Macro-Intensive Exam for NES PhD **July 29, 2024**

Part 1: Microeconomics (20 points)

1) (Consumer theory, 10 points) Consider a consumer facing 2 commodities, $k = 1, 2$. Let $p = (p_1, p_2)$ denote a price vector, where $p_k > 0$ is the unit price of commodity k. The commodities can be purchased in non-negative quantities. Let $x = (x_1, x_2) \in \mathbb{R}^2_+$ denote a generic consumption bundle, where x_k is the associated amount of commodity k. The consumer has a wealth level $w > 0$, and a utility function given by

$$u(x) = (x_1)^{2/3}(x_2)^{1/3}.$$

a) (4 points) Calculate the consumer's Walrasian demand function. Show your work (first order conditions etc).

b) (2 points) Calculate the elasticity of good 1 with respect to its own price.

c) (4 points) Suppose $w = p_1 = p_2 = 1$. What is the corresponding indirect utility level of the consumer? What can you say about the consumer's Hicksian demand at this particular utility level and given prices? Provide a short answer based on a duality result.

2) (Uncertainty, 10 points) The following questions are concerned with expected utility theory for lotteries on the set of strictly positive monetary prizes, $\mathbb{R}_{++}$.

a) (3 points) A decision maker U has the utility index $u(x) = x + \ln x$ for $x \in \mathbb{R}_{++}$. Is U (absolutely) risk averse? Explain your answer.

b) (3 points) A decision maker V has the utility index $v(x) = x^2$, while a decision maker $\hat{V}$ has the utility index $\hat{v}(x) = x^6$ for $x \in \mathbb{R}_{++}$. Is it true that V is relatively more risk averse than $\hat{V}$? Explain your answer.

c) (4 points) Let us denote by $\sum_{i=1}^{k} p_i \delta_{x_i}$ a lottery that pays a prize $x_i \in \mathbb{R}_{++}$ with probability p_i. Consider the following two lotteries

$$L = \frac{1}{2}\delta_4 + \frac{1}{2}\delta_6, \quad L' = \frac{1}{4}\delta_2 + \frac{1}{4}\delta_4 + \frac{1}{2}\delta_7.$$

Prove or disprove: Any risk-averse decision maker would (weakly) prefer L to L'.

Part 2: Macroeconomics (60 points)

Problem 1. (Macro-1, 20 points) *Long-run equilibrium in closed/open economy*

Consider an economy with linear consumption function: $C(Y-T) = c_0 + c_1(Y-T)$, where c_0 and c_1 are constants. Investment demand function is given by $I(r) = i_0 - i_1 r$. Assume that this economy is closed and $c_0 = 200$, $c_1 = 0.75$, $i_0 = 500$, $i_1 = 50$, $Y = 5000$, $T = 1000$, $G = 1500$.

1. (**5 points**) In this economy, compute private and public saving, national saving, consumption, real interest rate and investment. Illustrate using graphs.

2. (**5 points**) Now suppose that government increases government expenditures from 1500 to 1600. Compute private and public saving, national saving, consumption, real interest rate and investment in this new equilibrium. Explain and interpret the results. Illustrate using graphs.

Assume now a small open economy model with the same parameters ($G = 1500$). The world real interest rate is equal $r^* = 2$ and net export is given by the following function: $NX(\epsilon) = nx_0 - nx_1\epsilon$, where ϵ is a real exchange rate, $nx_0 = 200$ and $nx_1 = 40$.

3. (**5 points**) Compute private and public saving, national saving, consumption, real interest rate, investment, net export and real exchange rate in this small open economy. Illustrate using graphs.

4. (**5 points**) Now suppose that higher oil price increases nx_0 from 200 to 300. Compute private and public saving, national saving, consumption, real interest rate, investment, net export and real exchange rate in this new equilibrium. Illustrate using graphs and explain.

Problem 2. (Macro-2 20 points) *Aggregate Supply and Aggregate Demand*

1. (**12 points**) What determines the shape of the aggregate supply curve? consider the 3 typical cases: upward sloping, vertical and horizontal. and what role do these different AS curves play in the Keynesian model? Explain in words only. You can use math or graphs for exposition only.

2. (**8 points**) Why does the aggregate demand function have a negative slope in the case of a closed economy? Explain in words (you can use the IS-LM system for graphical exposition)

Problem 3. (Macro-3, 20 points) *Phase diagrams in the Neoclassical growth model.*

Consider an expected future permanent increase in capital depreciation δ in a standard Neoclassical Growth Model with no technological or population growth, $g = n = 0$. That is assume that initially the economy is in its steady state. Then at time 0 agents learn that at some future date $T > 0$ capital depreciation is going to jump from its initial value $\delta_0 > 0$ to a higher value $\delta_1 > \delta_0$, and it is going to remain fixed at δ_1. Analyze the dynamics of capital and consumption: show the phase diagrams, plot the paths of $c(t)$ and $k(t)$ as a function of time, and explain the intuition.

