SUMMER TERM 2023
CENTRALLY-MANAGED ONLINE EXAMINATION
ECON0019: QUANTITATIVE ECONOMICS AND ECONOMETRICS

Time Allowance: You have 3 hours to complete this examination, plus additional collation time of 20 minutes and an Upload Window of 20 minutes. The additional collation time has been provided to cover any additional tasks that may be required when collating documents for upload, and the Upload Window is for uploading, completing the Cover Sheet and correcting any minor mistakes. The additional collation time and Upload Window time allowance should not be used for additional writing time.

If you have been granted SoRA extra time and/or rest breaks, your individual examination duration and additional collation time will be extended pro-rata and you will also have the 20-minute Upload Window added to your individual duration.

All work must be submitted anonymously in a PDF file and you should follow the instructions for submitting an online examination in the AssessmentUCL Guidance for Students.

If you miss the submission deadline by up to 40 minutes late in the Late Submission Period, a late submission penalty will be applied unless you submit a valid claim for Technical Failures. At the end of the 40-minute Late Submission Period, you will not be able to submit your work via AssessmentUCL and you will not be permitted to submit the work via email or any other channel. If you are unable to submit your work or have submitted your work late during the Late Submission Period due to technical difficulties which are substantial and beyond your control, you should submit a claim for Technical Failures via the AssessmentUCL Query Form.

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Page Limit: 8 pages. Your answers, excluding the Cover Sheet, should not exceed this page limit. Please note that a page is one side of an A4 sheet with a minimum margin of 2 cm from the top, bottom, left and right borders of the page. The submission can be handwritten or typed, but the font size should be no smaller than the equivalent to an 11pt font size. This page limit is generous to accommodate students with large handwriting. We expect most of the submissions to be significantly shorter than the set page limit. If you exceed the maximum number of pages, the mark will be reduced by 10 percentage points, but the penalised mark will not be reduced below the pass mark and marks already at or below the pass mark will not be reduced.

Query on the Examination Paper: If you have a query about the examination paper, instructions or rubric, you should complete an AssessmentUCL Query Form. Please note that you will not receive a response during your examination.

Academic Misconduct: By submitting this assessment, you are confirming that you have not violated UCL's Assessment Regulations relating to Academic Misconduct contained in Section 9 of Chapter 6 of the Academic Manual.

Number of Questions Answered Policy: In cases where a student answers more questions than requested by the examination rubric, the policy of the Economics Department is that the student's first set of answers up to the required number will be the ones that count (not the best answers). All remaining answers will be ignored.

QUESTIONS:

Answer ALL TWO questions from Part A and answer ONE question from Part B.

Questions in Part A carry* 60 *per cent of the total mark and questions in Part B carry* 40 *per cent of the total mark. Tables for the normal and F-distribution are at the end of the examination paper.

PART A

Answer all questions from this section.

A.1 You are working for a major political party called A and wish to better understand which types of voters that are more likely to vote for either A or its main competitor called B. You collect data on n voters where for each individual you observe whether he or she voted for A or B, together with k voter characteristics. For voter $i = 1, ..., n$ in the sample, let

$$y_i = \begin{cases} 0, & \text{didn't vote for A or B} \\ 1, & \text{voted for A} \\ 2, & \text{voted for B} \end{cases},$$

and $\mathbf{x}_i = (x_{i1}, ..., x_{ik})$ contains the k household characteristics (such as years of education of each member, total income, etc).

(a) To learn about which voter characteristics explain the relative attractiveness of the two different parties, you estimate the following regression,

$$y = \beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k + u,$$

where we are willing to assume that $\mathbb{E}[u|\mathbf{x}] = 0$, using your sample. Is this regression useful for the purpose of your analysis? Explain.

