Dennis Dhaese Product Rapor

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Criteria A

My goals of learning? What is my product going to be?

When I started my goal was predicting the stock market crash. I was very keen on going through this path but when I tried to find information, I found out only universities provided it, besides, they were only allowed to the university students. Microeconomics (from Greek prefix behavior micro-behavior meaning "small" + economics) is a branch of economics that studies the behaviour of individuals and firms in making decisions regarding the allocation of scarce resources and the interactions among these individuals and firms (“Microeconomics” (9)). This was a struggle because information was scarce and wasn’t understandable. After a lot of searches I finally found what I wanted to do. I wanted to calculate the expected GDPin the U.S.A.. When I calculate the GDP I will compare my graphs to analysis’s graphs.

What are some of the skills you believe will be helpful?

I have skills that are useful in economics, for example I am good at memorising in short amount of time. I also have little knowledge in the financial world, as my dad watches Bloomberg everyday so I picked up some terminology and its meaning related to economics.

Where did you get your information and how much?

I read articles accumalative of sixty pages PDF “Mathematical Modeling and Algorithms to Simulate The Economy's Behavior.(8) Economic Models and Algorithms for Distributed Systems”(2) and most of it was useless but some of it was helpful in understanding the concept of simple economics and microeconomics. After long research I decided to choose calculating the GDP eventhough it was above my grade but it was doable. My next big struggle was understanding the maths behind formulas. This was above my grade, its maths were done by universtity students, considering I am at thenth grade makes this difficult. Neverdeless, I continued to proceed. I needed some help so I went to Khanacademy to learn ‘Partial(∂)’ and Sigma(Σ)’. I took some help from my maths teacher. She explained me how it worked but it wasn’t very useful. I am going to a broker firm I will try to get some help from them but i believe I wont be able to ask because they are working and I am a guest. I have a reference number of a Professor at Izmir Economy University but he hasn’t responded yet.

Why I choose this project?

I choose this project because I had a desire to learn how money flows facinates me. My dad was a CFO and a few years CEO this meant that whenever we are in the car we talk about the stock markets and the big projects that independent campanies and state investments are dealing with. This is the main reason I chose this project. The other reason is that I want to go to “London School Of Economics” and I need to start early in order to succeed amongst others in the university. The slightest bit of knowledge I can gain is for my benefit.

My main goals in this project?

I want to learn and understand the basic economics and a proportion of microeconomics in it. The product that I want to put out is a calculation of the GDP. I am doing this product also my own benefit , as I want to understand the rules of economy.

I also want to be able to know the terms economists use so I can understand the true meaning of what they are saying. I don't know if the product is what people should use but in theory it should work.

During creating my project what determined the choices I made? How did my view of the product change?

My research changed the way I looked at project by a landslide. When I learned a new information I became more realistic of the probability that I will fail. About four weeks I trimed it down and deluted to create a product that was realistic. The product that I started off was raw and I didn't know much about it. Understanding what I was getting into, I had to retreat. The problem with predicting the crash was that there were too many possibilities, I needed to see into the future with my eyes closed. Which is clearly impossible. So at last I decided to calculate the GDP. I still don't know if I will stick to this considering the amount of math symbols I have no clue about. At the end, at this point how much my project has changed just by research.

Which global context I chose and why?

My global context is 'Scientific and technical inovasion' because my goal is to understand how these theories are based on economics and the worlds money flow. I am interested in the exchange of money and its impact on economies. It can be used in all countries.

Criteria B

Process Journal

Day 1: 23/09/2019 I have decided the format pdf the Process Journal, catogorizing it day by day and meeting by meeting.

1 meeting: We talked about our own projects and what we have to do; process journal, global context and corrolation to maths. The project theme is maths. Our assignment was to make a brief research and a deep brain storm. I am clear on what I want to do and that is to predict the GDP but I have very little knowledge on "economical algorithms".

Day 2: 18/10/2019 I started first in depth research. I had a general idea of what I wanted to achieve. But it was too general of a topic to complete. I decided to simplify and focus on whatI wanted to learn. I found the topic that I wanted to choose and I choose trust because

trust had a corrolation with economics. This caused a lot of sparks in my head. But the problem is that it is not possible to create a product because everything that I put out has already been put out . This is why I did not feel right on copying other people. Trust is much harder than people think because trust is an assesment on reputation, recommendation, experience and other foctors, such as: promptness, availability and reliability. These examples are from one theory that believes that with trust, predicting politicians doings can be predicted. I quickly came to the conclusion that understanding was the easy part, bad news for me the maths was the hardest part of them all. I new this was going to be a struggle but seeing the maths actualy killed my hope. Then I knew I had to choose a topic that had a much simpler math. I am going to take help from my teachers, reference people or family members that have expertise in economics. Until now I have failed. I don not have a clear idea on what I want to do but I have a general idea and that is that it has to be with economics. The end of my second research day.

Meeting 2. It was exam week. There were not much said. We just had been shown examples of process journals. We were also given the assignment to hand over our process journal drafts by next meeting. That was the end of meeting 2.

Meeting 3: Process journals were shown. This meeting was not for me in particularly as it was for the people who needed clearity. That was the end of meeting 3. Our assignment for meeting four is to get a clear topic.

Writing my report draft: I started answering all of the report questions until criteria C. I gave my reasons of choosing this project and put my proccess journal.

Meeting 4: Report drafts were given in. Time deadlines were shown. Feedback was given. My feedback was that not many people would not understand what my theories meant. Thats why I started giving detailed explanations of the simple modeling. I also chose not to explain the formula. I felt it is unnecessary try to explain the maths that I did not really understood. I wrote about the theory that made me change direction and the theory I am going to use.

The first time I started on my product: I started by listing all the data on paper. Government investments, exports, imports, consumer consumption, corporate investment and so on. I found the deflator rates of the given time. I found some old estimate graphs. I wrote down every symbol and their meaning for example sigma, partila, delta, etc. I went to Khan acadamy to solve some examples of partials and derivatives. I found some meanings of some letters like ‘r’ ‘Fa’ and etc.

Second product day”: I put most of the data in the functions but I quickly understood that the numbers were way to big for me to calculate by paper. So I used calculator. I understood what ‘F’ function was but I could not find ‘r’. This caused me many problems. This was key because the graph that I was creating was based on GDP, time and ‘r’, it was essential.

Meeting 5: Report must be given. I showed it to my teacher but I came across a few technical issues. The mail I sent could not be read by the teacher.

Third product day: I found what 'r' is. It is coefficient of determination. It is a statistical term which means how efficient is the used model. The product I am creating is a calculation of GDP and comparing my calculation on a graph to other calculations in other graphs.

Fourth product day: My goal is to find the gdp(s) which means future predicted GDP.

I found out that there are 2 ways of getting there.

First way:

1. Preforming least square method by applying appropiat reggresion method on figure down below..This is the first step.

2. Formula (13) or Formula (16) is applied.

$$GDP_s = \frac{N}{2N-1-2P}\Delta t F_{GDP} + GDP_n \qquad (13)$$

$$\alpha_{i_s} = \begin{cases} \dfrac{(N-1)F_{\alpha_k}(GDP_s - GDP_n)\Delta t}{(GDP_s - GDP_n) + \Delta t + F_{GDP}} + \alpha_{k_n}, i = k \\ \dfrac{F_{\alpha_i}}{F_{\alpha_k}}(GDP_s - GDP_n) + \alpha_{i_n}, \quad \alpha_i \text{ is "+"} \\ \dfrac{F_{\alpha_i}(\alpha_{k_s} - \alpha_{k_n})\Delta t}{2F_{\alpha_i}(\alpha_{k_s} - \alpha_{k_n}) - \Delta t + F_{\alpha_k}} + \alpha_{i_n}, \alpha_i \text{ is "}-\text{"} \end{cases} \qquad (16)$$

3. Getting the deffrentiation between real values and simulated values.

$$\overline{\Delta t} - F_{GDP}\overline{GDP_s - GDP_n}) \quad F_{\alpha_i} \quad \overline{\alpha_{i_s} - \alpha_{i_n}}$$

4. Determine the factor of expectation.
5. Determine the expected value of GDP(s)
6. Draw graph

Second way:

1. Preform the least square methods by applying appropiat regression method on.

2. Find the defrenciation for resultant fitting.Calculat (Fai) by using formula (14)

$$\alpha_{i_s} = \begin{cases} \dfrac{F_{\alpha_i}}{F_{GDP}}(GDP_s - GDP_n) + \alpha_{i_n}, & \alpha_i \text{ is "}-\text{"} \\ (\dfrac{2}{\Delta t} - F_{GDP}\dfrac{1}{\overline{GDP_s - GDP_n}})^{-1}F_{\alpha_i} + \alpha_{i_n}, \alpha_i \text{ is "+"} \end{cases} \qquad (14)$$

3. Determine the error between real values and simulated values.Keep the number.

$$\overline{\Delta t} - F_{GDP}\overline{GDP_s - GDP_n}) \quad F_{\alpha_i} \quad \overline{\alpha_{i_s} - \alpha_{i_n}}$$

4. Determine the factor of expectation

5. Determine expected values
6. Draw graph

5th Product day: I found my own way in calculating GDP by using least square method and regression method. I can determine an estimated linear line by using least square method. And check how accurate my estimated lines are to the actual lines . I used a formula and simplyfied it on a graph.

INDEPENDENT CONSUMPTİON

x	y	(x-mx)	y-my	(x-mx)2	(x-mc)(y-my)	b1= sum((x-mx)*(y-my))/ sum(x-mx)?(x-mx))	b0=(mx*b1)/my	(y-my)*(y-my)	hy=bo+(b1*x)	r = ((hy-my)*(hy-my))/((y-my)*(y-my))
13.066	18.783	0.122	0.145	0.015	0.018			0.021	16.779	163.730
13.019	18.732	0.075	0.094	0.006	0.007			0.009	16.722	413.232
12.909	18.598	-0.035	-0.040	0.001	0.001			0.002	16.588	2,660.070
12.782	18.438	-0.162	-0.200	0.026	0.032			0.040	16.433	121.866
12.944	**18.638**			**0.012**	**0.015**	**1.220**	**0.837**			

INDEPENDENT İNVESTMENT

x	y	(x-mx)	y-my	(x-mx)2	(x-mc)(y-my)	b1= sum((x-mx)*(y-my))/ sum(x-mx)?(x-mx))	b0=(mx*b1)/my	(y-my)*(y-my)	hy=bo+b1*x	r = ((hy-my)*(hy-my))/((y-my)*(y-my))
3.429	18.783	0.069	0.145	0.005	0.010			0.021	7.244	6,152.996
3.404	18.732	0.044	0.094	0.002	0.004			0.009	7.194	14,742.661
3.296	18.598	-0.064	-0.040	0.004	0.003			0.002	6.977	86,054.769
3.311	18.438	-0.049	-0.200	0.002	0.010			0.040	7.007	#REF!
3.360	**18.638**			**0.003**	**0.007**	**2.009**	**0.357**			

INDEPENDENT INVESTMENT IMPORT / EXPORT

x	y	(x-mx)	y-my	(x-mx)2	(x-mc)(y-my)	b1= sum((x-mx)*(y-my))/ sum(x-mx)?(x-mx))	b0=(mx*b1)/my	(y-my)*(y-my)	hy=bo+b1*x	r = ((hy-my)*(hy-my))/((y-my)*(y-my))
-684.148	18.783	-45.936	0.145	2,110.093	-6.672			0.021	1.267	14,301.925
-671.353	18.732	-33.141	0.094	1,098.309	-3.124			0.009	1.245	34,055.924
-568.391	18.598	69.821	-0.040	4,875.007	-2.775			0.002	1.063	195,483.525
-628.957	18.438	9.255	-0.200	85.660	-1.849			0.040	1.170	7,647.351
-638.212	**18.638**			**2,042.267**	**-3.605**	**-0.002**	**0.060**			

GOVERNMENT EXPENDİTURE

x	y	(x-mx)	y-my	(x-mx)2	(x-mc)(y-my)	b1= sum((x-mx)*(y-my))/ sum(x-mx)?(x-mx))	b0=(mx*b1)/my	(y-my)*(y-my)	hy=bo+b1*x	r = ((hy-my)*(hy-my))/((y-my)*(y-my))
6.901	18.783	0.115	0.145	0.013	0.017			0.021	11.060	2,721.725
6.821	18.732	0.035	0.094	0.001	0.003			0.009	10.938	6,673.824
6.756	18.598	-0.030	-0.040	0.001	0.001			0.002	10.839	38,491.480
6.667	18.438	-0.119	-0.200	0.014	0.024			0.040	10.703	1,577.753
6.786	**18.638**			**0.007**	**0.011**	**1.524**	**0.545**			

FEDERAL NON-DEFENSE GROSS İNVESTMENT

x	y	(x-mx)	y-my	(x-mx)2	(x-mc)(y-my)	b1= sum((x-mx)*(y-my))/ sum(x-mx)?(x-mx))	b0=(mx*b1)/my	(y-my)*(y-my)	hy=bo+b1*x	r = ((hy-my)*(hy-my))/((y-my)*(y-my))
136.107	18.783	1.939	0.145	3.760	0.282			0.021	13.052	1,479.030
134.826	18.732	0.658	0.094	0.433	0.062			0.009	12.935	3,661.102
133.265	18.598	-0.903	-0.040	0.815	0.036			0.002	12.793	21,622.306
132.474	18.438	-1.694	-0.200	2.870	0.338			0.040	12.721	877.505
134.168	**18.638**			**1.969**	**0.179**	**0.091**	**0.648**			

FEDERAL DEFENSE GROSS İNVESTMENT

x	y	(x-mx)	y-my	(x-mx)2	(x-mc)(y-my)	b1= sum((x-mx)*(y-my))/ sum(x-mx)?(x-mx))	b0=(mx*b1)/my	(y-my)*(y-my)	hy=bo+b1*x	r = ((hy-my)*(hy-my))/((y-my)*(y-my))
162.603	18.783	6.407	0.145	41.053	0.931			0.021	4.715	9,187.392
155.731	18.732	-0.465	0.094	0.216	-0.044			0.009	4.516	22,449.501
154.606	18.598	-1.590	-0.040	2.527	0.063			0.002	4.483	126,794.226
151.843	18.438	-4.353	-0.200	18.946	0.869			0.040	4.403	5,078.124
156.196	**18.638**			**15.686**	**0.455**	**0.029**	**0.236**			

All data is from(“US GDP and Its Components.”)(14))

I studied and learned the least square method(“How to Calculate Linear Regression Using Least Square Method.”)(5c))(“How to Calculate R Squared Using Regression Analysis.”)(5b)). I simplified every term to it is core.

Key symbols:

my=mean/y value

Y=current gdp

X=current component value

xm=mean/avarage x value

hy=estimated component value

Bo=constant value of the given column

Bi=coefficient of x value

My steps I have found the x and y values of each component, then added the estimated component values. It added up to 23,637 B $.

Seing that the Nominal GDP for 2019 was 21,678 T $, the difference between the estimated and the Nominal GDP is about 2T $. Understanding that I was not able to add all the components I believe it is an accaptable result.

Important Notes:

GDP(s) assumed GDP

GDP(n) Present GDP

P : Number of components with negatif signs.

