Motivation

1. TFP differences account for most of the cross-country differences in per-capita income

2. TFP growth main driver of the long term increase in the standards of living
Economic development is characterized by three inter-related processes

1. Increase in productivity

2. Increase in human capital attainment (both education and health)

3. Shift in population from rural areas to urban areas
Urbanization and TFP

1. Agglomeration effects: Enhanced flow of ideas and knowledge, Cities facilitate interactions needed to generate, diffuse, and accumulate knowledge

2. Economies of Scale: Specialization by firms and individuals and the emergence of specialized services (e.g. accounting, management services)

3. Amenities and public services and infrastructure
Education and TFP

1. Determines ability of a country to develop new technologies

2. Adopt and effectively utilize existing technologies

3. Affects the speed of technological diffusion and catch-up

In the literature, there is a big debate about the role of education in the growth process. Does it affect per-capita income directly as a factor of production or indirectly through its effect on TFP?
Health and TFP

1. Affects capacity to work

2. Reduces absenteeism by workers

3. Healthier children have better cognitive abilities

4. High mortality rate can prevent the emergence of institutions conducive to development
Main Contribution

1. Estimate a variant of augmented Solow growth model to derive the estimate TFP of 100 countries using panel data approach

2. Use health capital as one of the factors of production

3. Empirically examine the effects of urbanization, education, and health on TFP

4. Use IV approach to control for the potential endogeneity of urbanization, education, and health
Main Results

1. Both urbanization and health indicators affect TFP significantly

2. Their coefficients remain significant even after controlling for endogeneity

3. Education has insignificant effect on TFP
Literature


Morbidity and TFP – Cole and Neumayer (2006)
Methodology

Two-stage approach:

(i) Generate the estimate of TFP using Augmented Solow Model

(ii) Then analyze the effects of urbanization and human capital on TFP
First Stage: Growth Regression

Let the production function be

\[ Y_{it} = [A_{it} L_{it}]^{1-\alpha-\beta} K_{it}^\alpha H_{it}^\beta \]  \hspace{1cm} (1)

where \( Y \) is output, \( A \) is technology, \( L, K, \) and \( H \) are labor, physical and health capital respectively.

Let lower case letters denote variables per worker (e.g. \( y_{it} = \frac{Y_{it}}{L_{it}} \)), then, one can derive,

\[
\ln y_{it} = \ln A_{i0} + gt - \frac{\alpha}{1 - \alpha} \ln(n_i + g + \delta) + \frac{\alpha}{1 - \alpha} \ln s_i^K + \frac{\beta}{1 - \alpha} \ln \hat{h}_i^* \]  \hspace{1cm} (2)

which is a steady-state relationship.
Then by linearizing (5) around the steady state, one can derive (see Mankiw et. al. 1992, Islam 1995)

\[
\ln y_{it_2} = \left(1 - \exp^{-\lambda \tau}\right) \frac{\alpha}{1 - \alpha} \ln s_{i\tau}^K - \left(1 - \exp^{-\lambda \tau}\right) \frac{\alpha}{1 - \alpha} \ln (n_{i\tau} + g + \delta) + \\
\left(1 - \exp^{-\lambda \tau}\right) \frac{\beta}{1 - \alpha} \ln h_{i\tau}^* + \exp^{-\lambda \tau} \ln y_{it_1} + g(t_2 - \exp^{\lambda \tau} t_1) + \left(1 - \exp^{-\lambda \tau}\right) \ln A_{i0}
\]

(3)

where \(\lambda = (1 - \alpha - \beta)(n + g + \delta)\) is the rate of convergence.

We estimate (3) to generate the values of \(\ln A_{i0}\) (TFP)
Data

Data for the growth regression is from Penn World Tables 6.3 and World Development Indicators for the period 1960-2005.

Two proxies for health capital – Life-Expectancy and Infant Mortality Rate.

Total period divided in 10 sub-periods of five years each.
## Growth Regression

### Table 1
Growth Regression Results

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>AB 1-Step (1)</th>
<th>AB 2-Step (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y_{i,t-1}$</td>
<td>0.6415 (0.057)*</td>
<td>0.652 (0.03)*</td>
</tr>
<tr>
<td>$\ln(s^K_{i\tau}) - \ln(n_{i\tau} + g + \delta)$</td>
<td>0.0715 (0.038)**</td>
<td>0.0785 (0.018)*</td>
</tr>
<tr>
<td>$\hat{LLE}^*_{i\tau}$</td>
<td>0.1968 (0.074)*</td>
<td>0.2151 (0.037)*</td>
</tr>
<tr>
<td>p Values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wald Test</td>
<td>0.15</td>
<td>0.47</td>
</tr>
<tr>
<td>Sargan Test</td>
<td>0.003</td>
<td>0.13</td>
</tr>
<tr>
<td>$H(0)$: AR(2) is absent</td>
<td>0.16</td>
<td>0.19</td>
</tr>
<tr>
<td>No. of Observations</td>
<td>796</td>
<td>796</td>
</tr>
<tr>
<td>No. of Countries</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Methodology

Using (3) we derive the estimate of TFP given by

$$\ln A_{i0} = \frac{\mu_i}{1 - \exp^{\lambda\tau}}.$$  \hspace{1cm} (4)

Second stage regression:

$$\ln A_{i0} = \pi U + \Pi_1 H + \Pi_2 S + \Pi_3 Z + u_i$$ \hspace{1cm} (5)
All data pertains to 1960.

