Comprehensive Exams – Economics - Class of 2012

The second day of the Economics comprehensive exams is divided into three sections, microeconomics (100 points total), macroeconomics (100 points total), and econometrics (40 points total. You will receive these three sections plus a clean copy of the paper by Cutler, Meara, and Richards.

We hope that you will be able to finish the entire exam in three hours, but you will be allowed four hours. If you use all four hours, that works out to one point per minute. Put you ID number and not your name on all three sections and turn them in separately.

The micro and econometrics parts of the exam include use of the computer. You will need to save the Excel file for the micro exam to your Econ 401 folder (the title of the file should be youridnumber.xlsx, e.g. 4.xlsx if your id number is 4). You will not need to save the Stata file from the econometrics exam.

You may not communicate with anyone other than the proctors of the exam or work with or use any resources on the computer other than the Excel file and the Stata file accompanying the exam.

Hint: On questions 12 and 13 of the micro exam, note that the Excel file gives a specific example of the spillover effect. Questions 12 and 13 ask for a general formulation of the spillover effect.

Good luck!

ID NUMBER (Do not put your name) _____________

Comprehensive Exams – Micro Portion - Class of 2012

This exam is based on Section II of Cutler, Meara, and Richards, "Induced Innovation and Social Inequality: Evidence from Infant Medical Care" (NBER Working Paper 15316). Each question on the written portion is worth 5 points, for a total of 75 points. *Please write legibly*. The Excel portion, called MicroComps2012.xlsx, located in the Eco 401 Commons folder, is worth 25 points. Please open this document after you have completed the written portion and save it to your Eco 401 individual folder with the file name YOURID.xlsx. (For example, if your ID is 7, you would save it as 7.xlsx.)

WRITTEN PORTION

In Section II of their paper, the authors set up a framework to explain endogenous technological innovation in medical care.

1. Economics is all about incentives. In microeconomic analysis, we routinely explain investment in R & D as the result of a profit-maximization problem. The authors, however, do not take this approach. Why not, and what framework and objective function do they adopt?

Let us suppose that there are two diseases, indexed by *i.* There are two time periods, 0 and 1. The mortality rate for diagnosis *i* at time *t* is d_i^t. The overall death rate at time *t* is then $D^t = \sum_{i=1}^{2} d_i^t$. Medical research on a particular disease will improve survival according to an "innovation possibility function". This is modeled as a function $f_i(r_i)$ that converts a dollar amount of research, r_i, devoted to the disease *i* to an increase in survival probability at time 1. We assume that $f_i(0)$=0, $f_i < 1, f_i' > 0, f_i'' < 0$.

2. Draw a rough sketch of this innovation possibility function. Please label everything carefully.

The death rate for condition *i* at time 1, is $d_i^1 = d_i^0 \cdot (1 - f_i(r_i))$ and the aggregate death rate in period 1 is $D^1 = \sum_{i=1}^{2} d_i^0 \cdot (1 - f_i(r_i))$.

The National Institutes of Health have *R* dollars to spend on research, and their goal is to minimize mortality in period 1.

3. Write down in mathematical form the optimization problem assuming that there are only two diseases.

4. What are the endogenous variables? What are the exogenous variables?

5. If you haven't already, set up the Lagrangean and derive the first order conditions.

6. On page 5, the authors refer to the expected marginal benefit of research. Explain in non-technical words what this means referencing the FOC's you found in question 5.

7. What is the meaning of lambda in this context? Please be as specific as you can.

8. The authors claim that their model shows that more common diseases get more research dollars in equilibrium. What equation do they use to support this claim? Explain carefully the reasoning here.

Now introduce a majority group, *a*, and a minority group *b*. The initial death rates per condition for the two groups are $d_{a,i}^0$ and $d_{b,i}^0$ and their respective sums across conditions are D_a^0 and D_b^0. The authors are interested in the condition under which the overall mortality ratio (that is, the aggregate minority mortality rate divided by the aggregate majority rate ratio) increases from period 0 to period 1.

9. Express this condition mathematically using the authors' notation.

10. Using the authors' notation (including the r's), define mathematical expressions for D_a^1 and D_b^1.

11. Please refer to Equation 4 on page 6 of the paper. Suppose for the moment that $f_1(r_1^*) = f_2(r_2^*)$. What will happen to the mortality ratio $\frac{D_b}{D_a}$ from period 0 to period 1? Will it increase, decrease, or stay the same, and why?

12. We will now put aside the notion of minority and majority mortality rates and return to the original casting of the optimization problem. The authors assume that there is no “spillover effect” in research – that is, research dollars spent on one particular disease do not increase survivor rates in other diseases. Recast the optimization problem you set up in question 3 to incorporate the idea of a positive spillover effect for research on both diseases.

