Prescriptive Analytics - HW 5

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1. Readings completed

2. The solutions are given below:
   a. Naïve: $F_6 = A_5$
   $= 1{,}390{,}000$

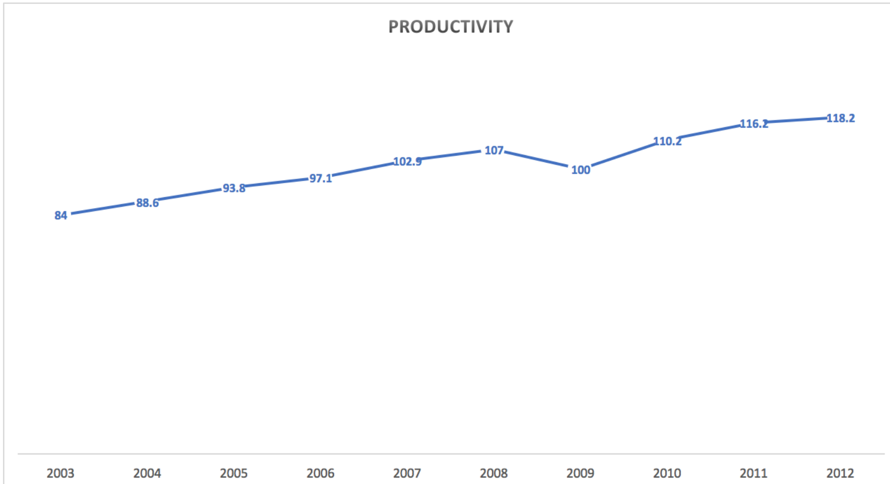
   b. SMA: $F_6 = (A_5+A_4+A_3) / 3$
   $= (1{,}390{,}000 + 1{,}168{,}500 + 1{,}198{,}400) / 3$
   $= 1{,}252{,}300$

   c. WMA: $F_6 = (A_1*0.05)+(A_2*0.1)+(A_3*0.15)+(A_4*0.3)+(A_5*0.4)$
   $= (1{,}356{,}800*0.05) + (1{,}545{,}200*0.1) + (1{,}198{,}400*0.15) + (1{,}168{,}500*0.3) + (1{,}390{,}000*0.4)$
   $= 1{,}308{,}670$

   d. SES: $F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$
   $F_4 = 1{,}146{,}400 + 0.8*(1{,}198{,}400 - 1{,}146{,}400) = 1{,}188{,}000$
   $F_5 = 1{,}188{,}000 + 0.8*(1{,}168{,}500 - 1{,}188{,}000) = 1{,}172{,}400$
   $F_6 = 1{,}172{,}400 + 0.8*(1{,}390{,}000 - 1{,}172{,}400) = 1{,}346{,}480$

3. The solution is as follows:

a. The Excel graph is as follows:



Based on the graph prescribed above, the forecasting method used is the trend of a time series. This is because the graph has a positive, gradual, long-term movement.

b. The table below gives the values for finding *a* and *b*.

t	**At**	**t2**	**tAt**
1	84.0	1	84
2	88.6	4	177.2
3	93.8	9	281.4
4	97.1	16	388.4
5	102.9	25	514.5
6	107.0	36	642
7	100.0	49	700
8	110.2	64	881.6
9	116.2	81	1045.8
10	118.2	100	1182
55	**1018**	**385**	**5896.9**

n = 10

b = [10(5896.9)-55(1018)] / [10(385)-(55)^2]

