



Assignment

Probability and Statistics

MAT 4601

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Assignment on Time Series Analysis & Forecasting

1. Below are the net sales in \$ million for Home Depot, Inc. and its subsidiaries from 2015 to 2024.

Table 1: Net sales of different years

Year	Net Sales (\$)	Year	Net Sales (\$)
2015	50,600	2020	156,700
2016	67,300	2021	201,400
2017	80,800	2022	227,300
2018	98,100	2023	256,300
2019	124,400	2024	280,900

Note: Add last three digits of your ID with Net Sales

- i) Determine the least square equation. Based on this information, what are the estimated sales for 2030?
- ii) Plot Net Sales and Trend Line

Solution:

Year	X	Net Sales (\$) (Y)	XY	XX
2015	0	50600026	0	0
2016	1	67300026	67300026	1
2017	2	80800026	161600052	4
2018	3	98100026	294300078	9
2019	4	124400026	497600104	16
2020	5	156700026	783500130	25
2021	6	201400026	1208400156	36
2022	7	227300026	1591100182	49
2023	8	256300026	2050400208	64
2024	9	280900026	2528100234	81
	45	1493200234	9182301170	285

$$m = (n\sum xy - \frac{\sum y \sum x}{n\sum x^2 - \sum x^2}) \quad \text{Here, } n=10; \sum x=45; \sum y=1493200234$$

