Name _ Mr. Key _
ID _____ ___ ___ _____

ECO 5350
Intro. Econometrics

Prof. T. Fomby
Spring 2006

Mid-Term 1

Instructions: Put your name and student ID in the upper right-hand-corner of this exam. This exam is worth a total of 50 points. The breakout of these points by questions is as follows:

Q1 = (2,1,1,1) = 5 points
Q2 = (3,2) = 5 points
Q3 = (2,2,2,4) = 10 points
Q4 7 points
Q5 - 15 points
Q6 – (4,4) = 8 points

You have one hour and twenty minutes to take this test. Good luck.

hypotheses and produce economic predictions

1. **Definitions**:

(2) a) Define the term **econometrics**. That field in economics where statistical methods are developed and used to test economic hypotheses and produce economic predictions

b) Monthly observations on the U.S. unemployment rate from 1950 to the present represent what kind of a data set? time series data set

(1)

c) Observations on the real gross domestic products of 35 countries in 1998 represent what kind of a data set? cross section data set

(1)

d) Observations on the real gross domestic products of 35 countries from 1950 to the present represent what kind of data set? panel data set

(1)

2. **Interpretation of Coefficients**

a) Consider the following estimated regression equation

$\widehat{bwght} = 119.77 - 0.514cigs$ birthweight when cigs = 10 is $119.77 - 0.514(10) = 114.63$ oz.

where bwght is infant birth weight in ounces and cigs is the average number of cigarettes the mother smoked per day during pregnancy. Explain to me the interpretation of b_2 in this model. What is the predicted birth weight of a child when cigs = 10 per day? Show your work below. $b_2 = -0.514$. It represents the change in birthweight that is expected to occur with a one unit change in cigarettes smoked per day. The predicted

(3)

b) Using data from 1988 for houses sold in Andover, Massachusetts, from Kiel and McClain (1995), the following equation relates housing price (price) to the distance from a recently built garbage incinerator (dist):

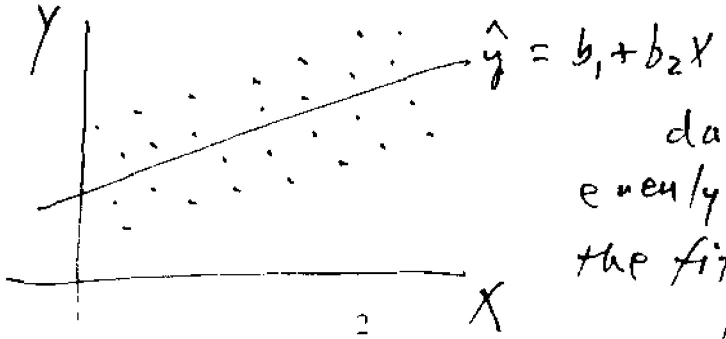
$\log(\widehat{price}) = 9.40 + 0.312\log(dist)$

Explain to me the interpretation of b_2 in this model.

(2) with each one percent increase in the distance from the incinerator, the price of the home is expected to increase by 0.312 of one percent.

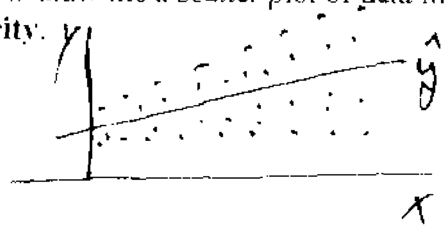
3. (a) In the space below draw me a scatter plot of data involving y and x that exhibits **homoskedasticy.**

(2)



data scatter is evenly spaced around the fitted regression line.

(2) (b) In the space below draw me a scatter plot of data involving y and x that exhibits **heteroskedasticity**.



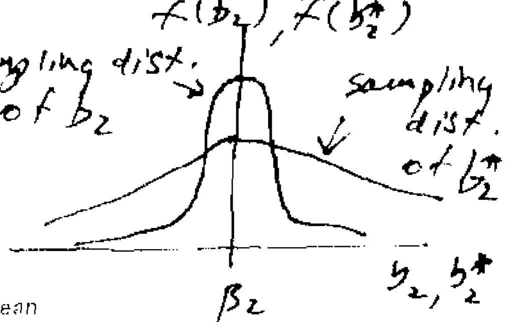
The spread of the scatter of points is increasing (or decreasing) in X.

(2) (c) In which of the above scatter plots would the method of least squares be more appropriately applied? Explain your answer.

The plot in part (a) above is appropriate for least squares estimation because one of the maintained assumptions for Least Squares is homoskedasticity.

