Solution Guide for Written Exam in Development Economics, B.Sc. June 2010

Problem A

Please explain briefly:

1. Why a "big push" may be necessary in order to kick start economic development.
2. The theory behind the Kuznets curve.
3. The Gini coefficient and its relationship with the Lorentz curve.
4. The concept of sharecropping and some motivations for the existence of this particular agrarian institution.
5. Why the number of people living on less than a dollar a day is larger when we calculate it using market exchange rates instead of purchasing power exchange rates.
6. The main message of the Lewis model.
7. How one may use the Solow model to quantify productivity differences across countries
8. The relationship between productivity (A), technology (T), and efficiency (E).

Answer guide for Problem A:

A.1. A big push may be neccesary because of the existence of *pecuniary externalities*, say, which may entrap countries in a underdevelopment equilibrium. The idea works as follows: Imagine a region where there is a potential for investment in a number of enterprises, and that output must be sold within the region. Suppose then that a giant shoe factory is set up. This factory produces a million dollars worth of shoes and thus creates a million dollars of income in wages, rents, and profits. Can this enterprise survive? The answer is probably no. The reason is that not all people spend all their income on shoes. The recipients of income will spend money on other items, and not just on footwear. This creates a coordination type problem, which can only succesfully addressed by a simultanous expansion of all firms: a so-called big push. Let us consider a simple big-push type scenario: here factories are established in the ratios in which people spend their money. For example, if people spend their money in the fallowing proportion: 50% on shoes, 30% on food, and 20% on furniture. In that case, setting up three factories in the ratio 50:30:20 would generate the income to make the experiment viable.

Basu, Chapter 2, shows how the big-push idea can be formalized by assuming the existence of a *demand spillover*. We need to assume some sort of *externality*, because the above makes no sense in a Walresian world where every competitive equilibrium will lead to a Pareto efficient outcome; and, to be sure, the above uncoordinated equilibrium is not efficient.

A.2. The Kuznets curve, basically an empirical relationship, is an inverse U-shaped relation between the level of economic development and the level

of inequality. The extent to which the Kuznets curve is "found" in the data remains controversial. Theoretically, Kuznets reasoned that economic growth, represented by the arrival of new technologies and changes in the structure of the economy, would initially raise the return to skills, such as education and entrepreneurial ability. New technologies would furthermore raise the return to physical capital. Since skills and capital are found in the high end of the income distribution, the said changes will raise income inequality. Over time, however, countervailing forces set in. A higher return to skill induces unskilled workers (or their children) to obtain formal education, which will increase the supply of skilled workers. This will tend to lower inequality. Workers would also tend to migrate out of regions falling behind, which will also work to lower inequality.

A.3. The Gini coefficient is a measure of inequality (a Gini of 1 means total inequality while a Gini of zero means total equality). It is obtained as the area between the line of equality (see Fig. 1) and the Lorenz curve (i.e., the shaded area A) divided by the total area under the line of equality (i.e., BCD). The latter is constructed by plotting, on the horizontal axis, the number of income recipients in cumulative percentages and plotting, on the vertical axis, the share of income received by each percentage of income recipients (also cumulative, so axes are of equal length). Figure 1 illustrates.

