```
% 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 all
```

```
% 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 = 5;

% Parameter #1
LA_MIN = 0.25;
LA_MAX = 0.25;
LA_STEP = 0.01;
% Parameter #2
LB_MIN = 0.25;
LB_MAX = 0.25;
LB_STEP = 0.01;
% Parameter #3
PA_MIN = 0.20;
PA_MAX = 0.20;
PA_STEP = 0.01;
% Parameter #4
PB_MIN = 0.20;
PB_MAX = 0.20;
PB_STEP = 0.01;
% Parameter #5
M_MIN = 0.0;
M_MAX = 1.0;
M_STEP = 0.01;
% Parameter #6
K_MIN = 0.2;
K_MAX = 0.2;
K_STEP = 0.01;
% Parameter #7
C_MIN = 0.0001;
C_MAX = 0.0001;
C_STEP = 0.00001;
% Parameter #8 (G or Gamma!!!)
G_MIN = 0.2;
G_MAX = 0.2;
G_STEP = 0.01;

% 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 = 50;
% 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-10;
% Set the maximum number of iterations to be conducted by the
 optimizer.
MaxIterations = 1000;
% Set the maximum number of function evaluations to be conducted by
 the
% optimizer.
MaxFunctionEvaluations = 10000;

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,Tolerance,FvalsTolerance,DerivativeTol
                                    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))]);
                                    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
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.
plot_parameters_tuples(Topts,Sopts,Xopts,Popts,Qopts,Fopts,Params,ParamIndex,Const

Grid Evaluation Process in Progess...
M = 0 TAopt = 0.314903 TBopt = 0.314903 FilterFlag = 0 DigitsAccuracy
 = 11
M = 0.01 TAopt = 0.315105 TBopt = 0.315105 FilterFlag = 0
 DigitsAccuracy = 12
M = 0.02 TAopt = 0.315318 TBopt = 0.315318 FilterFlag = 0
 DigitsAccuracy = 13
```

```
M = 0.03 TAopt = 0.315543 TBopt = 0.315543 FilterFlag = 0
 DigitsAccuracy = 13
M = 0.04 TAopt = 0.315779 TBopt = 0.315779 FilterFlag = 0
 DigitsAccuracy = 9
M = 0.05 TAopt = 0.316027 TBopt = 0.316027 FilterFlag = 0
 DigitsAccuracy = 14
M = 0.06 TAopt = 0.316286 TBopt = 0.316286 FilterFlag = 0
