Module 03 – Production Modeling

Exploratory Data Analysis

In this section, you should perform some data analysis on the data provided to you. Please format your findings in a visually pleasing way and please be sure to include these cuts:

- *Make a table of average demand, production capacity, and costs for each quarter, are there differences between quarters?*
- *Since we have temporal data (i.e. year and quarter), see if you can make a yearly and/or quarterly chart showing these metrics over time.*

Row Labels	Average of demanc	Average of prodi	Average of capacity
2000	478.285	50.5325	507.905
2001	381.945	50.535	536.22
2002	404.6175	45.7	524.6475
2003	365.7	49.5775	483.32
2004	405.615	48.8825	551.7575
2005	475.2775	51.0525	496.9425
2006	409.945	53.5025	546.98
2007	526.3675	49.3075	513.8225
2008	375.9175	52.5425	522.8675
2009	368.8325	47.4075	523.6175
2010	394.6575	50.3425	495.2725
2011	359.5275	49.78	543.485
2012	477.3125	50.8175	510.61
2013	469.69	52.43	518.3375
2014	419.475	44.8275	498.36
2015	389.2075	46.2875	560.845
2016	439.635	47.44	518.145
2017	509.835	52.94	543.6575
2018	511.6125	51.4425	539.8075
2019	356.905	52.205	509.8525
2020	463.075	48.765	529.2475
2021	473.74	45.26	457.2175
2022	428.8175	46.615	535.2525
2023	344.01	53.1025	541.8225
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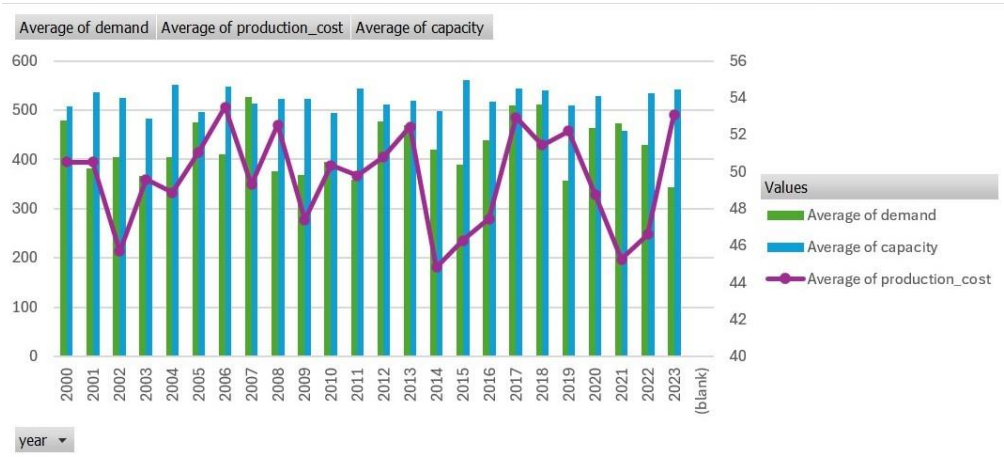
Grand Total	**426.2501042**	**49.63729167**	**521.2496875**



Row Labels	Min of capacity	Max of capacity	Min of productic	Max of productic	Min of demand	Max of demand
1	367.7	785.94	37.58	71.83	219.22	611.16
2	353.8	680.51	29.22	69.86	272.93	670.16
3	415.28	717.8	33.91	63.83	256.94	681.74
4	327.72	632.04	39.33	68.8	264.24	809.63
Grand Total	**327.72**	**785.94**	**29.22**	**71.83**	**219.22**	**809.63**

Model Formulation

Write the formulation of the model into here prior to implementing it in your Excel model. Be explicit with the definition of the decision variables, objective function, and constraints

MIN: 51X1 + 51X2 + 47X3 + 49X4 + 1.87(Y1+Y2) + 1.87(Y2+Y3) 1.87(Y3+Y4) 1.87(Y4+Y5)

X1<= 545
X2<= 502
X3<= 541
X4<= 497

37<=Y1
42<=Y2
43<=Y3
49<=Y4

Model Optimized for Cost Reduction

Implement your formulation into Excel and be sure to make it neat. This section should include:

- *A screenshot of your optimized final model (formatted nicely, of course)*
- *A text explanation of what your model is recommending*

The optimized production model aims to minimize total costs by aligning quarterly production with demand while maintaining required safety stock levels. It strategically adjusts production volumes each quarter to balance production costs and inventory holding costs, producing more in lower-cost quarters and reducing production in higher-cost quarters.

Quarter	Capacity	Demand	Safety Stock	Production Cost
1	545	367	37	51
2	502	419	42	51
3	541	433	43	47
4	497	486	49	49

	1	2	3	4
Beginning Inventory	200	37	42	150
Units Produced	204	424	541	385
Units Demanded	367	419	433	486
Ending Inventory	37	42	150	49
Maximum Production	545	502	541	497
Minimum Inventory	37	42	43	49
Average Inventory	120	233	345	217
Unit Production Cost	$ 51.25	$ 51.12	$ 47.27	$ 48.91
Unit Carrying Cost	$ 1.87	$ 1.87	$ 1.87	$ 1.87
Monthly Production Cost	$10,439.56	$21,684.88	$ 25,573.28	$18,815.58
Monthly Carrying Cost	$ 224.77	$ 435.80	$ 645.99	$ 405.14
			Total cost	$78,225.01

Model with Stipulation

Please copy the tab of your original model before continuing with the next part to avoid messing up your original solution. If we remove the production capacity constraint from the model & we removed the carrying cost, what do you think will happen? Try it out and see if it matches your expectation. Try to explain what is happening and talk a bit about fallbacks of models.

Without production capacity constraints and carrying costs, the model tends to concentrate production in the earliest periods, particularly when unit costs are lower. This approach minimizes total production costs by producing as much as possible upfront, without worrying about the financial impact of holding excess inventory.

	1	2	3	4
Beginning Inventory	200	37	-382	-815
Units Produced	204			385
Units Demanded	367	419	433	486
Ending Inventory	37	-382	-815	-917
Maximum Production	545	502	541	497
Minimum Inventory	37	42	43	49
Average Inventory	120	-191	-408	-266
Unit Production Cost	$ 51.25	$ 51.12	$ 47.27	$ 48.91
Unit Carrying Cost				
Monthly Production Cost	$ 10,439.56	$ -	$ -	$ 18,815.58
Monthly Carrying Cost	$ -	$ -	$ -	$ -
			Total cost	$ 29,255.15