAopt and
 TBopt
% for the two firms (Firm A and Firm B) of the Simplified
 Oligopolistic
% Optimal Influence model which also involves a single consumer C. The
 rest
% of the model parameters (Sopt,Xopt,Popt,Qopt,Fopt) are also
 computed.

% Specifically, the internal model parameters whose optimal values are
 to
% be determined during the grid searching optimization process are the
% follwing:
% (i):   [TAopt,TBopt]
% (ii):  [SAopt,SCopt,SBopt]
% (iii): [XAopt,XBopt]
% (iv):  [PAopt,PBopt] (These are the optimal prices!!!)
% (v):   [QAopt,QBopt]
% (vi):  [FAopt FBopt FA_rev_opt FB_rev_opt FA_cost_opt FB_rev_opt]

% The grid searching process will be conducted within the 8-
dimensional
% space defined by the Cartesian product of the following external
 model
% parameters:
% (i):    LA (direct influnce exerted by consumer C on Firm A).
% (ii):   LB (direct influnce exerted by consumer C on Firm B).
% (iii):  PA (initial belief consumer C holds for product A).
% (iv):   PB (initial belief consumer C holds for product B).
% (v):    M  (sensitivity coefficient).
% (vi):   K  (sensitivity coefficient).
% (vii):  C  (marginal cost).
% (viii): G  (marginal influence cost or Gamma).

% IMPORTANT NOTE!!!
% Mind that the underlying continuous game may not have an equlibrium
 point
% for any given configuration of the external parameters. Since all
 the
% internal parameters to be determined accept positive values, the
 value of
% (-1) will be utilized in order to indicate the absence of an
 equilibrium
% point for a particular configuration of the external parameters.

% Define ranges and corresponding increment step for each external
 parameter
% of the Simplified Oligopolistic Optimal Influence model.

clc
clear
```

```
% Construct a cell array storing the names of model parameters.
ParamsNames = {'LA','LB','PA','PB','M','K','C','G'};

% Set the varying parameter index.
ParamIndex = 1;

% Parameter #1
LA_MIN = 0.01;
LA_MAX = 1.00;
LA_STEP = 0.01;
% Parameter #2
LB_MIN = 0.50;
LB_MAX = 0.50;
LB_STEP = 0.01;
% Parameter #3
PA_MIN = 0.80;
PA_MAX = 0.80;
PA_STEP = 0.01;
% Parameter #4
PB_MIN = 0.80;
PB_MAX = 0.80;
PB_STEP = 0.01;
% Parameter #5
M_MIN = 0.40;
M_MAX = 0.40;
M_STEP = 0.01;
% Parameter #6
K_MIN = 0.10;
K_MAX = 0.10;
K_STEP = 0.01;
% Parameter #7
C_MIN = 0.0;
C_MAX = 0.0;
C_STEP = 0.01;
% Parameter #8 (G or Gamma!!!)
% G = 0.2; % Mind that G is the Gamma parameter defined elsewhere.
% Determine the minimum value for G.
alpha0 = (K_MAX*M_MAX - 2) / (M_MIN^2 - 4);
beta0 = (2*K_MAX - M_MIN) / (M_MIN^2 - 4);
Fmax = max(alpha0^2,(3*beta0^2+2*alpha0*beta0));
Lmin = min(LA_MIN,LB_MIN);
G0 = Fmax  / (Lmin^2);
Gfraction = 0.0001; % This value should be set to 1.
G0 = Gfraction * G0;
G_MIN = G0;
G_MAX = G0;
G_STEP = 1.00;
% G_STEP = (G_MAX - G_MIN)/1000;

% Set the corresponding ranges for each parameter of the model.
LA_RANGE = LA_MIN:LA_STEP:LA_MAX;
LB_RANGE = LB_MIN:LB_STEP:LB_MAX;
PA_RANGE = PA_MIN:PA_STEP:PA_MAX;
PB_RANGE = PB_MIN:PB_STEP:PB_MAX;
```

```
M_RANGE = M_MIN:M_STEP:M_MAX;
K_RANGE = K_MIN:K_STEP:K_MAX;
C_RANGE = C_MIN:C_STEP:C_MAX;
G_RANGE = G_MIN:G_STEP:G_MAX;

% Initialize matrices that store fundamental intermediate quantities
 of the
% underlying optimization problem within the simplified oligopolistic
% enviroment as well as the values of the external optimization
 parameters
% for each step of the multi-dimensional grid searching process.
Topts = []; % Optimal investment levels.
Sopts = []; % Optimal limiting influences.
Xopts = []; % Optimal limiting beliefs.
Popts = []; % Optimal prices.
Qopts = []; % Optimal quantities.
Fopts = []; % Optimal profits.
FilterFlags = []; % Solution filtering flag which may be indicative of
 a non-existing solution.
DigitAccuracies = []; % Length of maximal sequence of identical digits
 within the obtained optimal solutions.
Params = []; % 8-tuple of the varying optimization parameters.