$$\sum xy = 9182301170; \sum x^2 = 40783885$$

$$m = (10 \cdot 9182301170 - \frac{1493200234 \cdot 45}{10 \cdot 285 - 285})$$

$$= 91796815205$$

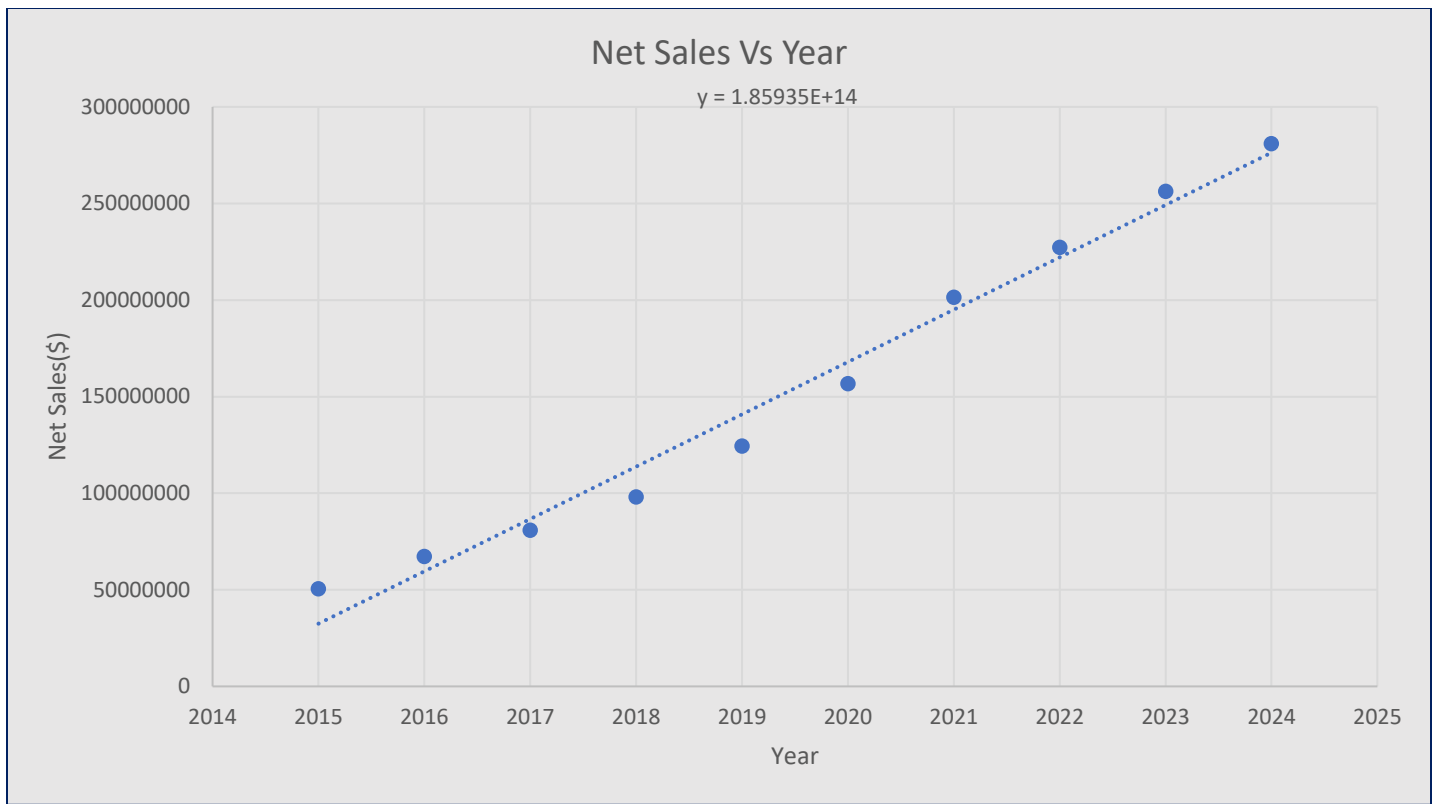
$$b = \frac{\sum y - m \sum x}{n}$$

$$= \frac{1493200234 - 91796815205 \cdot 45}{10}$$

$$= -4.12936E+11$$

$$y = 91796815205 \cdot x - 4.12936E+11$$

For x=2030 we get y = 1.85935E+14\$



2. It appears that the imports of carbon black have been increasing by about 10 percent annually.

Table 2: Amount of Carbon Block imported in different years.

Year	Imports of Carbon Block (thousands of tons)	Year	Imports of Carbon Block (thousands of tons)
2011	124	2018	2463
2012	175	2019	3358
2013	306	2020	4181
2014	524	2021	5388
2015	714	2022	8027
2016	1052	2023	10587
2017	1638	2024	13537

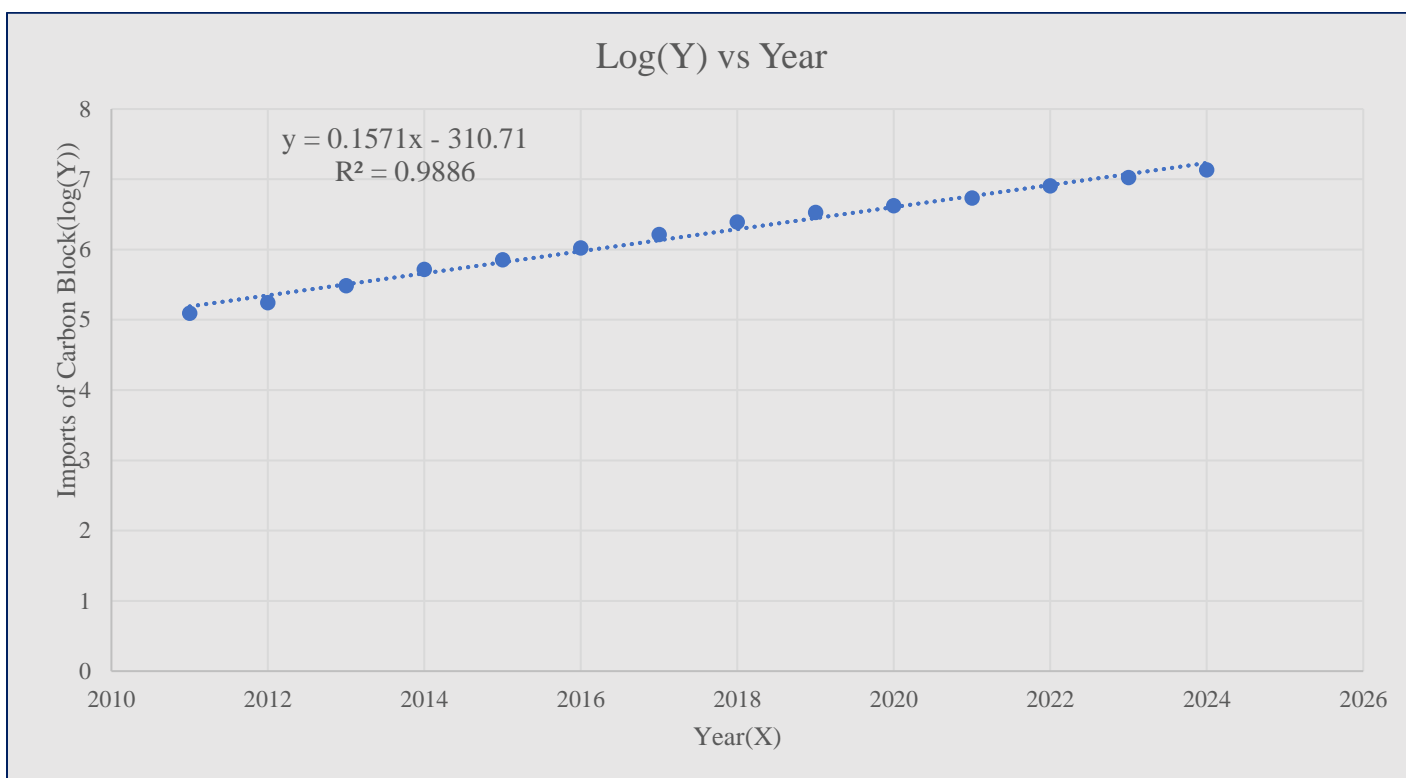
Note: Add last three digits of your ID with imports of Carbon Block