(b) Next, you decide to build a model for each party's share of votes from a given segment of the population of voters. Formally, among the subpopulation of voters with characteristics $\mathbf{x}$, let $0 \leq \pi_j(\mathbf{x}) \leq 100$ be the percentage that voted for party $j \in \{A, B\}$. Your chosen model assumes that $\pi_j(\mathbf{x})$ satisfies

$$\pi_j(\mathbf{x}) = \beta_{j0} + \beta_{j1}x_1 + \cdots + \beta_{jk}x_k,$$

for some unknown coefficients $\beta_{j0}, \beta_{j1}, ..., \beta_{jk}$ for $j \in \{A, B\}$. Explain how you would estimate the coefficients in these two equations by OLS.

(c) How would you compute standard errors for the OLS estimators in part (b)? Justify your answer.

(d) A colleague claims that more efficient estimators of the coefficients are available. Is your colleague right? Explain. If your answer is yes then describe such estimators in detail.

(e) Given estimates of the coefficients $\beta_{j0}, \beta_{j1}, ..., \beta_{jk}$ for $j \in \{A, B\}$, how would you predict the likelihood of a given voter, whose characteristics $\mathbf{x}$ you know, will vote for neither A nor B?

(f) How would you estimate the share of voters who would vote for neither A nor B in the whole population? Justify your answer. Provide standard errors for your proposed estimator.

A.2 You collect data on log–wages, *lwage*, work experience, *exper*, and education, *educ*, of 2000 individuals and obtain the following estimated regression function:

$$\widehat{lwage} = \underset{(0.23)}{1.90} + \underset{(0.09)}{0.35}\,exper + \underset{(0.09)}{0.11}\,exper^2 + \underset{(0.08)}{0.32}\,educ,$$

with $\bar{R}^2 = 0.26$ and $\hat{\sigma} = 0.12$.

(a) Consider an employed male individual with 10 years of education and 5 years of experience. Based on the above regression, provide a prediction of this individual's wages if he stays in his current position one additional year. Justify your answer and any limitations to it.

(b) Is there an optimal level of years of experience in terms of predicted earnings? Explain.

(c) Given the information provided, do you find that the above model provides a better description of data compared to the model that assumes that log-wages are linear in experience and education? Explain.

(d) You estimate the following alternative model:

$$\widehat{lwage} = \underset{(0.19)}{1.75} + \underset{(0.08)}{0.41}\,exper + \underset{(0.07)}{0.21}\,(educ \cdot exper) + \underset{(0.09)}{0.23}\,educ$$

with $\bar{R}^2 = 0.32$ and $\hat{\sigma} = 0.09$. Interpret the interaction term and its estimated coefficient.

(e) Which of the above two models would you recommend based on the information provided?

(f) How would you formally test the two models against each other?

PART B

Answer ONE question from this section.

B.1 Fajgelbaum, Goldberg, Kennedy, and Khandelwal (Quarterly Journal of Economics, 2020) estimate the demand for imports from China in the U.S. and the supply of exports in China to analyze the consequences of the trade war between the two countries in 2018. To do so, they leverage the variation in import tariffs imposed by the U.S. in that year across products. For a large sample of products they specify the import demand equation (where we simplify some details and suppress the intercepts):

$$q_i = \alpha_d \cdot (p_i + \tau_i) + d_i, \tag{1}$$

where q_i is the quantity of product i imported from China into the U.S. in 2018, τ_i is the new import tariff, p_i is the producer price in China (not including the tariff), $p_i + \tau_i$ is the consumer price (inclusive of the tariff), d_i is the error term, and $\alpha_d < 0$ is the slope of the demand curve. They also specify the Chinese export supply equation:

$$q_i = \alpha_s p_i + s_i, \tag{2}$$

where s_i is the error term and $\alpha_s > 0$.[1] The authors assume that the tariffs are exogenous with respect to demand and supply factors, d_i and s_i.

(a) Write down the reduced-form equations for price and quantity.

(b) Does OLS regression of q_i on the producer price p_i yield a consistent estimate for α_s? And for α_d? In each case, explain why or why not and discuss whether the bias is likely towards zero or away from zero.

(c) How can you consistently estimate α_s? Describe the estimator precisely. What problem with your estimator can arise if export supply is very elastic? Explain the economic intuition for this problem.

(d) How can you consistently estimate α_d? Discuss what is special about this setting, relative to the model of demand and supply studied in class, that allows you to estimate both parameters.