% Initialize internal solver parameters.
% Set the number of initial solution points.
N = 2000;
% Set the tolerance value for the minimizer. (Preferable value =
 1e-10)
Tolerance = 1e-15;
% Set the Fvals tolerance value for filtering the obtained solutions.
 (Preferable value = 1e-15)
FvalsTolerance = 1e-15;
% Set the derivative tolerance value for filering the obtained
 solutions. (Preferable value = 1e-08).
DerivativeTolerance = 1e-08;
% Set the maximum number of iterations to be conducted by the
 optimizer.
MaxIterations = 2000;
% Set the maximum number of function evaluations to be conducted by
 the
% optimizer.
MaxFunctionEvaluations = 20000;
% Set the display flag parameter to 'off' or to 'iter'.
DisplayFlag = 'off';
% Set the minimum digits accuracy.
MinimumDigitsAccuracy = 7;

fprintf('Grid Evaluation Process in Progess...\n');
% Perform the actual grid searching.
for LA = LA_RANGE
    for LB = LB_RANGE
        for PA = PA_RANGE
            for PB = PB_RANGE
                for M = M_RANGE
```

```
                    for K = K_RANGE
                        for C = C_RANGE
                            for G = G_RANGE
                                % Additional parameters definition.
                                alpha = (K*M - 2) / (M^2 - 4);
                                beta = (2*K - M) / (M^2 - 4);
                                gamma = C / (M - 2);
                                gamma_prime = gamma * (M - 1); %
gamma_prime is the gamma' parameter.
                                % Set the current params vector.
                                params = [LA LB PA PB M K C G];
                                Params = [Params;params];

[TAopt,TBopt,FilterFlag,DigitsAccuracy] =
SimplifiedOligopolisticOptimalInfluences(N,DisplayFlag,Tolerance,FvalsTolerance,D
                                DigitsAccuracy = min(DigitsAccuracy);
                                T = [TAopt TBopt];
                                if(FilterFlag==0)
                                    [S,X,P,Q,F] =
RetrieveOptimalModelParameters(T,C,G,LA,LB,PA,PB,alpha,beta,gamma,gamma_prime);
                                else
                                    S = -1*ones(1,3);
                                    X = -1*ones(1,2);
                                    P = -1*ones(1,2);
                                    Q = -1*ones(1,2);
                                    F = -1*ones(1,6);
                                end
                                    % Print current solution.
                                param_value_string
= strcat([ParamsNames{ParamIndex} ' = '
num2str(params(ParamIndex),10)]);
                                fprintf('%s TAopt =
 %f TBopt = %f FilterFlag = %d DigitsAccuracy = %d
\n',param_value_string,TAopt,TBopt,FilterFlag,DigitsAccuracy);
                                Topts = [Topts;T];
                                FilterFlags =
[FilterFlags;FilterFlag];
                                DigitsAccuracies =
[DigitAccuracies;DigitsAccuracy];
                                Sopts = [Sopts;S];
                                Xopts = [Xopts;X];
                                Popts = [Popts;P];
                                Qopts = [Qopts;Q];
                                Fopts = [Fopts;F];
                            end
                        end
                    end
                end
            end
        end
    end
end
```

```
% Set parameters' indices and corresponding values for the parameters
 that
% remain constant.
ConstIndices = setdiff(1:length(params),ParamIndex);
ConstValues = params(ConstIndices);
% Perform plotting operations.
PlotParametersTuples(Topts,Sopts,Xopts,Popts,Qopts,Fopts,Params,ParamIndex,ConstIn

Grid Evaluation Process in Progess...
LA = 0.01 TAopt = 0.109714 TBopt = 0.023527 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.02 TAopt = 0.140984 TBopt = 0.040360 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.03 TAopt = 0.163204 TBopt = 0.055078 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.04 TAopt = 0.180631 TBopt = 0.068361 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.05 TAopt = 0.194869 TBopt = 0.080526 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.06 TAopt = 0.206745 TBopt = 0.091756 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.07 TAopt = 0.216760 TBopt = 0.102170 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.08 TAopt = 0.225249 TBopt = 0.111853 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.09 TAopt = 0.232454 TBopt = 0.120867 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.1 TAopt = 0.238559 TBopt = 0.129262 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.11 TAopt = 0.243709 TBopt = 0.137078 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.12 TAopt = 0.248021 TBopt = 0.144352 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.13 TAopt = 0.251595 TBopt = 0.151114 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.14 TAopt = 0.254514 TBopt = 0.157392 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.15 TAopt = 0.256849 TBopt = 0.163211 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.16 TAopt = 0.258665 TBopt = 0.168597 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.17 TAopt = 0.260017 TBopt = 0.173572 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.18 TAopt = 0.260955 TBopt = 0.178159 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.19 TAopt = 0.261522 TBopt = 0.182377 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.2 TAopt = 0.261757 TBopt = 0.186248 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.21 TAopt = 0.261698 TBopt = 0.189791 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.22 TAopt = 0.261375 TBopt = 0.193025 FilterFlag = 0
 DigitsAccuracy = 8
```

