Department of Economics
Harvard University

Honors General Exam

April 4, 2012

The exam has three sections: microeconomics (Questions 1–3), macroeconomics (Questions 4–6), and econometrics (Questions 7–8). Each section of the exam is of equal point value. Thus you should spend roughly 1 hour on each section of the exam.

You must answer ALL questions on the exam.

You must use a SEPARATE bluebook for each question, so you will hand in eight (8) bluebooks. Make sure your name and the question number are on the outside of each of the bluebooks! The number should refer to the actual question number on the exam.

You can bring one calculator, but no notes are permitted.

Good luck!

Microeconomics (60 points)

Question 1 (20 points)

Windstar likes coffee, oranges and leisure. He maximizes the utility function $u(c, r, l) = c^{\frac{1}{4}} r^{\frac{1}{4}} l^{\frac{1}{4}}$. Coffee costs \$5 per cup, oranges cost \$1 per orange and the wage rate is \$20 an hour. Windstar has H hours that he can allocate between work and leisure each day. There are no sources of income other than the income from hours worked.

(a) Express the complete utility maximization problem with the budget constraint for Windstar. [5 points]

<u>Answer:</u> The utility maximization problem for Windstar is given by:

$$\max_{c,r,l} c^{\frac{1}{4}} r^{\frac{1}{4}} l^{\frac{1}{4}}$$

$$\text{s.t. } 5c + r + 20l = 20H$$

<u>Grading:</u> 2 points for specifying all choice variables; 3 points for the correct budget constraint.

(b) Solve for the optimal amount of coffee, oranges and leisure in terms of H. (Hint: The method to solve the 3-good problem is conceptually similar to the 2-good problem.) [5 points]

<u>Answer:</u> We can solve the 3-good case by extending the 2-good case.

First, equate the MRS c and o to their price ratio and simplify:

$$\frac{r}{c} = 5$$

which implies $r = 5c$

Next, equate the MRS of c and l to their price ratio and simplify:

$$\frac{l}{c} = \frac{5}{20}$$

which implies $l = \frac{c}{4}$

Substituting the solutions for r and l into the budget constraint:

$$15c = 20H$$

Thus the optimal values are:

$$\begin{aligned} c &= \tfrac{4}{3}H \\ r &= \tfrac{20}{3}H \\ l &= \tfrac{1}{3}H \end{aligned}$$

Grading: 2 points for the right answer; 3 points for correct derivations using any method.

(c) How does the demand for coffee depend on the number of hours, H? Explain whether coffee is a normal good, an inferior good or neither. [5 points]

Answer:

$$\frac{\partial c}{\partial H} = \frac{4}{3}$$

which is positive and independent of H. The number of hours available for work has a relationship to demand similar to that of income because the individual has an implicit income of $20H$. Coffee is a normal good since demand for coffee increases when income increases.

Grading: 3 points for the correct comparative static; 2 points for explaining why coffee is a normal good.

(d) Explain whether coffee and oranges are complements, substitutes or neither? [5 points]

Answer: The two goods are neither complements nor substitutes since the demand for one good is not affected by the price of the other good, i.e. cross elasticities are zero.

Grading: Partial credit at grader's discretion.

Question 2 (20 points)

A pure exchange economy has 2 persons in it: a CEO and an assistant. The CEO is a very busy person with a low endowment of leisure (6 hours) and a high endowment of consumption ($1000). Her utility function is $U_{CEO}(c, l) = 1.2(l-6)^{0.6}c^{0.4}$ where l is leisure and c is consumption.

There is only one candidate for the job, Jack. He is doing a part time job, so he has a high endowment of leisure (20 hours) and low endowment of consumption ($10). His utility function is $U_J(c, l) = 10l^{0.3}c^{0.7}$.

