A decomposition of China’s productivity through calibration of an endogenous growth model

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Background
The death of Communist leader Mao in 1976 led to the restructuring of the Chinese economy under the Four Modernization (agriculture, industry, science and technology, and defense) in late 1978, which paved the way for unprecedented growth in the Chinese economy. How did this structural change so drastically effect the Chinese economic growth? Human capital and investment specific technology (IST) capture two fundamentally different sources of growth: human capital centers on the idea that human intellect and innovation are the driving force of growth, while IST focuses on the evolution of productivity of physical capital. We show human capital and IST together play an essential role in explaining the Chinese economic growth.

Objectives
1) Use an endogenous growth model with human capital enhancing labor productivity in the production function and IST augmenting capital investment in the law of motion of capital to decompose the Chinese labor augmented productivity (LAP).
2) Based on the growth structure of LAP, we are able to more accurately project when the Chinese economy will surpass the U.S. economy.

Investment Specific Technology
IST (\(\tau\)) describes the state of capital technology by formalizing the amount of output needed to produce one unit of capital. Growth in IST imply a new—more productive—vintage of capital and an improvement in the conversion technology. The state of the technological is reflected in the price of capital. As technology advances, capital, particularly equipment, become less expensive. Thus, IST is defined as: \(\tau = 1/\text{price of capital}\). As seen below, China’s price of capital has been falling steadily since the 1980s.

Human Capital
For this study, we focus on education driven human capital. Namely, the better educated the labor force, the more productive are the laborers and the faster the knowledge stock grows. During Mao’s era, the Chinese education system was reorganized to follow a Soviet style system and aimed to bring education to the rural masses. However, because this education was viewed as inferior rural worker were hesitant to enroll. After Mao’s Death, the Chinese education system was again reorganized to follow a Western style. Since then China’s education rate has doubled.

Chinese Growth Decomposition
LAP: \(A_t = Y_t^{(t-1)} = (K_t^{(t-1)}, h_t, L_t)\)

Human capital: \(h_t = \exp(\phi/\sigma)\)

Law of Motion (\(K_t\)): \(K_{it} = (1-\delta)K_i + \tau_s Y_i\)

Variable Definition
\(Y = \text{GDP}, K = \text{Capital}, A = \text{Labor Augmenting Productivity}, h = \text{Human Capital}, L_{it} = \text{Years of Schooling Parameters}\)
\(\gamma = \text{Capital Share Parameter}, \psi = \text{Intercept}, \delta = \text{Depreciation Rate}, s = \text{Savings}\)

GDP Forecasting
Production: \(Y_t = K_t^{\alpha} (A_t L_t)^{\beta - 1}\)

Law of Motion (\(K_t\)): \(K_{it} = (1-\delta)K_i + \tau_s Y_i\)

Population Growth: \(L_{it} = (1 + g_s) L_i\)

IST growth: \(A_{it} = (1 + g_a) A_i\)

LAP Growth (China): \(A_{it} = A_{it-1} + g_a A_{it-1}\)

where \(\alpha\)\(,\) the catch-up parameter and \(g_a\) are the growth rates.

China’s LAP follows a catch-up formation to account for non-balanced growth of the Chinese economy. As China’s LAP approached that of the U.S., the Chinese LAP growth converges to the U.S. LAP growth rates.

Data and Calibration
The model is calibrated using data for the period 1952-2009. Data for population, real GDP per worker, purchasing power parity (PPP), savings, and price of investment data were collected from the Penn World Tables. Data for average years of schooling came from Barro and Lee. The consumption of fixed capital to output was collected from the World Bank, and the physical capital share was calculated from data collected from the Bureau of Economic Analysis.

Results
Chinese Growth Decomposition
The Chinese LAP is broken down in three steps: 1) for the baseline, we calculate LAP using the growth model without human capital or IST, 2) we incorporate human capital into the production function and compare the structure of LAP to that in the first step, and 3) we combine both human capital and IST into the model and compare the growth structure to that in the previous two steps.

Conclusions
• Human capital plays a central role in decomposition LAP, and the importance of this role has increased over time. Human capital accounts for 47% of LAP.
• IST: There is a pronounced divergence between LAP calculated from the growth model in step 2 and that calculated in step 3. China’s capital vintage was stagnant before the Chinese economy opened. After 1979, the capital vintage dramatically improved and played a major role in explaining China’s LAP growth. IST accounts for an additional 27% of LAP.
• The GDP Predictions are robust to reasonable economics shocks.