= 3.6109

a = (1018 - 3.6109*55) / 10

= 81.9401

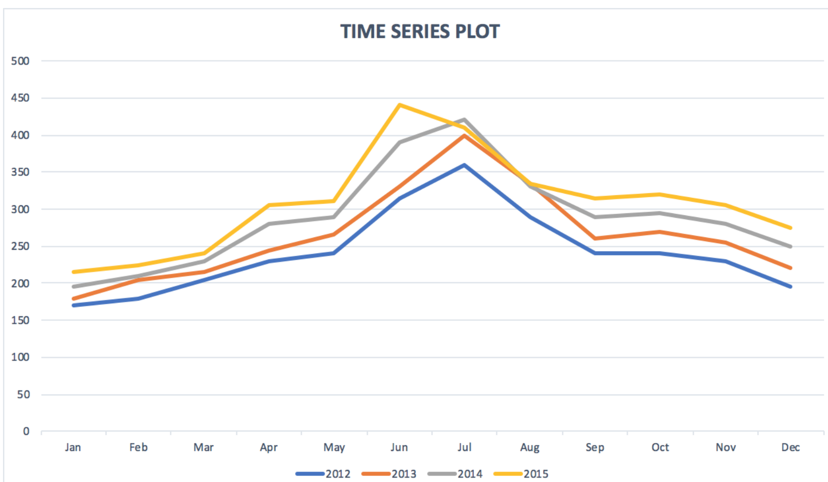
F_{11} (2013) = 81.9401 + 3.6109(11)

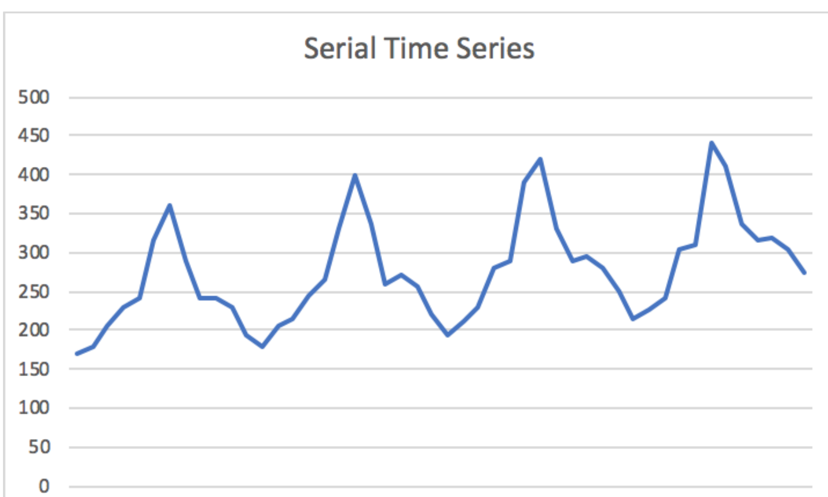
= 121.66

c. The slope tells us the rate at which productivity has been fluctuating from 2003-2012.

4. The solution is as follows:

a. The Excel graphs is as follows:





There are repetitive changes in the forecast from May to September from 2012 - 2015. This is a seasonal pattern. Additionally, there is also a steady increase in the production. This shows an increasing trend pattern.

b. The trend projection method should be used for normal forecasts. For the seasonal increases and decreases, you should use the seasonal index to find the seasonally adjusted forecasts.

c. The trend projections are as follows:

t	At	t2	tAt
1	2895.0	1	2895
2	3180.0	4	6360
3	3460.0	9	10380
4	3695.0	16	14780
10	13230	30	34415

n = 4

b = [4(34415)-10(13230)] / [4(30)-$(10)^2$]

= 268

a = (13230 - 268*10) / 4

= 2,637.5

F_5 (2016) = 2,637.5 + 268(5)

= 3,977.5

d. The seasonally adjusted indexes are given below:

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2012	170	180	205	230	240	315	360	290	240	240	230	195	**2895**
2013	180	205	215	245	265	330	400	335	260	270	255	220	**3180**
2014	195	210	230	280	290	390	420	330	290	295	280	250	**3460**
2015	215	225	240	305	310	440	410	335	315	320	305	275	**3695**
Total	**760**	**820**	**890**	**1060**	**1105**	**1475**	**1590**	**1290**	**1105**	**1125**	**1070**	**940**	**13230**
SI	0.0574	0.0620	0.0673	0.0801	0.0835	0.1115	0.1202	0.0975	0.0835	0.0850	0.0809	0.0711	