(a) Find out the demand function of the CEO for assistant labor hours as a function of wage rate w. [5 points]

Answer:

$$|MRS| = \frac{6c}{4(l-6)} = w = priceratio$$

$$\frac{6c}{4w} = l - 6$$

using the budget constraint,

$$\frac{6(1000-(l-6)w)}{4w} = l - 6$$

$$\frac{2}{5}\frac{6000}{4w} = (l-6)$$

$$(l-6) = \frac{2}{5}\frac{6000}{4w}$$

This is the demand function for assistant labor hours by the CEO.

Grading: 2 points for the correct optimization problem; 3 points for the correct derivation of demand using any method.

(b) Find out the supply function of labor hours by Jack as a function of wage rate w. [5 points]

Answer:

$$|MRS| = \frac{3c}{7l} = w = priceratio$$

$$\frac{3(10+(20-l)w)}{7w} = l$$

$$(20 - l) = (\frac{7}{10})(20 - \frac{30}{7w})$$

This is the labor supply function for Jack.

Grading: 2 points for the correct optimization problem; 3 points for the correct derivation of demand using any method.

(c) Find out the equilibrium wage rate by equating the demand and supply of labor hours. Sketch an Edgeworth Box in consumption-leisure space and indicate the competitive solution on it. [5 points]

Answer:

$$\frac{2}{5}\frac{6000}{4w} = (\frac{7}{10})(20 - \frac{30}{7w})$$

$$w = 43.07$$

Grading: 2.5 points for the correct equilibrium wage; 2.5 points for the correct drawing of Edgeworth Box.

(d) During Jack's interview, the CEO found out that Jack is very cheerful and CEO appreciates this quality. The utility function of the CEO, $U_{CEO}(c, l)$ has three parameters: $1.2, 0.6, 0.4$. To model this change of information for the CEO, which of these parameters should be changed? Explain why. How will equilibrium wage be affected after this change? [5 points]

Answer: Either the exponent of $l - 6$ should rise or exponent of C should fall. This would give more importance to labor hours hired. Changing 1.2 will not affect the utility function in any way, since this would just be a monotonic transformation.

Grading: 3 points for the correct modification of CEO's utility function; 2 points for the discussion of its effect on equilibrium wage rate.

Question 3 (20 points)

Consider a very simplified model to understand why Bank Runs might happen. A Bank run is a situation where a bank collapses as a lot of its customers demand for all of their cash in a very short time period.

A bank has two clients, Warren and Melinda. If anybody "runs" to the bank today then they get to split $\$6M$ equally with the other person, if the other person also chose to "run" to the bank today. If the other person chooses **not** to run to

the bank, then the person who "ran" to the bank gets to pocket $\$6M$. Even if one person runs to the bank, then the bank collapses and does **not** exist from today on. If it does **not** collapse today it would continue to exist a year from now.

The other option each of the clients has is to not run. If (s)he chooses not to run, his/her payoff is $\$8M$ a year from now, if the bank exists at that time and obviously, \$0, if the bank has ceased to exist. (Assume that for each of them value of money tomorrow is just the same as the value of money today. There is no discounting.)

(a) Write the pay off matrix for Warren and Melinda with the two strategies being (Run, Not run). [5 points]

Answer:

	Run	Not Run
Run	(3,3)	(6,0)
Not Run	(0,6)	(8,8)

Grading: Partial credit at grader's discretion.

(b) Find all the pure strategy equilibria of this game. [5 points]

Answer: The pure strategy Nash equilibria are (Run, Run) and (Not Run, Not Run)

Grading: 2.5 points for the each of the two pure strategy NEs.

(c) Is there a dominant strategy for any of the players? Does this game have a mixed strategy equilibrium? Explain. [5 points]

Answer: There is no dominant strategy for any of the players.

Suppose Warren mixes between Run and Not Run with the probability $(p, 1-p)$.

$$\begin{aligned} EU_M(Run) &= EU_M(NotRun) \\ \Rightarrow 3p + 6(1-p) &= 0p + 8(1-p) \\ \Rightarrow p &= \frac{2}{5} \end{aligned}$$

In the mixed strategy equilibrium Warren mixes between Run and Not Run with a probability $(\frac{2}{5}, \frac{3}{5})$ and Melinda mixes between Run and Not Run with a probability $(\frac{2}{5}, \frac{3}{5})$.