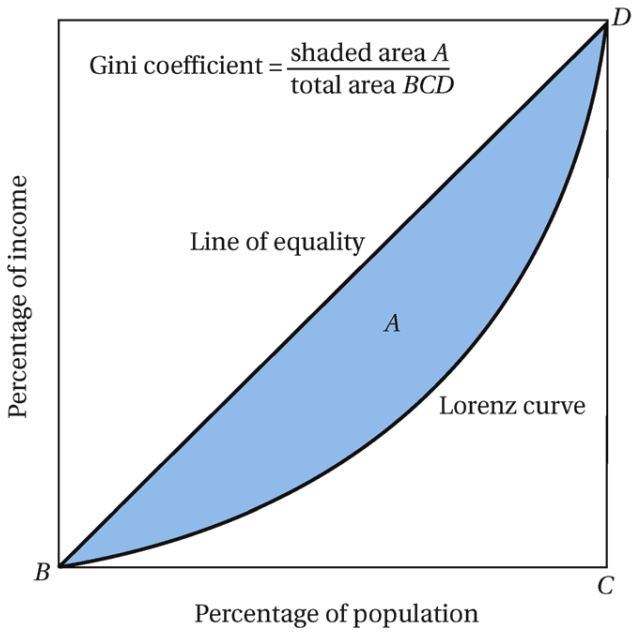

Figure 1: The Gini coefficient

A.4. Sharecropping arises when a peasant-farmer uses the landlord's farm-

land in exchange for a share of the food output, such as for example half the rice grown. In reality, the landlord's share may vary from less than one-third to more than two-thirds. At first glance, sharecropping seems to be inefficient with respect to the peasant's work incentives. As observed by Alfred Marshall early on, the peasant is not paid his marginal product and should therefore (rationally) reduce his work effort. This view, however, overlooks the fact that sharecropping is essentially a *risk sharing* institution (risk coping institutions are of crucial importance for people living at or below the poverty line). Sharecropping strikes a balance between the risk to the landlord that (under a *fixed wage contract*) the peasant will not work hard and the risk to the peasant that (under a *fixed rent contract*) he would in some years be left with no income at all. In fact, sharecropping may well be an optimal way to share risk between the risk neutral landlord a the risk averse peasant.

A.5. The reason is that market exchange rates tend to overstate income differences between rich and poor countries. The problem stems from two facts: First, the price of traded goods relative to non-traded is much higher in poor countries compared to rich countries. Second, by the law of one price, exchange rates tend to be such that the price of traded goods will be the same when converted to a common currency at the market exchange rate. The interaction of these two forces implies that GDP at market exchange rates systematically understate relative income of poor countres.

A.6. The dual economy of Sir Arthur Lewis (i.e., the Lewis model) shows how the industrial sector can withdraw surplus labor (that is, zero marginal product labor of which there is an abundance in less developed economies, according to the model's assumptions) from the agricultural sector without any loss of output. Entrepreneurs in the modern sector can then expand output and reinvest profits until all surplus labor is absorbed. When this turning point is reached, labor can only be withdrawn from agriculture at the cost of lower food production. After the turning point, the less developed economy looks much like a developed one, according to the model.

A.7. The Solow model provides us with the concept of an aggregate production function. For country i this is given by $y_i = A_i k_i^{\alpha} h_i^{1-\alpha}$, where $y_i = Y_i/L_i$, $k_i = K_i/L_i$ and $h_i = H_i/L_i$. If we divide the production functions of countries i and j and rearrange, we get

$$\frac{A_i}{A_j} = \frac{\left(\frac{y_i}{y_j}\right)}{\left(\frac{k_i^{\alpha} h_i^{1-\alpha}}{k_j^{\alpha} h_j^{1-\alpha}}\right)}.$$

Since we can observe everything of the right-hand side, we can simply back out the ratio of productivity levels in countries i and j. This method is called *development accounting*.

Of course, while the y's, the k's and the h's are immediately observable we have to make strong assumptions in order to calculate α. Specifically, in a *competitive economy* the assumption of a *Cobb-Douglas production function* gives us that

$$\frac{RK}{Y} = \alpha,$$

where R is the rental rate of capital. This means that we can use capital's share of national income to compute α.

A.8. A natural way to think about this relationship is as follows:

$$\text{productivity} = \text{technology} \times \text{efficiency}.$$

That is, productivity is determined by the level of technology (knowledge about how factors of production can be combined to produce output) and efficiency (how effectively the given technology and the factors of production are actually used).

Problem B

Please outline the O-Ring theory and explain how it may aid us in understanding cross country income differences.

Answer guide for Problem B:

The answer provided here builds on Kaushik Basu's Chapter 2. Note that the model is outlined formally below, but a more verbal account (as in Todaro, Chapter 4) would suffice just as well.

The O-ring theory is build around the notion of strong complementarities: modern production requires many activities to be done well in order for any of them to amount to high value. It is a natural way to think about specialization, and it is inspired by the Challenger disaster in which the failure of one small inexpensive part caused the space shuttle to explode..

To formalize the theory, assume that workers differ by levels of skill $q_i \in [0, 1]$. Here q is interpreted as the probability of completing a work task successfully. Assume in addition that a production task is characterized by n tasks, and that success is contingent upon all n tasks being completed successfully (complementarity of tasks). Now let B be output per worker when all tasks are successfully completed. This leads to the *O-Ring production function:*

$$y = q_1 q_2 \cdot \cdot \cdot \cdot q_n nB \equiv \left(\prod_{i=1}^{n} q_i \right) nB,$$

where y is expected output.

