On the welfare implications of Southern catch-up

Susan Chun Zhu *

Department of Economics, Michigan State University, Marshall-Adams Hall, East Lansing, MI, 48824, USA

Received 27 July 2005; received in revised form 3 August 2006; accepted 30 August 2006
Available online 11 December 2006

Abstract

I examine the implications of technological catch-up by developing countries (the South). With Southern catch-up, production of unskilled-intensive goods moves South. Because the improved terms of trade fully offsets the income lost by having production migrate South, the North benefits.

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Keywords: Southern catch-up; The Heckscher–Ohlin model

JEL classification: F1

Recent decades have seen two important trends in the world economy: (1) the technological superiority of industrialized nations has been eroding gradually, and (2) production of unskilled-intensive goods (e.g., apparel and footwear) has been relocated from developed countries to less developed ones. As a result, imports from less developed countries have been the fastest growing component of world trade flows. As manufacturing jobs go offshore and imports from low-income countries keep rising, there is growing concern that U.S. workers would be harmed and the living standard in the United States would decline.

To address the concern, in this paper I extend the continuum-of-goods Heckscher–Ohlin model (Dornbusch et al., 1980; Feenstra and Hanson, 1996) to incorporate technological catch-up by less developed countries that constitute the ‘South.’ With Southern catch-up, production of less skill-intensive goods moves from the North to the South. This reduces the North–South income gap. However, since the terms of trade improve in the North, the North’s real income rises. Due to higher demands for skills in the
North and lower prices of imports from the South, the real wage of Northern skilled workers also rises. If skilled and unskilled workers are sufficiently substitutable, cheaper imports from the South may benefit the Northern unskilled as well.

The above results stand in sharp contrast to those obtained by Krugman (1985). Differing from this paper, Krugman’s technology gap model has only one factor, labor. In his model, with Southern catch-up, production migrates South, raising demands for Southern labor. As a result, the South’s wage rises relative to the North’s wage. Hence, the terms of trade must improve in the South while deteriorating in the North. It further implies that the North may be harmed by Southern catch-up. In contrast, my model has two factors, skilled and unskilled workers. As production moves South, the wage of skilled workers relative to that of unskilled workers rises in both regions. This makes it more expensive to produce skill-intensive goods. Since the North specializes in more skill-intensive goods, the price of Northern goods must rise relative to the price of Southern goods. That is, in my two-factor model, the terms of trade must improve in the North. Because the improved terms of trade fully offsets the income lost by having production to migrate South, the North as a whole benefits from Southern catch-up and production relocation.

1. The basic model

The basic setup follows Dornbusch et al. (1980). There are 2 regions, North (N) and South (S). There are 2 factors, unskilled labor (L) and skilled labor (H). There is a continuum of goods indexed by \( z \) with \( 0 \leq z \leq 1 \). Production functions are quasi-concave and exhibit constant return to scale. For simplicity, I assume that there are Hicks-neutral technology differences between the North and the South. Furthermore, there are no factor intensity reversals, which implies that I can use a higher \( z \) to index a more skill-intensive good. Goods markets and labor markets are perfectly competitive. Consumers have identical Cobb–Douglas preferences. Finally, there are no trade barriers. Trade is always balanced.

Let \( p_i(z) \) be the competitive price for good \( z \) produced in region \( i \). Let \( w_{fi} \) be the wage of factor \( f (=L, H) \) in region \( i (=N, S) \). Let \( \omega_i \equiv w_{Hi}/w_{Li} \) be the wage of skilled labor relative to that of unskilled labor. I assume that the North is sufficiently skill abundant so that \( \omega_N < \omega_S \). This implies that the North has a comparative advantage in skill-intensive goods ( \( z \), 1] while the South has a comparative advantage in unskilled-intensive goods [0, \( z \)). Good \( \bar{z} \) is the ‘competitive margin’ which is determined by

\[
p_N(\bar{z}) = p_S(\bar{z}).
\]

Let \( Y_i \) be national income in region \( i \). Preferences are given by the Cobb–Douglas utility function

\[
U = \int_0^1 \alpha(z) \ln x(z) dz\text{ where for each } z, \alpha(z) \text{ is a budget share and } x(z)\text{is a quantity consumed. Worldwide demand is}
\]

\[
x(z) = \alpha(z) \frac{Y_N + Y_S}{p_i(z)}
\]

where \( i = N \text{ for } z > \bar{z} \text{ and } i = S \text{ for } z < \bar{z} \).

Let \( L_i \) and \( H_i \) be region \( i \)’s endowments of unskilled and skilled labor, respectively. Let \( L_i(\omega_i, z) \) and \( H_i(\omega_i, z) \) be the amount of unskilled and skilled labor, respectively, needed to produce one unit of good \( z \).