```
LA = 0.23 TAopt = 0.260817 TBopt = 0.195967 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.24 TAopt = 0.260051 TBopt = 0.198636 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.25 TAopt = 0.259101 TBopt = 0.201047 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.26 TAopt = 0.257987 TBopt = 0.203217 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.27 TAopt = 0.256729 TBopt = 0.205161 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.28 TAopt = 0.255344 TBopt = 0.206894 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.29 TAopt = 0.253848 TBopt = 0.208429 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.3 TAopt = 0.252255 TBopt = 0.209780 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.31 TAopt = 0.250579 TBopt = 0.210959 FilterFlag = 0
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LA = 0.32 TAopt = 0.248830 TBopt = 0.211978 FilterFlag = 0
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LA = 0.33 TAopt = 0.247020 TBopt = 0.212848 FilterFlag = 0
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LA = 0.34 TAopt = 0.245157 TBopt = 0.213581 FilterFlag = 0
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LA = 0.35 TAopt = 0.243250 TBopt = 0.214185 FilterFlag = 0
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LA = 0.46 TAopt = 0.221071 TBopt = 0.214687 FilterFlag = 0
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 DigitsAccuracy = 8
LA = 0.49 TAopt = 0.215046 TBopt = 0.213527 FilterFlag = 0
 DigitsAccuracy = 8
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LA = 0.51 TAopt = 0.211097 TBopt = 0.212568 FilterFlag = 0
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LA = 0.52 TAopt = 0.209147 TBopt = 0.212044 FilterFlag = 0
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LA = 0.53 TAopt = 0.207214 TBopt = 0.211493 FilterFlag = 0
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LA = 0.54 TAopt = 0.205299 TBopt = 0.210919 FilterFlag = 0
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LA = 0.55 TAopt = 0.203404 TBopt = 0.210324 FilterFlag = 0
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LA = 0.56 TAopt = 0.201527 TBopt = 0.209710 FilterFlag = 0