N: Total number of components

(Fai): formula of a component

Delta (t) : Time difference, in our case we use quarters thats why we will write one every where that writes delta (t).

(Fgdp):Formula of GDP

G: government investment

X: Exports

M: Imports

I: Investments

C: Consumption

Key Functions:

$$\frac{\partial(GDP)}{\partial t} = F_{GDP},$$
$$\frac{\partial \alpha_i}{\partial t} = F_{\alpha_i}$$

$$\frac{\partial(GDP)}{\partial t} = \frac{GDP_s - GDP_n}{\Delta t}$$
$$\frac{\partial \alpha_i}{\partial t} = \frac{\alpha_{i_s} - \alpha_{i_n}}{\Delta t}$$

$$\frac{\partial(GDP)}{\partial t} = \sum_{i=1}^{i=N} \frac{\partial \alpha_i}{\partial t} \frac{\partial(GDP)}{\partial \alpha_i}$$

$$\alpha_{i_s} = \begin{cases} \frac{F_{\alpha_i}}{F_{GDP}}(GDP_s - GDP_n) + \alpha_{i_n}, & \alpha_i \text{ is "} - \text{"} \\ (\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n})^{-1} F_{\alpha_i} + \alpha_{i_n}, & \alpha_i \text{ is "} + \text{"} \end{cases} \quad (14)$$

This formula is for every component in every group(X,M,G,I,C). (Fai) is the formula below

$$\frac{\partial(GDP)}{\partial t} = F_{GDP},$$
$$\frac{\partial \alpha_i}{\partial t} = F_{\alpha_i}$$

GDP(s) is the future assumption of the GDP. GDP(n) is the real GDP in the current given time. (ain) is the current amount of money in that component. This is if the component is in a negatif rate. The positif function is listed at number (14) above. Then I am going to continue on formula (15).

$$GDP_s = \frac{5}{7}\Delta t F_{GDP} + GDP_n,$$
$$M_s = \frac{F_M}{F_{GDP}}(GDP_s - GDP_n) + M_n,$$
$$X_s = \left(\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n}\right)^{-1} F_X + X_n,$$
$$C_s = \left(\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n}\right)^{-1} F_C + C_n, \quad (15)$$
$$I_s = \left(\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n}\right)^{-1} F_I + I_n,$$
$$G_s = (\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n})^{-1} F_G + G_n$$

We can use the top one or one of the four for more accurate estimation We can calculate each one and add them all toghether and we will get GDP(s). This is the way I followed and I got similar results. All data is taken from(US GDP and Its Components Bibliografpy (14)). All I have to do is put the numbers in there place and use a calculator.

Pictures of my proccess Journal:

2 Way

(1) Preform the least square methods b
applying appromate reggresion method

$(a_1 \ldots\ldots a_n)$

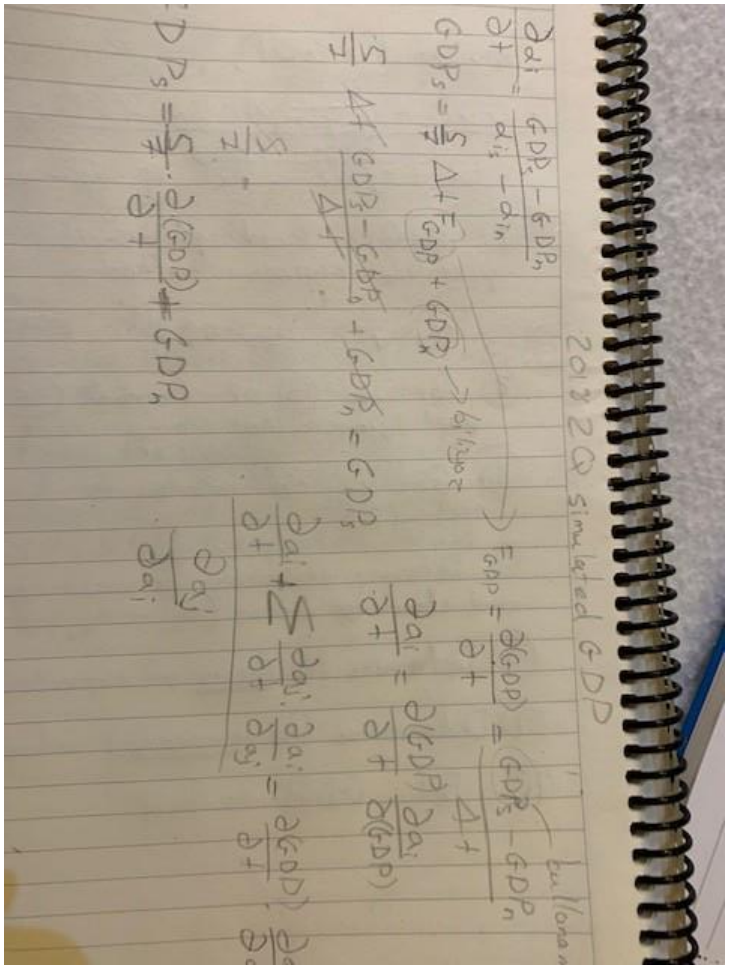
(2) Find the deffrenentiation for reultan
fitting. Calculate F_{a_i} by using form
"14"

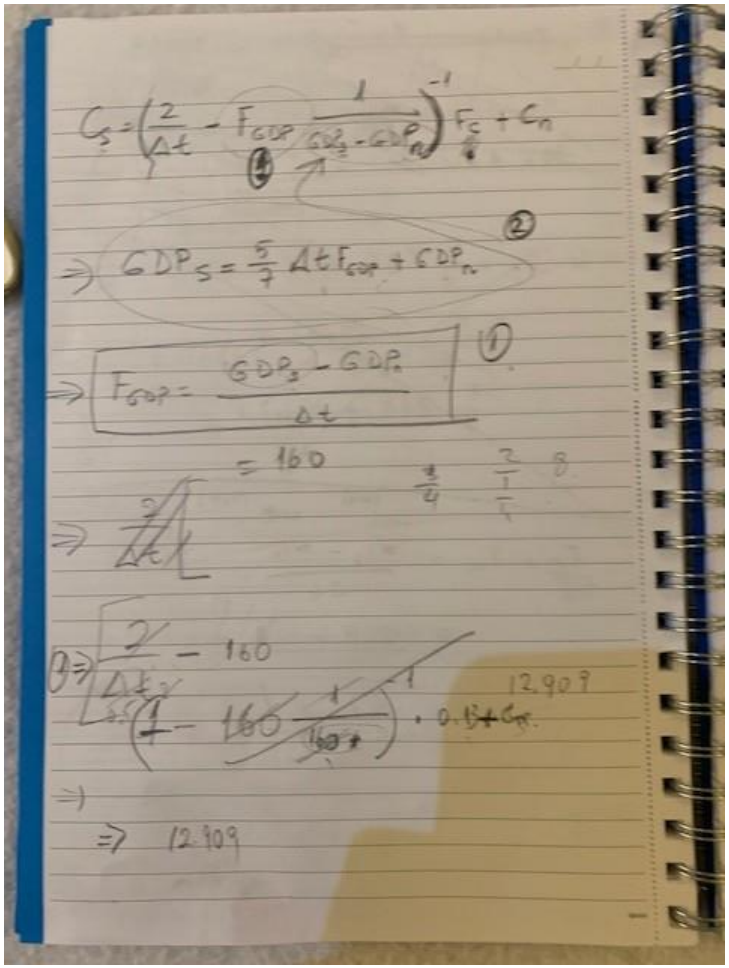
(3) Determine the error between real va
and simulated values. Store it. $(GDP_s - G$
$(\alpha_s - \alpha_n)$

(4) Determine the factor of expectation

(5) Determine expected values

(6) End GDP_s = expected values





$$C_s = \left(\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n}\right)^{-1} F_c + C_n$$

$$\Rightarrow GDP_s = \frac{5}{7}\Delta t F_{GDP} + GDP_n \quad (2)$$

$$\Rightarrow \boxed{F_{GDP} = \frac{GDP_s - GDP_n}{\Delta t}} \quad (1)$$

$= 160$ $\quad \frac{3}{4} \quad \frac{2}{\frac{1}{4}} \quad 8$

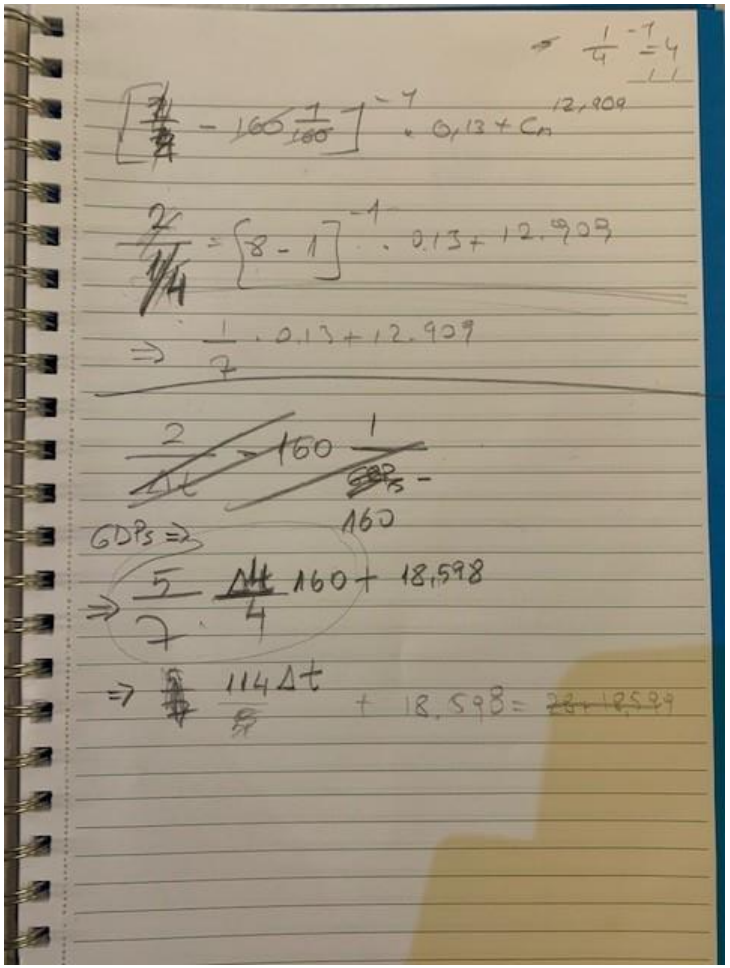
$$\Rightarrow \cancel{\frac{2}{\Delta t}}$$

$$(1) \Rightarrow \left[\frac{2}{\Delta t} - 160\right.$$

$$\left(1 - \cancel{160\frac{1}{160}}\right)^{-1} \cdot 0.13 + C_n \quad 12.909$$

$\Rightarrow$

$\Rightarrow 12.909$



$\Rightarrow \frac{1}{4}^{-1} = 4$

$$\left[\frac{2}{4} - 160\frac{1}{160}\right]^{-1} \cdot 0,13 + C_n \quad 12,909$$

$$\frac{2}{1/4} = [8 - 1]^{-1} \cdot 0.13 + 12.909$$

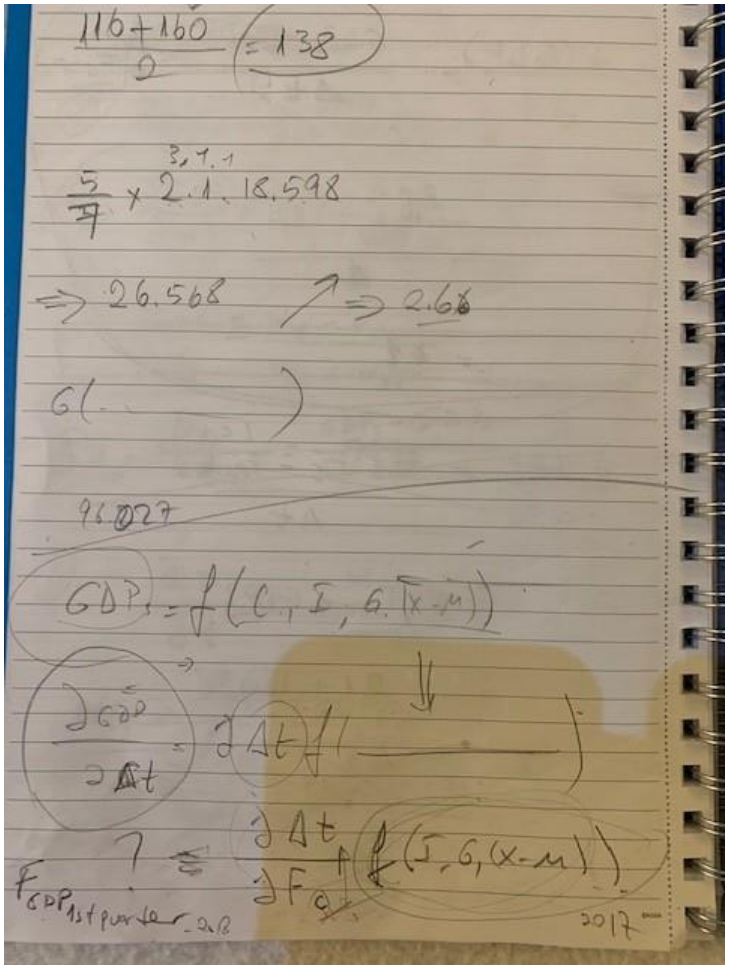
$$\Rightarrow \frac{1}{7} \cdot 0.13 + 12.909$$

$$\cancel{\frac{2}{\Delta t} - 160\frac{1}{GDP_s}} - 160$$

$GDP_s \Rightarrow$

$$\Rightarrow \frac{5}{7} \cdot \frac{\Delta t}{4} 160 + 18,598$$

$$\Rightarrow \frac{114\Delta t}{8} + 18.598 = \cancel{28 + 18.599}$$



$$\frac{116+160}{2} = 138$$

$$\frac{5}{7} \times \overset{3,1,1}{2.1.18.598}$$

$\Rightarrow 26.568 \nearrow \Rightarrow 2.66$

$G(\quad)$

96.027

$$GDP_s = f(C, I, G, (X-M))$$

$$\frac{\partial GDP}{\partial \Delta t} = \partial \Delta t \, f(\quad)$$

$$? \equiv \frac{\partial \Delta t}{\partial F_C} f(I, G, (X-M))$$

$F_{GDP_{1st\ quarter\_2018}}$

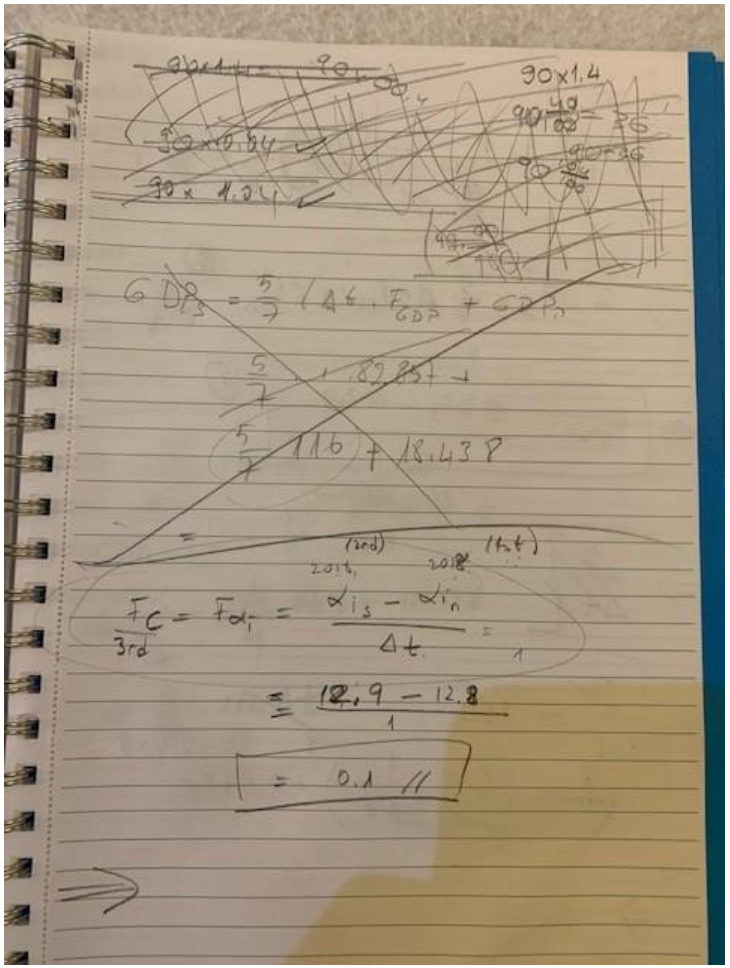
2017

90×1.4

90×0.04

90×1.04

$$GDP_s = \frac{5}{7}(\Delta t \cdot F_{GDP} + GDP_n$$



$$\frac{5}{7} \cdot 82.857 +$$

$$\frac{5}{7} \cdot 116 + 18.438$$

$$\underset{3rd}{F_C} = F_{\alpha_i} = \frac{\overset{2018}{\alpha_{i_s}} - \overset{2018}{\alpha_{i_n}}}{\Delta t} = 1$$

$$= \frac{12.9 - 12.8}{1}$$

$$\boxed{= 0.1 \ //}$$

$\Rightarrow$

N is a number of components in a sepesific row.