(4) (d) Briefly state the **Gauss-Markov Theorem**. In a diagram below represent the implication of the Gauss-Markov theorem by drawing two competing sampling distributions.

Among the class of unbiased, linear estimators of β_2, say $b_2^* = c_1 y_1 + c_2 y_2 + \cdots + c_N y_N$, the estimator with the least variance is the least squares estimator, b_2.



4. Fill in the blanks in the following regression output:

The REG Procedure
Model: MODEL1
Dependent Variable: lsalary

Analysis of Variance

(4)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.85091	0.85091	2.33964	0.1284
Error	175	63.79531	0.36369		
Corrected Total	176	64.64622			

(1)

Root MSE	0.60378	R-Square	0.01316
Dependent Mean	6.56285	Adj R-Sq	0.0075
Coeff Var	9.17195		

$R^2 = \frac{SSR}{SST} = \frac{0.85091}{64.64622} = 0.01316$

Parameter Estimates

(2)

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	6.50550	0.06794	95.68	<.0001
ceoten	1	0.00972	0.00636	1.5283	0.1284

$t_{b_2} = \frac{b_2}{se(b_2)} = \frac{0.00972}{0.00636} = 1.5283$

$\frac{6.500550}{se} = 95.68$

$\therefore se = \frac{6.500550}{95.68} = 0.06794$

5. Using the following data, fill in the appropriate blanks:

X	Y	X^2	XY	$\hat{e}_i = y_i - \hat{y}_i$	$\hat{e}_i^2$
1	6	1	6	6.0-5.9=0.1	0.01
2	4	4	8	4-4.3=-0.3	0.09
3	3	9	9	3-2.7=0.3	0.09
4	1	16	4	1-1.1=-0.1	0.01

(1) $\bar{X} = \frac{10}{4} = 2.5$ (1) $\bar{Y} = \frac{14}{4} = 3.5$ (1) $\bar{X}\cdot\bar{Y} = 8.75$

(1) $b_2 = \frac{\sum X_i Y_i - N\bar{X}\bar{Y}}{\sum X_i^2 - N\bar{X}^2} = \frac{27 - 4(8.75)}{30 - 4(2.5)^2} = \frac{-8}{5} = -1.6$

(1) $b_1 = \bar{Y} - b_2\bar{X} = 3.5 - (-1.6)(2.5) = 3.5 + 4.0 = 7.5$

Opps! Forgot to take square root. However, I adjusted your answer for it.

(1) var $\text{se}(b_2) = \frac{\hat{\sigma}^2}{\sum X_i^2 - N\bar{X}^2} = \frac{\sum (Y_i - \hat{Y}_i)^2/(N-2)}{\sum X_i^2 - N\bar{X}^2} = \frac{0.20/2}{5} = 0.02$

$se(b_2) = \sqrt{var(b_2)} = \sqrt{0.02} = 0.1414$

(1) $t_{b_2} = \frac{b_2}{se(b_2)} = \frac{-1.6}{0.01414} = -11.3154$ [I accepted your answer of $\frac{-1.6}{.02} = -80$]

(1) When $X_0 = 2.5$ then $\hat{Y}_0 = b_1 + b_2 X_0 =$ $7.5 - 1.6(2.5) = 3.5$

(1) The 95% confidence interval for β_2 is [-2.2084, -0.9916].

$-2.2084 = -1.6 - (0.1414)(4.303)$ $-0.9916 = -1.6 \pm (0.1414)(4.303)$ (I accepted your answer of [-1.68606, -1.511394])

Note: $\Pr(b_2 - se(b_2)t_{N-2,\alpha/2} < \beta_2 < b_2 + se(b_2)t_{N-2,\alpha/2}) = 1-\alpha$

(1) Therefore, when I test $H_0: \beta_2 = 0$ versus $H_1: \beta_2 \neq 0$ at the 5% level of statistical significance, I conclude that $H_1: \beta_2 \neq 0$

and β_2 is apparently not equal to zero. Thus, X_2 is a statistically significant explanator of the variation in y. This is because $\beta_2 = 0$ is not inside the 95% confidence interval for β_2.

Note: I am giving you 5 points on this question no matter what!

6. Consider the **Computer Output** you have been given. Recall the Alesina and Summers model where we have a regression equation that explains a developing country's future rate of inflation as a function of the independence of its central bank. Suppose we have a country whose central bank independence measure is 1.80. Use the computer output to produce a prediction of the country's subsequent inflation rate and also provide me with a 95% confidence interval for your prediction. Show your work below so that you will obtain full credit for your answer.