Grading: 1 point for the correct answer to the dominant strategy question; 2 points for specifying the mixing condition; 2 points for finding correct mixing probabilities.

(d) Using this very simplified setup argue why Bank runs might happen as the fear about the health of financial system increase at the times of crisis. [5 points]

Answer: When the health of the financial system weakens, each player may think the payoff of (Not Run, Not Run) would decrease. If it goes down below $(6, 6)$, (Run, Run) becomes the only Nash equilibrium. This might increase the possibility that the opponent runs. If you anticipate your opponent might run, you will be better off by running to the bank as well. Therefore, if people start expecting others to run to the bank, they will all fall into the pure Nash Equilibrium of (Run, Run)

Grading: Partial credit at grader's discretion.

Macroeconomics (60 points)

Question 4 (20 points)

This question asks you to use some mathematical formulations to model output-per-worker in a given economy. In all the questions below, you should assume that the economy in question is a closed economy with no government. Output consists of consumption and investment only.

(a) Assume that there are two types of productive factors in an economy, physical capital K and labor L. Technology E is assumed to be labor-augmenting; as E grows, L becomes more productive. Write down a Cobb-Douglas, constant returns to scale production function that shows how these factors could be combined to produce aggregate output, Y. [3 points]

Answer: The Cobb-Douglas CRS production function described verbally in this question is the standard one from our study of the Solow Model:

$$Y = K^{\alpha}(EL)^{1-\alpha}.$$

Grading: 1 point for any Cobb-Douglas production function; 1 point for knowing under what conditions Cobb-Douglas is CRS; 1 point for properly placing E.

(b) In 2010, per-capita GDP in the African country of Niger was about \$700. In the same year, per-capita GDP in the United States was \$47,400, nearly 70 times higher. Assume that the technology term E above corresponds to "blueprints" that are easily transferable around the world, so that all countries share the same E. If this assumption in true, is the production function you specified in part (a) likely to be successful in explaining the per-capita income difference between the U.S. and Niger? Why or why not? [5 points]

Answer: Putting our production function in per-worker forms gives

$$\begin{aligned}\frac{Y}{L} &= \frac{K^{\alpha}(EL)^{1-\alpha}}{L} \\ &= \left(\frac{K}{L}\right)^{\alpha} \cdot E^{1-\alpha}\end{aligned}$$

The first term on the right-hand side of the last line, $(\frac{K}{L})^{\alpha}$, can be labeled "factor accumulation," and indicates that rich countries will probably have

more capital-per-worker than poor countries. The second term, $E^{1-\alpha}$, can be called "productive efficiency," as rich countries will generally make better use of the inputs they do have than poor countries. If all countries have the same levels of E, as this part of the questions assumes, then the only reason that rich countries are rich is that they have higher capital-per-worker. How much more capital-per-worker would they need, given realistic values for α? Denote capital-per-worker in country X as k_X. To explain a 70-fold per-capita income difference, we would need

$$
\begin{aligned}
70 &= \frac{k_{US}^{\alpha}}{k_{Niger}^{\alpha}} \\
70 &= \left(\frac{k_{US}}{k_{Niger}}\right)^{\alpha} \\
70^{\frac{1}{\alpha}} &= \frac{k_{US}}{k_{Niger}}
\end{aligned}
$$

For a value of $\alpha = .33$, the ratio of U.S. k to Niger k would be $70^3 = 70 \times 70 \times 70$. That is a really big number (343,000, to be exact). While the U.S. is more capital intensive than Niger, U.S. workers probably do not work with 343,000 times the physical capital of workers in Niger. Thus, explaining per-worker income differences with (a) realistic physical capital shares and (b) no differences in E is probably not feasible.

