

Detailed Experimental Setup and Results for multi-producte learning Framework

1 Experiment Setup and Policies

The table below shows the case when product number is 2.

Demand Model	Param Set 1	Param Set2	Noise
$A - B \cdot P$	$A = \begin{pmatrix} 0.76 \\ 0.76 \end{pmatrix} B = \begin{pmatrix} 0.05 & 0.01 \\ 0.01 & 0.04 \end{pmatrix}$	$A = \begin{pmatrix} 0.8 \\ 0.92 \end{pmatrix} B = \begin{pmatrix} 0.05 & 0.01 \\ 0.01 & 0.04 \end{pmatrix}$	$\mathcal{N}(0, 5 \times 10^{-3})$
$\frac{\exp(a_i - b_i p_i)}{1 + \sum_{j=1}^2 \exp(a_j - b_j p_j)}$	$\begin{pmatrix} a_1 & a_2 \\ b_1 & b_2 \end{pmatrix} = \begin{pmatrix} 1 & 2 \\ 0.2 & 0.35 \end{pmatrix}$	$\begin{pmatrix} a_1 & a_2 \\ b_1 & b_2 \end{pmatrix} = \begin{pmatrix} 1 & 2.5 \\ 0.6 & 0.3 \end{pmatrix}$	$\mathcal{N}(0, 10^{-5})$

The table below shows the case when product number is 5, 10. The price range is assumed to be uniformly distributed $[50, 100]$ and the cost range is assumed to be uniformly distributed $[10, 20]$.

The noise for each demand $\eta_{it} \sim \mathcal{N}(0, 0.004)$.

Scenario	$\beta_{ij}(i \neq j)$	β_{ii}
Low Price	$\mathcal{U}(-0.5, 0)$	$\mathcal{U}(-1, -0.5)$
High Price	$\mathcal{U}(0, 0.5)$	$\mathcal{U}(-2, -1.5)$

The policies and parameters we use for the policy are listed below.

Table 1: Policy with Pamameter Settings for different models

Model Name (No.)	Description	Parameter
Ordinary(1)	Linear estimation model as the benchmark	-
Pes-Ordinary(2)	Linear estimation model with pessimistic bias	$\tau = \frac{2d}{d+1}$
Opt-Ordinary(3)	Linear estimation model with optimistic bias	$\tau = \frac{2}{d}$
JERO-Ordinary(4)	Linear estimation model with robustness	$losspercent = 0.1$
MF-Revenue(5)	NN with relu active-function for model-free revenue	2 layers (10 Hidden Nodes)
MF-Demand(6)	NN with sigmoid active-function for model-free demand	1 layers for each demand
Mix-Demand1(7)	Model in Section IV.A. with MF-Revenue	$\lambda = 0.1, 0.001$
Mix-Demand2(8)	Model in Section IV.A. with MF-Demand	$\lambda = 0.1$
Mix-Revenue1(9)	Model in Section IV.B. with MF-Revenue	$\mu = 1, 10$
Mix-Revenue2(10)	Model in Section IV.B. with MF-Demand	$\mu = 0.5$

2 Full Experimental Results

2.1 Revenue Performance

Table 2: Policy-Best Revenue of each model for model-free demand learning (2 Products, Well-specified 1)

sample numbers	1	2	3	4	5	6	7	8	9	10
10	5.320	5.328	5.307	5.285	2.964	4.200	3.958	5.306	5.295	4.209
20	5.326	5.307	5.317	5.305	3.074	4.273	4.351	5.307	5.314	4.268
30	5.317	5.310	5.316	5.294	3.123	4.201	4.629	5.308	5.308	4.199
50	5.318	5.312	5.319	5.302	3.871	4.245	4.442	5.300	5.318	4.237

Table 3: Policy-Best Revenue of each model for demand and revenue learning (2 Products, Well-specified 2)

sample numbers	1	2	3	4	5	6	7	8	9	10
10	6.997	6.963	6.971	6.996	3.396	6.193	5.948	6.982	6.993	6.200
20	6.997	6.964	6.973	7.004	5.180	6.207	5.659	6.986	6.992	6.201
30	7.000	6.969	7.001	7.006	6.279	6.206	5.839	6.975	6.992	6.202
50	7.002	6.958	6.992	6.992	4.925	6.195	5.721	6.988	6.996	6.192

Table 4: Policy-Best Revenue of each model for demand and revenue learning (2 Products, Mis-specified 1)

sample numbers	1	2	3	4	5	6	7	8	9	10
10	3.959	4.076	3.948	3.942	1.837	3.564	3.806	3.957	3.973	3.618
20	4.017	4.072	3.796	3.972	2.339	3.746	3.981	4.011	4.017	3.763
30	3.943	4.062	3.905	3.994	2.332	3.714	3.882	3.949	3.954	3.720
50	3.817	3.961	3.735	3.890	2.913	3.679	3.782	3.816	3.813	3.722

Table 5: Policy-Best Revenue of each model for demand and revenue learning (2 Products, Mis-specified 2)

sample numbers	1	2	3	4	5	6	7	8	9	10
10	4.120	3.760	3.801	4.109	2.409	3.676	4.045	4.077	4.119	3.676
20	4.130	4.185	3.801	4.235	2.329	3.799	3.844	4.077	4.138	3.811
30	4.163	4.139	3.801	4.223	2.380	3.426	3.983	4.104	4.140	3.426
50	4.140	4.155	3.801	4.170	3.270	3.676	4.155	4.039	4.069	3.676