(e) Suppose now that export supply elasticities vary across industries, such that equation (2) is replaced by

$$q_i = \alpha_i p_i + s_i, \tag{2'}$$

[1] To be precise, q_i and p_i are *logs* of quantity and price, and τ_i is the *ad valorem* tariff that multiplies the price. For brevity, we ignore the logs. To be even more precise, all variables are measured as differences between 2018 and the previous year 2017, before the tariffs were introduced.

where α_i is positive in all industries and independent from the tariff. Continue to assume that the import demand elasticity α_d is homogeneous. Are your estimators from parts (c) and (d) consistent for $\mathbb{E}[\alpha_i]$ and α_d, respectively? Explain why or why not and, in cases when it's not, discuss the direction of the bias.

B.2 This question concerns the problem of forecasting oil prices, using either autoregressive models or autoregressive distributed lag models with U.S. employment growth. Figure 1 shows the Brent oil price and total U.S. employment, both in 12-month percent changes. The variables are defined in Table 1, and Table 2 gives regression results. Figures 2 and 3 follow with model diagnostics.

Figure 1: Brent oil price and U.S. Employment 12-month percentage changes

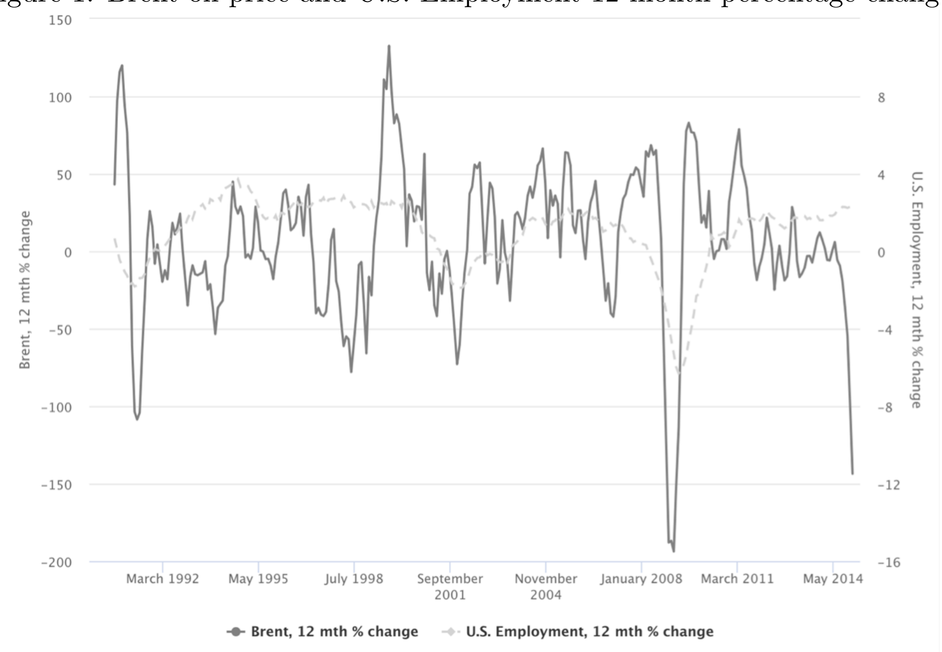

Table 1: Variable Definitions

Unit of Observation: Monthly, July 1987 – November 2014 ($T = 329$)

Variable name	Variable definition	Mean	Std. Dev.
dlbrent	Monthly percentage change in brent oil price (computed as $100\Delta \ln(Brent_t)$, where $Brent_t$ is the Brent oil price in month t)	0.48	8.74
dlemp	Total employment in the U.S., monthly percent change (computed as $100\Delta \ln(Emp_t)$, where Emp_t is the monthly employment)	0.93	0.169

