Replication: Berry and Jia 2010 Tracing the Woes

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relevant code used in this file are all uploaded via github link below:
https://github.com/Tli2023/IO_validation_project/tree/main

A brief summary of the paper

Berry and Jia (2010) use avian-data from 8 legacy carriers and lcc(new comers) in 1999 and 2006 trying to provide an answer to a puzzle where they witness air tranportion indsutry booms with increasing profits, but individually, each legacy carriers was going through financial distress.

Berry and Jia's main contribution would be providing a comprehensive structural model, which uses a 1) **BLP demand estimation** (inner loop on market shares and outer loop for other parameters) and 2) **a nested-logit model** for the market share.

Their main findings on the profit losses for legacy carriers are due to the following 3 factors:

1. Consumers prefer direct flight than connecting flights;
2. Consumers are more price sensitive;
3. Supplier side-wise, the cost for connecting flights increases.

Part 1: Replication plan:

In this part, we choose to replicate the main program for year 2006, which is the structural model running BLP estimation based on the consumer utility function, market share function.

In this part, we have 2 loops (fmincon), first stage the inner loop which is the inverted market share function to calculate the unobserved consumer characteristic ξ_{jt}, and in the second stage, we estimated the demand side and supply side paramters with another fmincon.

We included 2 modifications for the code to run:

```
% use fmincon to refine the search
options=optimset('Display','iter','MaxIter',1000,'MaxFunEvals',1000,'GradObj','on',...
    'DiffMinChange',1e-6,'DerivativeCheck','off');
% here we set 'DerivativeCheck','off' to be off, as the fmincon function could not run

mex M40_MkSum.c
% in order for the marker share calculation written in C langauge to be able to run in
```

We now briefly attemps to explain the author's code:

Part 1:

From line 8 to line 57, the authors set up the variables from the data tables;

Part 2:

From line 59 to line 134, the authors set up the IV matrix, calculated the inverse matrix of the demand and supply side iv. We need the variance covariance, inverse of the IV for the GMM objective function;

Part 3:

In this part, the authors run the inner loop (first estimation) inverse market share:

```
[theta, fval,exitflag,output,laglamb,fgrad] = fmincon(@M130_gmmGredMM,theta0,...
    A,b,[],[],lb,ub,[],options,XMat,VM,dM,0)
```

- this is objective function for the inner loop, M130_gmmGredMM is the different modifications the authors have on the model, for example such as including LCCs, delay, grouping 25 airports etc, and it includes both stage of estimations;
- theta0 is the initial value that we assigned for the 1st iteration to run;
- XMat are the independent variables in our estimation; it includes both demand and supply side independent variables;
- A,b are the linear constraints;
- VM are our IVs;
- dM are our refined parameters, including number of markets, total obervations etc.
- 0 means the first estimation

Part 4 and 5 calculated the opitmal weight and the variance of the parameters

Part 6:

From 1st estimation, we obtained the theta(estimated parameters), now we run the IVGMM objective function to obtained the best fitted values:

```
[theta2, fval2,exitflag2,output2,laglamb2,fgrad2] = fmincon(@M130_gmmGredMM,theta,...
    A,b,[],[],lb,ub,[],options,XMat,VM,dM,1)
```

We can see the difference between first stage and second stage are in **theta** and **1**; which calls differently in M130_gmmGredMM.