Now assume that there are N workers, and that their skills are uniformly distributed over the unit interval. The number of workers with skill level less than q is then Nq. A *competitive equilibrium* is a specification of a wage schedule as a function of skill type (i.e., $w(q)$) such that excess demand for each type of labor equals zero, and such that firm profit is zero (because of a free entry

assumption, say). Consider the maximization problem of a firm facing a wage schedule $w(q)$:

$$\max_{\{q_i\}} \left(\prod_{i=1}^{n} q_i \right) nB - \sum_{i=1}^{n} w(q_i),$$

where the functional form is $w(q_i)$ is of yet unknown. The FOCs are given by

$$w'(q_i) = \left(\prod_{\substack{i=j \\ j \neq i}}^{n} q_j \right) nB. \tag{1}$$

This is a *necessary condition* for optimum. *Sufficiency* requires in addition that there is *skill clustering*: $q_1 = \cdots = q_n = q$, as demonstrated in Basu (pages 35-36).

With the skill-clustering theorem in hand we can characterize the competitive equilibrium. Knowing that the optimal skill vector has $q_1 = ... = q_n = q$, we have that the FOC, i.e. equation (1), can be written as

$$w'(q_i) = q^{n-1} nB. \tag{2}$$

Now, because in equilibrium profits are zero, a q-firm's profit is characterized by

$$\begin{aligned} \left(\prod_{i=1}^{n} q_i \right) nB - \sum_{i=1}^{n} w(q_i) &= q^n nB - nw(q) = 0 \Leftrightarrow \\ w(q) &= q^n B. \end{aligned} \tag{3}$$

Using $w(q) = q^n B$ we get $w'(q) = nq^{n-1}B$, which is equal to (2) as required. Consequently, the competitive equilibrium wage is indeed $w(q) = q^n B$, as derived in (3).

An important *corollary* is that $w(q)$ increases in skill at an increasing rate; formally,

$$w(q) = q^n B \Rightarrow w'(q) = q^{n-1} nB > 0 \Rightarrow w''(q) = (n-1)\, q^{n-2} nB > 0.$$

This means that the value (or productivity) of a certain level of skill in a certain task goes up if the other tasks are performed by more skilled workers.

In an development context the skill-clustering theorem is important to the extent that skill clustering also takes places at the national level. That is, as there are more skilled workers in rich countries (as compared to poor countries), rich country workers will earn disproportionately more than workers in poor countries. It is therefore immediate that we can have multiple equilibria (low skilled Pareto inferior versus high skilled Pareto superior) driven by, say, international brain-drain type dynamics, despite no innate differences between countries. This provides one simple explanation as why to some countries are rich while others are poor.

Problem C

Please provide a discussion of the importance of geography, climate, and natural resources in the process of economic development.

Answer guide for Problem C:

The answer provided here builds on David Weil's Chapter 15.

As opposed to proximate sources such as human and physical capital, geography, climate and natural resources are fundamental determinants growth and development.

Turning first to *geography*, it is most likely that it is an important determinant of countries ability to participate in *international trade*. For instance, proximity to the ocean is important since ocean transport is the cheapest ways to ship goods. Geography also determines a country's distance to major markets, which again has implications for trade costs. On average, 1,000 kilometers of distance from one of the most developed regions of the world raises trade costs by one percentage point. Geography may also have important effects on the *size of states* and the *conduct of government*. The differences between China and Europe are telling in this regard. China was highly centralized, beginning with the first unified state in 221 BC. Europe in contrast was highly divided into a number of competing states. One prominent theory attributes the degree of division to geography. More specifically, historically Europe's most fertile lands were widely dispersed among vast areas of reduced fertility. In addition, Europe is also cut apart by numerous natural barriers, including mountain chains such as the Alps and bodies of water such as the English Channel. Although different parts of the continent can trade with each other, they are sufficiently separated that they are difficult to govern as a single unit. China was geographically much more prone to be ruled by a centralized entity. The advantage of a fragmented political was external competition, which served as a check on government power in Europe (not so in China). Government size, for instance, was limited by the extent to which capital owners could move their wealth to neighboring states. These constraints forced Europe's rulers to be less prone to wasteful extravagance as compared to their Chinese peers. Chinese rulers, for instance, stopped all oceanic exploration, whereas in Europe, Columbus turned to the Spanish when the Portuguese refused to finance his voyage.