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LA = 0.57 TAopt = 0.199671 TBopt = 0.209079 FilterFlag = 0
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LA = 0.58 TAopt = 0.197836 TBopt = 0.208434 FilterFlag = 0
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LA = 0.59 TAopt = 0.196021 TBopt = 0.207776 FilterFlag = 0
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LA = 0.6 TAopt = 0.194227 TBopt = 0.207107 FilterFlag = 0
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LA = 0.61 TAopt = 0.192454 TBopt = 0.206429 FilterFlag = 0
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LA = 0.62 TAopt = 0.190703 TBopt = 0.205742 FilterFlag = 0
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LA = 0.63 TAopt = 0.188973 TBopt = 0.205049 FilterFlag = 0
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LA = 0.64 TAopt = 0.187264 TBopt = 0.204350 FilterFlag = 0
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LA = 0.65 TAopt = 0.185577 TBopt = 0.203647 FilterFlag = 0
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LA = 0.67 TAopt = 0.182267 TBopt = 0.202232 FilterFlag = 0
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LA = 0.69 TAopt = 0.179042 TBopt = 0.200811 FilterFlag = 0
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LA = 0.7 TAopt = 0.177461 TBopt = 0.200101 FilterFlag = 0
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LA = 0.71 TAopt = 0.175901 TBopt = 0.199391 FilterFlag = 0
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LA = 0.72 TAopt = 0.174362 TBopt = 0.198684 FilterFlag = 0
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 DigitsAccuracy = 8
LA = 0.75 TAopt = 0.169866 TBopt = 0.196574 FilterFlag = 0
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LA = 0.76 TAopt = 0.168407 TBopt = 0.195878 FilterFlag = 0
 DigitsAccuracy = 8
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LA = 0.77 TAopt = 0.166968 TBopt = 0.195185 FilterFlag = 0
 DigitsAccuracy = 8
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LA = 0.84 TAopt = 0.157423 TBopt = 0.190475 FilterFlag = 0
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LA = 0.95 TAopt = 0.144135 TBopt = 0.183682 FilterFlag = 0