Part 3: Econometrics (20 points)

Table 2 reports estimated regressions computed using data on employees in a developing country. The data set consists of information on over 10,000 full-time, full-year workers. The workers' ages range from 25 to 40 years. The data set also contains information on the region of the country where the person lives, gender, and age. The variables that appear in Table 2 are defined in Table 1.

Table 1: Definition of variables

Name	Description
AWE	logarithm of average weekly earnings (in 2007 units)
$High\ School$	binary variable (1 if high school or college, 0 if less than high school)
$Male$	binary variable (1 if male, 0 if female)
Age	age (in years)
$North$	binary variable (1 if Region = North, 0 otherwise)
$East$	binary variable (1 if Region = East, 0 otherwise)
$South$	binary variable (1 if Region = South, 0 otherwise)
$West$	binary variable (1 if Region = West, 0 otherwise)

Table 2: Results of regressions of average weekly earnings on gender and education binary variables and other characteristics using 2007 data from a developing country survey. Standard errors are reported in brackets below the coefficients.

Dependent variable: log average weekly earnings (AWE)			
Regressor	(1)	(2)	(3)
High school (X_1)	0.352	0.373	0.371
	(0.021)	(0.021)	(0.021)
Male (X_2)	0.458	0.457	0.451
	(0.021)	(0.020)	(0.020)
Age (X_3)		0.011	0.011
		(0.001)	(0.001)
North (X_4)			0.175
			(0.037)
South (X_5)			0.103
			(0.033)
East (X_6)			-0.102
			(0.043)
Intercept	12.840	12.471	12.390
	(0.018)	(0.049)	(0.057)
Summary statistics and joint tests			
F-statistic for regional effects = 0			21.87
SER	1.026	1.023	1.020
R^2	0.0710	0.0761	0.0814
n	10,973	10,973	10,973

1. (2 points) Is the estimated high school earnings difference statistically significant at the 5% level? Construct a 95% confidence interval for this difference.

2. (2 points) Interpret the coefficient at the variable *Male*. Discuss both its magnitude and statistical significance.

3. (2 points) Is age an important determinant of earnings? Use an appropriate statistical test and/or confidence interval to explain your answer.

4. (3 points) Are there any important regional differences? Use an appropriate hypothesis test to explain your answer.

5. (3 points) Suppose Alvo is a 30-year-old male college graduate, and Kal is a 40-year-old male college graduate. Construct a 95% confidence interval for the expected difference between their earnings.

   Using the regression results in column (3):

6. (3 points) Suppose Juan is a 32-year-old male high school graduate from the North, and Mel is a 32-year-old female college graduate from the East. Explain how you would construct a 95% confidence interval for the difference in expected earnings between Juan and Mel.

7. (3 points) The regression shown in column (2) was estimated again, this time using data from 1993 (5,000 observations selected at random and converted into 2007 units using the Consumer Price Index). The results are:

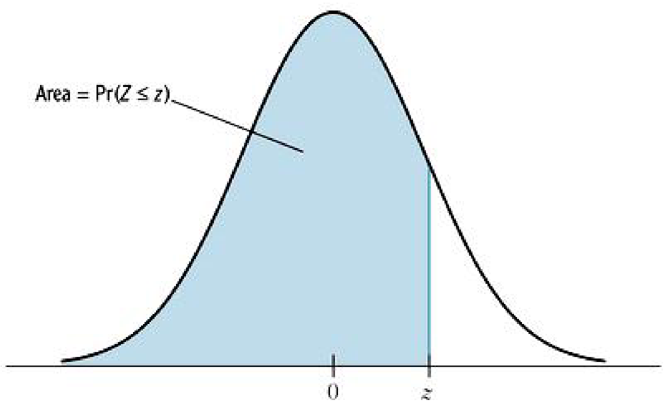
$$
\begin{aligned}
\log \widehat{AWE} \;&=\; \underset{(0.20)}{9.32} + \underset{(0.019)}{0.301}\, High\ school + \underset{(0.047)}{0.562}\, Male + \underset{(0.002)}{0.011}\, Age, \\
&\qquad SER = 1.25,\ \bar{R}^2 = 0.08
\end{aligned}
$$

   Comparing this regression to the regression for 2007 shown in column (2), was there is a statistically significant change in the coefficient on *High school*?

