

Trade and the Great Divergence: The Family Connection

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January 3, 2006

The last two centuries have been characterized by dramatic changes in the distribution of income and population across the globe. While Western European economies have tripled their domination in terms of income per capita over Asian economies, significant resources in Asian countries have been channeled into doubling their lead over Western Europe in the population dimension.

This research argues that the rapid expansion of international trade in the second phase of the industrial revolution has played a major role in the timing of demographic transitions across countries and has thereby been a significant determinant of the distribution of world population and a prime cause of the ‘Great Divergence’ in income levels across countries in the last two centuries. The analysis suggests that international trade had an asymmetrical effect on the evolution of industrial and non-industrial economies. While in the industrial nations the gains from trade were directed primarily towards investment in education and growth in output per capita, a significant portion of the gains from trade in non-industrial nations was channeled towards population growth.

In the second phase of the Industrial Revolution, international trade enhanced the specialization of industrial economies in the production of industrial, skilled intensive, goods. The associated rise in the demand for skilled labor induced an investment in the quality of the population, expediting a demographic transition, stimulating technological progress and further enhancing the comparative advantage of these industrial economies in the production of skilled intensive goods. In non-industrial economies, in contrast, international trade generated an incentive to specialize in the production of unskilled intensive, non-industrial, goods. The

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absence of significant demand for human capital provided limited incentives to invest in the quality of the population and the gains from trade were utilized primarily for a further increase in the size of the population. The demographic transition in these non-industrial economies was significantly delayed, increasing further their relative abundance of unskilled labor, enhancing their comparative disadvantage in the production of skilled intensive goods and delaying their process of development. Thus, the historical patterns of international trade reinforced the initial patterns of comparative advantage and generated a persistent effect on the distribution of population in the world economy and a great divergence in income per capita across countries and regions.

In contrast to the literature on growth and comparative advantage,² the focus on the interaction between population growth and comparative advantage and the persistent effect that this interaction may have on the distribution of population and income in the world economy generates an important new insight regarding the distribution of the gains from trade. The theory suggests that even if trade equalizes output growth of the trading countries, (due to the terms of trade effect), income *per capita* of developed and less developed economies will diverge since in less developed economies the growth of total output will be generated primarily by population growth, whereas in developed economies it will be generated principally by an increase in output per capita.

The proposed hypothesis is consistent with the evidence about the effect of trade on industrialization, the rise in the demand for human capital in the second phase of industrialization, the effect of human capital formation on the demographic transition, and the forces behind the transition from stagnation to growth discussed by Galor and Weil (2000), Galor and Moav (2002), Galor and Mountford (2003), and Galor (2005).

I. An Autarkic Economy

Consider a perfectly competitive overlapping-generations economy. In each period t , two goods, an industrial good, Y_t^m , and an agricultural good, Y_t^a , may be produced using two factors of production: skilled labor, H_t , and unskilled labor, L_t . The population of the adult population,

²E.g., Ronald Findlay and Henryk Kierzkowski (1983), Gene Grossman and Elhanan Helpman (1991), Kiminori Matsuyama (1992), Alwyn Young (1991), and Nancy Stokey (1991).

N_t and its decomposition between skilled and unskilled workers evolve endogenously over time.

A. Production

The output of the agricultural good produced in period t , Y_t^a , is

$$Y_t^a = A^a L_t^a, \quad (1)$$

where A^a is the productivity level, and L_t^a is the level of employment of unskilled labor, in the agricultural sector in period t .

The output of the industrial good produced in period t , Y_t^m , is

$$Y_t^m = A_t^m (H_t)^\gamma (L_t^m)^{1-\gamma} = A_t^m L_t^m (h_t^m)^\gamma, \quad 0 < \gamma < 1 \quad (2)$$

where A_t^m is the productivity level, and L_t^m and H_t are the levels of employment of unskilled and skilled labor, in the manufacturing sector in period t ; $h_t^m \equiv H_t/L_t^m$.

As long as both goods are produced, the inverse demand for unskilled labor in the agricultural sector is $w_t^u = p_t A^a$, and in the industrial sector is $w_t^u = (1 - \gamma) A_t^m (h_t^m)^\gamma$, and the inverse demand for skilled workers is $w_t^s = \gamma A_t^m (h_t^m)^{\gamma-1}$, where w_t^u and w_t^s are the wages of skilled and unskilled workers, and p_t as the relative price of the agricultural good in terms of the industrial good, in period t . Since unskilled workers are perfectly mobile between the agricultural and the industrial sectors, the wages of unskilled labor in both sectors are equal if both goods are produced and $p_t = (1 - \gamma) (h_t^m)^\gamma (A_t^m / A^a)$.