 DigitsAccuracy = 12
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 DigitsAccuracy = 13
M = 0.09 TAopt = 0.317132 TBopt = 0.317132 FilterFlag = 0
 DigitsAccuracy = 13
M = 0.1 TAopt = 0.317437 TBopt = 0.317437 FilterFlag = 0
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M = 0.11 TAopt = 0.317754 TBopt = 0.317754 FilterFlag = 0
 DigitsAccuracy = 13
M = 0.12 TAopt = 0.318082 TBopt = 0.318082 FilterFlag = 0
 DigitsAccuracy = 13
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 DigitsAccuracy = 11
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M = 0.21 TAopt = 0.321579 TBopt = 0.321579 FilterFlag = 0
 DigitsAccuracy = 11
M = 0.22 TAopt = 0.322029 TBopt = 0.322029 FilterFlag = 0
 DigitsAccuracy = 9
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 DigitsAccuracy = 12
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 DigitsAccuracy = 13
M = 0.25 TAopt = 0.323454 TBopt = 0.323454 FilterFlag = 0
 DigitsAccuracy = 11
M = 0.26 TAopt = 0.323955 TBopt = 0.323955 FilterFlag = 0
 DigitsAccuracy = 10
M = 0.27 TAopt = 0.324468 TBopt = 0.324468 FilterFlag = 0
 DigitsAccuracy = 10
M = 0.28 TAopt = 0.324995 TBopt = 0.324995 FilterFlag = 0
 DigitsAccuracy = 11
M = 0.29 TAopt = 0.325535 TBopt = 0.325535 FilterFlag = 0
 DigitsAccuracy = 12
```

```
M = 0.3 TAopt = 0.326088 TBopt = 0.326088 FilterFlag = 0
 DigitsAccuracy = 14
M = 0.31 TAopt = 0.326654 TBopt = 0.326654 FilterFlag = 0
 DigitsAccuracy = 10
M = 0.32 TAopt = 0.327234 TBopt = 0.327234 FilterFlag = 0
 DigitsAccuracy = 10
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 DigitsAccuracy = 12
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M = 0.5 TAopt = 0.340150 TBopt = 0.340150 FilterFlag = 0
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 DigitsAccuracy = 11
M = 0.52 TAopt = 0.341899 TBopt = 0.341899 FilterFlag = 0
 DigitsAccuracy = 12
M = 0.53 TAopt = 0.342799 TBopt = 0.342799 FilterFlag = 0
 DigitsAccuracy = 12