PS. The replication is shown under the diary file, named as M130_est_tong.txt

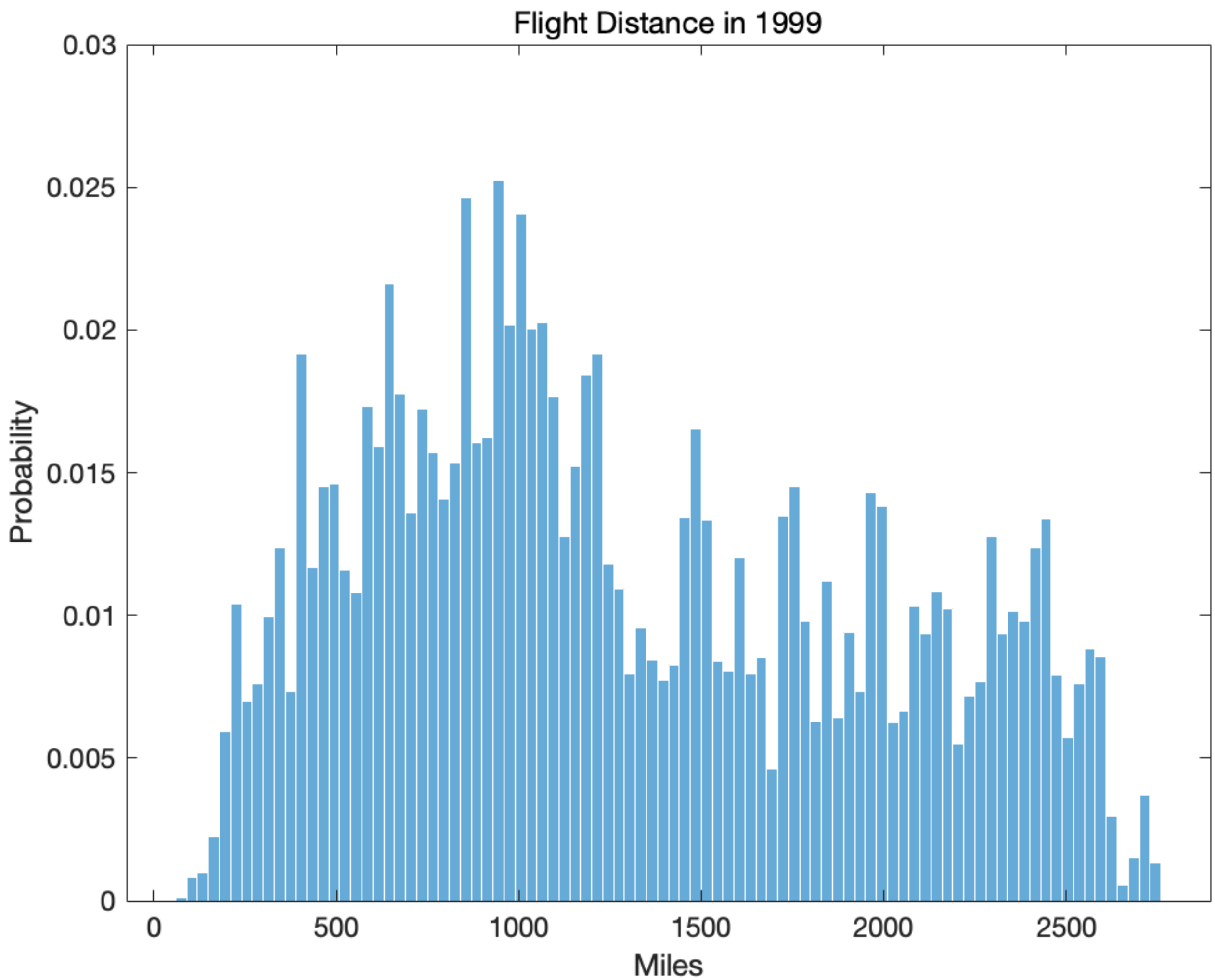
Part 2a: modification on demand relative to flight distance:

The authors assumed the demand is decreasing with distance, however, we believed that there should be a kinked-demand curve for long distance haul, as there are no substitutes for long distance travel besides flight especially at the year of 1999. Therefore, the demand should be increasing with distance passing a certain benchmark.

To be more explict, for short to medium haul flights, the American consumers could still prefer self-drive or railroads. However, if we have longer distance flight, such as more than 2500 mi (at least more than 24 hours of driving from LA to Boston), then the business type of consumer has no choice but to fly, implying an inelasticity of demand.