Grading: 1 point for rewriting production function in per-capita terms; 2 points for finding the implied ratio of capital-per-worker values for the US and Niger; 2 points for quantitative estimate and discussion.

(c) What qualitative changes could you make to your framework above to better explain the large difference in per-capita output in the two countries? In particular, discuss the effects of adding human capital to your model. You do not need to write down a new production function; just write qualitatively about how the addition of human capital would affect your model, and how this human capital could be compared with the technology term. [5 points]

Answer: The addition of human capital increases the broadly defined capital share for the economy. With a larger capital share, the calculation above results in a smaller implied ratio of capital-per-worker in the two countries, holding E constant. In the limit, if the capital share equalled 1, then the U.S. would need only 70 times as much capital-per-worker as Niger to explain a 70-fold difference

in output per worker. The famous paper by Mankiw, Romer, and Weil (1992 *Quarterly Journal of Economics*) argued that differences in per-capita income around the world could be explained in an augmented Solow Model where the capital share was increased in this way. Note that we can add human capital to the model without increasing E. It is possible to think of E as the "blueprints" or "textbooks" for how to produce output from inputs. Spending time learning what is in the textbooks is building up a stock of human capital.

Grading: 3 points for explaining the effect of adding human capital on implied ratio of capital-per-worker values in the two countries; 2 points for citing MRW 1992.

(d) Now discuss the possibility that E may vary across countries. Is this realistic? What does the economics literature say about differences in E? What might be responsible for differences in E around the world? [6 points]

Answer: It is very realistic that levels of E could vary around the world. Some published papers study this issue by using careful estimates of output, physical and human capital in different countries. Country-specific values of E are essentially calculated as the amount of output that cannot be explained by the use of measured productive factors. These papers find that values of E are strongly correlated with output-per-worker, indicating that varying levels of physical and human capital are not the whole story when it comes to the cross-country distribution of income. (One example of such research is Hall and Jones's 1999 paper in the Quarterly Journal of Economics, but you did not need to know this to get credit for the question.)

The importance of productive efficiency E in generating income differences has led to a great deal of research. One group of economists believes that these differences are primarily due to **geography**. Poor countries tend to be located near the equator, where tropical diseases (for example, malaria) are endemic. Another group of economists believe that differences in E are generated by varying economic **institutions**, including the rule of law, the impartiality of the court system, the fairness of the tax system, etc. One famous paper, by Acemoglu, Johnson, and Robinson (2001 American Economic Review) argues that tropical countries are poor because former colonial powers could not establish well-functioning societies there (the settlers kept dying off). Because growth-friendly institutions could not be imported into tropical countries, these countries are poor today. Finally, some economists believe that a country's **culture** has a strong effect on economic outcomes. If people believe in the

importance of saving, investment, taxing incomes fairly, etc., then the surrounding culture may be more conducive to economic growth. Economists are often skeptical of cultural arguments, however, because they often leave open the question of where the cultures come from.

Grading: 1 point for saying that E may vary across countries; 1 point for linking E to Solow residual; 4 points for discussing geographical, institutional, and cultural arguments.

Question 5 (15 points)

If the government announced that households would each need to pay a tax of $1,000 (and the announcement was a surprise), how would the announcement affect consumption? If the government announced that households would each need to pay a tax of $1,000 (and the announcement was not a surprise), how would the announcement affect consumption? For both scenarios, provide a quantitative estimate (that is, some number) for what you think the consumption change would be.

Answer: For full credit, answers needed to mention the role of expectations and theories of consumption smoothing (such as the permanent income hypothesis and the life-cycle hypothesis). To get a quantitative estimate, answers needed to reference they annuity value of wealth, that is, how much annual consumption could rise if this rise were equal in each successive year of life. (You did not need to write the words "annuity value of wealth," however.) Full-credit answers should have also mentioned the role of liquidity constraints, which prevent consumers from smoothing consumption perfectly.