$\alpha_n =$ n = present value
s = estimated value

2x+4(1 17.10^9
17(trilyo

The estimation (~~guess~~) of the next quarter value could be calculated by the formula below:

On this one we take the ~~comp.~~ example of the component of Consumptions, i.e + Health Care

(Health Care Consumption)

3.6 Billion (2018)

3.6B x 1.04 => (3.74T) => (2019)

$x + \%Q =$ ✓ x+

2018 2017

$$\frac{\partial(GDP)}{\partial t} = \frac{GDP_s - GDP_n}{\Delta t} = F_{GDP}$$

$$= \frac{18.6 - 18.4}{1}$$

$$= 0.1$$

$$\frac{\partial F_{GDP}}{\partial \alpha_i} = \frac{F_{is} - F_{in}}{\Delta t} \quad F_{\alpha_i}$$

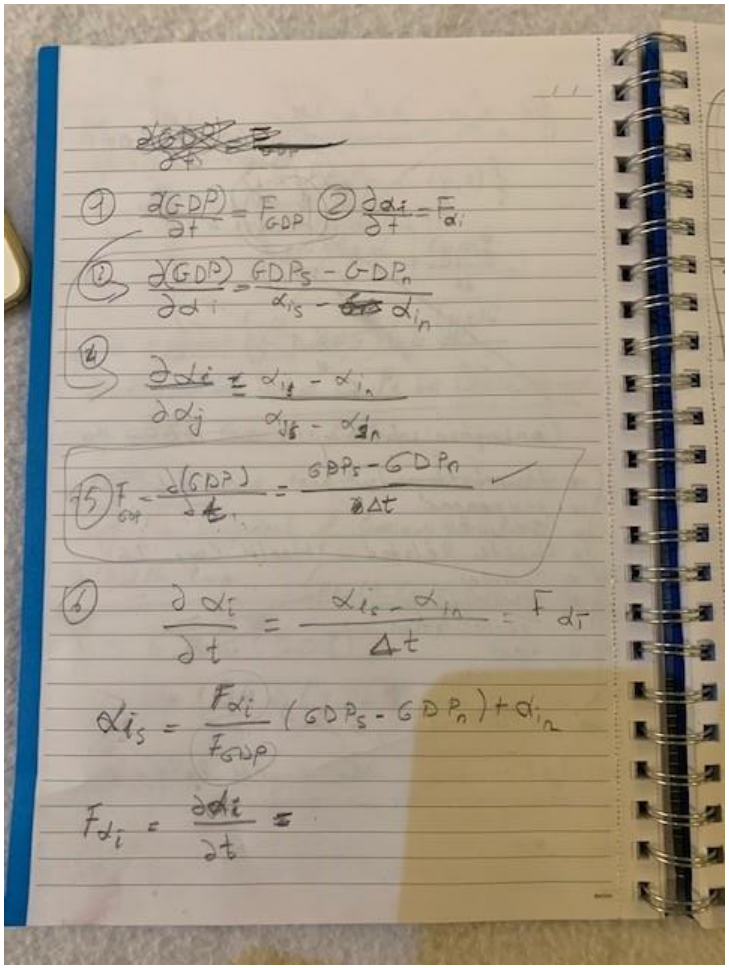
$$GDP_s = \frac{5}{7} \Delta t_1 F_{GDP} + GDP_n$$

$$18.598 = \frac{5}{7} \cdot 2 \; 0.1 + 18.438$$

2018, 1st quarter

$$= \frac{18.438 - 18.322}{} \quad 2017, 4th Q$$

$$\Delta_{GDP_1} = 116$$



① $\frac{\partial GDP}{\partial t} = F_{GDP}$ ② $\frac{\partial \alpha_i}{\partial t} = F_{\alpha_i}$

③ $\frac{\partial GDP}{\partial \alpha_i} = \frac{GDP_s - GDP_n}{\alpha_{is} - \alpha_{in}}$

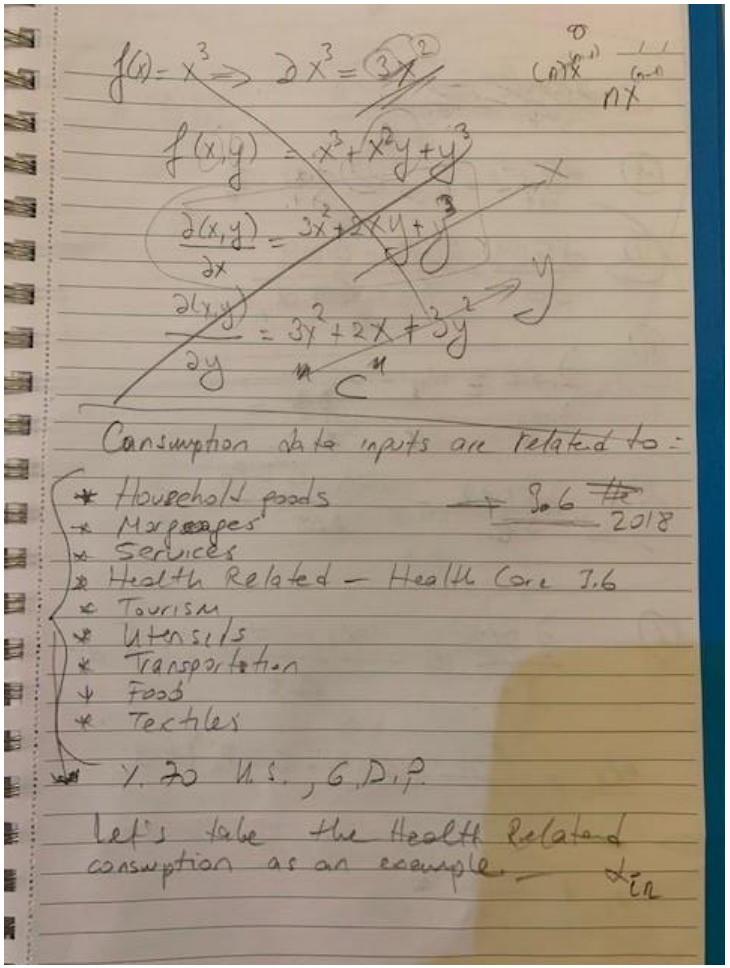
④ $\frac{\partial \alpha_i}{\partial \alpha_j} = \frac{\alpha_{is} - \alpha_{in}}{\alpha_{js} - \alpha_{jn}}$

⑤ $F_{GDP} = \frac{\partial (GDP)}{\partial t} = \frac{GDP_s - GDP_n}{\Delta t}$ ✓

⑥ $\frac{\partial \alpha_i}{\partial t} = \frac{\alpha_{is} - \alpha_{in}}{\Delta t} = F_{\alpha_i}$

$\alpha_{is} = \frac{F_{\alpha_i}}{F_{GDP}} (GDP_s - GDP_n) + \alpha_{in}$

$F_{\alpha_i} = \frac{\partial \alpha_i}{\partial t} =$



$f(x) = x^3 \Rightarrow \partial x^3 = 3x^2$

$f(x,y) = x^3 + x^2y + y^3$

$\frac{\partial (x,y)}{\partial x} = 3x^2 + 2xy + y^3$

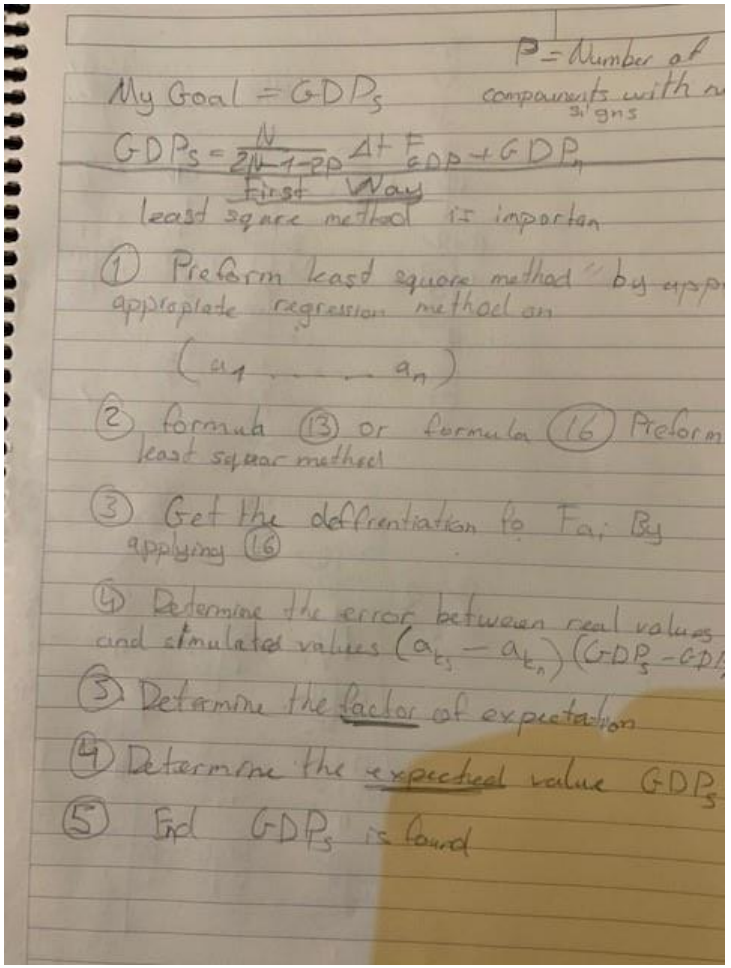
$\frac{\partial (x,y)}{\partial y} = 3y^2 + 2x + 3y^2$

Consumption data inputs are related to:

* Household goods
* Mortgages
* Services
* Health Related – Health Care 3.6 — 2018
* Tourism
* Utensils
* Transportation
* Food
* Textiles

Y. To U.S., G.D.P.

Let's take the Health Related consumption as an example. α_{in}



P = Number of compaunents with n signs

My Goal = GDP_s

$$GDP_s = \frac{N}{2N-1-2P} \Delta t \, F_{GDP} + GDP_n$$

First Way

least sqare method is importan

① Preform least square method by appr appropiate regression method on

$(a_1 \ldots\ldots a_n)$

② formula ⑬ or formula ⑯ Preform least squar method

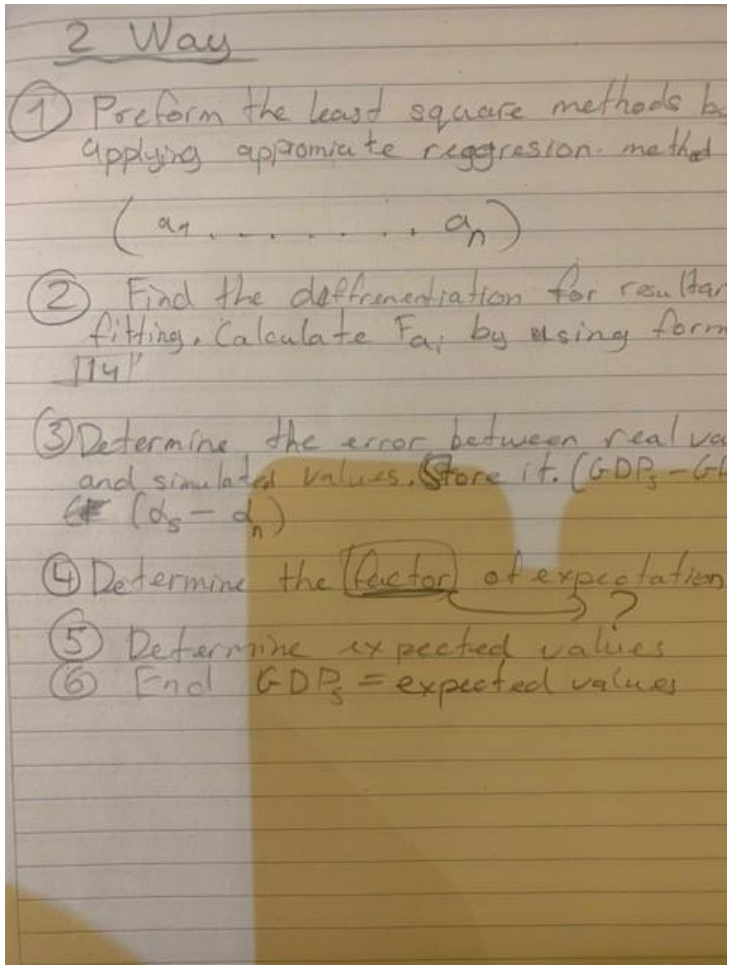
③ Get the deffrentiation fo F_{a_i} By applying ⑯

④ Determine the error between real values and simulated values $(a_{t_s} - a_{t_n})$ $(GDP_s - GDP$