Table 2: Oil price forecasting models, monthly data, 1988-2014

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimation period:	1988m1-2012m12	1988m1-2012m12	1988m1-2012m12	1988m1-2012m12	2010m1-2012m12	1988m1-2014m11	2010m1-2014m11
Regressors							
$dlbrent_{t-1}$	0.265***	0.275***	0.275***	0.262***	0.214	0.270***	0.321**
	(0.075)	(0.076)	(0.077)	(0.074)	(0.212)	(0.073)	(0.142)
$dlbrent_{t-2}$	–	-0.037	-0.041	–	–	–	–
		(0.61)	(0.64)				
$dlbrent_{t-3}$	–	–	0.013	–	–	–	–
			(0.064)				
$dlemp_{t-1}$	–	–	–	1.85**	-8.67	1.50**	-11.76**
				(0.78)	(6.12)	(0.68)	(5.35)
Constant	0.46	0.48	0.46	0.30	1.75	0.20	1.48
	(0.51)	(0.51)	(0.51)	(0.66)	(1.05)	(0.64)	(0.93)
BIC	4.334	4.351	4.370	–	–	–	–
Adjusted R^2	0.0670	0.0674	0.0641	0.075	0.009	0.074	0.104
RMSFE, 2013m1-2014m11	3.96	3.96	3.96	4.03	3.98	3.95	3.59
Total no. observations	300	300	300	300	36	323	59

Notes: All regressions are estimated by OLS. Standard errors (in parentheses below coefficients) are heteroskedasticity-robust. The RMSFE is the root mean squared forecast error, computed over the period 2013m1-2014m11, using the reported estimation period to estimate the model parameters (note that the units of the RMSFE are the same as for the dependent variable). Coefficients are significant at the **5% and ***1% significance levels.

(a) Of the three autoregressive models (1)-(3), choose a preferred model. Justify your choice.

(b) Figure 2 plots the Quandt Likelihood Ratio statistic, computed for regression (4) (note: the maximum value is 3.67).

  i. Explain precisely what is plotted in the figure and how you could produce those values.

  ii. In order to draw a conclusion, to what must you compare the values in Figure 2? Why?

  iii. What do you conclude?

(c) Choose a preferred forecasting model from regressions (4)-(7) and justify your choice.

(d) Using your preferred model from question part (c):

  i. Forecast the Brent oil price for January 2015 (in $/barrel), based on the following partial data through December 2014. You can assume that the predicted change is "small". (Hint 1: first produce a forecast of the percentage change).

Variable	December 2014 value
Brent price ($/barrel)	$62.12
$dlbrent_t$	-16.3
$dlemp_t$	0.19

  ii. Give a 67% forecast interval for your forecast. (Hint 2: first compute a forecast interval for the percentage change.)

(e) Suppose you were interested in estimating the causal effect of changes in employment, $dlemp_t$, on oil prices, and added $dlemp_t$ to the regression model in (6). Would the estimated coefficient on $dlemp_t$ be an unbiased estimator of this causal effect? Why or why not?

(f) The FRED-MD database is a monthly database consisting of 127 macroeconomic timeseries, with 767 observations for each. Suppose you had this database available to forecast oil prices.

  i. Give one reason why you would not want to include all 127 variables in a forecasting model.

  ii. "Big data" prediction methods can also be used for time series forecasting. Describe **one** such method that would be appropriate to exploit the FRED-MD database to forecast oil prices.

  iii. The method you recommended in ii. should involve a "tuning parameter". What is the tuning parameter for your method? How would you choose its value in practice?