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LA = 0.96 TAopt = 0.143021 TBopt = 0.183105 FilterFlag = 0
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LA = 0.97 TAopt = 0.141922 TBopt = 0.182535 FilterFlag = 0
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LA = 0.98 TAopt = 0.140838 TBopt = 0.181971 FilterFlag = 0
 DigitsAccuracy = 8
LA = 0.99 TAopt = 0.139767 TBopt = 0.181415 FilterFlag = 0
 DigitsAccuracy = 8
LA = 1 TAopt = 0.138711 TBopt = 0.180866 FilterFlag = 0 DigitsAccuracy
 = 8
```
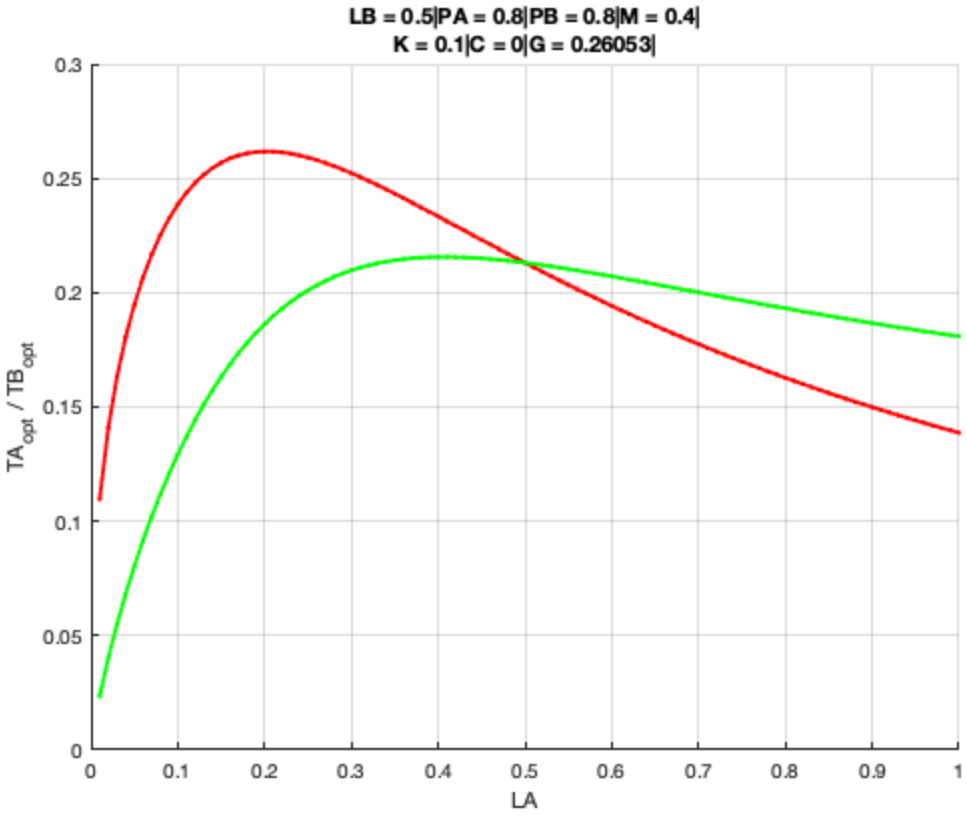
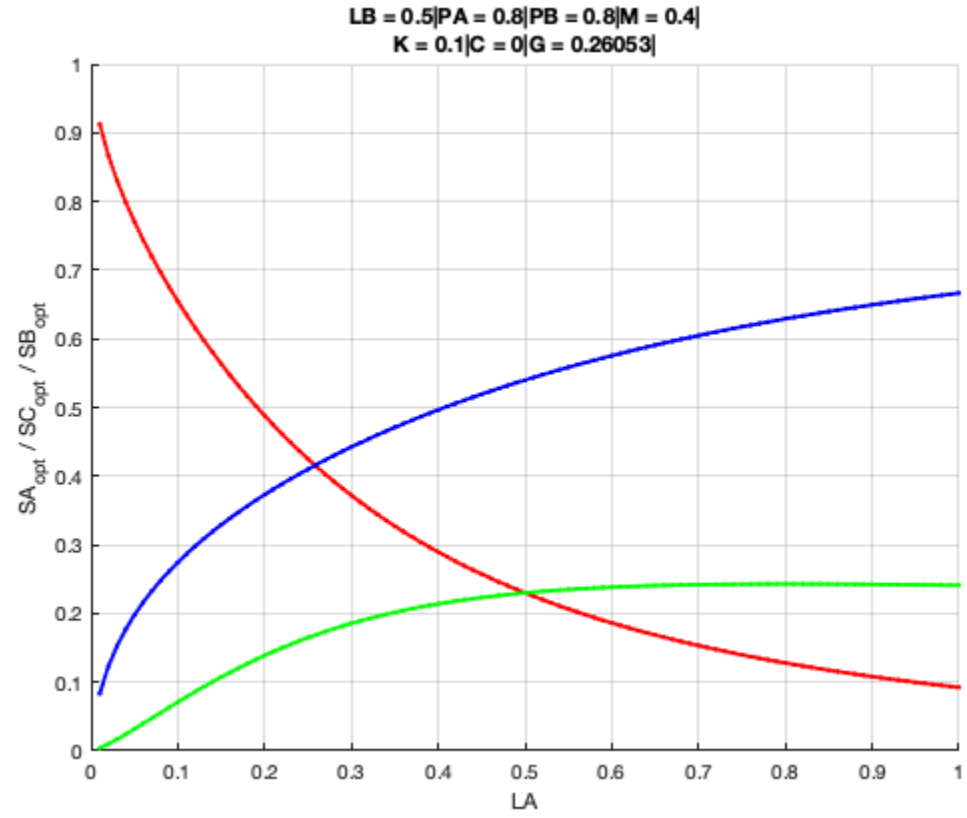
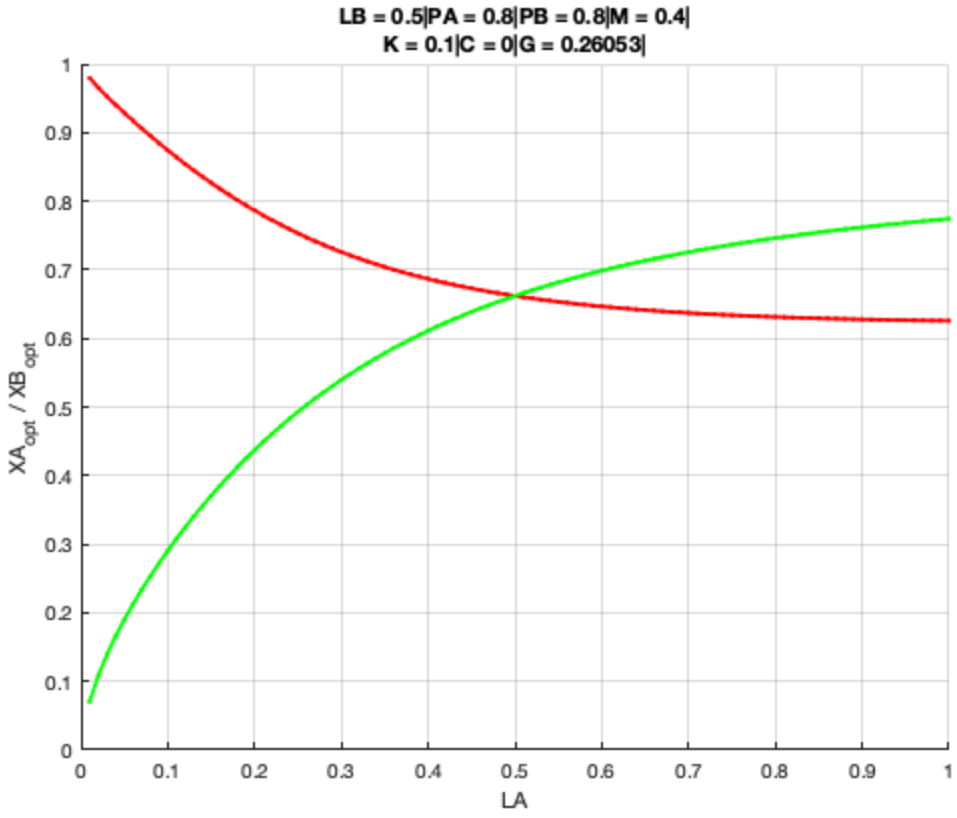
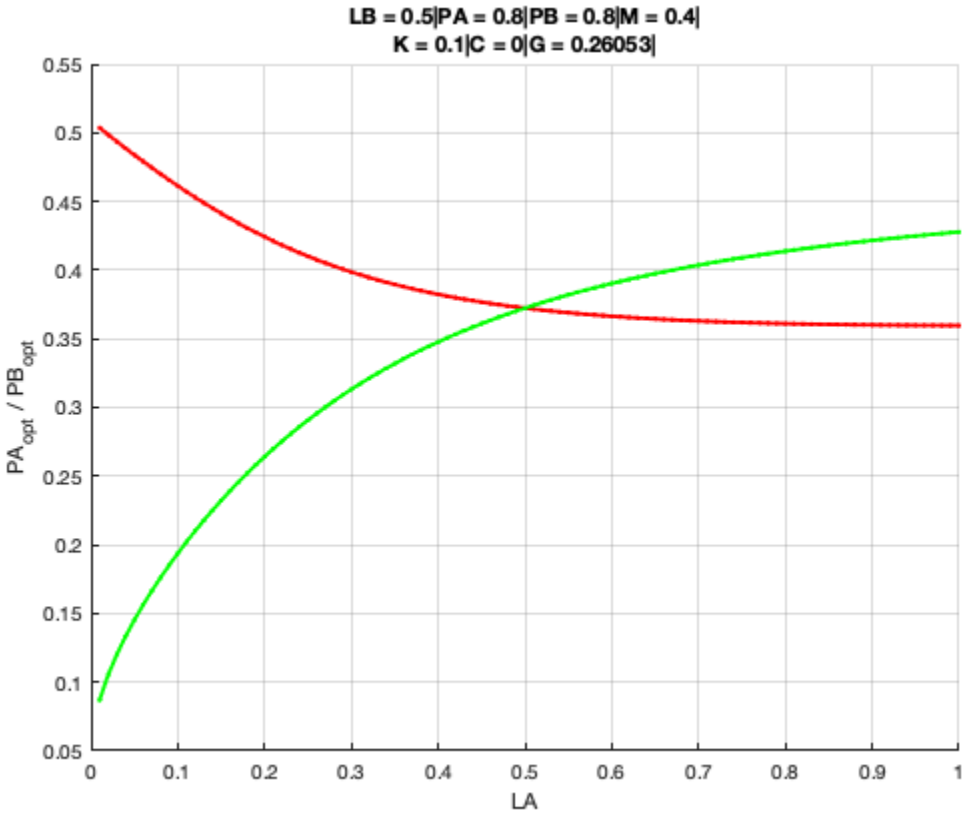
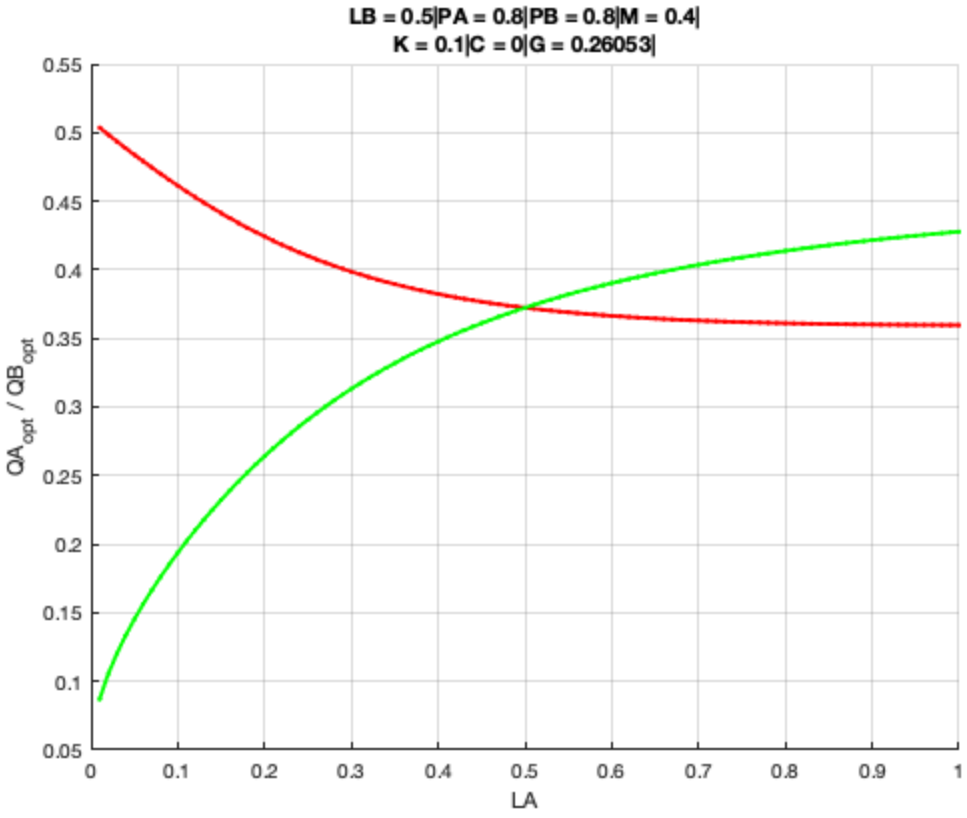
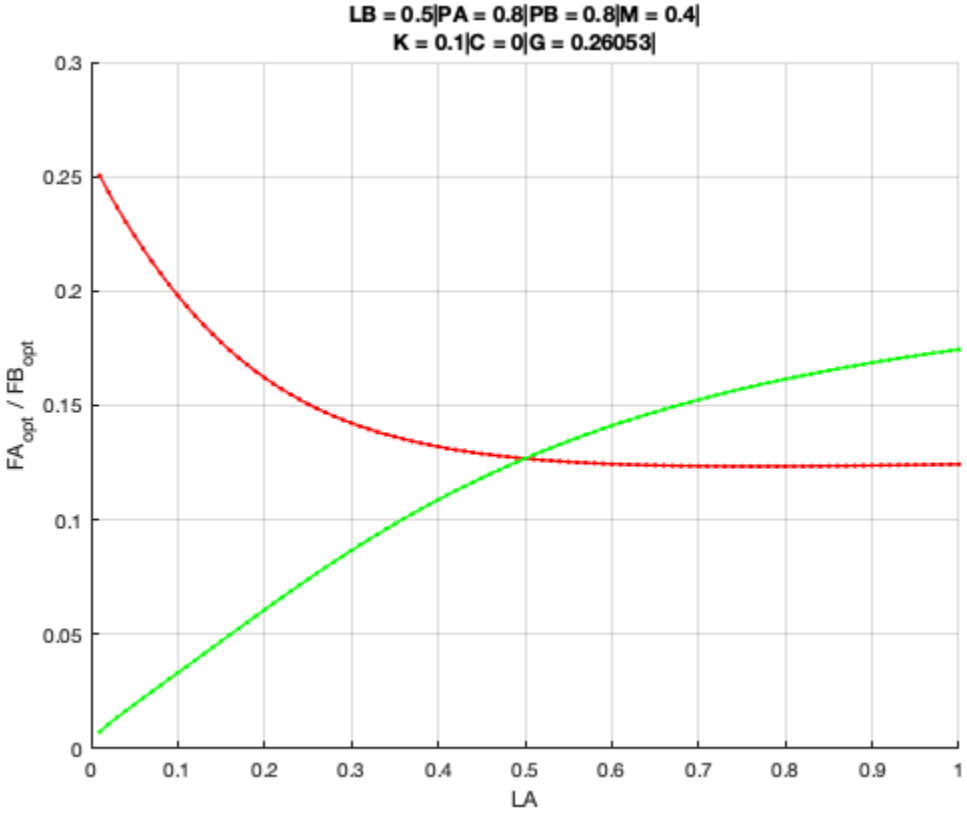


LB = 0.5|PA = 0.8|PB = 0.8|M = 0.4|
K = 0.1|C = 0|G = 0.26053|
TA_opt / TB_opt
LA
0
0.05
0.1
0.15
0.2
0.25
0.3
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

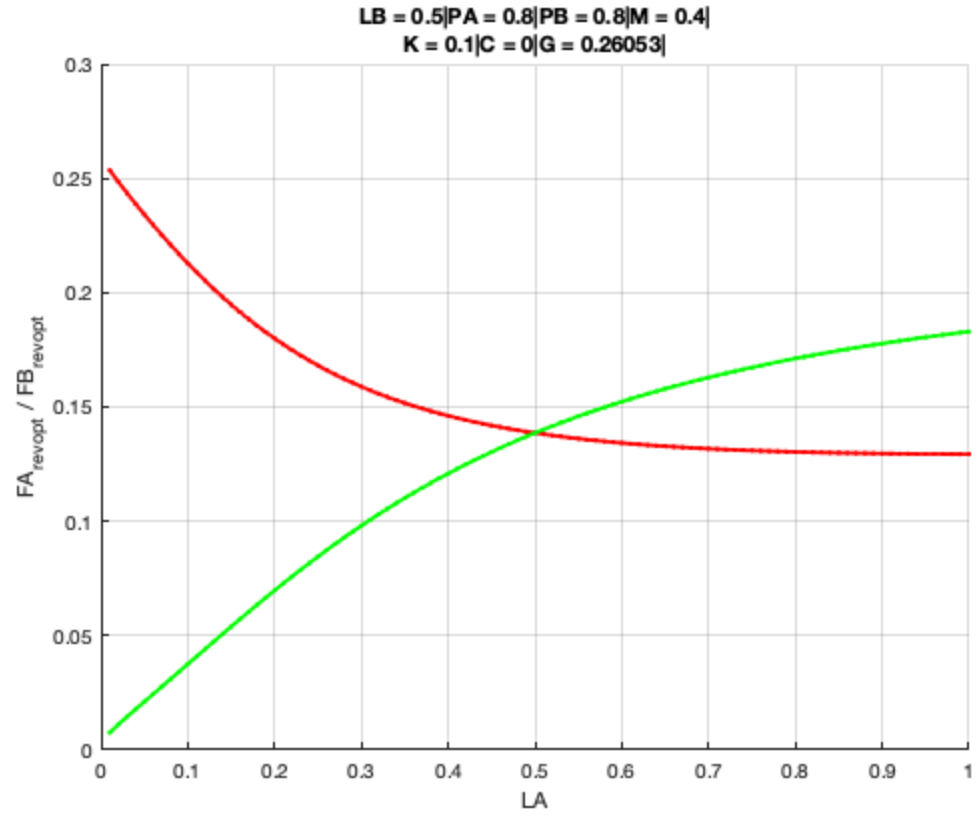

LB = 0.5|PA = 0.8|PB = 0.8|M = 0.4|
K = 0.1|C = 0|G = 0.26053|
SA_opt / SC_opt / SB_opt
LA
