Econ 512 HW 2
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1.
Demand for product A, B and outside option: $D_A = D_B = 0.4223$, $D_0 = 0.1554$.
Program

```
% Define demand function

demand = @(v,p) exp([v-p;0])/sum(exp([v-p;0]));

% Compute demand
v = [2;2];
p = [1;1];
d = demand(v,p);

D_A = d(1) % Demand for product A
D_B = d(2) % Demand for product B
D_0 = d(3) % Demand for outside option
```

2. The starting value used for the Boyden's method is $p_A = p_B = 1$. After running the code, we know that the iteration number is smaller than $maxit$, so in this case, the convergence critia is the norm of the function falls below tol.

The equilibrium price is $p_A = p_B = 1.5989$.
Program

```
v = [2;2];
% Initial guess of p = [p_A;p_B]
p_ini = [1;1];

% Call Broyden
addpath /Users/YinshiG/Desktop/'Econ 512'/Lectures/CEtools

tic % calculate the execution time for comparison in Problem_3
[x,fval,flag,it,fjacinv] = broyden(@(p) bertrand_foc(p,v),p_ini);
T_boyden = toc;

% Nash pricing equilibrium
p_nash = x
```

3.
During the running of the program, I calculated the execution time of the methods, and it turned out Guass-Seidel method (with inner secant method) was quicker than Boyden's method. This may due to the inverse matrix calculation in Boyden's method.
Program

```
v = [2;2];

p_ini = [1;1];

tic
p_nash2 = gauseid(p_ini, v);
T_gauseid = toc;


% Compare the execution time between Boyden's method and Gauss-Seidel (with Secant
% method in inner iteration)

T_boyden > T_gauseid
```

4. The method converges. The execution time it used was shorter than Boyden's method, and longer than Gauss-Seidel method.
Program

```
v = [2;2];

% Still use Gauss-Seidel method for outer iteration

p_ini = [1;1];

tic
p_nash3 = update(p_ini, v);
T_update = toc;
```

5. Program

```
% Using Boyden's method

v_A = 2;
v_B = 0: .2 : 3;
p_ini = [1;1];
p_A = [];
p_B = [];

for i = 1:length(v_B)
    x = broyden(@(p) bertrand_foc(p,[v_A;v_B(i)]),p_ini);
    p_A(i) = x(1);
    p_B(i) = x(2);
end

plot(v_B, p_A, v_B, p_B);
legend('p_A', 'p_B');
xlabel('v_B');
ylabel('p_A or p_B');
```

Plot