Figure 2: Chow F-statistic for different break dates with 0.15 trimming

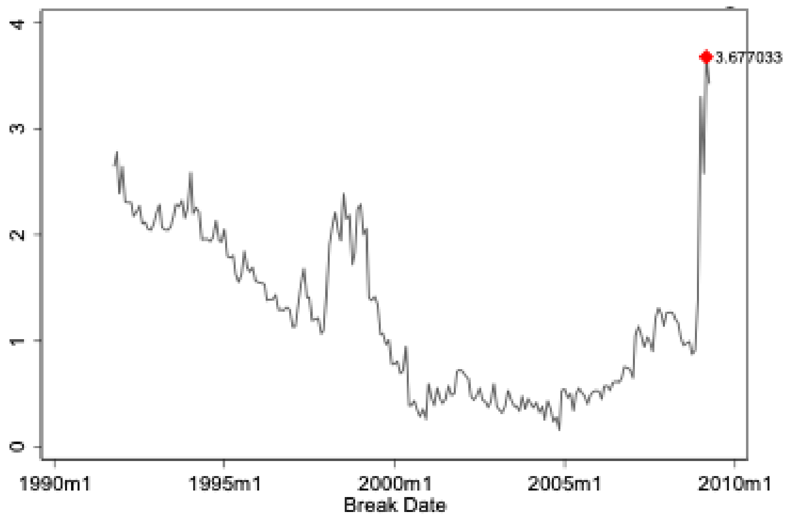

Figure 3: Monthly percentage change in Brent oil price: actual and forecast

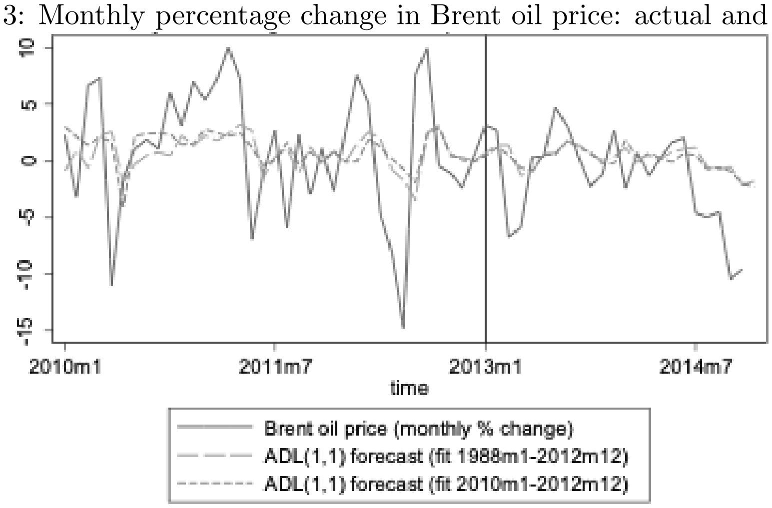

Table 3: Critical values of the QLR statistic with 15% trimming

Number of restrictions (q)	10%	5%	1%
1	7.12	8.68	12.16
2	5.00	5.86	7.78
3	4.09	4.71	6.02
4	3.59	4.09	5.12
5	3.26	3.66	4.53
6	3.02	3.37	4.12
7	2.84	3.15	3.82
8	2.69	2.98	3.57
9	2.58	2.84	3.38
10	2.48	2.71	3.23

Table 4: 5 % Critical values for the F_{ν_1,ν_2} distribution

$\nu_2 \backslash \nu_1$	1	2	3	4	5	6	7	8	10	12	15	20	30	50	∞
1	161	199.	216.	225.	230.	234.	237.	239.	242.	244.	246.	248.	250.	252.	254.
2	18.5	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.5	19.5	19.5
3	10.1	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.79	8.74	8.70	8.66	8.62	8.58	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	5.96	5.91	5.86	5.80	5.75	5.70	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.74	4.68	4.62	4.56	4.50	4.44	4.36
10	4.96	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.38	2.31	2.23	2.16	2.07	2.00	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.35	2.28	2.20	2.12	2.04	1.97	1.84
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.16	2.09	2.01	1.93	1.84	1.76	1.62
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	1.99	1.92	1.84	1.75	1.65	1.56	1.39
80	3.97	3.11	2.72	2.49	2.33	2.21	2.13	2.06	1.95	1.88	1.79	1.70	1.60	1.51	1.32
100	3.94	3.09	2.70	2.46	2.31	2.19	2.10	2.03	1.93	1.85	1.77	1.68	1.57	1.48	1.28
120	3.91	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.91	1.83	1.75	1.66	1.55	1.46	1.25
∞	3.85	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.83	1.75	1.67	1.57	1.46	1.35	1.00

Table 5: Normal cumulative distribution function ($Prob(z < z_a)$ where $z \sim N(0,1)$)

z_a	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7703	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995