⑤ Determine the factor of expectation

④ Determine the expected value GDP_s

⑤ End GDP_s is found



2 Way

① Preform the least square methods b applying appromiate reggresion method

$(a_1 \ldots\ldots\ldots a_n)$

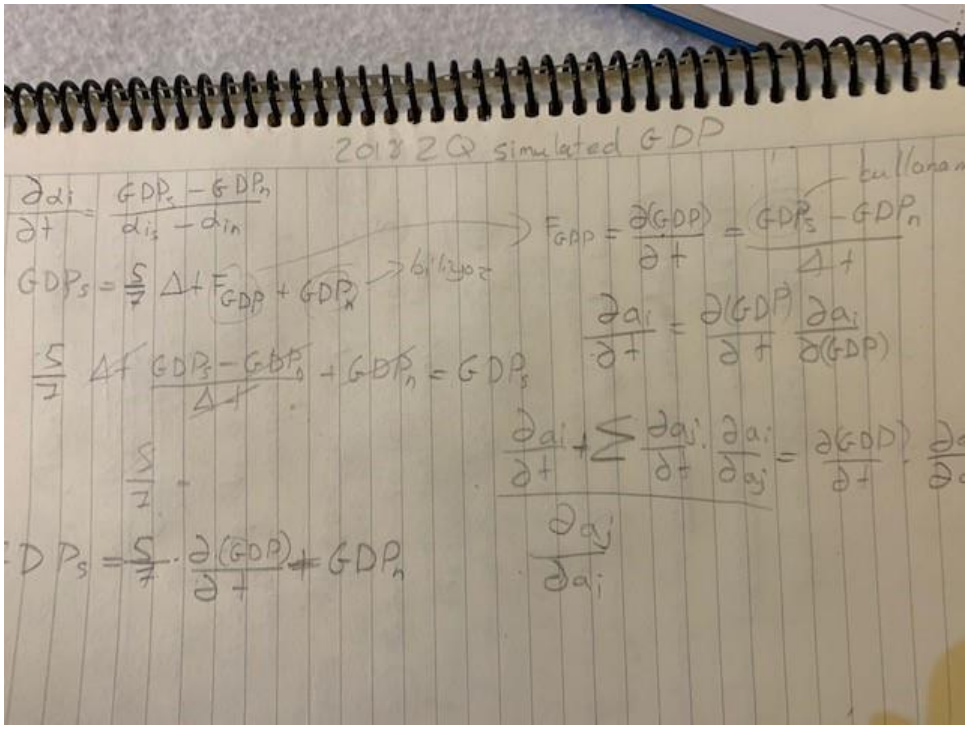
② Find the deffrenentiation for resultan fitting. Calculate F_{a_i} by using form ⑭

③ Determine the error between real va and simulated values. Store it. $(GDP_s - G$ $(\alpha_s - \alpha_n)$

④ Determine the factor of expectation ?

⑤ Determine expected values

⑥ End GDP_s = expected values



2018 2Q simulated GDP

$$\frac{\partial \alpha_i}{\partial t} = \frac{GDP_s - GDP_n}{\alpha_{i_s} - \alpha_{i_n}}$$

$$GDP_s = \frac{5}{7} \Delta t \, F_{GDP} + GDP_n$$

bilinyoz

$$\frac{5}{7} \cancel{\Delta t} \frac{GDP_s - \cancel{GDP_n}}{\cancel{\Delta t}} + \cancel{GDP_n} = GDP_s$$

$$\frac{5}{7} \cdot$$

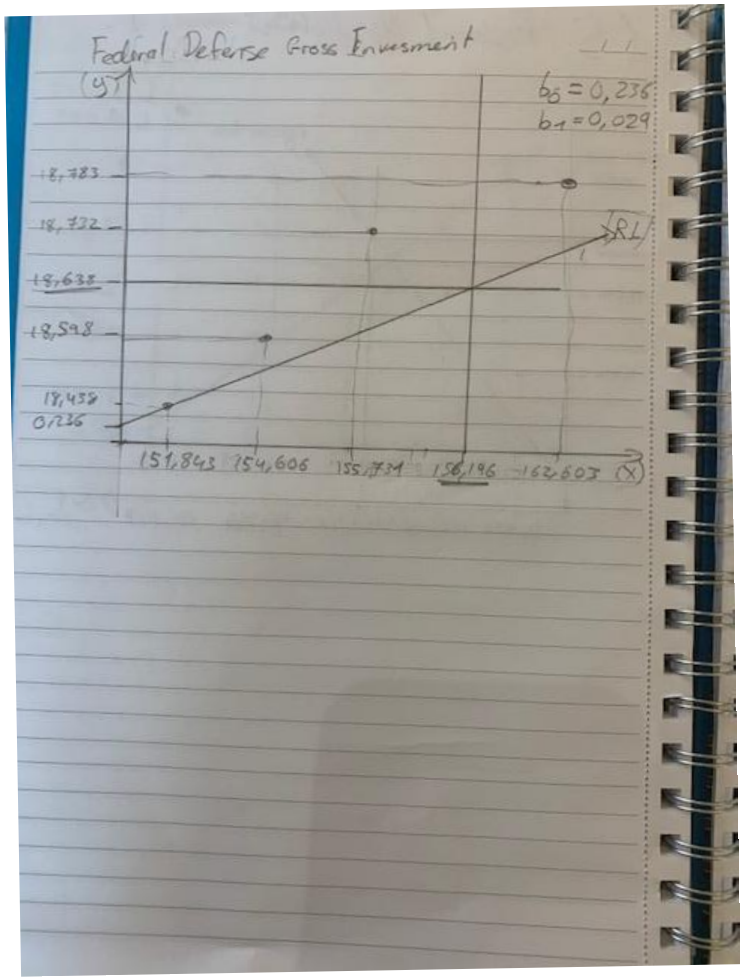
$$GDP_s = \frac{5}{7} \cdot \frac{\partial (GDP)}{\partial t} + GDP_n$$

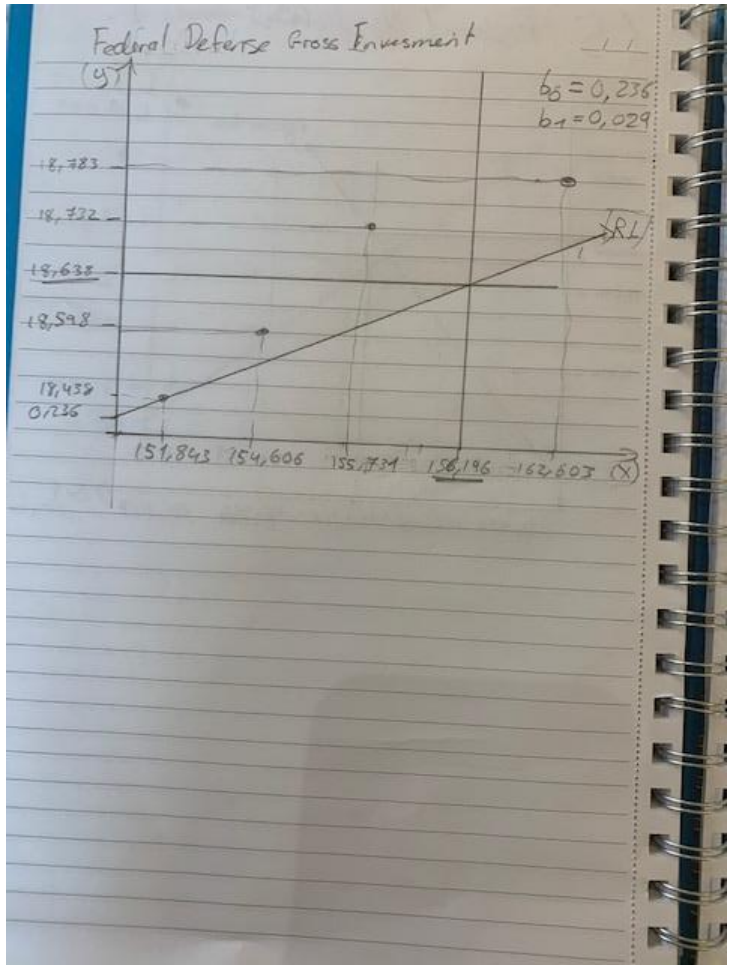
bullanan

$$F_{GDP} = \frac{\partial (GDP)}{\partial t} = \frac{GDP_s - GDP_n}{\Delta t}$$

$$\frac{\partial a_i}{\partial t} = \frac{\partial (GDP)}{\partial t} \frac{\partial a_i}{\partial (GDP)}$$

$$\frac{\frac{\partial a_i}{\partial t} + \sum \frac{\partial a_j}{\partial t} \cdot \frac{\partial a_i}{\partial a_j}}{\frac{\partial a_j}{\partial a_i}} = \frac{\partial (GDP)}{\partial t} \cdot \frac{\partial a}{\partial a}$$


Federal Defense Gross Investment
(y)
b0 = 0,236
b1 = 0,029
18,783
18,732
18,638
18,598
18,439
0,236
RL
151,843
154,606
155,731
156,196
162,603
(x)


Federal Defense Gross Investment
(y)
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18,783
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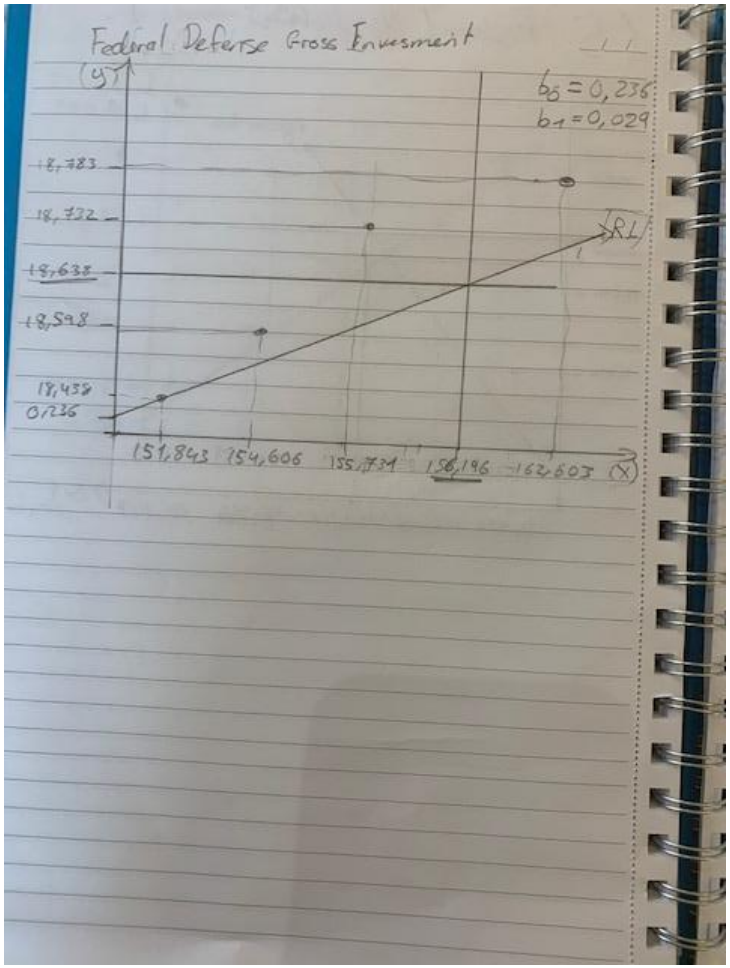
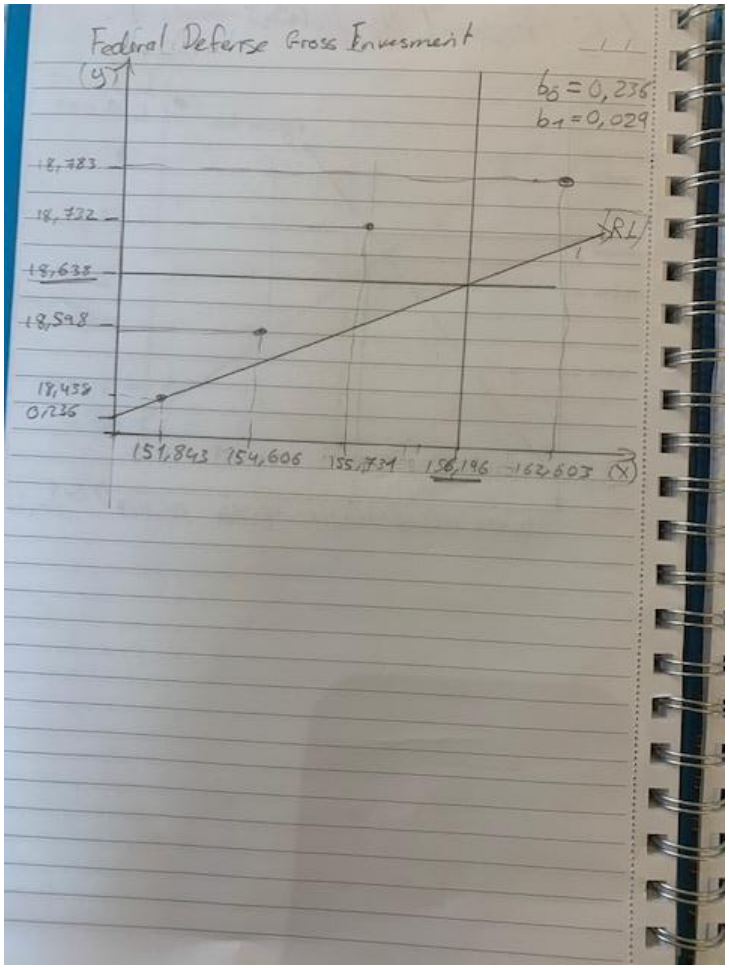
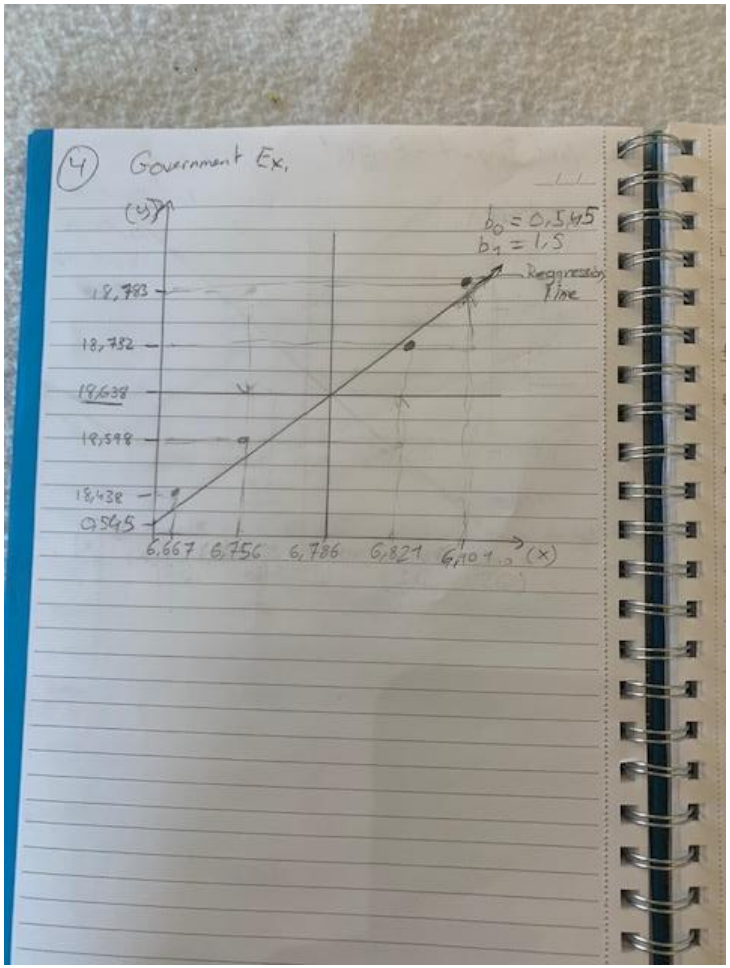
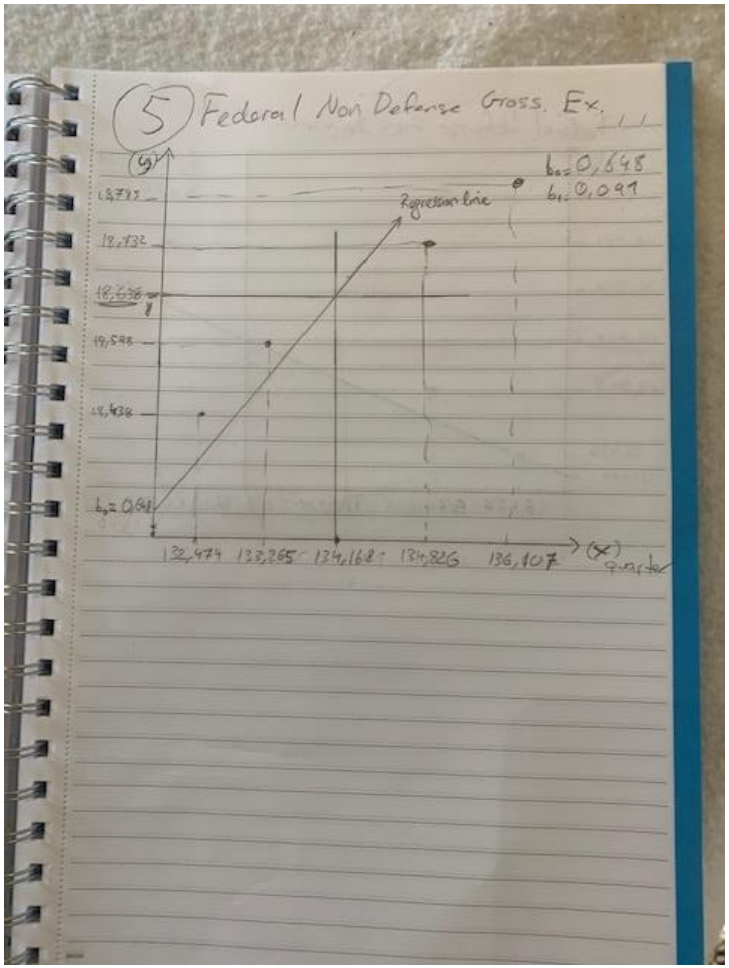
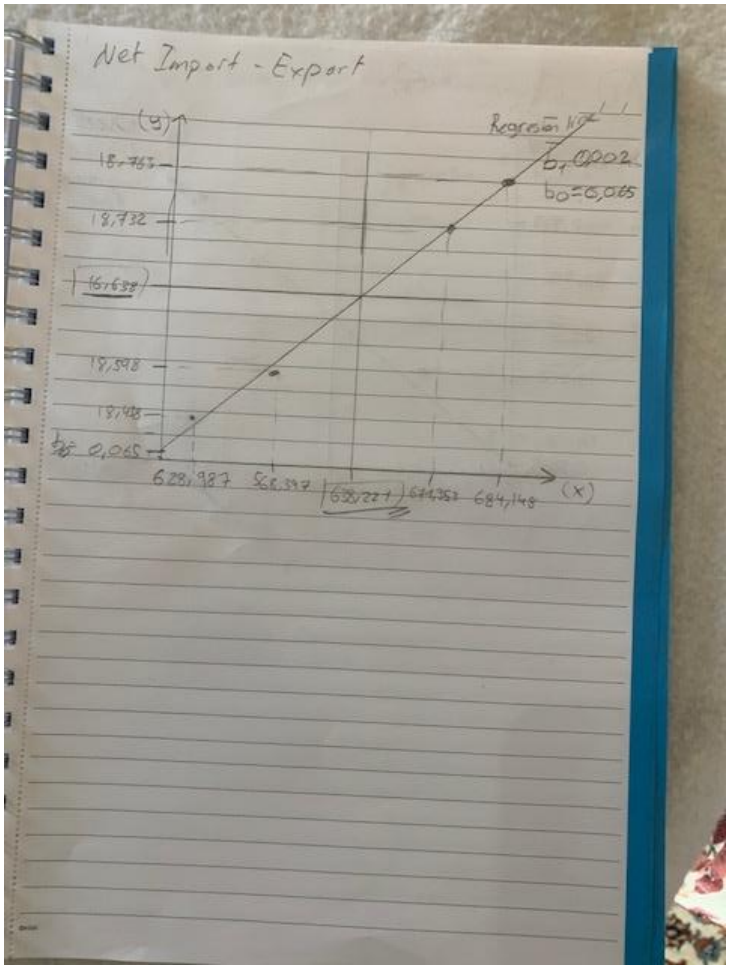
162,603
(x)