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1 The assumption of Hicks-neutral technology differences is not required for any of the results in this paper.
in region \( i \). Define \( h_i \equiv H_i / L_i \) and \( h_i(\omega_i, z) \equiv H_i(\omega_i, z) / L_i(\omega_i, z) \). Market clearing for Southern labor is given by

\[
\int_0^\infty x(z)H_S(\omega_S, z)dz = H_S, \tag{3}
\]

\[
\int_0^\infty x(z)L_S(\omega_S, z)dz = L_S. \tag{4}
\]

Following Dornbusch et al. (1980), I combine the zero profit condition \( p_i(z) = w_L L_i(\omega_i, z) + w_H H_i(\omega_i, z) \) with Eqs. (3) and (4) to obtain\(^2\)

\[
S(\omega_S, \bar{z}) = \frac{Y_N + Y_S}{w_{LS}H_S} \int_0^\infty x(z) \frac{h_S(\omega_S, z) - h_S}{1 + \omega_S h_S(\omega_S, z)} \, dz = 0 \tag{5}
\]

where \( S(\omega_S, \bar{z}) \) represents the excess demand for skilled labor relative to unskilled labor in the South. Likewise, the corresponding Northern factor market clearing conditions can be written as

\[
N(\omega_N, \bar{z}) = \frac{Y_N + Y_S}{w_{LN}H_N} \int_0^1 x(z) \frac{h_N(\omega_N, z) - h_N}{1 + \omega_N h_N(\omega_N, z)} \, dz = 0. \tag{6}
\]

Define the trade balance as the value of Southern imports divided by the value of Northern imports:

\[
B(\bar{z}) = \frac{(Y_S \int_0^\infty x(z)dz) / (Y_N \int_0^\infty x(z)dz)} {\omega_S(\omega_S)} = 1.
\]

Substituting Eq. (1) and the zero profit condition into the balance-of-trade condition \( B(\bar{z}) = 1 \) yields

\[
B(\bar{z}) = \frac{L_S}{L_N} \cdot \frac{L_N(\omega_N, \bar{z})}{L_S(\omega_S, \bar{z})} \cdot \frac{1 + \omega_S h_S}{1 + \omega_N h_N} \cdot \frac{1}{\omega_S h_S(\omega_S, \bar{z})} \cdot \frac{1}{\omega_N h_N(\omega_N, \bar{z})} \cdot \int_0^1 x(z)dz \cdot \int_0^\infty x(z)dz = 1. \tag{7}
\]

The competitive margin \( \bar{z} \) and relative wages \( \omega_N, \omega_S \) are determined simultaneously by Eqs. (5) (6) and (7). It can be shown that there exists a unique equilibrium.

2. The definition of Southern catch-up

Let \( t \) denote the state of technology. For each \( t \), there is a unique equilibrium and unique equilibrium outcomes \( \omega_S(t), \omega_N(t) \) and \( \bar{z}(t) \). Re-write factor demands in a way that highlights their dependence on \( t \).

\(^2\) Consider a \( z \in [0, \bar{z}] \). From Eq. (2) and zero profits, \( x(z) = (Y_N + Y_S)z(\omega_S) / [w_{LS}L_S(\omega_S, z) + w_{HS}H_S(\omega_S, z)] = \frac{Y_N + Y_S}{w_{LS}} z(\omega_S) / [1 + \omega_S h_S(\omega_S, z)] \). Hence, \( \int_0^\infty x(z)H_S(\omega_S, z)dz = \frac{Y_N + Y_S}{w_{LS}H_S} \int_0^\infty x(z)h_S(\omega_S, z) \, dz \) and \( \int_0^\infty x(z)L_S(\omega_S, z)dz = \frac{Y_N + Y_S}{w_{LS}H_S} \int_0^\infty x(z)h_S(\omega_S, z) \, dz \). Eq. (5) follows from labor market clearing.
Thus the \( H(\omega_i, z, t) \) and \( L(\omega_i, z, t) \) are factor demands per unit of \( z \). Let \( C_i(w_{Hi}, w_{Li}, z, t) = w_{Hi}H(\omega_i, z, t) + w_{Li}L(\omega_i, z, t) \) be the costs per unit of \( z \). Let \( C_i(w_{Hi}, w_{Li}, z, t) \equiv w_{Hi}H(\omega_i, z, t) + w_{Li}L(\omega_i, z, t) \) be the costs per unit of \( z \). I assume that these functions are differentiable in \( t \).