Health Indicators:- Life Expectancy (LLE), Infant Mortality Rate (LMR), Malaria Ecology (ME) (Data Source: WDI and Sachs 2003)

Education Indicators:- The average years of school for adults (LAV), The fraction of population aged 15 years and above completing primary schooling (LPC), secondary schooling (LSC), tertiary schooling (LTC) (Data Source: Barro and Lee 2001)

Urbanization:- Fraction of urban population (LUR) (Data Source WDI)

Other control variables: trade openness, ethno-fractionalization, Dummy for oil-exporting and African Countries, Legal Origin
## Regression Results: OLS

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$LLE_{60}$</td>
<td>1.0682*</td>
<td>0.6315*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.17)</td>
<td>(0.15)</td>
<td></td>
</tr>
<tr>
<td>$LMR_{60}$</td>
<td></td>
<td></td>
<td>−0.3143*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.05)</td>
</tr>
<tr>
<td>ME</td>
<td>−0.0235***</td>
<td>−0.0254**</td>
<td>−0.0337*</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>LSC</td>
<td>0.1208**</td>
<td>0.0545</td>
<td>0.0527</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.04)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>LUR</td>
<td></td>
<td>0.3877*</td>
<td>0.3562*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.08)</td>
<td>(0.07)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.74</td>
<td>0.83</td>
<td>0.77</td>
</tr>
<tr>
<td>$N$</td>
<td>74</td>
<td>74</td>
<td>63</td>
</tr>
</tbody>
</table>
Instrument Variables

1. TROPIC: The percentage of area of a country under tropics *Gallup et. al. (1999)*
2. LT100: The proportion of population within 100 k.m. of coast *Gallup et. al. (1999)*
3. LAND: Dummy for land-locked countries
4. MUSLIM: Proportion of muslim population *La Porta et. al. (1999)*
5. CATH: Proportion of catholic population *La Porta et. al. (1999)*
6. SON: Dummy for countries where son-preference is prevalent *Williamson 1976, Fuse 2010*
## Regression Results: 2SLS

<table>
<thead>
<tr>
<th>Variable</th>
<th>(4)/2SLS</th>
<th>(5)/2SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>$LLE_{60}$</td>
<td>0.8945**</td>
<td>0.8945**</td>
</tr>
<tr>
<td></td>
<td>(0.38)</td>
<td>(0.38)</td>
</tr>
<tr>
<td>$LMR_{60}$</td>
<td></td>
<td>-0.2097***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.12)</td>
</tr>
<tr>
<td>ME</td>
<td>-0.0158***</td>
<td>-0.0371*</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>LSC</td>
<td>0.1244</td>
<td>0.1279</td>
</tr>
<tr>
<td></td>
<td>(0.23)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>LUR</td>
<td>0.5093**</td>
<td>0.3896**</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(0.16)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.75</td>
<td>0.85</td>
</tr>
<tr>
<td>N</td>
<td>74</td>
<td>63</td>
</tr>
<tr>
<td>Sargan (p-value)</td>
<td>0.60</td>
<td>0.64</td>
</tr>
</tbody>
</table>
Conclusion

1. Empirically examine the effects of urbanization, education, and health on TFP

2. Both urbanization and health indicators affect TFP significantly

3. Their coefficients remain significant even after controlling for endogeneity

4. Education has insignificant effect on TFP
Health, Education, and the Dynamics of TFP
with Wenshu Chen
Main Contribution

1. Studies the dynamics of the total factor productivity (TFP) for a sample of 97 countries for the period 1960-2005.
2. Examines the effect of education and health capital on the growth rate of TFP (GRTFP)
Methodology

Similar to Kumar and Kober (2011). Two stage approach

(i) Estimate the TFP using the Augmented Solow Model

(ii) Analyzes the effects of education and health on TFP

(iii) Studies the issue of convergence in the productivity levels
Growth Regression

\[
\ln y_{it2} = \left(\frac{1 - \exp^{-\lambda \tau}}{1 - \alpha}\right) \alpha \ln s_{i\tau}^K - \left(\frac{1 - \exp^{-\lambda \tau}}{1 - \alpha}\right) \alpha \ln(n_{i\tau} + g + \delta) + \\
\left(\frac{1 - \exp^{-\lambda \tau}}{1 - \alpha}\right) \beta \ln h_{i\tau}^* + \exp^{-\lambda \tau} \ln y_{it1} + g(t_2 - \exp^{\lambda \tau} t_1) + (1 - \exp^{-\lambda \tau}) \ln A_{i0}
\]

(3) is estimated for two sub-periods: 1960-1985 and 1985-2005. From this we generate values of \(\ln A_{i1960}\) and \(\ln A_{i1985}\)
Second Stage Regression

\[ \ln A_{i1985} - \ln A_{i1960} = \gamma_1 \ln A_{i1960} + \Pi_1 H + \Pi_2 S + \Pi_3 Z + u_i \] (4)

where \( H \) and \( S \) are indicators of health and education. \( Z \) is a matrix of other explanatory variables.
Data

All data pertains to the average of 1960-85.

Health Indicators:- Life Expectancy (LLE), Infant Mortality Rate (LMR) (Data Source: WDI and Sachs 2003), % of Population Undernourished (Data Source: FAO)

Education Indicators:- The average years of school for adults(LAV), The fraction of population aged 15 years and above completing primary schooling (LPC) (Data Source: Barro and Lee 2001)

Other control variables: trade openness, urbanization, dummy for countries with English laws (ENGLISH), dummy for African countries (AFRICA), the index of ethno-linguistic fractionalization (ETH) and the percentage of Muslim population (MUSLIM)
Main Findings

1. Both health capital and education have positive and significant effect on the growth rate of TFP (GRTFP).
2. There is evidence of both the absolute and the conditional convergence in the TFP.
3. Urbanization has negative effect on GRTFP.