B. Individuals

Individuals live for two periods. In their first period of life they consume a fraction of their parental unit time endowment. In their second period of life they are endowed with one unit of time which they allocate between child rearing and labor force participation.

An adult in period t generates utility from the consumption of the agricultural good, c_t^a , and the industrial good, c_t^m , and the total potential income of their children. In particular,

$$u_t = \alpha \ln c_t^a + \beta \ln c_t^m + (1 - \alpha - \beta) \ln(w_{t+1}^s n_t^s + w_{t+1}^u n_t^u) \quad (3)$$

where n_t^s and n_t^u are the number of children trained to be skilled and unskilled workers, and w_{t+1}^s , and w_{t+1}^u are their wages in period $t + 1$.

The budget constraint of a adult i (skilled or unskilled) in period t , is

$$p_t c_t^a + c_t^m + w_t^i (n_t^s \tau^s + n_t^u \tau^u) \leq w_t^i, \quad (4)$$

where τ^s and τ^u is the time required to raise skilled and unskilled offspring respectively; $\tau^s > \tau^u$.

Given the homotheticity of the utility function the optimal consumption of each good and the time devoted to child rearing have constant budget shares. In particular, $c_t^a = \alpha w_t^i / p_t$, $c_t^m = \beta w_t^i$, and $(n_t^s \tau^s + n_t^u \tau^u) = (1 - \alpha - \beta)$ where

$$n_t^s > 0 \text{ and } n_t^u > 0 \text{ only if } w_{t+1}^s / w_{t+1}^u = \tau^s / \tau^u. \quad (5)$$

C. Technological Progress

Technological progress in the industrial sector between periods t and $t + 1$, g_{t+1} , is affected positively by the skill abundance, $h_t \equiv H_t / N_t$, in the labor force period t .

$$g_{t+1} \equiv \frac{A_{t+1}^m - A_t^m}{A_t^m} = g(h_t), \quad (6)$$

where $g(h_t)$ is strictly positive, increasing concave function.³

D. The Autarkic Equilibrium

In autarky, since both goods are desired by consumers, they are produced. The demand for skilled and unskilled labor is therefore strictly positive and as follows from (5) $w_{t+1}^s / w_{t+1}^u = \tau^s / \tau^u$. Hence, the ratio of skilled and unskilled labor employed in the industrial sector is unique and constant.

$$H_t / L_t^m = \gamma \tau^u / (1 - \gamma) \tau^s \equiv \hat{h}^m,$$

and the autarkic relative price of the agricultural good in period t , is therefore $p_t = (1 - \gamma)(\hat{h}^m)^\gamma (A_t^m / A^a)$, i.e., it is increasing over time due to technological progress in the industrial sector.

The employments of unskilled labor in each of the two sectors, $L_t^a = \alpha / [(1 - \gamma) + \gamma \alpha / (\alpha + \beta)] L_t$, and $L_t^m = \beta / [1 + (\alpha \gamma / (1 - \gamma) (\alpha + \beta))] L_t$, are fixed fractions of the number of unskilled workers in the period L_t , and since $H_t = L_t^m \hat{h}^m$, the employment of skilled labor is a fixed

³Technological progress in the agricultural sector will not affect the qualitative results as long as it is slower than that in the manufactured sector.

fraction of L_t as well. Moreover, noting that only a fraction $(\alpha + \beta)$ of individuals time is devoted for labor force participation, and therefore, $H_t + L_t = (\alpha + \beta)N_t$, the skill abundance in the labor force, $h_t \equiv H_t/N_t$, is constant over time. Thus, the economy is in a state of balanced growth with constant rates of growth of technology, population, and output per capita.

II. International Trade

Consider a world consisting of two economies that are identical in every respect except that economy A is more technologically advanced than economy B . Since technological advancement is biased towards the industrial sector, the autarkic relative price of the agricultural good, p^A , in the technologically advanced economy, A , is higher. i.e., $p^A > p^B$.

When international trade is established the international equilibrium price, p_t^* , is $p_t^B \leq p_t^* \leq p_t^A$. Suppose that initially $p_t^B < p_t^* < p_t^A$. The technologically advanced economy A specializes in the production of the industrial good, producing $(\alpha + \beta)(\hat{h}^m)^\gamma [A_t^m]^A L_t^A$ and exporting $\alpha(\hat{h}^m)^\gamma [A_t^m]^A L_t^A$ units of the good. Economy B specializes in the production of the agricultural good, producing $(\alpha + \beta)[A^a]^B L_t^B$, and exporting $\beta[A^a]^B L_t^B$ units of the good. The international equilibrium price is therefore,

$$p_t^* = \frac{\alpha(\hat{h}^m)^\gamma [A_t^m]^A L_t^A}{\beta[A^a]^B L_t^B}. \quad (7)$$

A. Trade, Fertility and Education

Economy A completely specializes in the production of the industrial good and its demand for skilled workers increases. It induces investment in children's quality and thus, given the constant fraction of time devoted to child rearing, it decreases fertility to $(n^A)^* = (1 - \alpha - \beta)(1 - \gamma(1 - \tau^u/\tau^s))/\tau^u$. The skill abundance in economy A rises to $(h^A)^* = \hat{h}^m/(\hat{h}^m + 1)$ and its rate of technological progress therefore increases relative to autarky.