The natural measure of productivity growth in the production of good \( z \) in region \( i \) is \(-\partial \ln C_i(w_{Hi}, w_{Li}, z, t)/\partial t\), which is the dual of the Solow residual. For simplicity, I assume that technical change is Hicks-neutral and uniform across goods. Define \( \pi_i(t) \equiv -\partial \ln C_i(w_{Hi}, w_{Li}, z, t)/\partial t \) as the rate of technical change in region \( i \). I use the convention that the \( C_i(w_{Hi}, w_{Li}, z, t) \) are non-increasing in \( t \), i.e., technical change never increases unit costs. I will write that the South is ‘catching up’ if

\[
\gamma(t) = \pi_S(t) - \pi_N(t) > 0. \tag{8}
\]

Eq. (8) states that the South is catching up if Southern productivity rises relative to Northern productivity. Zhu and Trefler (2005) show that Southern catch-up implies that (1) \( d\bar{z}/dt > 0 \), i.e., production migrates from the North to the South; and that (2) \( d\omega_S > 0 \) and \( d\omega_N > 0 \), i.e., the wage of skilled labor relative to that of unskilled labor rises in both regions. (Also see the technical appendix.)

3. Welfare implications

Southern catch-up has welfare implications that have been hotly contested. For one, the South’s terms of trade are expected to deteriorate as faster productivity growth in the export sector reduces export prices relative to import prices. The usual Bhagwati (1958) analysis of immiserizing growth suggests that this may reduce Southern welfare. Another hotly debated question in Northern countries is whether the North has been made worse off as a result of production migrating South. I revisit these issues within the context of my model.

To discuss real income I will need a price index \( P \). With Cobb–Douglas preferences, the natural choice of \( P \) is the Cobb–Douglas price index as defined by \( \ln P = \int_0^{\bar{z}} x(z) \ln p_S(z) \, dz + \int_0^{\bar{z}} x(z) \ln p_N(z) \, dz \). Then \( Y_i/P (i=N, S) \) is both real income and a measure of welfare for a representative consumer with income \( Y_i \).

**Theorem 1.**

1. \( d(Y_N/P)/dt > 0 \) and \( d(Y_S/P)/dt > 0 \). That is, real income rises in both the North and the South.
2. \( d(p_S(z)/p_S(z'))/dt > 0 \) for all pairs \( z \) and \( z' \) with \( z < \bar{z} < z' \). That is, the South’s terms of trade deteriorate and the North’s terms of trade improve.
3. \( d(Y_S/Y_N)/dt > 0 \). That is, Southern catch-up reduces the North–South income gap.

Theorem 1 states that even though catch-up leads to a deterioration of the South’s terms of trade, the South’s real income rises. In Bhagwati’s terminology, growth is not immiserizing even though it leads to a deterioration of the terms of trade. Theorem 1 also states that the North’s real income rises. That is, the income lost by having production migrate South is offset by an improvement in the terms of trade. Thus, Theorem 1 at least partly buttresses claims that Southern catch-up is no threat to the North.

3 Skill-biased technical change is taken up in Zhu and Trefler (2005). Most results in this paper remain valid for that case. Differing from this paper, Zhu and Trefler (2005) focus on the implications of Southern catch-up for wage inequality within countries.
Theorem 2 collects results about earnings. Let \( \varepsilon_i(z, t) \equiv -\partial \ln h_i(\omega_i, z, t)/\partial \ln \omega_i \geq 0 \) be the elasticity of substitution between skilled and unskilled labor.

**Theorem 2.**

1. \( d(w_{Hi}/P)/dt > 0, i = N, S \). That is, real earnings for skilled workers rise in both the North and the South.
2. There exist \( \kappa_S(t) \in (0, 1) \) and \( \kappa_N(t) \) for which the following holds: \( \varepsilon_i(\cdot; t) > \kappa_i(t) \Rightarrow d(w_{Li}/P)/dt > 0, i = N, S \). That is, if elasticities of substitution are sufficiently large then real earnings for unskilled labor rise in both the North and the South.

Part (1) is a consequence of rising real income \( Y_i/P \), rising inequality \( w_{Hi}/w_{Li} \), and the fact that \( Y_i \) is a weighted average of \( w_{Hi} \) and \( w_{Li} \). Part (2) is non-trivial. Rising \( Y_i/P \) means that a weighted average of \( w_{Hi}/P \) and \( w_{Li}/P \) is rising. With sufficiently large substitution possibilities, the wage gap between skilled and unskilled workers cannot widen too much. So even \( w_{Li}/P \) must rise.

**4. Conclusion**

In this paper I extended the continuum-of-goods Heckscher–Ohlin model to allow for Southern technological catch-up. With Southern catch-up, production of unskilled-intensive goods (e.g., apparel and footwear) moves South. This narrows the North–South income gap. However, because the terms of trade improve in the North, the North as a whole benefits from Southern catch-up. I also showed that Northern skilled workers must see their real wage rise. If skilled and unskilled workers are sufficiently substitutable, the real wage of Northern unskilled workers may also rise. Therefore, this paper at least partly buttresses claims that Southern catch-up is no threat to the North.

**References**