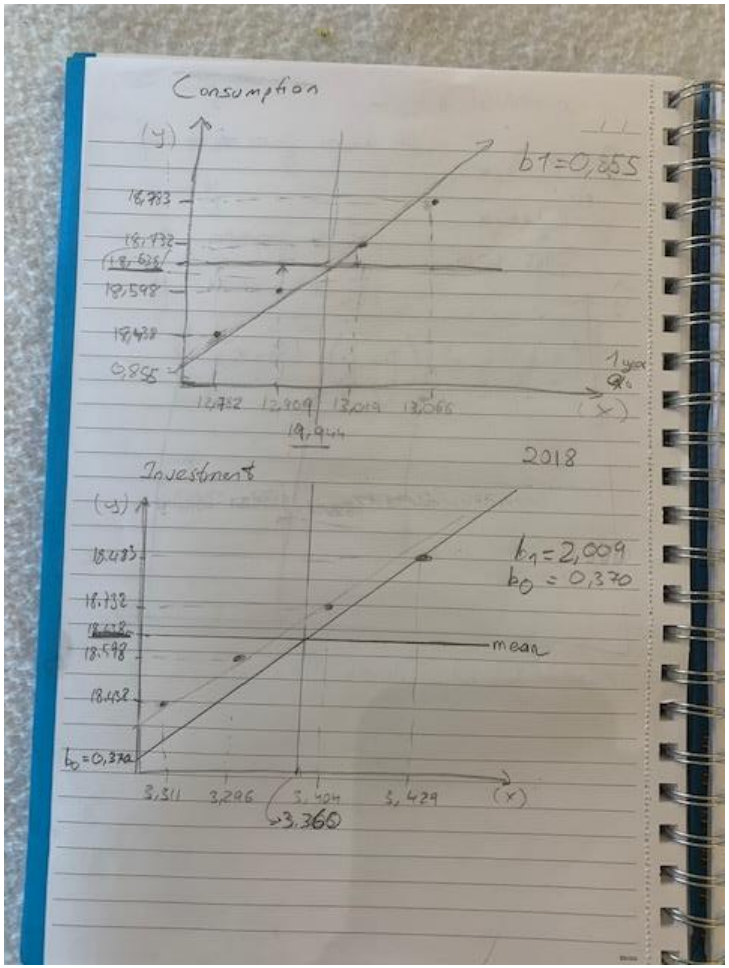

Federal Defense Gross Investment
(Y)
$b_0 = 0,236$
$b_1 = 0,029$
18,783
18,732
18,638
18,598
18,439
0,236
RL
151,843
154,606
155,731
158,196
162,603
(X)

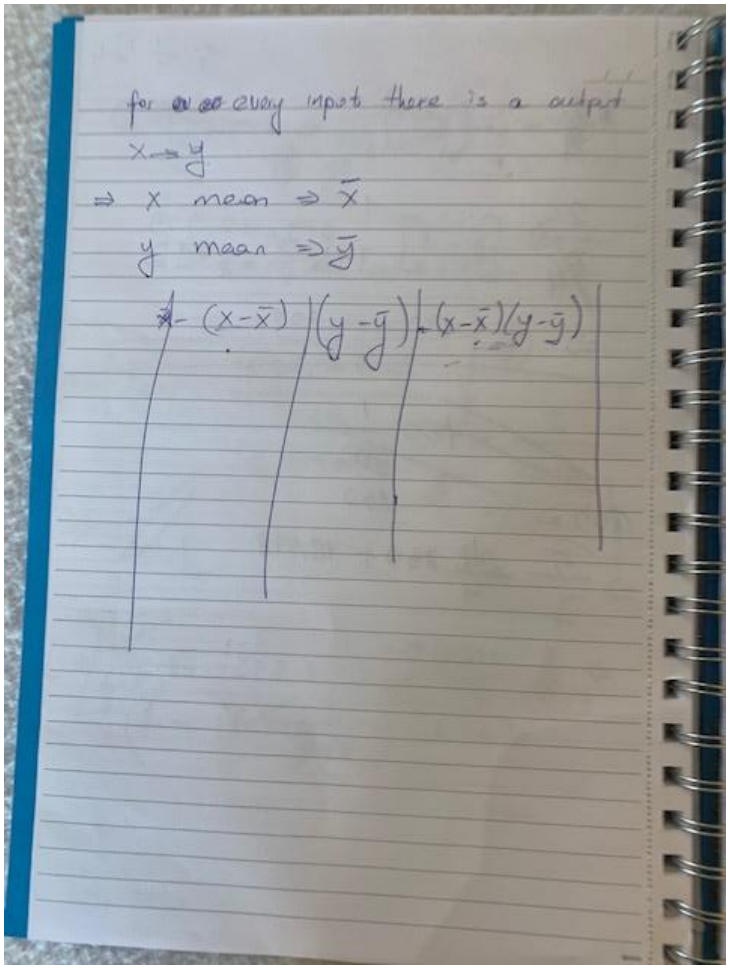

Federal Defense Gross Investment
(Y)
$b_0 = 0,236$
$b_1 = 0,029$
18,783
18,732
18,638
18,598
18,439
0,236
RL
151,843
154,606
155,731
158,196
162,603
(X)

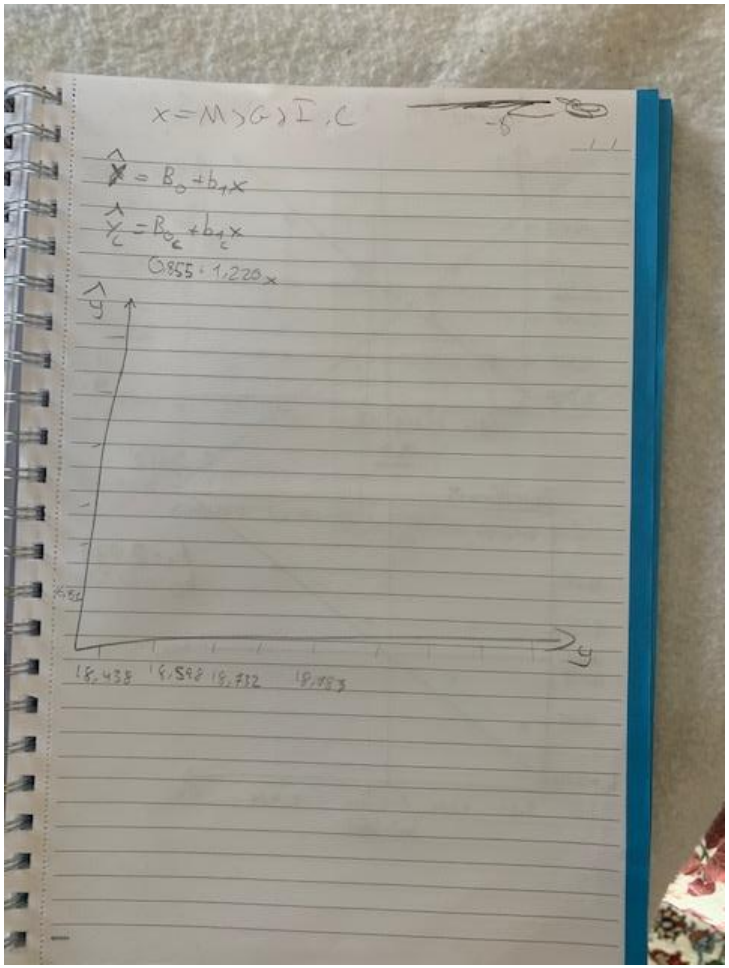

(4) Government Ex.
(y)
$b_0 = 0,545$
$b_1 = 1,5$
Regression line
18,783
18,732
19,638
19,598
18,438
0,545
6,667
6,756
6,786
6,821
6,107
(x)

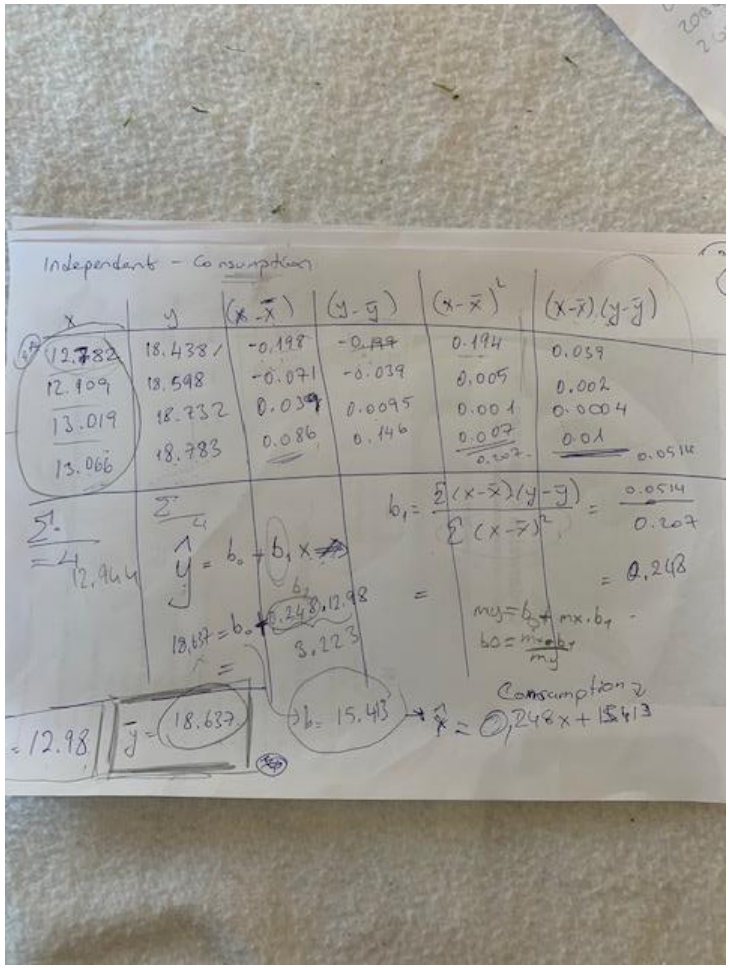

(5) Federal Non Defense Gross. Ex.
(y)
$b_0 = 0,648$
$b_1 = 0,091$
Regression line
18,783
18,732
18,638
19,598
18,438
$b_0 = 0,641$
132,474
133,285
134,168
134,826
136,107
(x)