- Determine the logarithmic trend.
- Find the annual rate of increase.
- Estimate imports for the year 2030.

Solution:

Sl No	Year(X)	Imports of Carbon Block (Thousands of tons)(Y)	log(Y)
1	2011	124026	5.093513
2	2012	175026	5.243103

3	2013	306026	5.485758
4	2014	524026	5.719353
5	2015	714026	5.853714
6	2016	1052026	6.022026
7	2017	1638026	6.214321
8	2018	2463026	6.391469
9	2019	3358026	6.526084
10	2020	4181026	6.621283
11	2021	5388026	6.73143
12	2022	8027026	6.904555
13	2023	10587026	7.024774
14	2024	13537026	7.131523



Here slope, m is the annual rate of increase. Which is $m = 0.1571$

The logarithmic trend equation is, $\text{Log}(y) = 0.1571x - 310.71$

For $x = 2030$ we get $\text{Log}(y) = 8.203$

Thus, Imports of Carbon Block (thousands of tons) in 2030 = 159587914.7

3. The quarterly production of pine lumber, in millions of board feet, by Northwest lumber since 2018 is:

Table 3: Productions in different quarters of several years

Year	Quarter	Production	Year	Production	Sales	Year	Quarter	Production
2018	Winter	90	2021	Winter	201	2024	Winter	265
	Spring	85		Spring	142		Spring	185
	Summer	56		Summer	110		Summer	142
	Fall	102		Fall	274		Fall	333
2019	Winter	115	2022	Winter	251	2025	Winter	282
	Spring	89		Spring	165		Spring	175
	Summer	61		Summer	125		Summer	157
	Fall	110		Fall	305		Fall	350
2020	Winter	165	2023	Winter	241	2024	Winter	290
	Spring	110		Spring	158		Spring	201
	Summer	98		Summer	132		Summer	187
	Fall	248		Fall	299		Fall	400

Note: Add last three digits of your ID with number of Productions

- Develop a seasonal index for each quarter and interpret it.
- Project the production for 2030 and also find the base year production.
- Plot the original data, deseasonalize data, and interpret.

Solution:

Year	Winter(production)	Spring(production)	Summer(production)	Fall(production)	Mean
2018	90026	85026	56026	102026	83276
2019	115026	89026	61026	110026	93776
2020	165026	110026	98026	248026	155276
2021	201026	142026	110026	274026	181776
2022	251026	165026	125026	305026	211526
2023	241026	158026	132026	299026	207526
2024	265026	185026	142026	333026	231276
2025	282026	175026	157026	350026	241026
2026	290026	201026	187026	400026	269526

Seasonal Index calculation: Divide seasonal value of each year with the mean of each year. Then we get,

Year	Winter(production)	Spring(production)	Summer(production)	Fall(production)
2018	1.081058686	1.021015215	0.67276308	1.225163018
2019	1.226611071	0.949345761	0.650752349	1.173290819
2020	1.06279263	0.708577795	0.631294559	1.597335016
2021	1.105901316	0.781320658	0.605276911	1.507501114
2022	1.186740922	0.78016575	0.591061019	1.442032309