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


LB = 0.5|PA = 0.8|PB = 0.8|M = 0.4|
K = 0.1|C = 0|G = 0.26053|
XA_opt / XB_opt
LA
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


LB = 0.5|PA = 0.8|PB = 0.8|M = 0.4|
K = 0.1|C = 0|G = 0.26053|
PA_opt / PB_opt
LA
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


LB = 0.5|PA = 0.8|PB = 0.8|M = 0.4|
K = 0.1|C = 0|G = 0.26053|
QA_opt / QB_opt
LA
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


LB = 0.5|PA = 0.8|PB = 0.8|M = 0.4|
K = 0.1|C = 0|G = 0.26053|
FA_opt / FB_opt
LA
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1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K = 0.1|C = 0|G = 0.26053|
FA_revopt / FB_revopt
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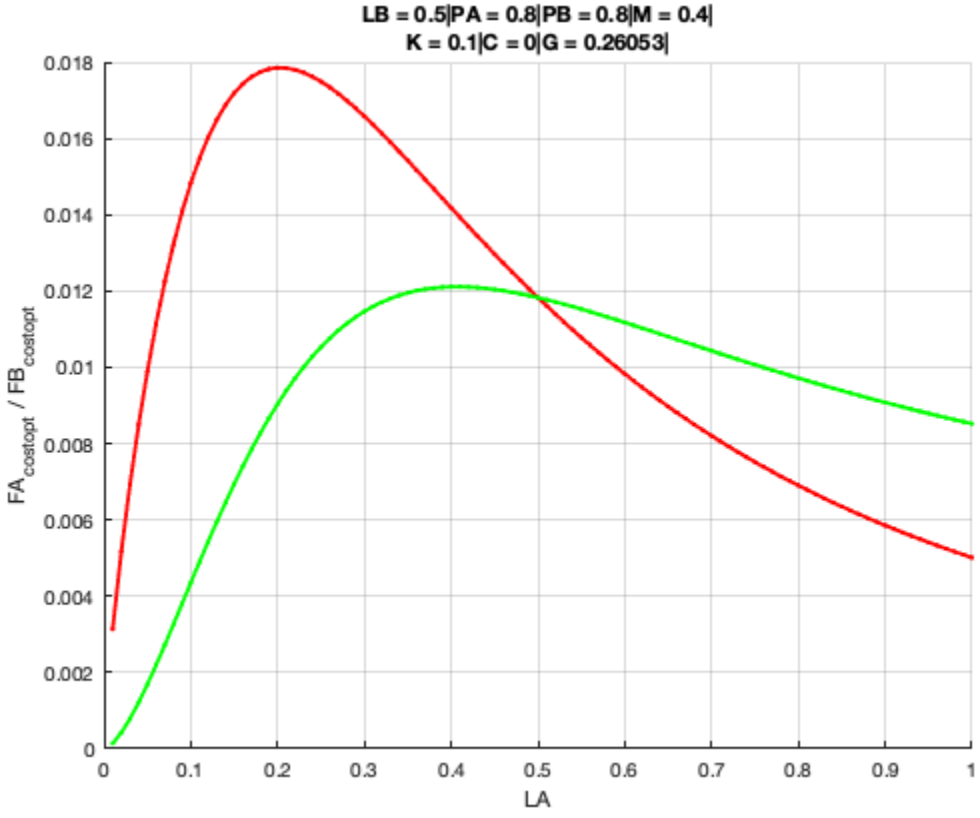
0.05
0.1
0.15
0.2
0.25
0.3
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


LB = 0.5|PA = 0.8|PB = 0.8|M = 0.4|
K = 0.1|C = 0|G = 0.26053|
FA_costopt / FB_costopt
LA
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

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