Solution guide

A. Verbal questions

Q1.

Based on Frankel and Romer (1999), Rodriguez and Rodrik (2000) and Feyrer (2009)

Theory.

Trade may influence growth in a variety of ways; directly as well as indirectly.

There could be a direct impact from trade in ensuring a more efficient allocation of scarce resources across the sectors of an economy. That is, division of labor may enhance macroeconomic efficiency. Perhaps more importantly, trade may indirectly induce knowledge (technology) diffusion.

At the same time the "division of labor" argument may cut both ways. It is possible, for instance, that countries end up specializing in non-dynamic sectors. Thus, despite the "static" efficiency gain, there might be dynamic costs over a certain time horizon.

Econometrics.

Naturally, trade and growth are jointly endogenous. Hence, OLS estimates are unlikely to establish causal relationships.

In an effort to try and identify the impact of trade on growth Frankel and Romer (FR) begin by estimating a so-called gravity equation. This approach consists of estimating the impact from geography (distance to other nations, landlocked etc) on bilateral trade. The useful aspect of such determinants is that they are unaffected by income making them potentially viable instruments for actual trade.

With an estimated gravity equation in hand, FR derive the *fitted values* for trade at the country level. Finally, they use these fitted values (essentially a linear combination of variation geographic characteristics of individual countries and their trade partners) as an *instrument* for actual trade. Their main (2SLS) result is that trade has a positive *impact* on growth.

Critical remarks on FR. A problematic aspect of FRs analysis is the key exclusion restriction required for IV validity: The geographic variables cannot be allowed to affect growth above and beyond their effect via trade. In fact, they are not allowed to be *correlated* with (other) geographic (or climate related) factors that influence growth. As shown in Rodriguez and Rodrik, once additional geo-controls are added (e.g., absolute latitude), trade is not longer significant.

A more recent contribution by Feyrer, however, re-examines the issue. The key novel aspect of the paper is to try to obtain identification in the *time dimension.* The basic idea it the following.
1967 saw the onset of the Six Days War. A key consequence of the hostilities between Isreal and Egypt was the closing of the Suez Canal. In fact, the canal remained closed to traffic until 1975. The implication is that the war induced an *arguably exogenous* (from the perspective of most countries, albeit not the warring parts, of course) increase in sea distance between a large number of nations. After the closing, for instance, the sea distance between (say) Europa and Asia grew appreciably. Greater distance should induce lower trade. In short, Feyrer treats the closing of the Suez canal as a *natural experiment* from which one may elicit information about the causal impact from trade on growth.

Feyrer – like FR – estimates a gravity equation which links *changes* in sea distance to changes in bilateral trade. There are two shocks from which he obtains identification; the increase in sea distance in 67, and the decrease in 1975. With fitted – changes – in trade in hand he proceeds to estimate – by way of panel data- the impact on growth.
Feyrer also finds a positive causal impact from trade on growth. The size of the impact is smaller however. The key advantage of this approach is, naturally, the time-varying nature of the instrument. In contrast to FR these results are thus less likely to be tainted by the cofounding influence from *time invariant* influences on growth (like e.g. factors that vary with latitude).

Critical remarks on Feyrer. Full marks requires that the student can put some form of critical perspective on the analysis.

One line of critique could be the following. A potentially problematic aspect of the analysis is that the period during which the canal was closed engulfs the Yom Kibbur war (1973). This crisis instigated the arab oil embago, which served to increase the world market price of oil by a factor of 5; it unleashed the first oil crisis.

Hence, the reduction in trade during the closing of the canal may have been influence (enhanced) by *other* factors than mere sea distance. If these factors has a direct impact on growth in their own right the exclusion restriction is violated. One may also add, that this period lead to considerable terrorist activity; hijacking of planes specifically. This too may have influence growth by affecting either trade or international interaction.

Q2.

Based on Ashraf and Galor (2010); Galor and Weil (1999); Galor (2010)**.**

The fertility transition is a unique event in human history. For the first time in human history do we see that fertility declines despite systematic and persistent increases in household income.
Up until this point, which generally occurs in the 1800s in the Western World and considerably later elsewhere, increases in income were associated with increases in family size. In an setting where land plays a central role in production this "Malthusian mechanism" is arguably key to an understand of the epoch of stagnation, which precedes the current regime (within which income rises secularly, in many places). That is, small increases in income (brought forth by technological innovation, or just a good harvest), would instigate larger families. In the follow "period" however, diminishing returns to labor input would serve to bring income per capita back to the pre-shock state. As a consequence population growth slows and ultimately grinds to a halt, absent further shocks to the system. These predictions are supported by the work of Ashraf and Galor (2010).

But after the fertility transition the stabilizing element from rising family size is eliminated. Instead, higher income is associated with smaller families, and usually with greater investment per child. This is a key element behind sustained growth in income per capita, for a number of reasons.

Slower population growth reduces capital dilution, which stimulates growth in per capital income. Greater child investments in human capital stimulates productivity in its own right, but also works to speed up technological change, or technology adoption. The reductions in fertility, associated with the transition, temporarily increases the fraction of the population that is active in the labor market (a “demographic divided”, elevating growth in income per capita.