Net Import - Export
(y)
Regresión
b1 0,002
b0=0,065
18,763
18,732
18,638
18,598
18,438
b0 0,065
628,987
568,397
638,227
671,353
684,148
(x)


Consumption
(y)
b1=0,855
18,783
18,732
18,638
18,598
18,438
0,855
12,732
12,909
13,019
13,066
19,944
(x)
2018
Investment
(y)
b1=2,009
b0 = 0,370
18,483
18,732
18,638
18,598
18,438
b0=0,370
mean
3,311
3,296
3,404
3,429
3,360
(x)


for every input there is a output
x → y
⇒ x mean ⇒ $\bar{x}$
y mean ⇒ $\bar{y}$
$(x-\bar{x})$ $(y-\bar{y})$ $(x-\bar{x})(y-\bar{y})$


x = M, G, I, C
$\hat{y} = B_0 + b_1 x$
$\hat{y}_c = B_{0c} + b_{1c} x$
0.855 + 1.220x
$\hat{y}$
y
18.438
18.598
18.732
18.983



Independent - Consumption

x	y	$(x-\bar{x})$	$(y-\bar{y})$	$(x-\bar{x})^2$	$(x-\bar{x})(y-\bar{y})$
12.782	18.4381	-0.198	-0.199	0.194	0.039
12.909	18.598	-0.071	-0.039	0.005	0.002
13.019	18.732	0.039	0.0095	0.001	0.0004
13.066	18.783	0.086	0.146	0.007	0.01
				0.207	0.0514

$\Sigma = 4$ 12.944

Σ 4

$\hat{y} = b_0 + b_1 x$

$b_1 = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{\Sigma(x-\bar{x})^2} = \frac{0.0514}{0.207} = 0.248$

$18.637 = b_0 + 0.248 \cdot 12.98$

$= 3.223$

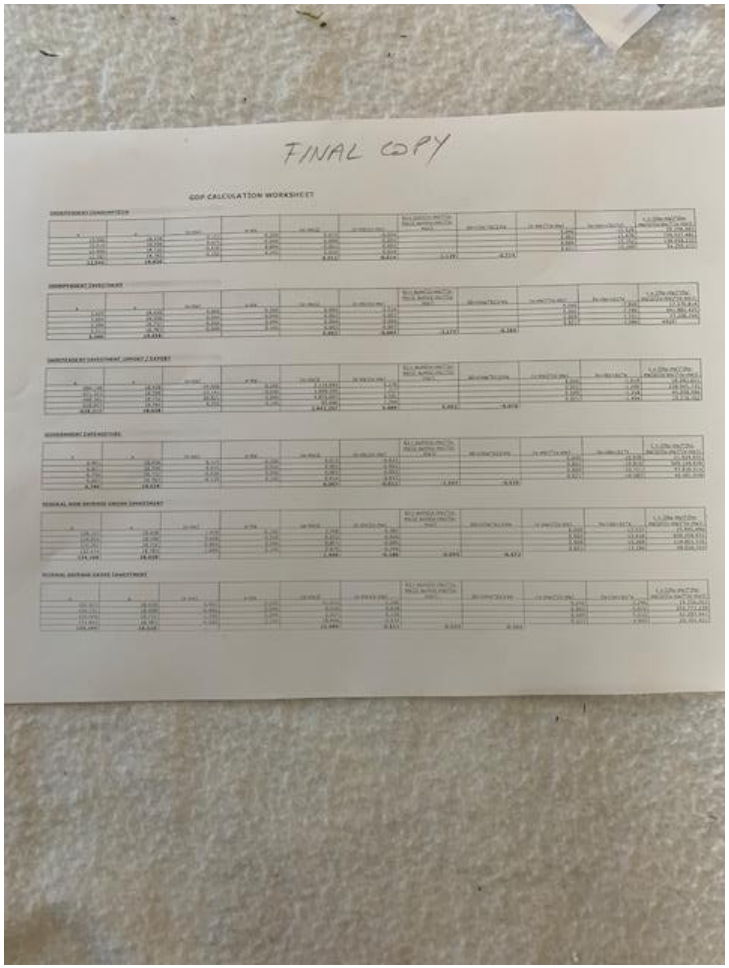
$my = b_0 + mx \cdot b_1$

$b_0 = \frac{mx \cdot b_1}{my}$

$= 12.98$ $\boxed{\bar{y} = 18.637}$

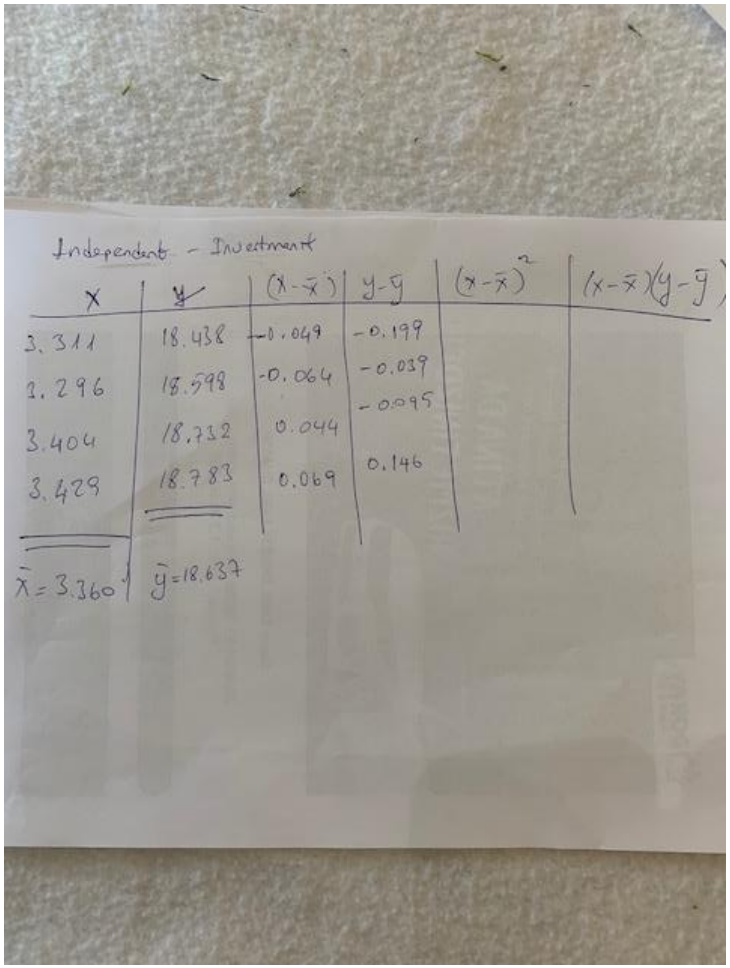
$b = 15.413 \rightarrow \hat{x} = 0.248x + 15.413$

Consumption



FINAL COPY

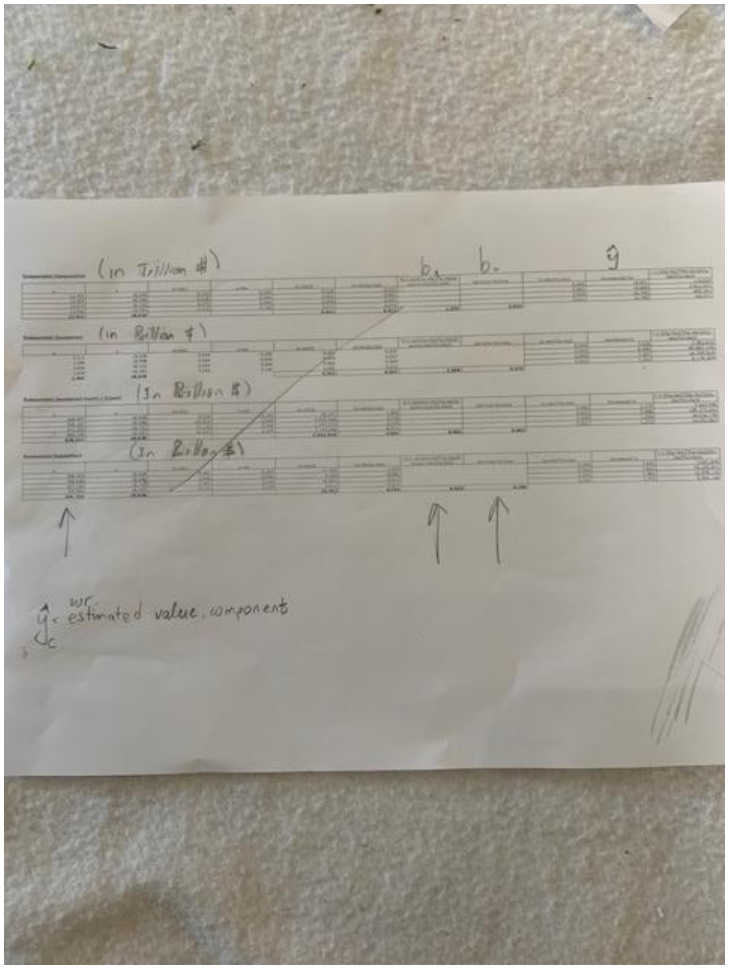
GDP CALCULATION WORKSHEET



Independent - Investment

X	Y	$(x-\bar{x})$	$y-\bar{y}$	$(x-\bar{x})^2$	$(x-\bar{x})(y-\bar{y})$
3.311	18.438	-0.049	-0.199		
3.296	18.598	-0.064	-0.039		
3.404	18.732	0.044	-0.095		
3.429	18.783	0.069	0.146		

$\bar{x} = 3.360$ $\bar{y} = 18.637$



(in Trillion $)

(in Billion $)

(in Billion $)

(in Billion $)

b_1 b_0 $\hat{y}$

$\hat{y}$ = estimated value, component

$\hat{y} = \frac{\sum y_i}{N} \Rightarrow \Rightarrow \hat{y} = b_0 + b_1 \hat{x}$

$\frac{\sum y_i}{N} = b_0 + b_1 \cdot \hat{x}$

$b_0 =$

$\hat{x} = \frac{\sum x_i}{N}$

x	y	$y - \bar{y}$	$(y - \bar{y})^2$

Total =

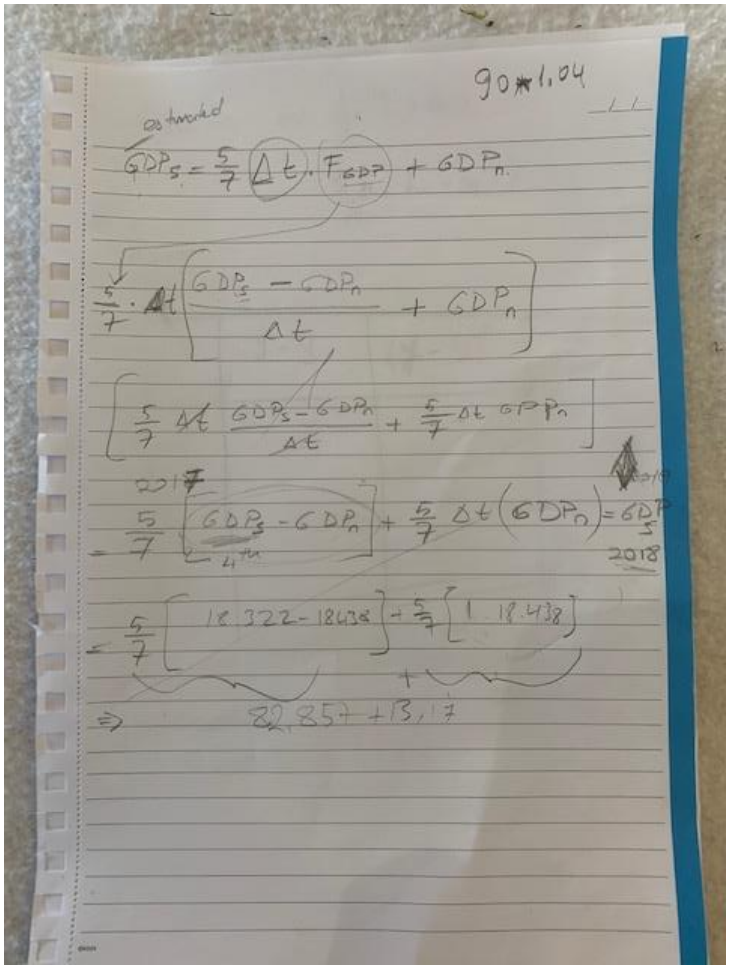
$\hat{y} =$ ~~Constant~~ $+ 0.248X$ consumption

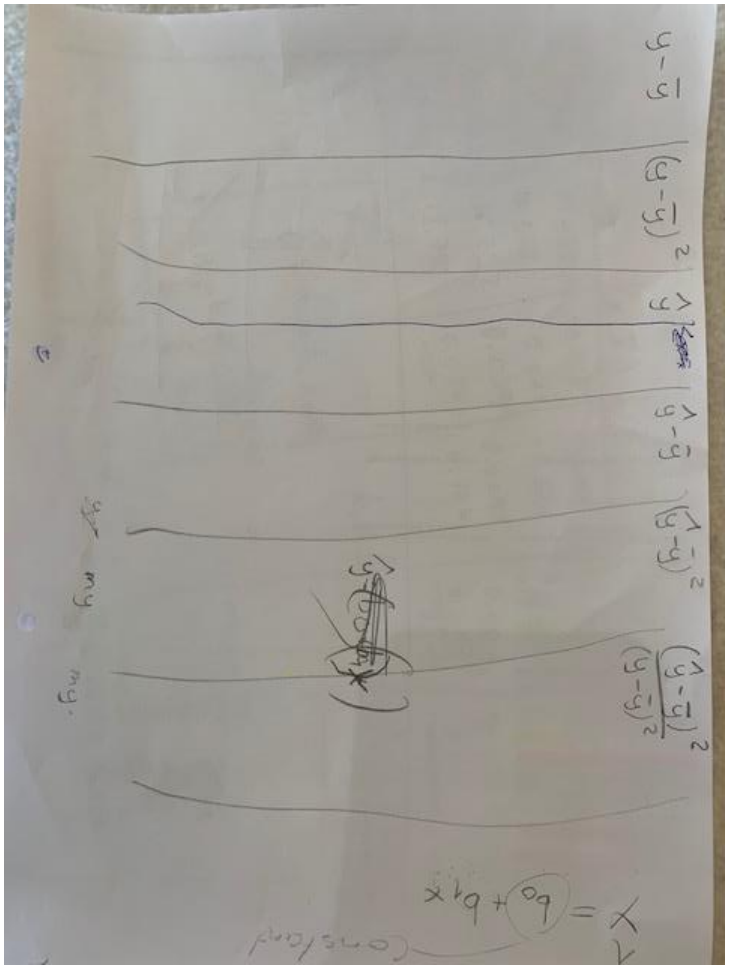
$15.413 + 0.248X$

Independent - Investment

x	$\bar{y}$	$(x - \bar{x})$	$(y - \bar{y})$	$(x - \bar{x})^2$
3.429	18.438		-0.199	
3.404	18.598		-0.039	
3.296	18.732		0.0095	
3.311	18.783		0.146	
$\bar{X} = 3.360$				

D.