13. Re-derive the first order conditions for a maximum.

14. Normally, when we have a positive production externality such as a research spillover effect, we find that the market solution is suboptimal. Explain why in general this is the case, using a standard diagram to support your answer.

15. Would you expect the results of the authors' optimization problem to exhibit the same suboptimal solution, in the presence of a recognized research spillover phenomenon? Why or why not?

Comprehensive Exams 2012 - Macro Portion – Class of 2012

This exam is based on Cutler, Meara, and Richards, "Induced Innovation and Social Inequality: Evidence from Infant Medical Care" (NBER Working Paper 15316). The total number of points on this part of the exam is 100.

The paper begins with:

> Technological change is a source of substantial aggregate welfare improvements. . . . In this paper, we investigate biased technological change using a particular example—medical technology for treating at risk infants. Infant mortality provides a useful setting to learn about induced innovation because the outcome is easy to measure (deaths) and disparities in outcomes are so widely noted.

Think about the Solow growth model and how it incorporates technological change. The production function is $Y = F(K, L \times E)$ Here, K is capital and L is labor. Assume that labor-augmenting technological progress increases the efficiency, E, of labor at a constant rate g. Effective units of labor are $L \times E$. The labor force, L, grows at a rate of n. Depreciation of capital is assumed to occur at a rate δ.

Capital per effective unit of labor is denoted by:. $k = {}^{K}/_{(L \times E)}$. Output per effective unit of labor is denoted by y: $y = {}^{Y}/_{(L \times E)}$.

1. (10 pts) Write down an equation that shows the change in capital per effective unit of labor over time, that is Δk. Explain each element of this equation.

2. (10 pts) Draw a graph of the Investment curve and the break-even Investment curve (i.e. the depreciation line). Put capital per effective worker on the horizontal axis and break-even investment on the vertical axis. Show where the steady state is on the graph.

3. (5 pts) Define what is meant by "steady state".

4. (10 pts) If the savings rate increased, what would happen to the steady state? Draw it in your graph from question 2 above and use the graph to explain your answer.

5. (5 pts) For the standard Solow model, write down the steady state growth rate of:

Capital per effective worker_____

Output per effective worker_____

Output per worker_____

Total Output_____

6. (10 pts) According to the Solow Growth Model, what is the main source of sustained economic growth? Use the results of the Cutler paper to explain your answer.

7. (10 pts) You are an economist working in the public health department for the federal government. Given the findings of the Cutler, Meara, and Richards paper, your fiscal policy recommendation is that the government should give new, large grants to support university research on medical technology to treat at-risk infants. Use the Aggregate Demand Expenditure model to show the effect of your policy recommendation and fully explain the impact of your policy on the economy as a whole. Draw a graph to illustrate your answer.

8 (20 pts) Use the IS-LM model to show the effect of the recommendation from question 7 on the economy. Explain clearly what happens to GDP, the interest rate, the demand for money, investment, and consumption. Draw a graph to illustrate your answer. Use your graph in your explanation.

(20 pts) Use the dynamic AD-AS model to show the effect of the recommendation from question 7 on the economy, if that fiscal policy is implemented each year for the next 5 years. What are the short run and long run effect of this policy? Draw a graph

<u>Comprehensive Exams – Econometrics Portion - Class of 2012</u>

This exam is based Cutler, Meara, and Richards, "Induced Innovation and Social Inequality: Evidence from Infant Medical Care" (NBER Working Paper 15316). Point totals for each question are given—the total value of this portion of the test is 40 pts. *Please write legibly*.

Taking a look at the data:

Here are means, SDs, minimums, maximums and definitions of variables in the data set:

Variable	Obs	Definiition	Mean	Std. Dev.	Min	Max
cause	70	Code for cause of death	378.11	220.134	10	999
initial3	70	Death rate, 1983-85	0.0001394	0.0003	0.0000010	0.002361
initial3per1000	70	Death rate/1000, 1983-85	0.1394	0.3384	0.000959	2.361
blkdeaths	70	Number of Black deaths, 1983-85	402.31	1159.828	1	8908
whtdeaths	70	Number of White deaths, 1983-85	905.73	2050.807	1	13238
Ninit	70	Number of births, 1983-85	9380019	0.000	9380019	9380019
final3	70	Death rate, 1996-99	0.0000945	0.000	0.0000007	0.001858
final3adj	70	Death rate, 1996-98, weight adjusted	0.0000875	0.000	0.0000007	0.001652
Nfin	70	Number of births, 1996-98	8682891	0.000	8682891	8682891
lnchg3	70	Ln (death rate 1996-98/death rate 1983-85)	-0.3885	0.552	-2.4341	0.5708
Vlnchg3	70	Variance for lnchg3	0.0243	0.056	0.0001	0.2667
lnchg3adj	70	lnchg3 adjusted for weight	-0.4461	0.559	-2.5690	0.5473
Vlnchg3adj	70	Variance for lnchg3adj	0.0246	0.056	0.0001	0.2708
articles	41	Number of journal articles published 1983-98 on cause of death	1314.9	1452.0	1	8334
grants	49	NIH grants on cause of death, 1983-98	135.7	167.4	0	776
grants75	49	NIH grants on cause of death, 1975-82	59.7	102.6	0	509