Accordingly, countries that managed to have a head start in undergoing the demographic transition will also start growing before countries venturing through the transition at a later date. During the delay an income gap emerges. These income gaps are still visible in the global distribution of income, and thus represents a first order explanation for the fact that European countries (so far) are found at the top of the global distribution of income.

Analytical questions

Based on: Hasan and Zoabi (2006); Aghion et al. (2009); Acemoglu and Johnson (2008); Shastry and Weil (2003)

Question 1.

(i). The first budget constraint says that total income of the individual is πh; total (potential) lifetime income. The right hand side shows how the budget may be spend. Either on consumption, c, or, on child rearing; here τ is obligatory whereas educational expenses comes on top, e. These costs are modeled as time costs. Hence, the real (expected) income of the individual i $(\pi-(\tau-e)n)h$. The second budget constraint simply says that more educational spending increases human capital and thus income of the off spring.

(ii) The model is clearly only relevant if it makes sense that individuals actively can limit their fertility (insofar as their optimization gives them cause to do so). In contemporary societies it is clear that a number of measures can be taken in preventing pregnancy. But modern birth control measures (such as the contraceptive pill) was not available in the pre-industrial times; nor is it always available in developing countries. Still, as discussed at the lectures there is a very long history for other (clearly, less effective) contraceptive measures. In addition, more “brute force” measures could be invoked like infanticide. Finally, delayed time of marriage was in preindustrial Europe the main mechanism. This “worked” due to the social stigma involved with child birth out of wedlock; it may also be effective in some (but clearly not all) less developed countries today.

Question 2. The problem is $\max_{e_{t+1},n_t} W_t = U\left(\pi_t h_t - \left(\tau + e_{t+1}\right) n_t h_t\right) + V\left[n_t \pi_{t+1} h_{t+1}\right]$.

Straight forward differentiation yields

$$e : U'\left(c\right)h = V'\left(n\pi h\right)\pi h'\left(e\right)$$
$$n : U'\left(c\right)\left(\tau + e\right)h = V'\left(n\pi h\right)\pi h$$

Where the FOC wrt e states that optimality requires that the marginal costs of foregone consumption due to lower labor market effort needs to equal the marginal benefit in the form of utility from greater child "quality". The FOC wrt n states that the marginal cost of an additional child (in terms of foregone consumption) needs to equal the marginal utility from a larger family.

Question 3. (i) Dividing the two FOC we obtain

$$\frac{h'\left(e\right)}{h\left(e\right)} = \frac{1}{\left(\tau + e\right)}$$

Which gives an (implicit) solution for optimal educational investments, e. Evidently, the survival rate *does not influence optimal educational investments*. (ii) The intuition is that increased longevity increases both the marginal return on quality (i.e., e) as well as quantity (i.e., n); this is immediately evident from the FOC printed above. On net, therefore, there is no impact on quality investments.

Question 4. Here the students need to summarize the work of Acemoglu and Johnson (2008) as well as Aghion et al. (2009). It needs to be clear (i) how AJ exploits the international epidemiological transition to construct an instrument for changes in life expectancy, (ii) that their key result is zero impact on long run productivity from increases in longevity, (iii) That aghion et al. provide an argument that both the level and the rate of change in longevity matters (thus criticizing AJs specification; and thus argues that their instrument is invalid due to a violation of the exclusion restriction) and therefore employs additional instruments for the level of life expectancy "at time zero", (iv) that they reach a very different conclusion: they find greater longevity is good for growth. Hence, there is a *debate* on this topic at the moment, and so far it is unclear how this debate will end.

Question 5. (i) The first derivative simply states that healthier individuals will be able to supply more efficiency units of labor (better powers of concentration say), whereas the second cross-partial says that with greater health the marginal educational investment has a greater impact on skill formation. It states, in other words, that schooling and health are complements.

(ii) The formal analysis proceeds exactly as before. Hence optimal educational expenses is determined by the following modified elasticity rule

$$\frac{h'(e,\theta)}{h(e,\theta)} = \frac{1}{(\tau + e)}$$

Which pins down e, for θ given

(iii) Implicit differentiation now shows that if the degree of complementarity (i.e., the cross partial between e and θ) is sufficiently large then better health will unambiguously increase educational investments by households. Hence, this finding suggests that – when fertility is endogenous – the impact from lower morbidity and mortality is rather *different*. Whereas the former does increase schooling the latter does not.

Question 6. Here the students need to describe the approach taken in Shastry and weil (2003). The main finding of the paper, which makes use of development accounting, is that morbidity can account for a substantial share of the total variation in income per capital across countries (about 20%).

Question 7. In order to tell the "full" story, we need a few additional assumptions. First, suppose that health improves with income, θ(y). Second, assume that improvements in health also raises longevity, π(θ). finally, assume the production function is linear in human capital: y=A π h. Consider a situation, initially, where the level of income is very low. As a consequence, morbidity and mortality is high. By extension is may imply that households are not investing in education (e=0) due to the low level of health. Nevertheless, due to the linearity of the production function, income rises incrementally, gradually raising θ and π. Eventually, θ is high enough to trigger investments in schooling (due to the complementarity effect); at the same time fertility declines. Schooling investments means that income per capita grows faster; an additional "kick" is provided in that π rises as well.