2016	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SAF	228.4883	246.5268	267.5718	318.6810	332.2099	443.4477	478.0215	387.8288	332.2099	338.2228	321.6875	282.6039

5. The solution is as follows:

a. Naïve: $F_7 = 5{,}300$

SMA: $F_7 = (5{,}000+4{,}700+5{,}300) / 3 = 5{,}000$

SES: $F_2 = 5{,}100 + 0.2(5{,}100-5{,}100) = 5{,}100$

$F_3 = 5{,}100 + 0.2(4{,}900-5{,}100) = 5{,}060$

$F_4 = 5{,}060 + 0.2(5{,}200-5{,}060) = 5{,}088$

$F_5 = 5{,}088 + 0.2(5{,}000-5{,}088) = 5{,}070.4$

$F_6 = 5{,}070.4 + 0.2(4{,}700-5{,}070.4) = 4{,}996.32$

$F_7 = 4{,}996.32 + 0.2(5{,}300-4{,}996.32) = 5{,}057.056$

b. The table provides values for calculating MAD & MSE:

		Naïve		3-Month SMA		SES	
t	At	Ft	et(At-Ft)	Ft	et(At-Ft)	Ft	et(At-Ft)
1	5100						
2	4900	5100	-200			5100	-200
3	5200	4900	300			5060	140
4	5000	5200	-200	5066.6667	-66.6667	5088	-88
5	4700	5000	-300	5033.3333	-333.3333	5070.4	-370.4
6	5300	4700	600	4966.6667	333.3333	4996.32	303.68

Naïve MAD $= (|-200|+|300|+|-200|+|-300|+|600|) / 5$
$= 320$

SMA MAD $= (|-66.6667|+|-333.3333|+|333.3333|) / 3$
$= 244.4444$

SES MAD $= (|-200|+|140|+|-88|+|-370.4|+|303.68|) / 5$
$= 220.416$

Based on the MAD values, the simple exponential smoothing method is the most reliable.

c. $F_7 = 4{,}996.32 + 0.2(5{,}300-4{,}996.32) = 5{,}057.056$

d. Naïve MSE $= [(-200)^2+(300)^2+(-200)^2+(-300)^2+(600)^2] / 5$
$= 124{,}000$

SMA MSE $= [(-66.6667)^2+(-333.3333)^2+(333.3333)^2] / 3$

= 7,5555.5422

SES MSE = $[(-200)^2+(140)^2+(-88)^2+(-370.4)^2+(303.68)^2) / 5$
= 5,9352.3405

Based on the MSE values, the simple exponential smoothing method is the most accurate.

6. The solution is as follows:

a. Naïve:
F_2 = 1,703
F_3 = 1,720
F_4 = 1,649
F_5 = 1,686

b. 2-Hour SMA:
F_3 = (1,703+1,720) / 2 = 1,711.5
F_4 = (1,720+1,649) / 2 = 1,684.5
F_5 = (1,649+1,686) / 2 = 1,667.5

c. The table provides values for calculating MAD & MSE:

		Naïve		**2-Month SMA**	
t	**At**	**Ft**	**et(At-Ft)**	**Ft**	**et(At-Ft)**
1	1703				
2	1720	1703	17		
3	1649	1720	-71	1711.5000	-62.5000
4	1686	1649	37	1684.5000	1.5000
5	1718	1686	32	1667.5000	50.5000

Naïve MAD = (|17|+|-71|+|37|+|32|) / 4
= 39.25

SMA MAD = (|-62.5|+|1.5|+|50.5|) / 3
= 38.1667

Based on MAD values, SMA is better.

d. Naïve MSE $= [(17)^2+(-71)^2+(37)^2+(32)^2] / 4$
$= 1{,}930.75$

SMA MSE $= [(-62.5)^2+(1.5)^2+(50.5)^2] / 3$
$= 2{,}152.9167$

Based on MSE values, Naïve is better.

e. The MAD and MSE values are not consistent with each other. A third error forecasting methodology such as MAPE or bias needs to be calculated to break the tie.