We first would like to know the flights that are more than 2500mi:

```
load P130_MkDist data
% distribution of the flight distance:
figure
histogram(distanceproduct, 'Normalization', 'probability', 'EdgeColor', 'white');
title('Flight Distance in 1999');
xlabel('Miles');
ylabel('Probability');
```



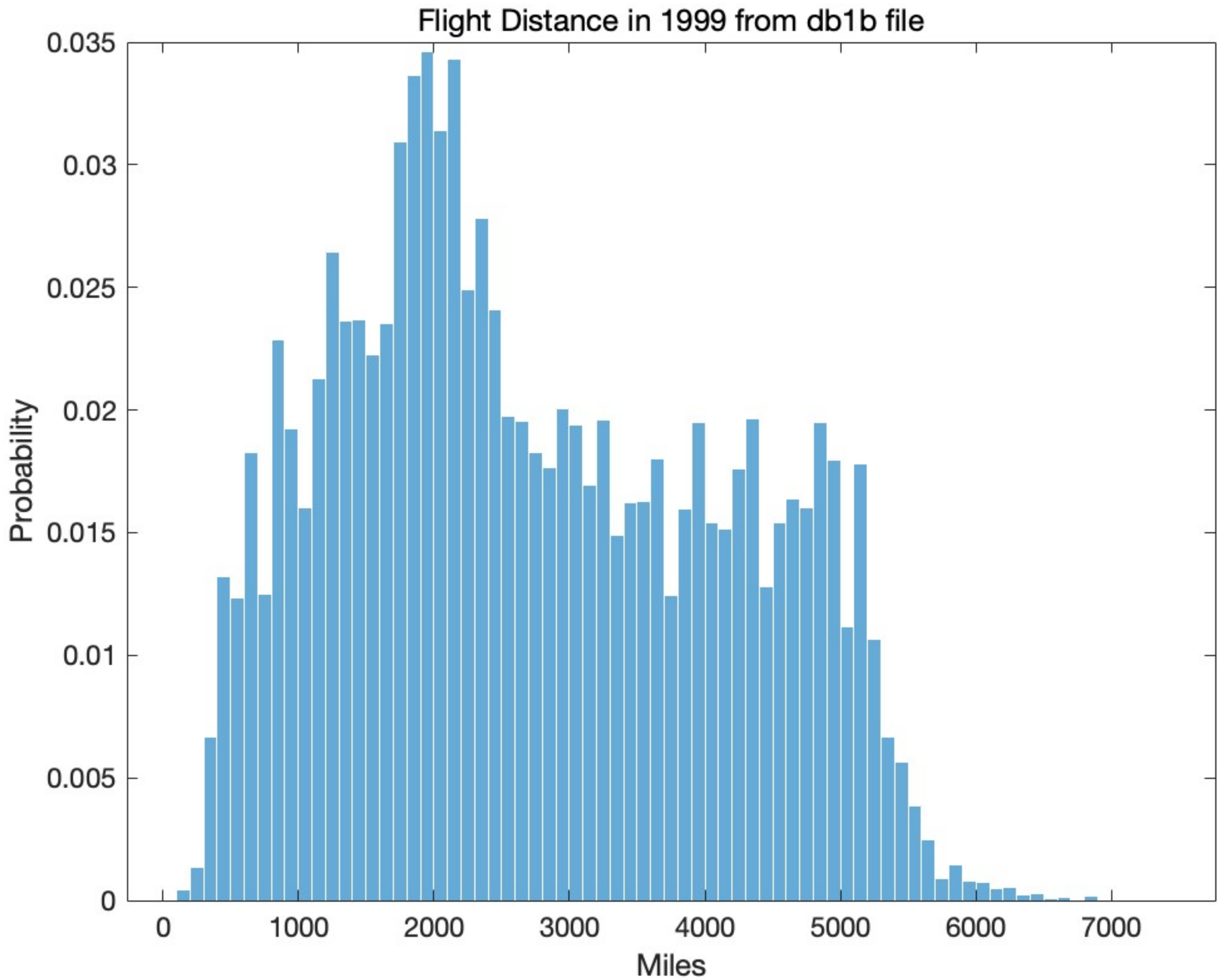
We could see indeed from the histogram distribution that this does not look alike an unimodal distribution, which confirms our guess of an existence of a kinked demand.

We make several concessions to test this change in assumption. First, we face a data constraint. The given data are already processed by the authors and they have deliberately removed the precise product characteristics, we do not know the destination, place of transit, and departure of the flight nor flight time.

Not being able to distinguish the transiting flight at the flight distance file does cause a problem on the inelasticity of demand assumption. A consumer taking a transit flight could include 2 facts: 1) they are price sensitive, 2) the direct flight distance may be too long (imagine flying from Hawaii to Alaska, 3000mi), so the carrier provider would offer connecting flight for increasing the depature time and arrival time variety.