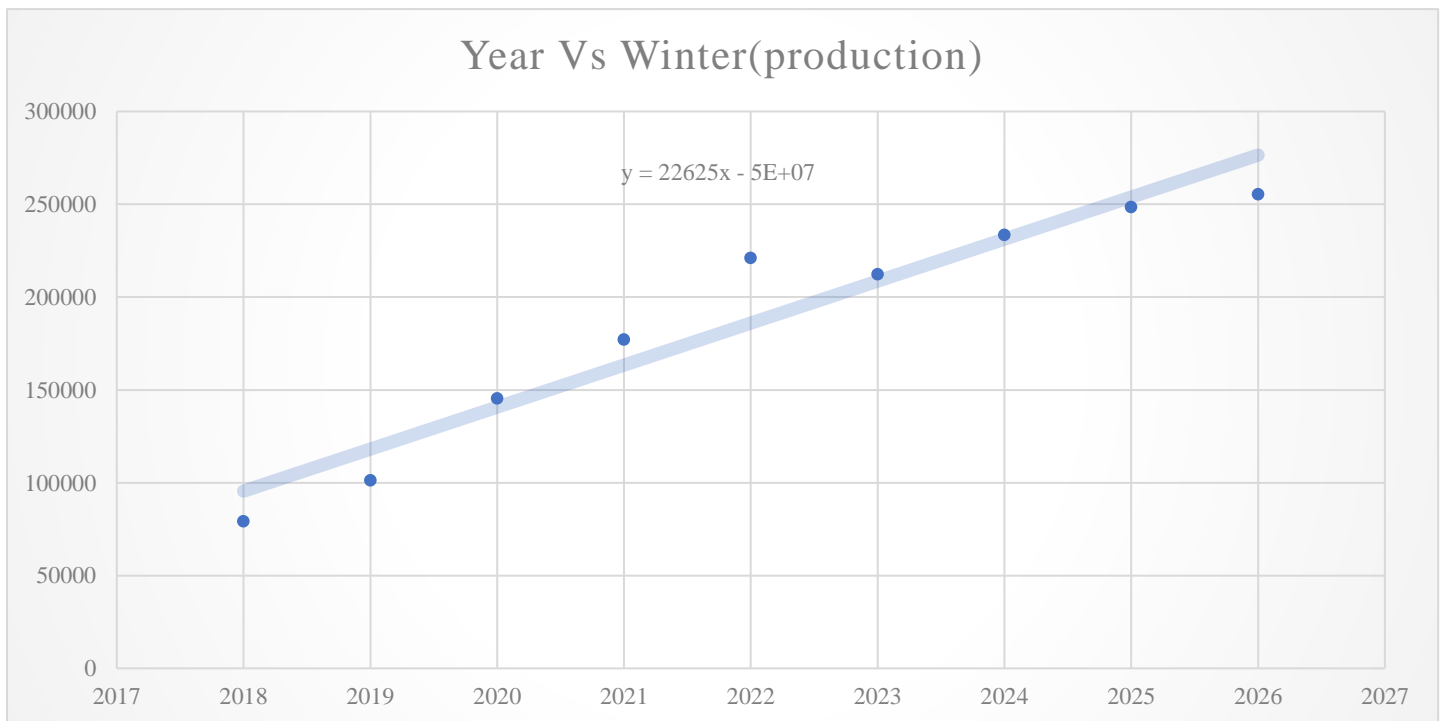
2023	1.16142789	0.761472222	0.636184905	1.440914983
2024	1.145931432	0.80001989	0.614092436	1.439956242
2025	1.170108247	0.726167212	0.651485543	1.452238998
2026	1.076060299	0.745847293	0.693903674	1.484188733

Overall Seasonal Index:

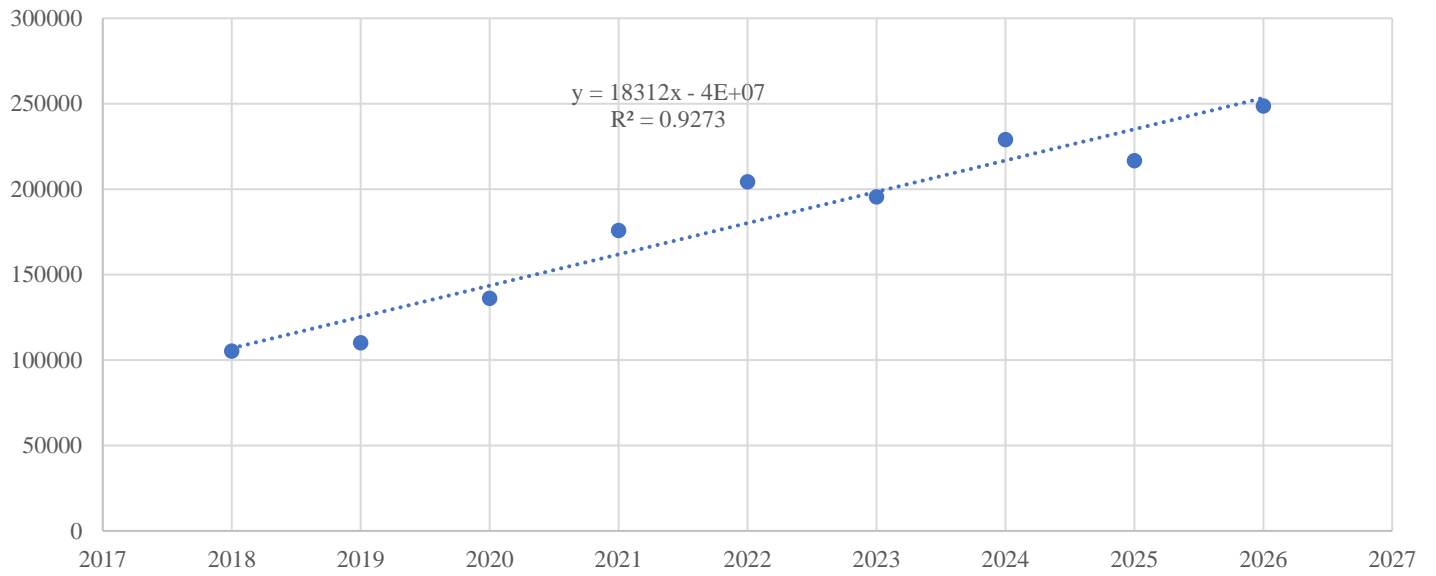
Seasonal Index	Winter	Spring	Summer	Fall
SI	1.135181388	0.808214644	0.638534942	1.418069026
Sum of SI	4			

De-seasonalize data:

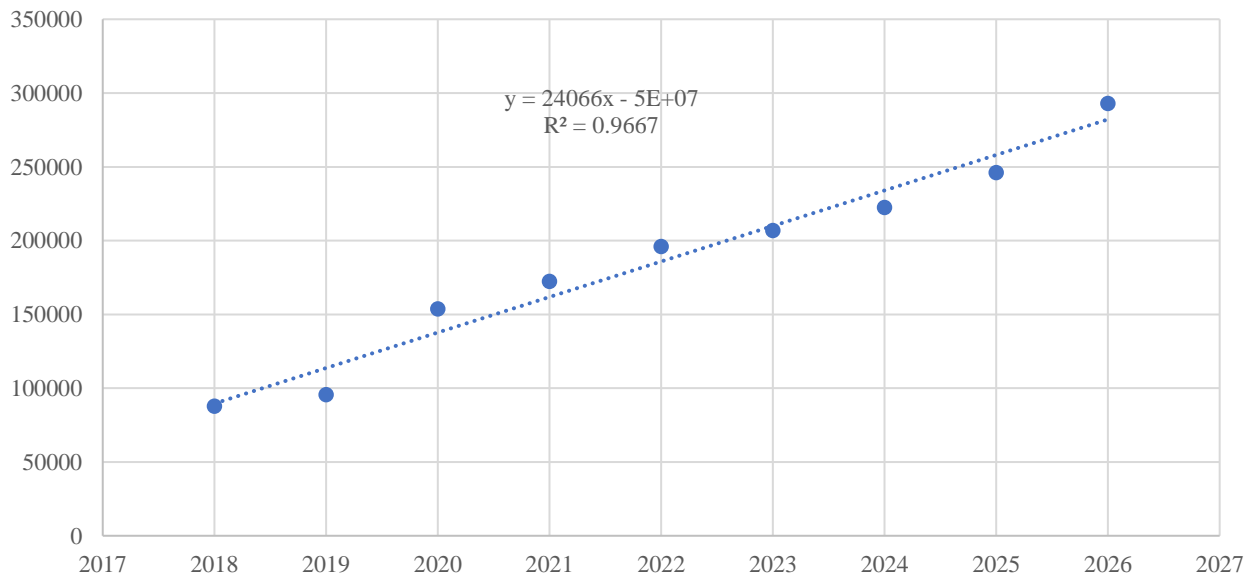
Year	Winter(production)	Spring(production)	Summer(production)	Fall(production)
2018	79302.74486	105198.5393	87736.78045	71945.01688
2019	101325.657	110147.7196	95567.20549	77586.4912
2020	145371.4813	136130.9162	153512.3508	174901.9233
2021	177084.4749	175724.3587	172305.3709	193236.7149
2022	221130.2992	204182.1454	195796.646	215097.4279
2023	212321.1343	195521.0799	206759.2411	210866.3221
2024	233463.13	228928.047	222420.0912	234842.588
2025	248438.7103	216555.0962	245911.3663	246830.7209
2026	255486.0422	248724.7682	292893.9166	282089.9355