Turning next to *climate*, characterized by for instance seasonal patterns of temperature, precipitation, winds, and cloud cover, it is thought to impact of economic outcomes in several ways. First of all, climate has direct effects on productivity through agriculture and indirect effects through human capital. *Direct effects*: Tropical climates suffer from many disadvantages in producing useful crops. The pattern of rainfall is not good for farming: rain falls seasonally, so torrential monsoons alternate with long dry seasons. Even where this seasonal pattern does not occur, tropical rain falls in deluges which may erode the soil. The seasonal pattern of sunlight in temperate zones is also better for growing staple grains. Absence of frost in tropical areas is also bad, since frost kills harmful organisms which compete with humans in consuming crops. Frost also

slows the decay of organic material, which means that the soil will be more fertile. Frost also controls many animal diseases that place a heavy toll on tropical agriculture. *Indirect effects*: Climate will affect human capital through the disease environment but also through the fact that in hot humid climates, where the evaporation of sweat cannot keep the body cool, people must work slower as a matter of human physiology. The former effect is a result of the fact that the tropics constitute a bad health environment; the tropics are rife with diseases such as malaria, sleeping sickness, schistosomaisis, just to name a few. Of course, diseases like malaria are endogenous to economic development, since many richer regions, including the US, have eradicated many tropical diseases (including malaria). Yet researchers have established a clear connection between malaria ecology (exogenous variable) and economic development.

Turning finally to *natural resources*, the picture is more complex. It is seemingly obvious that natural resources are important in the production of output; and, as such, the presence of vast deposits of natural resources is a good thing. And indeed it has been suggested that the reason as to why England saw an industrial revolution in the 18th century, while China did not (say), has to do with proximity to coal. However, we know from the resource curse that natural resources may interfere with politics. That is, the presence of natural resources may lead governments to undertake worse policies than they otherwise would. Two channels are operative. First, natural resources tend to lead to an over-expansion of government (which may have various deleterious effects on the economy, as explained in Weil's Chapter 12). Second, by increasing the size of rents up for grab, the presence of natural resources tend to encourage people in power to hang on to power by distributing rents to favored groups. Indeed, natural resources are often key elements in civil wars and foreign invasions in Africa.

It is important to note two things in any discussion of the role of geography. First and foremost, *geography is not destiny*. For every one channel that geography can affect economic outcomes, we can find exceptions. For instance, natural resources may be part blessing, as the case of Botswana illustrate. Botswana has maintained a staple, democratic, efficient and honest government despite the fact the diamonds account for 33% of Botswana's GDP. But it is also important to beware of after-the-fact rationalizations when putting forward some of the historical geographical explanations. Econometrically speaking, even though geography is predetermined, *endogeneity* is still an issue; more specifically, reverse causality is not an issue but it could be that that some unobserved factor is at play (omitted variables problem).

Academic Aims

The 3rd year advanced undergraduate course entitled Development Economics has as overall aim to introduce the students to the field of development economics. Having successfully taken this course, students will be able to:

- Explain both the basic concepts used and the issues addressed in Development Economics and document sound ability to apply standard micro, macro and empirical theory and methods to questions of development.
- Identify, describe and assess the measurable indicators, which are used in socioeconomic surveys and analyses of the economic, social and institutional situation and characteristics of developing countries.
- Describe the main historical experiences with development and structural change in the third world (including for example urbanization and rural-urban migration) and reflect convincingly on present challenges and perspectives for the future.
- Lay out the key elements of the classic theories of development as well as more recent theories and development models, and document ability to undertake critical assessment, add nuance and relate the various theories/models to each other.
- Review theories and empirical evidence on economic inequality, poverty and growth and their internal relationships.
- Present and discuss existing theory and empirical evidence on the importance of human resources (health, education and population) and the role of agriculture in the development process.
- Summarize and assess theory and empirical evidence on the economic characteristics and functions of selected markets (land, labour and capital/credit) in developing countries and relate the interaction between the environment and development to concepts and methods used in economics.
- Explain how selected macroeconomic policies (fiscal, financial, monetary, exchange rate, trade and structural) are applied in the context of economic reform programmes in developing countries and reflect about ongoing professional debate in areas such as international trade, foreign direct investment and foreign aid.
- Convey knowledge about issues, theory and empirical evidence in the field of development economics in a clear and well-argued manner and demonstrate ability to apply taught theoretical and empirical knowledge in a competent, coherent and original way in relation to current challenges.