The largest flight distance, as we can see from the table would be aproximately 2700mi. Farely speaking, as the authors have removed international flights in their assumption, the inelastic demand assumption is weaking tested in our modification.

The change in assumption would be tested simply if we are able to have the flying time data.



Secondly, we are not able to filtered the product characteristics file(db1b data file), but only the flight distance file, as by filtering the data, we ended up having difference dimension of estimation, which causes problem at fmincon function and IV invertion. The authors did not provide detailed explaination on why db1b and market product file have differences in distance for the same product.

Our solution would be testing 2 dummies: medium long haul be flight distance between 1500-2500mi; and long haul be more than 2500mi;

```
load P130_MkDist data
distanceproduct = data(:,2);
LgDist = distanceproduct >= 1500 & distanceproduct < 2500;
LLgDist = distanceproduct >=2500;
uproduct = unique(data(LLgDist, 1));
numbuproduct = numel(uproduct);
% We have 8682 unique products that have more than 2500 mi of flights;
```

Our modification now applies to the P130 file:

```
%our set of X now includes 2 extra terms that measures variations of distance on price:
XMat=[dist,dist2,dist.*LgDist,dist.*LLgDist...];
% Demand IV
Iv1=[..., dist.*LgDist,dist.*LLgDist]
% Supply IV
IV2=[...,...
    ones(nobs,1).*LgDist,dist.*LgDist,nconn.*LgDist,...
    ones(nobs,1).*LLgDist, dist.*LLgDist, nconn.*LLgDist];
```

we changed the supply side iv, LgDist is the medium long haul, and LLgDist is the haul over 2500mi and we added 2 interactive term between distance and long-hauls.

The results are stated as follows:

	parameters	standard deviation
fare traveler	-0.49579	0.0047782
traveler connection	-0.47541	0.0075125
traveler constant	-7.2677	0.10471
fare business	-0.055493	0.00059408
business connection	-0.35955	0.0076531
business constant	-8.7049	0.14501

Our assumption that demand is inelastic with distance for business consumer, is approximated true. As we find the business consumer's elasticity of demand does fall in between 0 and 1 |-0.055493|, and this is statistically significant. Notice that the original model finds |-0.07|, is also inelastic in increase in fare, but with distance we do see the inelasticness increases with distance;

Furthermore, when we see the parameters for distance:

	parameters	standard deviation
Distance	0.23122	0.039485
Distance squared	-0.065983	0.008577
Distance x 1500mi-2500mi	0.072326	0.011547

	parameters	standard deviation
Distance x 2500mi and above	0.097409	0.019231

Compared to the original model, where distance and distance squared are 0.3 and -0.05 respectively, our modification shows that the elasticity does reduce with distance.

Furthermore, by looking at the specific interactive terms, we do find the demand is increasing with distance, this confirms our hypothesis of the existance of kinked demand for long-haul flights which have no substitute.

The complete modification is shown under the diary file: P130_distance.txt on github.

Part 2b: modification on the nested logit model:

One of the major assumption would be the nested-logit model, we will try to break this assumption by assuming when $\lambda = 1$ in the market share equation, which deduced the model into a multinominal logit.

```
% we first modify the market share equation, which set lambda = 1
function sH=M75_sh(dM)
lamb=1;
grpsh=(tsum.^lamb)./(1+tsum.^lamb);
```

We are not able to fully remove lambda from all estimation, as the fmincon will be reporting errors

Futhermore, we set all functions under that could be called under @M130_gmmGredMM with dM.lambda=1;

	logit parameters	standard deviation
fare traveler	-0.57503	0.020271
traveler connection	-0.90787	0.019941
traveler constant	-8.057	0.090243
fare business	-0.084046	0.0021379
business connection	-0.43188	0.0084406
business constant	-8.7977	0.064208

We confirm that the author's finding on change in demand side is robust under a multinominal logit, as we do see an aversion towards connecting flights for both types of consumers and they are have been sensitive to price changes. The detailed modification can read through the diary file: M130_est_logit_modification.txt