M = 0.54 TAopt = 0.343717 TBopt = 0.343717 FilterFlag = 0
 DigitsAccuracy = 12
M = 0.55 TAopt = 0.344652 TBopt = 0.344652 FilterFlag = 0
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M = 0.56 TAopt = 0.345605 TBopt = 0.345605 FilterFlag = 0
 DigitsAccuracy = 12
```

```
M = 0.57 TAopt = 0.346576 TBopt = 0.346576 FilterFlag = 0
 DigitsAccuracy = 11
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 DigitsAccuracy = 11
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M = 0.7 TAopt = 0.360986 TBopt = 0.360986 FilterFlag = 0
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M = 0.71 TAopt = 0.362243 TBopt = 0.362243 FilterFlag = 0
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M = 0.77 TAopt = 0.370286 TBopt = 0.370286 FilterFlag = 0
 DigitsAccuracy = 13
M = 0.78 TAopt = 0.371714 TBopt = 0.371714 FilterFlag = 0
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M = 0.79 TAopt = 0.373168 TBopt = 0.373168 FilterFlag = 0
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M = 0.8 TAopt = 0.374649 TBopt = 0.374649 FilterFlag = 0
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M = 0.81 TAopt = 0.376157 TBopt = 0.376157 FilterFlag = 0
 DigitsAccuracy = 13
M = 0.82 TAopt = 0.377694 TBopt = 0.377694 FilterFlag = 0
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M = 0.83 TAopt = 0.379258 TBopt = 0.379258 FilterFlag = 0
 DigitsAccuracy = 12
```

```
M = 0.84 TAopt = 0.380852 TBopt = 0.380852 FilterFlag = 0
 DigitsAccuracy = 11
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 DigitsAccuracy = 12
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 DigitsAccuracy = 11
M = 0.96 TAopt = 0.402478 TBopt = 0.402478 FilterFlag = 0
 DigitsAccuracy = 12
M = 0.97 TAopt = 0.404511 TBopt = 0.404511 FilterFlag = 0
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M = 0.98 TAopt = 0.406584 TBopt = 0.406584 FilterFlag = 0
 DigitsAccuracy = 11
M = 0.99 TAopt = 0.408698 TBopt = 0.408698 FilterFlag = 0