Table 6: Policy-Best Revenue of each model for demand and revenue learning (5 Products, Well-specified)

sample numbers	1	2	3	4	5	6	7	8	9	10
50	62.904	62.721	62.904	61.606	56.758	49.316	62.191	59.299	61.101	54.889
100	60.391	59.887	60.438	59.085	52.361	45.280	59.587	55.231	59.458	49.324
150	52.082	50.896	51.730	50.129	44.060	32.893	51.472	46.196	51.339	40.370
200	54.676	54.510	54.652	53.046	45.353	39.798	54.120	47.365	54.004	46.113

Table 7: Policy-Best Revenue of each model for demand and revenue learning (5 Products, Mis-specified)

sample numbers	1	2	3	4	5	6	7	8	9	10
50	44.638	45.286	52.168	45.505	46.620	42.557	40.763	44.819	45.004	40.667
100	49.936	44.237	49.826	46.214	48.677	49.750	42.183	49.602	51.910	46.407
150	45.951	41.329	43.160	41.558	51.749	44.821	42.559	45.746	49.978	43.435
200	46.115	45.907	46.799	47.440	48.743	47.123	49.819	46.202	45.594	45.057

Table 8: Policy-Best Revenue of each model for demand and revenue learning (10 Products, Well-specified)

sample numbers	1	2	3	4	5	6	7	8	9	10
50	66.992	65.564	66.981	65.583	57.875	46.202	64.272	62.666	64.325	51.738
100	64.840	62.563	64.752	63.120	54.893	48.047	62.616	59.547	62.278	52.979
150	69.163	68.022	68.657	67.808	63.210	49.969	65.992	60.459	68.336	55.763
200	62.700	60.544	62.304	60.919	50.734	42.867	60.408	53.716	60.595	47.792

Table 9: Policy-Best Revenue of each model for demand and revenue learning (10 Products, Mis-specified)

sample numbers	1	2	3	4	5	6	7	8	9	10
50	53.956	49.615	60.041	53.908	50.234	76.593	51.486	57.587	55.049	51.898
100	52.650	56.219	57.281	57.998	50.338	69.344	55.141	56.472	54.151	53.025
150	52.048	51.341	52.082	51.543	47.897	74.727	54.414	60.249	54.900	54.038
200	53.978	43.579	49.891	48.502	48.246	64.116	59.719	55.073	58.189	49.196

2.1.1 RMSE Performance

Table 10: RMSE of each model for demand and revenue learning (2 Products, Well-specified 1)

sample numbers	1	5	6	7	9
10	0.058	1.045	1.227	1.264	0.104
20	0.049	0.526	1.110	1.055	0.098
30	0.058	0.728	1.200	0.922	0.110
50	0.046	0.313	1.269	1.012	0.105

Table 11: RMSE of each model for demand and revenue learning (2 Products, Well-specified 2)

sample numbers	1	5	6	7	9
10	0.321	0.994	0.823	0.511	0.347
20	0.207	1.073	0.909	0.581	0.234
30	0.217	0.893	0.708	0.385	0.257
50	0.191	0.314	1.102	0.186	0.203

Table 12: RMSE of each model for demand and revenue learning (2 Products, Mis-specified 1)

sample numbers	1	5	6	7	9
10	0.315	1.201	0.769	0.923	0.286
20	0.198	0.844	0.596	0.695	0.179
30	0.214	0.761	1.163	0.724	0.204
50	0.401	0.607	0.654	0.693	0.367

Table 13: RMSE of each model for demand and revenue learning (2 Products, Mis-specified 2)

sample numbers	1	5	6	7	9
10	0.321	0.994	0.823	0.511	0.347
20	0.207	1.073	0.909	0.581	0.234
30	0.217	0.893	0.708	0.385	0.257
50	0.191	0.314	1.102	0.186	0.203

Table 14: RMSE of each model for demand and revenue learning (5 Products, Well-specified)

sample numbers	1	5	6	7	9
50	0.741	2.675	7.262	1.817	3.404
100	0.815	1.845	7.418	1.669	3.226
150	1.284	1.805	9.549	2.270	4.430
200	0.913	1.473	10.483	2.036	4.685

Table 15: RMSE of each model for demand and revenue learning (5 Products, Mis-specified)

sample numbers	1	5	6	7	9
50	4.940	5.830	7.804	7.272	4.874
100	4.246	3.846	7.732	7.161	4.214
150	4.399	3.845	6.442	7.572	4.391
200	4.529	3.551	5.566	6.518	4.473

Table 16: RMSE of each model for demand and revenue learning (10 Products, Well-specified)

sample numbers	1	5	6	7	9
50	1.184	2.871	9.166	3.398	4.247
100	1.067	2.109	14.486	3.120	6.731
150	1.206	1.903	18.712	3.474	8.637
200	1.403	1.740	23.686	3.489	11.282

Table 17: RMSE of each model for demand and revenue learning (10 Products, Mis-specified)

sample numbers	1	5	6	7	9
50	6.003	7.316	6.489	9.391	5.882
100	5.268	5.919	5.856	7.886	5.202
150	5.099	5.332	4.926	7.674	5.004
200	5.714	5.826	5.374	8.893	5.690