$se(\text{prediction error}) = \sqrt{(0.89865)^2 + (0.27304)^2}$

(2) $\simeq 0.9392$

$\hat{y}_0 = 9.44019 - 1.63558(1.80)$

(2) $= 6.49615$ (= the reported intercept of the transformed model)

95% prediction confidence interval given That $X = 1.80$:

$\hat{y}_0 \pm se(\text{prediction error}) \cdot t_{N-2, \alpha/2}$

$t_{14, .025} = 2.145$

$6.49615 \pm 0.9392(2.145)$

6.49615 ± 2.014584

(4) $[4.481566, 8.510734]$

```
/* x = average index of central bank independence (1 = little independence
         4 = very independent)
   y = average Inflation 1955 - 1988
   Source: Alesina and Summers (1993) Jo. of Money,
   Credit, and Banking  */

data in;
  input x y;
cards;
1.5 8.5
1 7.6
2 6.4
1.75 7.3
2 6.7
2 6.1
2.5 6.5
2 4.1
2 6.1
2 6.1
2.5 4.5
2.5 4.2
2.5 4.9
3.5 4.1
4 3
4 3.2
;

proc reg data = in;
   model y = x;

run;

/*  Here we use the transformed model to obtain the point
    prediction when x = 1.80 (it is the estimate of the intercept
    in the transformed model) and the ingredients for the construction
    of the standard error of the prediction error.  We use the
    Standard Error of the Transformed Regression (RMSE in SAS) or the Mean
    Square of the Error in the ANOVA table) to construct the standard error of the
    prediction error.  se(prediction error) = sqrt(RMSE^2 + se(intercept)^2)=
    sqrt(mean square error + se(intercept)^2).  */

data in;
  set in;
  xstar = x - 1.80;

proc reg data=in;
  model y = xstar;

run;
```

The REG Procedure
Model: MODEL1
Dependent Variable: y

Number of Observations Read	16
Number of Observations Used	16

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	28.07829	28.07829	34.77	<.0001
Error	14	11.30609	0.80758		
Corrected Total	15	39.38437			

Root MSE	0.89865	R-Square	0.7129
Dependent Mean	5.58125	Adj R-Sq	0.6924
Coeff Var	16.10129		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	9.44019	0.69194	13.64	<.0001
x	1	-1.63558	0.27738	-5.90	<.0001

The REG Procedure
Model: MODEL1
Dependent Variable: y

Number of Observations Read	16
Number of Observations Used	16

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	28.07829	28.07829	34.77	<.0001
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Dependent Mean	5.58125	Adj R-Sq	0.6924
Coeff Var	16.10129		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	6.49615	0.27304	23.79	<.0001
xstar	1	-1.63558	0.27738	-5.90	<.0001

Statistical Tables

Table 1 Area Under the Standard Normal Distribution

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3079	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4773	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4983	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

Source. This table was generated using the SAS® function PROBNORM.

Table 2 **Right-Tail Critical Values for the *t*-distribution**

DF	α = .10	α = .05	α = .025	α = .01	α = .005
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
31	1.309	1.696	2.040	2.453	2.744
32	1.309	1.694	2.037	2.449	2.738
33	1.308	1.692	2.035	2.445	2.733
34	1.307	1.691	2.032	2.441	2.728
35	1.306	1.690	2.030	2.438	2.724
36	1.306	1.688	2.028	2.434	2.719
37	1.305	1.687	2.026	2.431	2.715
38	1.304	1.686	2.024	2.429	2.712
39	1.304	1.685	2.023	2.426	2.708
40	1.303	1.684	2.021	2.423	2.704
50	1.299	1.676	2.009	2.403	2.678
60	1.296	1.671	2.000	2.390	2.660
70	1.294	1.667	1.994	2.381	2.648
80	1.292	1.664	1.990	2.374	2.639
90	1.291	1.662	1.987	2.368	2.632
100	1.290	1.660	1.984	2.364	2.626
110	1.289	1.659	1.982	2.361	2.621
120	1.289	1.658	1.980	2.358	2.617
∞	1.282	1.645	1.960	2.326	2.576

Source: This table was generated using the SAS® function TINV

Table 3 **Right-Tail Critical Values for the *F*-Distribution**

	Upper 5% Points																		
$\nu_2 \backslash \nu_1$	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54	241.88	243.91	245.95	248.01	249.05	250.1	251.14	252.2	253.25	254.31
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.37
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	301	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.95	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

Source: This table was generated using the SAS® function FINV. ν_1 = numerator degrees of freedom; ν_2 = denominator degrees of freedom.