90*1.04

estimated

$$GDP_s = \frac{5}{7}\Delta t \cdot F_{GDP} + GDP_n$$

$$\frac{5}{7}\cdot \Delta t\left[\frac{GDP_s - GDP_n}{\Delta t} + GDP_n\right]$$

$$\left[\frac{5}{7}\Delta t\,\frac{GDP_s - GDP_n}{\Delta t} + \frac{5}{7}\Delta t\, GDP_n\right]$$

2017

$$= \frac{5}{7}\left[\underbrace{GDP_s - GDP_n}_{4^{th}}\right] + \frac{5}{7}\Delta t\left(GDP_n\right) = GDP_s$$

2018

$$= \frac{5}{7}\left[18.322 - 18.438\right] + \frac{5}{7}\left[1 \quad 18.438\right]$$

$$\Rightarrow \quad 82.857 + 13.17$$

$y - \bar{y}$

$(y - \bar{y})^2$

$\hat{y}$

$\hat{y} - \bar{y}$

$(\hat{y} - \bar{y})^2$

$\frac{(\hat{y} - \bar{y})^2}{(y - \bar{y})^2}$

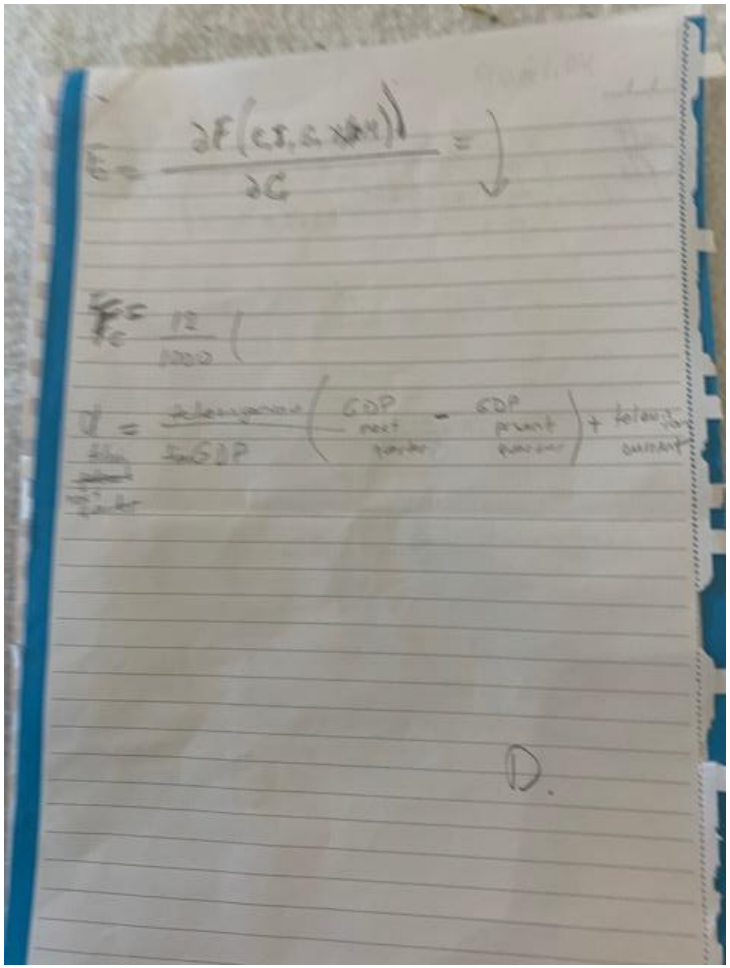
y

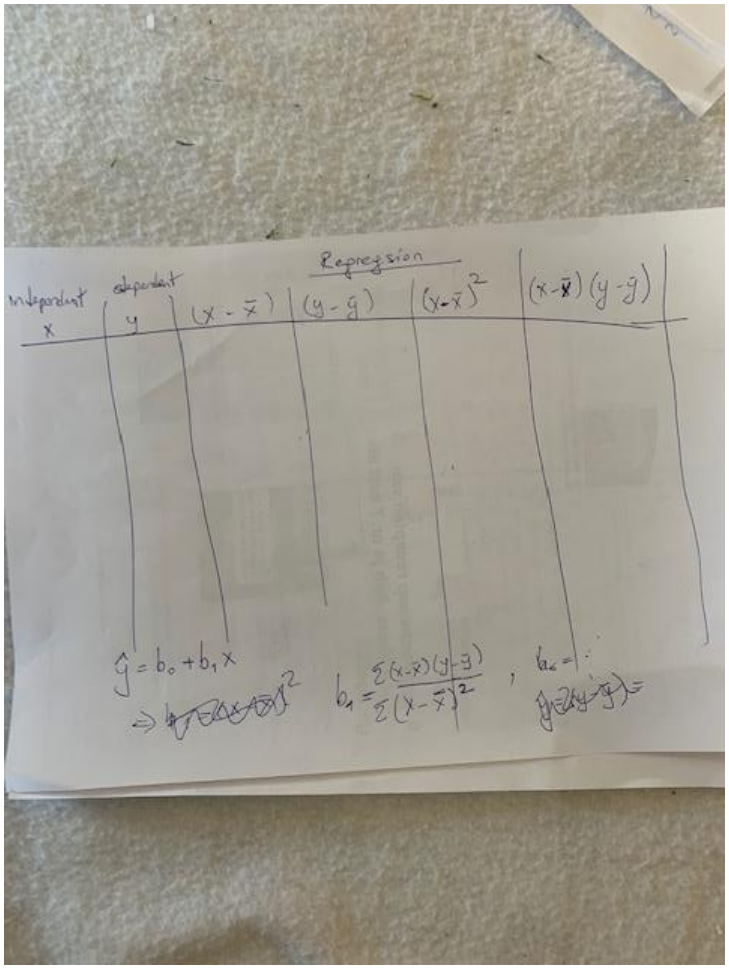
my

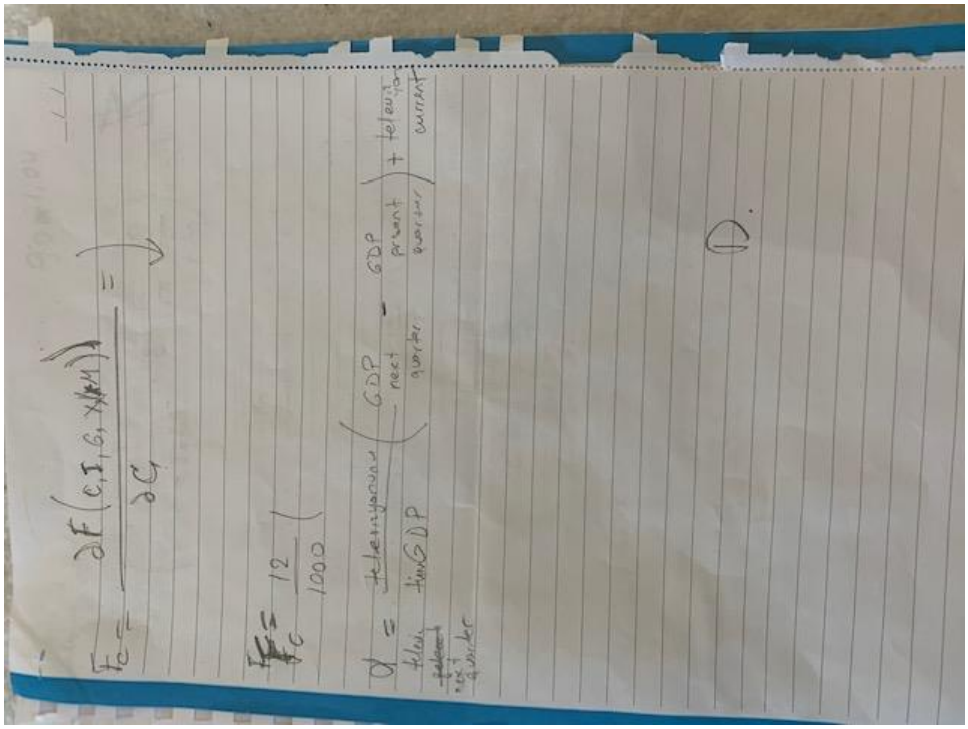
my

$\hat{y} = b_0 + b_1 x$

Constant


D.


Regression
independent x
dependent y
$(x-\bar{x})$
$(y-\bar{y})$
$(x-\bar{x})^2$
$(x-\bar{x})(y-\bar{y})$
$\hat{y} = b_0 + b_1 x$
$b_1 = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{\Sigma(x-\bar{x})^2}$



Criteria C

Could I improve my project?

Of course, I know I could improve because of my age and the knowledge that is available to me is limited. That is why I believe this is the best I could have done. I had help from my teachers and some from my mom, understanding the maths. As she studied Analitic Mathematics and Statistics.

Which materials I used?

The reasearch materials that I used are PDF and web sites. The sites are listed at the bibliography.

The changes I made in my project?

My goal was to understand how these theories worked but the problem was I had to have a product. This made me have to change theory because of its sheer complexity. I really disliked creating the product. I still do but as it is a must. So I decided to do a GDP calculation. Predicting the future GDP by using math was complicated but fun. I am going to make a graph and display it on presentation day. At the end of my Personal Project I understood how the financial world works. I believe my project fits with innovation because I am creating my own calculation of GDP and saw how much computer science needed for Scientific and Technical innovation is needed, as economy is a man made systems interacting with each other.

What type of help I got?

I did all the research my self. I had some help on the math issues.

Criteria D

Reflection: I am at the midway on finishing my product yet I believe that the outcome will not be similiar to analist graphs. I could not do all the data because of the complication of the maths. When I started this project my goal was to use the trust model. It was very unreliable because of the reasons listed in criteria A and because you take a gamble on a number between 1-0. The new model I am creating is doable, plus it has to do with economics. I can not say I had fun doing this project because of the fact that it was way out of my league. But overjoyed thatI am almost through it.

Why I believe this is the best project I could create?

I believe I have done every thing in my capabilities to make this project the best but there is always room for improvement.

Which ATL skills I used the most?

I used research mostly to find information. Understanding the information made me develop my research skills. I improved my thinking skills by trying to understand the maths.

What I think about product?

I believe my product is perfect for me but should be further studied for analists and investers.

If I created the project for the start,what would I change?

I would use the trust model because it actually was very interesting to me. I would make the product way before the deadlines.

Explaning models

"Economic Models and Algorithms for Distributed Systems

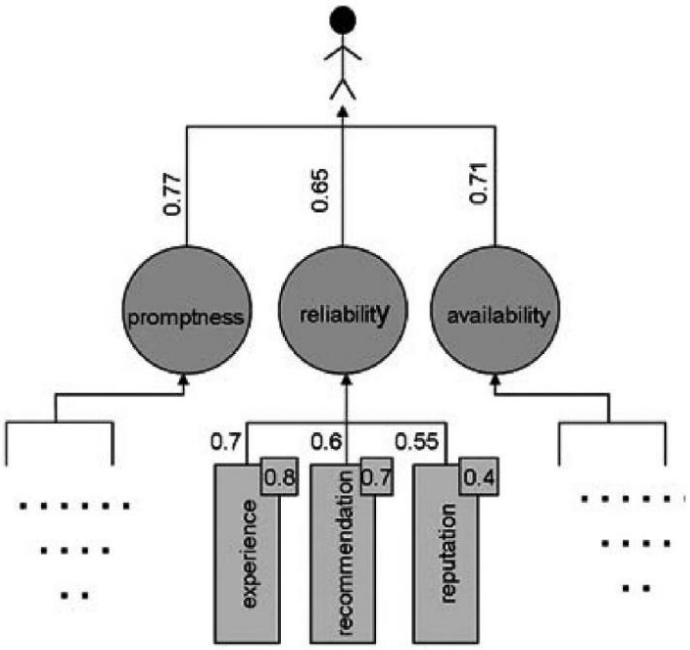
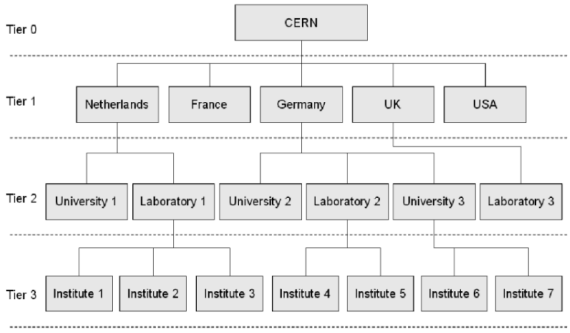


FIGURE 1. A complete scenario.

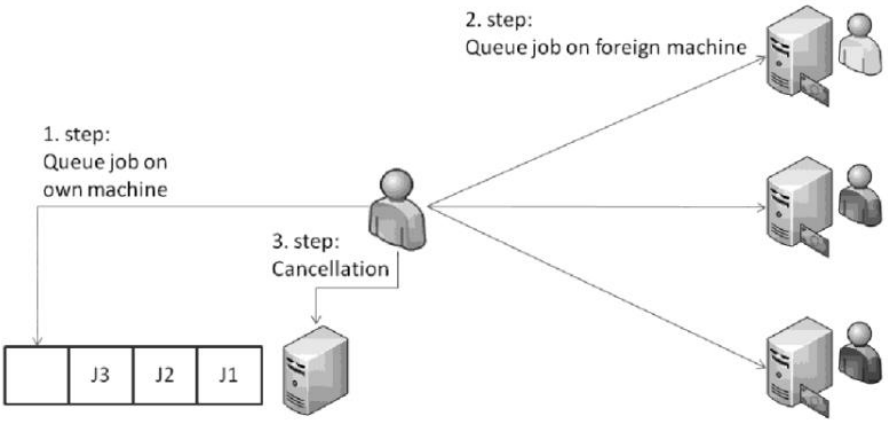
This is my first theory that I wanted to do. It is much more complicated than it looks, this is just the end phase model to help people understand the simple part. This theorem is not the most accurate because it is based on probability of assesments. This makes it very unrealiable, thus you should use this model and calculation as a helping tool instead of using it to buy stocks,bonds, etc. The model works on three main colums. These main columns in theory should be based on facts. The difficult part is that facts are things that have already happened, this means that every score you give in a column is a gamble. To win money in the market you have to see the future. Quite literally. So these columns are based on trust and trust is an assestment of promtness(when someone compliments your promptness, they're either admiring your tendency to act immediately or your punctuality)("Promptness - Dictionary Definition."Vocabulary.Com,2020,www.vocabulary.com/dictionary/promptness. Accessed 6 Feb. 2020.),reliability(the quality of being trustworthy or of performing consistently well)("Reliability | Definition of Reliability in English by Lexico Dictionaries." Lexico Dictionaries | English, 2019, www.lexico.com/en/definition/reliability.),availbility(the quality of being able to be used or obtained.). In theory if we were a robot these would always be consistent, Being the humans that we are, consciousness is our weakness. Consiousness has been proven to be unreliable but AI(artifitial intelegence). On top of all this reliability splits under three different catagories; experience, recommendation, reputation). This is a horse view because it is dependent on one person. I don't believe one person can change the world but I do believe in that one person can change the stock market. Thus, the world population is 7.7 billion. This creates either unreliability or every President, CEO of the top S&P 500, CEO NASDAQ 500 has to be assest in every country. This makes it impossible to do it as a human because these actions that each individual creates takes approximitly 1.25 seconds, this is impossible to do all of this in 1.25 seconds. However computers can do all

of this at the same time, this makes computers to slowly but surely take over the stock market. The reason why I did not use this theory is because understanding it was hard enough and the maths is near impossible for me to understand. This theorem is in microeconomics. Most of the matematical information is hidden in universities making it hard to complete. Thus staying away from this theory was inevitable.