8. (2 points) In all of the above regressions, the coefficient at *High school* is positive, large, and statistically significant. Do you believe this provides strong evidence of the high returns to schooling in the labor markets? Discuss.

Statistical Tables

TABLE 1 The Cumulative Standard Normal Distribution Function,



z	Second Decimal Value of z									
	0	1	2	3	4	5	6	7	8	9
−2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
−1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611

TABLE 1 *(continued)*

	Second Decimal Value of z									
z	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
–0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
–0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
–0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
–0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
–0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
–0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
–0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
–0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
–0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
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	0.7704	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

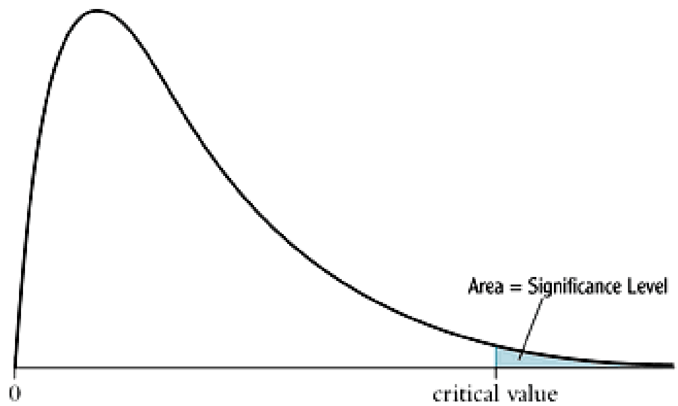
This table can be used to calculate Pr(Z" z) where Z is a standard normal variable. For example, when z = 1.17, this probability is 0.8790, which is the table entry for the row labeled 1.1 and the column labeled 7.

TABLE 3 Critical Values for the χ^2 Distribution

	Significance Level		
Degrees of Freedom	10%	5%	1%
1	2.71	3.84	6.63
2	4.61	5.99	9.21
3	6.25	7.81	11.34
4	7.78	9.49	13.28
5	9.24	11.07	15.09
6	10.64	12.59	16.81
7	12.02	14.07	18.48
8	13.36	15.51	20.09
9	14.68	16.92	21.67
10	15.99	18.31	23.21
11	17.28	19.68	24.72
12	18.55	21.03	26.22
13	19.81	22.36	27.69
14	21.06	23.68	29.14
15	22.31	25.00	30.58
16	23.54	26.30	32.00
17	24.77	27.59	33.41
18	25.99	28.87	34.81
19	27.20	30.14	36.19
20	28.41	31.41	37.57
21	29.62	32.67	38.93
22	30.81	33.92	40.29
23	32.01	35.17	41.64
24	33.20	36.41	42.98
25	34.38	37.65	44.31
26	35.56	38.89	45.64
27	36.74	40.11	46.96
28	37.92	41.34	48.28
29	39.09	42.56	49.59
30	40.26	43.77	50.89

This table contains the 90th, 95th, and 99th percentiles of the χ^2 distribution. These serve as critical values for tests with significance levels of 10%, 5%, and 1%.

TABLE 4 Critical Values for the $F_{m,\infty}$ Distribution



Degrees of Freedom	Significance Level 10%	5%	1%
1	2.71	3.84	6.63
2	2.30	3.00	4.61
3	2.08	2.60	3.78
4	1.94	2.37	3.32
5	1.85	2.21	3.02
6	1.77	2.10	2.80
7	1.72	2.01	2.64
8	1.67	1.94	2.51
9	1.63	1.88	2.41
10	1.60	1.83	2.32
11	1.57	1.79	2.25
12	1.55	1.75	2.18
13	1.52	1.72	2.13
14	1.50	1.69	2.08
15	1.49	1.67	2.04
16	1.47	1.64	2.00
17	1.46	1.62	1.97
18	1.44	1.60	1.93
19	1.43	1.59	1.90
20	1.42	1.57	1.88
21	1.41	1.56	1.85
22	1.40	1.54	1.83
23	1.39	1.53	1.81
24	1.38	1.52	1.79
25	1.38	1.51	1.77
26	1.37	1.50	1.76
27	1.36	1.49	1.74
28	1.35	1.48	1.72
29	1.35	1.47	1.71
30	1.34	1.46	1.70

This table contains the 90th, 95th, and 99th percentiles of the $F_{m,\infty}$ distribution. These serve as critical values for tests with significance levels of 10%, 5%, and 1%.