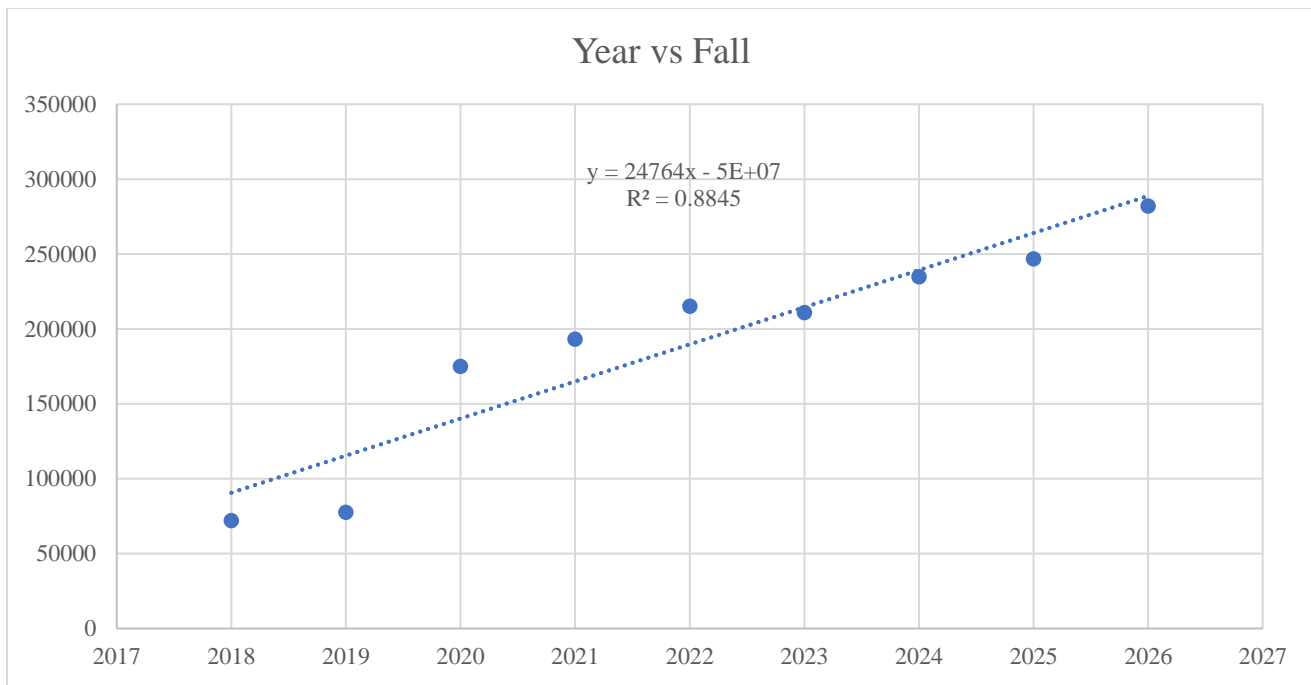


Year Vs Spring(Production)



Year vs Summer





Production in 2030:

For winter

$y = 22625x - 5E+07$; for $x=2030$ we get production =