The authors look at births and deaths for singleton (no twins), non-Hispanic births. Note that there are 70 causes of death, but that the regression analysis will be confined to the 69 identified causes. Cause 999 is a catch-all category, which we will leave out. When we look at articles or grants, we'll examine a smaller subset of the data (41 or 49 causes) because the authors could not obtain information on research for all 69 causes of death.

The change in the average death rate for each cause of death, from .0001394 in 1983-85 to .0000945, looks really small. However, there are 70 causes of death, so the combined infant mortality rates were:

$$IMR_{1983-85} = 70 \times .0001394 = .009758$$

$$IMR_{1996-98} = 70 \times .0000945 = .006615$$

These rates are more commonly expressed per 1000 persons, so $IMR\ per1000_{1983-85} = 9.76$ while $IMR\ per1000_{1996-98} = 6.62$. You may still think those levels are small, but consider that the death rate for 21 year olds in 2010 was about 0.96 per 1000 in 2006. Babies are almost seven times more likely to die than people your age.

1. (5 pts) Another way to measure the impact of the decline in birth rates is to compute the number of deaths which would have occurred using the 1983-85 overall death rate for the 8,682,981 non-Hispanic births that actually occurred in the 1996-98 period and compare

that to the number of deaths that actually occurred in the 1996-98 period. How many infant lives were saved by this measure? Show your work. (Read the whole question again carefully. This can be answered with the information you've been provided in the paragraph above.)

Note that in the paper, the authors work with weight-adjusted death rates for the 1996-98 ("final") period. These are the death rates which we would have seen had the birth rate distribution stayed the same between 1983-85 and 1996-98. Death rates are much higher for low weight babies, and the distribution of birth weights shifted downwards between 1983-85 and 1996-98. Had birth weights not fallen, death rates would have been lower in 1996-98 than they actually were. The authors want to remove this cause of change from the analysis, and so they work with the adjusted rates.

Induced Innovation and Heteroskedasticity

The authors want to study induced innovation. To do so, they specify equation (7):

$$ln\left(d_i^1 / d_i^0\right) = \beta_0 + \beta_1 d_i^0 + \varepsilon_i$$

Here d_i^1 is the death rate for cause *i* in the later period (1996-98); d_i^0 is the death rate for cause *i* in the earlier period (1983-85). The variable lnchg3adj corresponds to the left hand side of equation (7) where the authors have adjusted for changes in the birth weight distribution; the variable initial3per1000 corresponds to d_i^0.

2. (5 pts) How would you interpret the error term in equation (7)? I.e., what kinds of influences on the decline in death rate might belong in the error term?

3. (5 pts) The authors believe that the error term in equation (7) is heteroskedastic. Why might there be heteroskedasticity in this model?

4. (5 pts) Why are the estimates obtained by correcting for heteroscedasticity preferable to straightforward OLS estimates for equation (7)?

Go ahead and replicate the result in Column 1 of Table 4 by typing the following command in Stata:

reg lnchg3adj initial3per1000 [aweight= 1/ Vlnchg3adj] if cause <999

In this command, heteroskedasticity is corrected via the [aweight= 1/ Vlnchg3adj] option and we omit the catchall category by use of the if statement at the end. For ease of reading the regression results, we use the variable iniital3per1000 instead of initial3 (the paper does this as well).

5. (5 pts) Suppose, hypothetically, that the causes of death which were associated with the highest death rates were mostly the result of air pollution and that air quality improved considerably between 1985 and 1994. Would these circumstances strengthen or weaken the conclusions of the paper? Explain your answer.

We created a new variable called chg3adj, using this command:

gen chg3adj = exp(lnchg3adj)

The exp command takes the exponent, so chg3adj is the change in the death rates between 1983-95 and 1994-96 for each individual cause of death. Run the following regression using this variable

reg chg3adj initial3per1000 if cause < 999, robust

In this regression the robust option generates robust standard errors, which is alternative method for dealing with heteroskedasticity.

6. (10 pts) Suppose the authors had run this linear regression instead of the one with the logarithmic functional form:

   reg chg3adj initial3per1000 if cause < 999, robust

   Interpret the results. Discuss both the estimate of the constant term and the estimate of the slope term.

7. (5 pts) Finally, turn to the statement on the bottom of p. 26 ("these coefficients are not statistically different from each other") and column 3 of Table 5 (where results for the F-test for equal coefficients is presented). What are the constrained and unconstrained regressions that are used for the F-test?