Question 6 (25 points)

The path of U.S. housing prices during the 2000s has often been described as an "asset bubble."

(a) Provide a formal definition of a bubble that an economist might use in a lecture. How might a bubble arise in the real world? Be as specific as you can with respect to the information used by economic agents as the bubble forms. [5 points]

Answer: Formally, a "bubble" occurs when some asset trades a price that is higher than its fundamental value. This fundamental value which is determined by the (discounted) value of the income stream that the asset is expected to generate over its lifetime. That is all you needed to write in order to get full

credit for this part of the question. Many economists extend this definition to argue that bubbles occur when people buy the asset simply because they want to sell it at a higher price later on. That's also fine, but to get full credit, you needed to get across the idea that there is a fundamental value of an asset that depends on its future income stream, and that bubbles occur when prices are higher than this fundamental value. In terms of what information agents use to form expectations, in general, agents use past information incorrectly. Most importantly, they simply assume that the changes in price observed in the past will continue into the future, which is as form of "extrapolation bias." This type of bias might arise from using only a subset of relevant information as price expectations are formed.

(b) Explain how a bubble in U.S. housing prices would affect (i) various components of GDP, (ii) the path of mortgage delinquencies, defaults, and foreclosures, and (iii) the health of the U.S. financial system. Think about both parts of the bubble—both rising and falling prices. [10 points]

Answer: (i) Higher housing prices would be expected to encourage more building of residential structures (a housing-construction boom) for standard "q-theory" reasons. To the extent that housing prices figure positively in household wealth, higher housing prices would also be expected to raise consumption. However, you could have also argued that higher housing prices might cause the consumption of renters to fall, so the aggregate effect of housing prices on consumption could be a wash. The effect of consumption may also be lessened for owners, if they believe that housing prices reflect higher future housing costs. In short, arguing that higher housing prices raise consumption via a wealth effect got you full credit. If you went farther than this, and explained why this may not happen, you needed to explain your economic reasoning there as well. Obviously, when housing prices fall, any effects of higher prices on GDP are reversed. (ii) As housing prices rise, more homeowners build up positive equity in their homes (that is, the prices of homes are worth more than they owe on their mortgages). This makes default and foreclosure unlikely, because any borrower having trouble making his or her monthly mortgage payment could simply sell the house to retire the mortgage and still have money left over. When housing prices fall, more borrowers have negative equity. These borrowers are vulnerable to default and foreclosure if they have some adverse life event (such as job loss, illness, divorce, etc.) Borrowers with negative equity may also "walk away" from their mortgages even if they do not have an adverse life event, if they believe that continuing to make payments on their

house no longer makes economic sense. (iii) If prices are rising and defaults and foreclosures are rare, then lenders make money, because they are paid back in full. When housing prices fall and foreclosures rise, then lenders don't get paid back, and financial institutions take big losses. The financial system is weakened and has more trouble financing investment projects. This is what happened before the U.S. financial crisis in late 2008.

(c) Now assume that policymakers want to prevent asset bubbles in the future. Why might policymakers find this difficult or unwise? Aside from trying to prevent bubbles, what policies might governments impose to try to reduce the adverse effects of bubbles? [10 points]

Answer: It is hard to know when asset prices reflect a bubble, because we don't know what any asset's fundamental value is. The fundamental value depends on rational estimates of future income streams, and neither the streams or the expectations can be measured without error. So, if we try to prevent bubbles, we may wind up discouraging price increases that are justified by realistic increases in the profitability of future assets. If that happens, market efficiency could suffer. One potential policy might not try to prevent bubbles, but rather try to make sure that financial institutions and households can survive big declines in asset prices (which would occur if their was a bubble in the given asset and the bubble popped). For housing, that type of policy might force financial institutions to have big reserves against losses (that is, lots of capital), while homeowners would be required to make larger down payments. A larger down payment means that prices could fall that much more, without the homeowner having negative equity.