Function examples of trust models



$$U_{jm}(t) = \mu * \left(D_j \geq \frac{1}{\sqrt{r_m(t)}} * C_{jm}(t) + t \right) * V_j - \pi_{jm}(t) \, .$$



$$l_m^{delayLoss}(t) = \sum_{k=1}^{Q} \pi_{km}(t) * \mu\big(D_j < \hat{C}_{jm}(t) + t\big) \, .$$

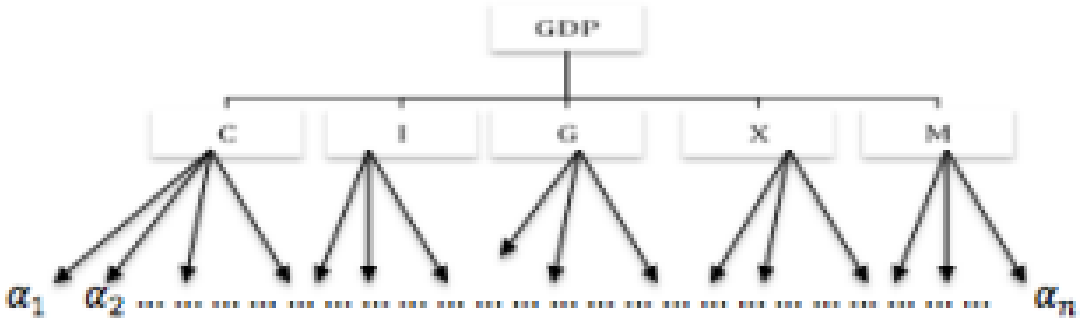
(Economic Models and Algorithms for Distributed Systems (2))

$$m(\phi) = (m_1 \cap m_2)(\phi) = \sum_{B \cap C = \phi} m_1(B) m_2(C) \,.$$

(Economic Models and Algorithms for Distributed Systems bibliography (2))

Mathematical Modeling and Algorithms to Simulate The Economy's Behavior

Basic assumptions: GDP of a country can be expressed in terms of many components. As a result, GDP's components can be represented like below.



$$GDP = C + I + G + (X - M)$$

Then,

$$GDP = f(C, I, , G, X, M),$$
$$C = f(I, G, X, M),$$
$$I = f(C, G, X, M),$$
$$G = f(C, I, X, M),$$
$$X = f(C, I, G, M) \text{ and } M = f(C, I, G, X)$$

Basic matematical concept of GDP

Wiki Least square definition:The method of least squares is a standard approach in regression analysis to approximate the solution of overdetermined systems by minimizing the sum of the squares of the residuals made in the results of every single equation.(“Least Squares.” (7)

Wiki Interpolation definition: In the mathematical field of numerical analysis, interpolation is a type of estimation, a method of constructing new data points within the range of a discrete set of known data points.(Wikipedia Contributors. “Interpolation.” Wikipedia, Wikimedia Foundation, 10 Nov. 2019, en.wikipedia.org/wiki/Interpolation. Accessed 19 Nov. 2019.)

Wiki definition of regresion: In statistical modeling, regression analysis is a set of statistical processes for estimating the relationships between a dependent variable and one or more independent variables.My understanding is that it is a estimate of a graph that is not straight.I believe it is an estimate of data to make a straight linear line.(Wikipedia Contributors.(“Regression Analysis.” *Wikipedia*, Wikimedia Foundation, 22 Mar. 2019, en.wikipedia.org/wiki/Regression_analysis.)

A reserve currency (or anchor currency) is a foreign currency that is held in significant quantities by central banks or other monetary authorities as part of their foreign exchange reserves. It is often considered a hard currency or safe-haven currency.(“Reserve Currency.” ()

“To calculate the GDP I will use the methods of regression and interpolation "Least square methods" by applying polynomial, exponential(optional) and linear models” (“Mathematical Modeling and Algorithms to Simulate The Economy's Behavior.” (8)). It is understandable that relations between each component effect each other. Relations between two variables y & x in a country can be different from the relations between y & x in other country, because of the characteristics of each economy. It's hard to make the fitting between a component and all the others in multidimensional variables, so we I will use this formula for every component and takes it derivative $\frac{\partial y}{\partial t}$. The fittings between y & t every two components separately, to determine specified relation, for example, I will deduce fitting between, then determine the derivative.((“Mathematical Modeling and Algorithms to Simulate The Economy's Behavior.” (8))

This is the simpifyed version of GDP

The formula to calculate the components of GDP is Y = C + I + G + NX.

This example is writen in order. That stands for: GDP = Consumption + Investment + Government + Net Exports, which are imports minus exports.

Consumer spending contributes 70% of total United States production. In 2019, that was $13.28 trillion.2

The figures reported are real GDP. It's the best way to compare different years. They are rounded to the nearest billion. The BEA(Bureau of Economic Analysis) uses personal consumption expenditures into goods and services. This means I will use goods and services instead of consumption. When you hear reports of a country’s GDP that do not specify the

type of GDP, it is likely to be nominal GDP. Nominal GDP includes both prices and growth, while real GDP is pure growth. This is key in calculations.

Personal consumption expenditures include:

1. Durable goods – cars, furniture, large appliances.
2. Non-durable goods – clothing, food, fuel.
3. Services – banking, health care, education.

These are very important tools. Understanding that 70% of GDP is consumption this makes it very important.

The formula for real GDP is nominal GDP divided by the deflator:

R = N/D.

R(real GDP) N(Nominal GDP) D(Deflator)

Meaning of deflator: In economics, the GDP deflator is a measure of the level of prices of all new, domestically produced, final goods and services in an economy in a year. What I understood is that the deflator is given by the BEA.

Deflator formula : GDP Price Deflator=(Nominal GDP÷Real GDP)×100

Some Formulas of Calculating GDP

$$\sum_{A \subseteq \theta} m(A) = 1 \,.$$

$$bel(A) = \sum_{B \subseteq A} m(B)$$

$$m_i = \frac{m_i^{wi}(A)}{\sum_{B \subseteq \theta} m_i^{wi}(B)} .$$

ı: Dynamic weighting

ıth is available, e.g. shortly after current me
ınation channels, it can be used by making the
ıe. A simple but effective practical impleme
ne:

$$w_i = \sum_{n=0}^{\infty} c_i(n).\frac{1}{n}$$

ction describing the correctness of source S_i'

$$c_i(n) = \begin{cases} 0 & \text{correct estimation} \\ 1 & \text{incorrect estimation} \end{cases}$$

lty factor", which is used to control the change
his penalty factor to:

$$(m_1 \cap m_2)(A) = \sum_{B,B \subseteq \theta, B \cap C = A} m_1(B) m_2(C) .$$

$$(m_1 \oplus m_2)(A) = \frac{(m_1 \cap m_2)(A)}{a - m(\phi)} , \quad \forall \phi \neq A \subseteq \theta$$

$$GDP = \alpha_1 + \alpha_2 + \alpha_3 \dots \alpha_N \quad (3)$$

$for\ i = 1,2,3 \dots N$ is representing specific component in
v in the tree presented in figure (1). Then,

$$GDP(t) = \alpha_1(t) + \alpha_2(t) + \alpha_3(t) .. \alpha_N(t) \quad (4)$$

to assumption 2 and (2), we can deduce the below
by using the chain rule.

$$\frac{\partial(GDP)}{\partial t} = \sum_{i=1}^{i=N} \frac{\partial \alpha_i}{\partial t} \frac{\partial(GDP)}{\partial \alpha_i} \quad (5)$$

s the number of components in specific row.
nstruct equations for every α_i using the same concepts.

$$\frac{\partial \alpha_i}{\partial t} = \frac{\partial(GDP)}{\partial t} \frac{\partial \alpha_i}{\partial(GDP)} - \sum_{j=1, j\neq i}^{j=N} \frac{\partial \alpha_j}{\partial t} \frac{\partial \alpha_i}{\partial \alpha_j} \quad (6)$$

an collect $N + 1$ equations from (5) and (6).
to a lot of experiments, the fitting of GDP and the
ts α_i versus time brings high efficient results and high
r (coefficient of determination),

$$r = \sqrt{\frac{\sum_{i=1}^{N_s} (\hat{y}_i - \bar{y})^2}{\sum_{i=1}^{N_s} (y_i - \bar{y})^2}} \quad (7)$$

is the theoretical y-value corresponding to t_i (calculated
e model) and $\bar{y}$ is the mean value of all experimental y-
N_s is the number of years or quarters in which the data
d.
ne results are shown in table(1), figures (2),(3).

Component Name	Exponential Fitting Value	Linear Regression Fitting values	Fitting value of the poly 2nd degree	The fitting of the power model

Figure.3 GDP of US from 1948-2011 by expo

We will replace each of the time derivatives f
and for GDP in the right hand side of (5) & (6) b
functions. These functions results from the diffe
interpolated function, which deduced from the fi
Consequently, we will assume the below

$$\frac{\partial(GDP)}{\partial t} = F_{GDP},$$
$$\frac{\partial \alpha_i}{\partial t} = F_{\alpha_i}$$

These modifications will generate system of I
describe the relations between the components d
hypothesis in (2).
We can apply the finite difference technique on
the right hand side of (5) & (6) then,

$$\frac{\partial(GDP)}{\partial \alpha_i} = \frac{GDP_s - GDP_n}{\alpha_{i_s} - \alpha_{i_n}}$$
$$\frac{\partial \alpha_i}{\partial \alpha_j} = \frac{\alpha_{i_s} - \alpha_{i_n}}{\alpha_{j_s} - \alpha_{j_n}}$$

Where the notation "s" refers to the simulated va
the next quarter or year (the new values are after
where "n" refers to the present values.
We will apply the finite difference on the left ha
of (5) and (6). Then,

$$\frac{\partial(GDP)}{\partial t} = \frac{GDP_s - GDP_n}{\Delta t}$$
$$\frac{\partial \alpha_i}{\partial t} = \frac{\alpha_{i_s} - \alpha_{i_n}}{\Delta t}$$

$$m(\phi) = (m_1 \cap m_2)(\phi) = \sum_{B \cap C = \phi} m_1(B) m_2(C) .$$

Where P is the number of components with negative sign and N is the total number of components with positive or negative signs.

$$\alpha_{i_s} = \begin{cases} \frac{F_{\alpha_i}}{F_{GDP}}(GDP_s - GDP_n) + \alpha_{i_n}, & \alpha_i \text{ is "}-\text{"} \\ (\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n})^{-1}F_{\alpha_i} + \alpha_{i_n}, \alpha_i \text{ is "}+\text{"} \end{cases} \quad (14)$$

Where "$-$" and "$+$" are the signs of the component and all factors of expectations equal zero. If we apply this algorithm in the first row of the tree as shown in figure (1). Then,

$$\begin{aligned} GDP_s &= \frac{5}{7}\Delta t F_{GDP} + GDP_n, \\ M_s &= \frac{F_M}{F_{GDP}}(GDP_s - GDP_n) + M_n, \\ X_s &= \left(\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n}\right)^{-1} F_X + X_n, \\ C_s &= \left(\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n}\right)^{-1} F_C + C_n, \\ I_s &= \left(\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n}\right)^{-1} F_I + I_n, \\ G_s &= (\frac{2}{\Delta t} - F_{GDP}\frac{1}{GDP_s - GDP_n})^{-1}F_G + G_n \end{aligned} \quad (15)$$

B. The second algorithm:

In this algorithm we will calculate GDP_s as the previous algorithm, but we will deduce the other simulated values for the other components by solving them simultaneously without GDP_s. On other words, we will solve equations result from (12) only without (11). Then, equation (13) still applied and (14) will be

$$\alpha_{i_s} = \begin{cases} \frac{(N-1)F_{\alpha_k}(GDP_s - GDP_n)\Delta t}{(GDP_s - GDP_n) + \Delta t + F_{GDP}} + \alpha_{k_n}, i = k \\ \frac{F_{\alpha_i}}{F_{\alpha_k}}(GDP_s - GDP_n) + \alpha_{i_n}, \quad \alpha_i \text{ is "}+\text{"} \\ \frac{F_{\alpha_i}(\alpha_{k_s} - \alpha_{k_n})\Delta t}{2F_{\alpha_i}(\alpha_{k_s} - \alpha_{k_n}) - \Delta t + F_{\alpha_k}} + \alpha_{i_n}, \alpha_i \text{ is "}-\text{"} \end{cases} \quad (16)$$

$i = k$ Is any specific component with positive sign in which the other components will be calculated through it and all factors of

Equation (5) will be

$$\frac{1}{\Delta t} = \sum_{i=1}^{i=N} F_{\alpha_i}\frac{1}{\alpha_{i_s} - \alpha_{i_n}} \quad (11)$$

Where the equations resultant from (6) will be

$$\frac{1}{\Delta t} = F_{GDP}\frac{1}{GDP_s - GDP_n} - \sum_{j=1, j\neq i}^{j=N} F_{\alpha_i}\frac{1}{\alpha_{i_s} - \alpha_{i_n}} \quad (12)$$

Some of the data I used:

US GDP and its Components

Date	Nominal US GDP ADF	Real US GDP ADF	Real Personal Consumption Expenditures ADF	Gross Private Domestic Investment ADF	Real Gross Private Domestic Investment ADF	Net Exports of Goods Services ADF
2018 Q4	$20,897.8	$18,783.5	$13,066.3	$3,725.23	$3,429.48	-684.148
2018 Q3	$20,749.8	$18,732.7	$13,019.8	$3,683.98	$3,404.23	-671.353
2018 Q2	$20,510.2	$18,598.1	$12,909.2	$3,561.59	$3,296.57	-568.391
2018 Q1	$20,163.2	$18,438.3	$12,782.9	$3,542.41	$3,311.83	-628.967

Exports ADF	Imports ADF	Govt Consumption Expenditures and Gross Investment ADF	Government Current Expenditures ADF	Federal Nondefense Gross Investment ADF	Federal Defense Gross Investment ADF	State and Local Government Gross Investment ADF	Nominal Quarterly US GDP Growth Rate	Real Quarterly US GDP Growth Rate	Calculated GDP (DO NOT USE)	Nominal GDP Change From 1 Year Ago	Trade Balance Change From 1 Year Ago
2,510.52	3,194.67	3,644.8	6,901.04	136.107	162.603	396.666	2.9%	1.1%		978.9	-88.038
2,510.29	3,181.65	3,622.56	6,821.13	134.826	155.731	403.34	4.8%	2.9%		1,138.1	-120.767
2,543.6	3,111.99	3,577.15	6,756.33	133.265	154.606	398.638	7.1%	3.5%		1,153.6	15.335
2,476.59	3,105.55	3,521.36	6,667.66	132.474	151.843	388.308	5.0%	2.6%		972.8	-59.045

("US GDP and Its Components." (14))

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