In contrast, economy B completely specializes in the production of the agricultural good eliminating the demand for skilled workers. Fertility rate rises to $(n^B)^* = (1 - \alpha - \beta)/\tau^u > (n^A)^*$, its skilled intensity decreases to $(h^B)^* = 0$, and its technological progress therefore decreases relative to autarky.

B. Trade on Economic Growth

Proposition 1 *If international trade induces both economies, A and B, to completely specialize in production, the rate of growth in the value of total output in economy A, $(g((h^A)^*) - 1)((n^A)^* - 1)$ is equal to that in economy B.*

Proof. Since economy B specializes in the production of the agricultural good, the value of its output is $p_t^*(Y_t^a)^B = p_t^*(A^a)^B L_t^B$ and since A specializes in the production of the industrial good, the value of its output is $(Y_t^m)^A = [A_t^m]^A (\hat{h}^m)^\gamma \bar{L}_t^A (\alpha + \beta)$. Thus noting (7) the growth rates of the value of total output of the two economies equal. \square

Thus, the improvements in the terms of trade of economy B offset the differential productivity in the two economies, enabling the value of total output in the two economies to grow at the same rate.

Corollary 1 *Although international trade equalizes the growth rates of the value of total output in the two trading economies, since the rate of population growth is higher in the technologically regressed economy B, i.e.,*

$$(n^B)^* - 1 > (n^A)^* - 1,$$

the rate of growth of total output per capita is higher in the technologically advanced economy A, i.e.,

$$(g((h^A)^*) - 1) > (g((h^A)^*) - 1)((n^A)^* - 1)/((n^B)^* - 1).$$

C. The Evolution of the World Economy

Complete specialization in production will be maintained as long as $p_t^B < p_t^* < p_t^A$. Hence, economy B will diversify its production once the left inequality will be violated, whereas A will diversify its production if the right inequality will be violated

$$\frac{(1 - \gamma)[A_t^m]^B}{[A^a]^B} < \frac{\alpha[A_t^m]^A L_t^A}{\beta[A^a]^B L_t^B} < \frac{(1 - \gamma)[A_t^m]^A}{[A^a]^A} \quad (8)$$

Since (L_t^A/L_t^B) declines over time, (i.e., $(n^B)^* > (n^A)^*$) the right inequality could not be violated and economy A will remain completely specialized. However, if population growth rate in economy B is sufficiently large then eventually it becomes diversified in production.

If the world economy is initially completely specialized when trade commences and B 's population growth rate is sufficiently large, then it ultimately becomes diversified in production. Trade causes fertility to rise in economy B and to decrease in economy A . Once economy B becomes diversified in production its fertility rate and technological growth rate tend towards their autarkic levels. Although the growth rate of total output will not be equal in the two economies, the fraction of the overall growth that will be attributed to population growth will be smaller in the technologically advanced economy.

III. Conclusion

This research argues that the Great Divergence in income per capita levels across countries as well as the current distribution of world population can be attributed, in part, to the contrasting effects that the rapid expansion of international trade in the second phase of the industrial revolution played in the timing of the demographic transition in industrial and non-industrial countries. In industrial economies international trade enhanced the specialization in the production of skilled intensive goods and stimulated technological progress. The rise in the demand for skilled labor induced an investment in the quality of the population, expediting the demographic transition, stimulating technological progress and further enhancing the comparative advantage of these industrial economies in the production of skilled intensive goods.⁴ In non-industrial economies, in contrast, the specialization in the production of unskilled intensive goods that was brought about by international trade reduced the demand for skilled labor and provided limited incentives to invest in population quality. The demographic transition was therefore delayed, increasing further the abundance of unskilled labor in these economies and enhancing their comparative disadvantage in the production of skilled intensive goods. International trade has therefore widened the gap between the technological level as well as the skill abundance of industrial and non-industrial economies, enhancing the initial patterns of comparative advantage and generating sustained differences in income per capita across countries. The gains from trade were channeled towards an increase in population in non-industrial economies and an increase in income per capita in industrial economies.

⁴The introduction of a subsistence consumption constraint or non-homothetic preferences would enable the model to capture the simultaneous rise in population growth and income per-capita prior to the demographic transition (see, Galor and Mountford (2003)).

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