 DigitsAccuracy = 12
M = 1 TAopt = 0.410853 TBopt = 0.410853 FilterFlag = 0 DigitsAccuracy
 = 12
```
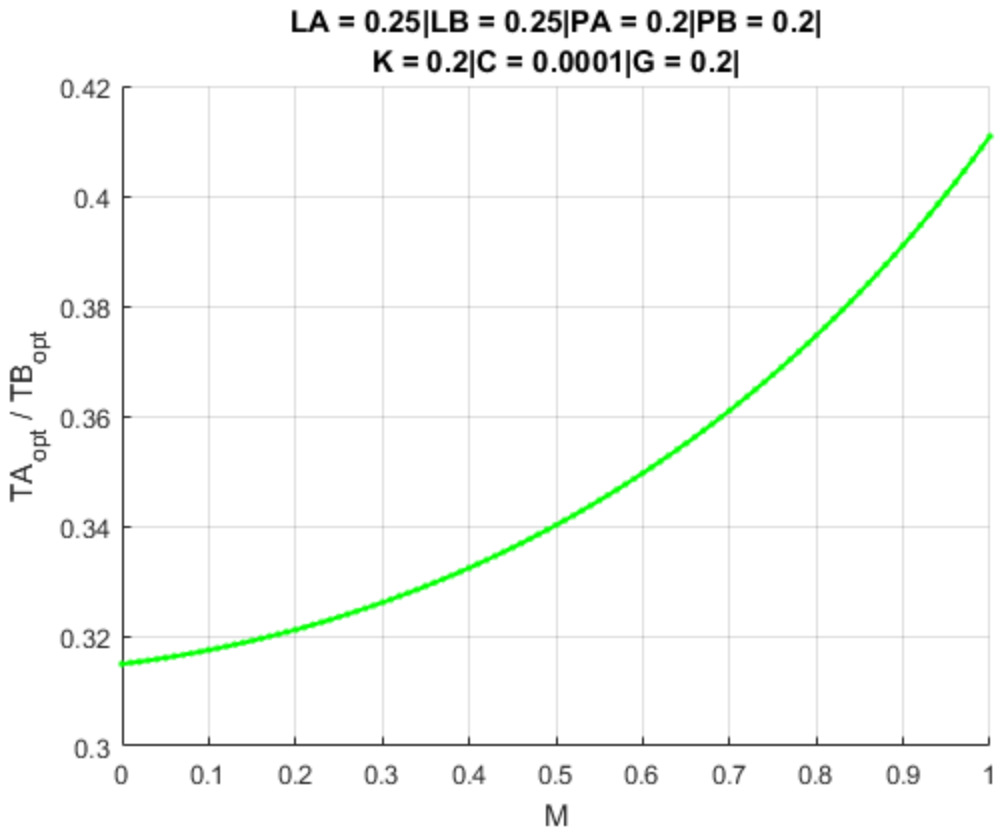
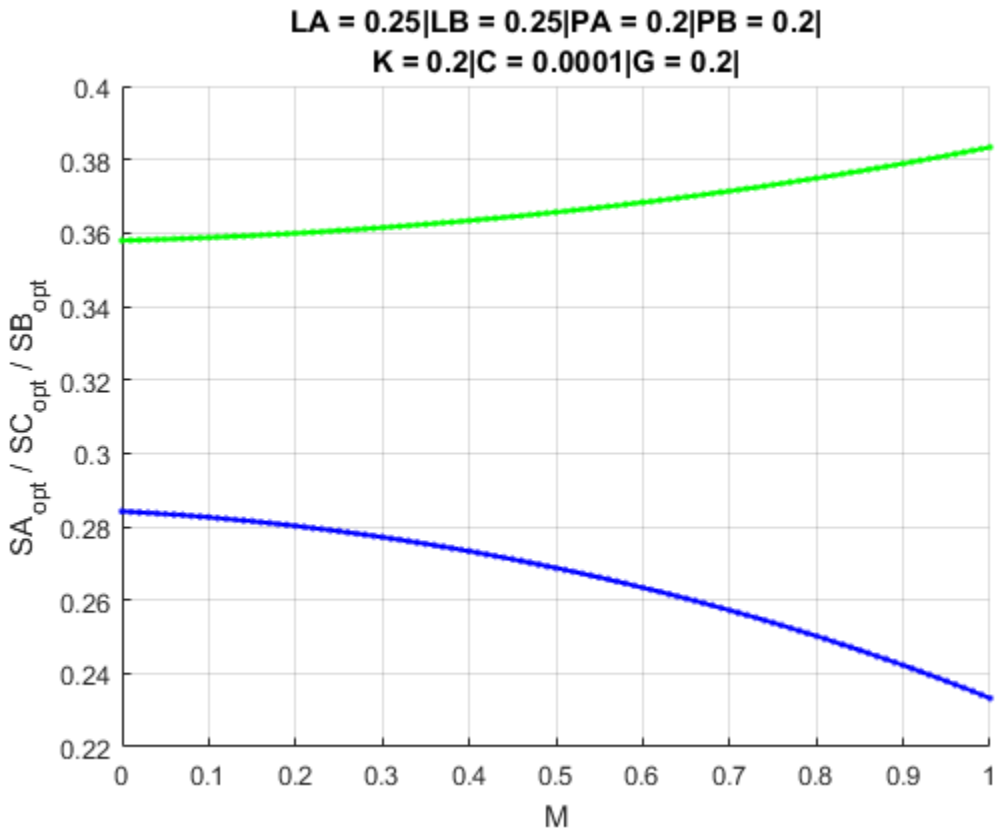
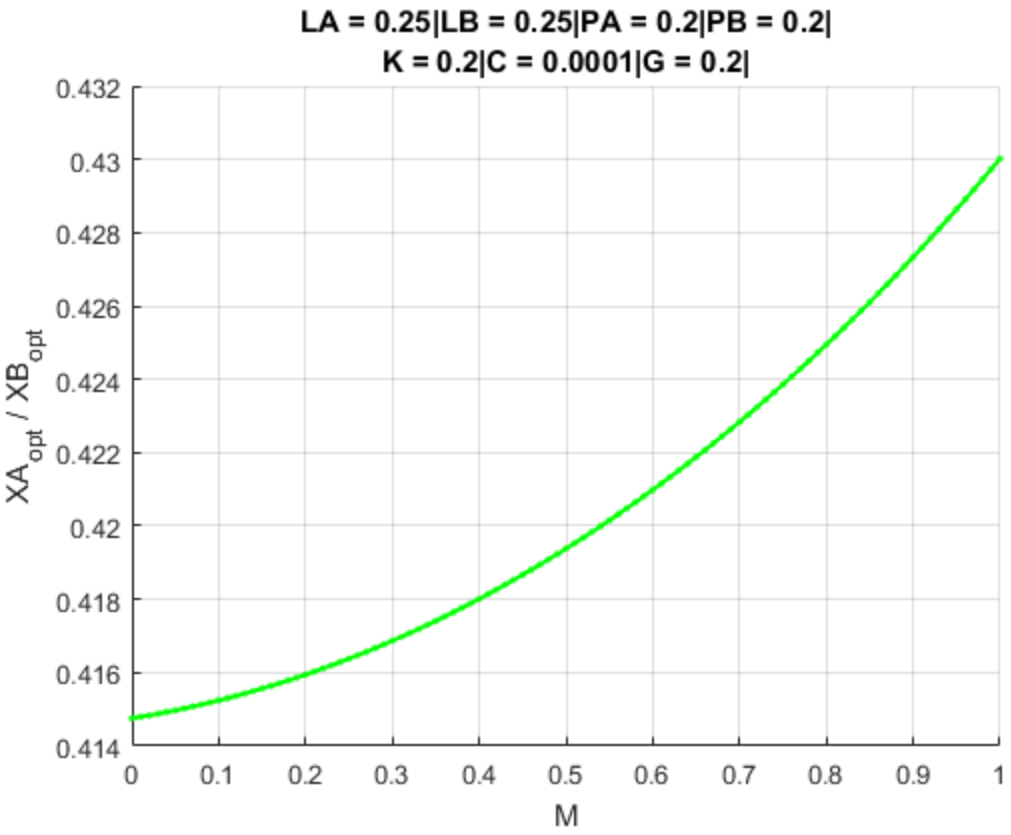
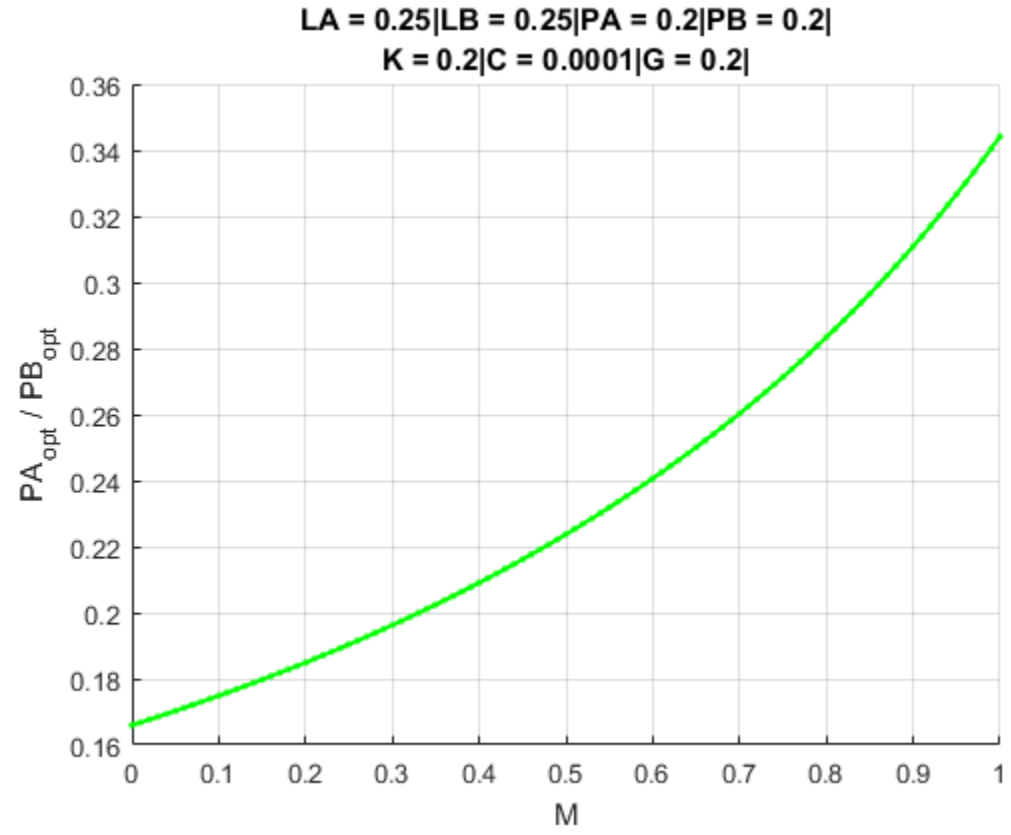
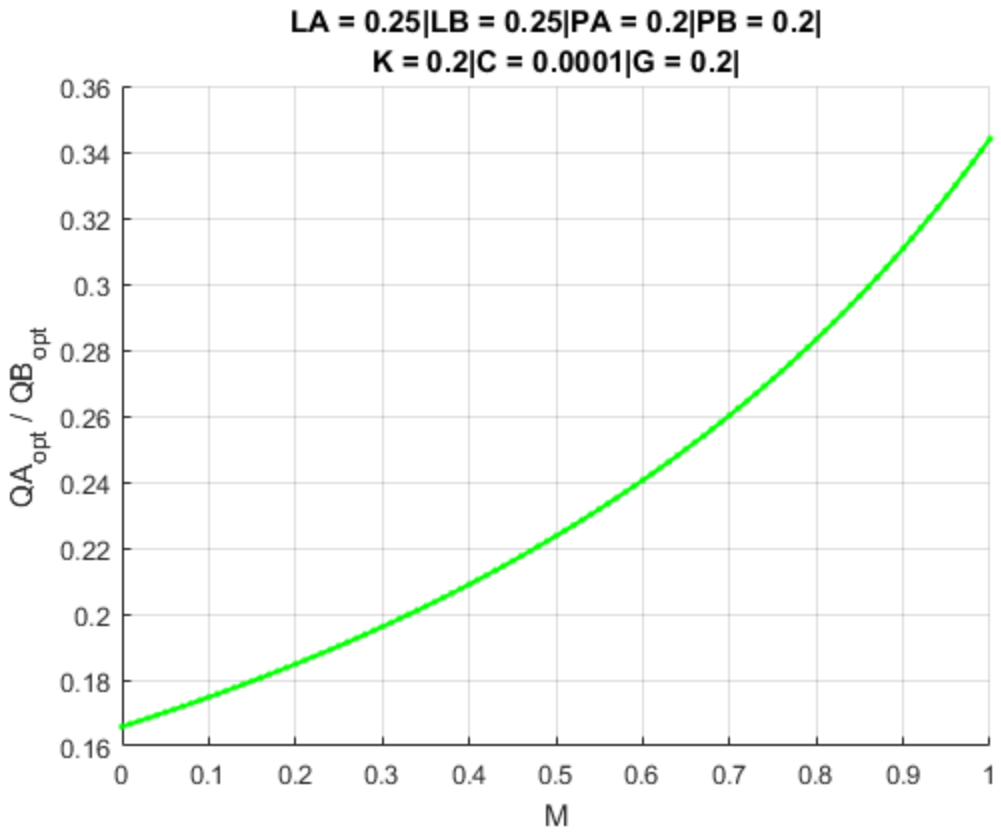
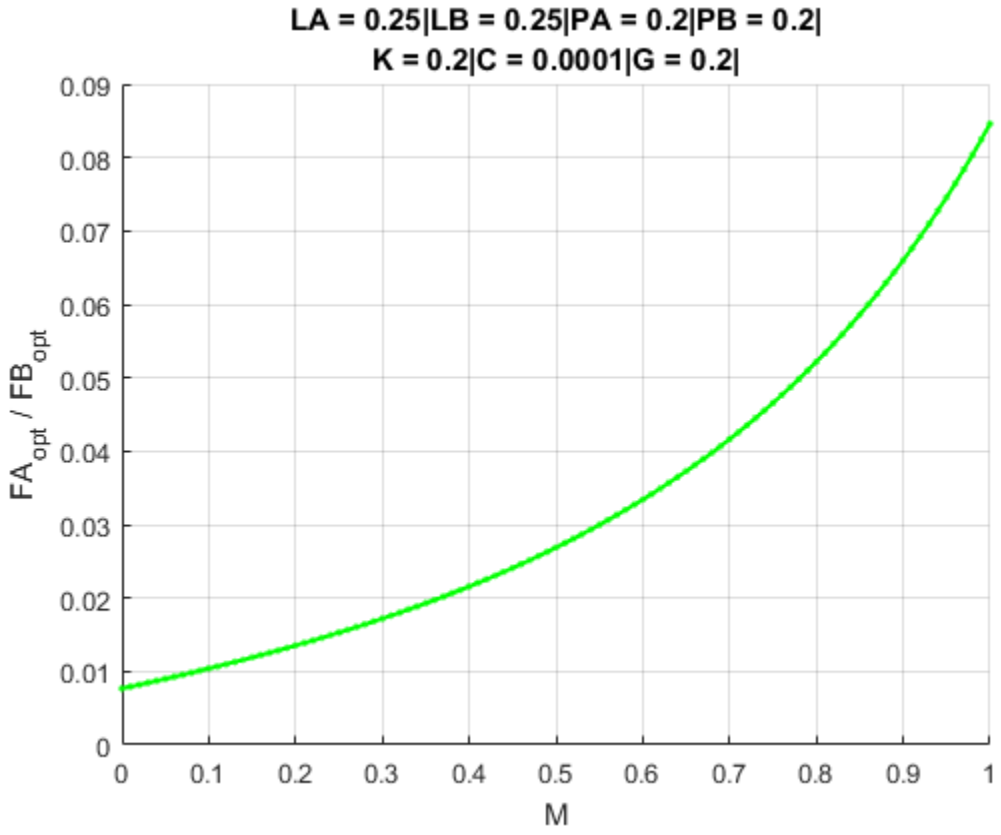


LA = 0.25|LB = 0.25|PA = 0.2|PB = 0.2|
K = 0.2|C = 0.0001|G = 0.2|
TA_opt / TB_opt
M
0.42
0.4
0.38
0.36
0.34
0.32
0.3
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


LA = 0.25|LB = 0.25|PA = 0.2|PB = 0.2|
K = 0.2|C = 0.0001|G = 0.2|
SA_opt / SC_opt / SB_opt
M
0.4
0.38
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


LA = 0.25|LB = 0.25|PA = 0.2|PB = 0.2|
K = 0.2|C = 0.0001|G = 0.2|
XA_opt / XB_opt
M
0.432
0.43
0.428
0.426
0.424
0.422
0.42
0.418
0.416
0.414
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


LA = 0.25|LB = 0.25|PA = 0.2|PB = 0.2|
K = 0.2|C = 0.0001|G = 0.2|
PA_opt / PB_opt
M
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0.18
0.16
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


LA = 0.25|LB = 0.25|PA = 0.2|PB = 0.2|
K = 0.2|C = 0.0001|G = 0.2|
QA_opt / QB_opt
M
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1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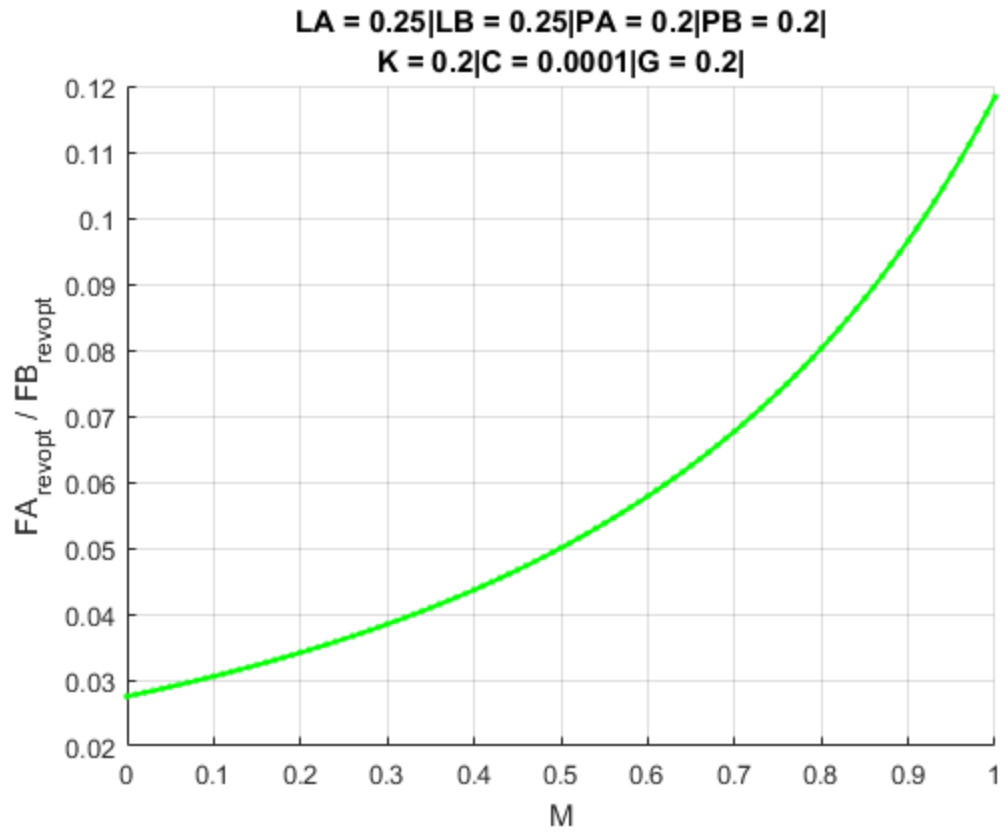
K = 0.2|C = 0.0001|G = 0.2|
FA_opt / FB_opt
M
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1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K = 0.2|C = 0.0001|G = 0.2|
FA_revopt / FB_revopt
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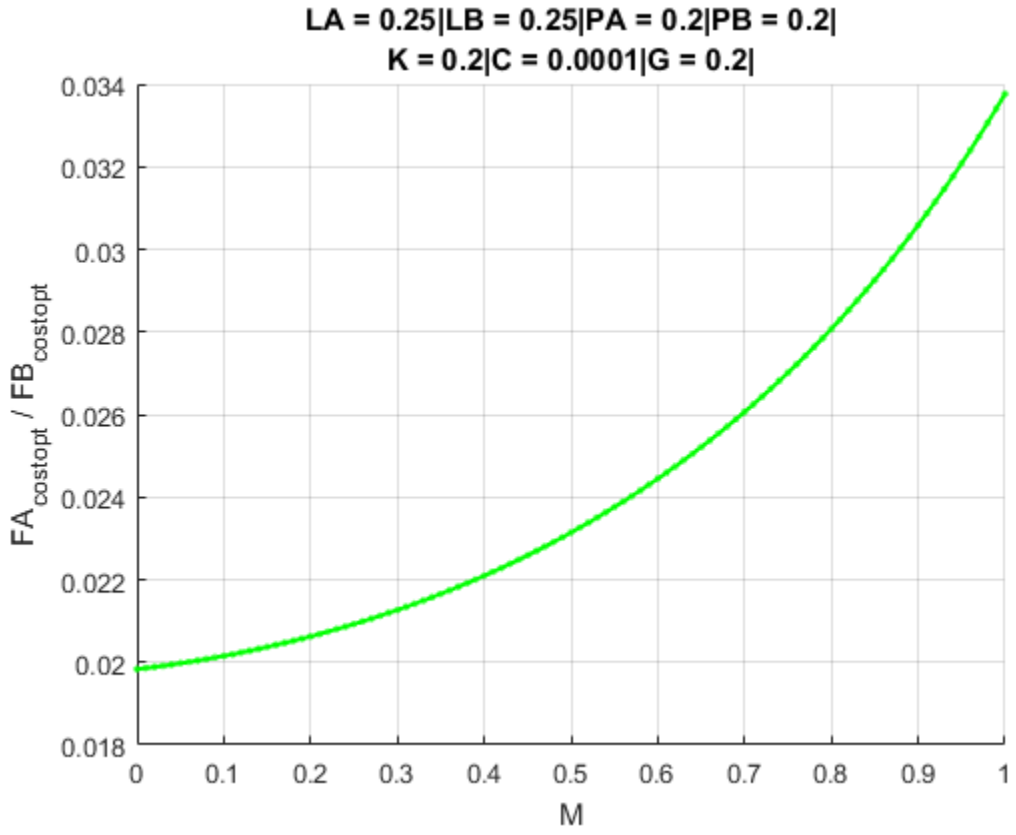
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


LA = 0.25|LB = 0.25|PA = 0.2|PB = 0.2|
K = 0.2|C = 0.0001|G = 0.2|
FA_costopt / FB_costopt
M
0.034
0.032
0.03
0.028
0.026
0.024
0.022
0.02
0.018
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

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