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Why are nontraded goods cheaper in poor countries?

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ABSTRACT

Balassa and Samuelson argued that production technologies differ among countries, and the price of the nontraded good is higher in countries with higher labor productivity. This paper shows that the Balassa-Samuelson effect exists even when countries share identical production technologies. In the celebrated Heckscher-Ohlin model, changes in factor endowments do not affect the equalized factor prices. This paper considers a three-factor, three-industry model, and demonstrates that endowment differences between countries can cause disparities in their wage rates and the prices of the nontraded good. A dynamic panel data analysis shows that a 10% increase in per capita real GDP results in a 2% increase in the housing price for non-EU OECD countries.

1. Introduction

Balassa (1964) and Samuelson (1964) first observed the phenomenon that the relative price of the nontraded good or service is higher in high-wage economies. There is a large body of literature on the role of the nontraded good, most of which are services. Ethier (1972) considered a two-factor, three-industry model to show that in the presence of a nontraded good, an increase in the relative price of the importable may not necessarily increase its supply. Bhagwati (1984) argued that when the Poor and Rich countries specialize in a different traded good and the nontraded good, the wage-rent ratio is lower and hence the services are cheaper in the Poor country.

Deardorff and Courant (1990) observed that as the fraction of income spent on the nontraded good increases, the cone of diversification contracts and, hence, the introduction of the nontraded good into the Heckscher-Ohlin model reduces the likelihood of factor price equalization. More recently, Beladi and Batra (2004) showed that factor intensities continue to play an important role in determining the Stolper-Samuelson effects and, in general, unskilled labor benefits from rising trade if the nontraded sector expands. Oladi, Gilbert, and Beladi (2011) argue that the nontraded sector uses unskilled labor while trade sectors employ skilled labor, and demonstrated that foreign direct investment raises the real wages of both skilled and unskilled workers.

There are some empirical papers analyzing the Balassa-Samuelson effect. For instance, Apergis (2013) observed that the Balassa-Samuelson effect explains about one-third of the overall inflation rate in Greece. In a 2005 study of 35 industries across 42 countries, Inklaar and Timmer (2014) showed that general price level, including the price of services, is higher in richer countries.

The Balassa-Samuelson model is overly simplistic in that it is based on the assumption that rich and poor countries possess different production technologies. This assumption may have held true for the world economy until the mid-20th century. However, the assumption that developing countries have inferior production technology is no longer tenable. Thus, Bhagwati (1984) had considered a two-factor, three-industry model to explore the possibility of the Balassa-Samuelson effect without assuming different production technologies.

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In this paper we assume, as in Bhagwati, that production technologies are identical and explore the presence of the Balassa-Samuelson effect by introducing the nontraded sector to the traditional Heckscher-Ohlin model. We assume that the poor and rich countries share identical production technologies. Even if prices of tradable goods are equalized by free trade, the price of the nontradable good may differ between countries and, hence, factor prices may not be completely equalized due to the presence of the nontraded good.[1]

This general Balassa-Samuelson effect with identical production technologies may be discounted if the nontraded sector is deemed unimportant. However, according to the European Central Bank (2015), the service sector accounts for the largest share of GDP (80.4 percent) in the United States as of 2014. Likewise, the service share of GDP was the largest (73.8 percent) segment in the European Union. Even in China, a developing country, the service share totaled 48.2 percent in 2014. Thus, the nontraded sector is sufficiently large to breach factor price equalization and cause a Balassa-Samuelson effect.

The plan of this paper is as follows: Section 2 considers the Rybczynski Theorem in a three-factor, three-industry model. Section 3 assumes identical production technologies and considers the general Balassa-Samuelson effect in a three-industry model. Section 4 investigates the effect of capital stock growth on the price of the nontraded good, while Section 5 uses a numerical example to illustrate the relationship between the factor prices and the price of the nontraded good while Section 6 shows the empirical results using house price indices and income data of 23 OECD countries. Section 7 contains the concluding remarks.

2. Rybczynski effects and nontraded sector

Balassa and Samuelson argued that the price of the nontraded good differs between rich and poor countries because they possess different production technologies. This paper assumes they share identical production technologies and show the Balassa-Samuelson effect in a three-factor, three-industry model. The home country exports good 1 and imports good 2. The home and foreign countries also produce a nontraded good.

Let y_i denote the output, and L_i, K_i and T_i denote the amounts of labor, capital and land employed in industry i. We employ the following assumptions of an open economy with three industries:

(i) Two countries, the United States and the foreign country, produce two tradable goods, y_1 and y_2 and a nontraded good, y_o.
(ii) The price of the nontraded good is determined in each country.
(iii) Consumers are identical and have homothetic preferences represented by a monotone-increasing utility function, $u(.)$. Consumers receive income from production and are subject to a budget constraint in each country. Accordingly, trade is balanced.
(iv) While the prices of tradable goods are determined in the world market, producers and consumers behave as price takers.
(v) The home and foreign countries share identical production technologies.
(vi) $\frac{K_1}{L_1} > \frac{K_o}{L_o} > \frac{K_2}{L_2}, \frac{L_0}{T_0} > \frac{L_1}{T_1} > \frac{L_2}{T_2}$, and $\frac{K_0}{T_0} > \frac{K_1}{T_1} > \frac{K_2}{T_2}$.

Regarding capital-labor ratios, $\frac{K_1}{L_1} > \frac{K_o}{L_o} > \frac{K_2}{L_2}$ means that the capital-labor ratio is the highest in industry 1 and the lowest in industry 2, and the capital-labor ratio of the nontraded sector takes on an intermediate value between the two. Regarding the amounts of factors employed per acre of land, $\frac{L_0}{T_0} > \frac{L_1}{T_1} > \frac{L_2}{T_2}$ means that the labor-land ratio is the highest in the nontraded sector (e.g., service sector) and lowest in industry 2, and the labor-land ratio of industry 1 (e.g., automobile industry) takes on an intermediate value. In other words, the service sector hires the most workers per acre of land, and the agricultural sector employs the fewest workers. Likewise, $\frac{K_0}{T_0} > \frac{K_1}{T_1} > \frac{K_2}{T_2}$ means that the amount of capital used per acre of land is the highest in the nontraded sector and the lowest in industry 2 while that of industry 1 also takes on an intermediate value.

Let p_i be the domestic price of good i and y_i be the output of industry i, $i = 0, 1, 2$, and let good 1 be numéraire, i.e., its price is unity ($p_1 = 1$.) The relationships between factor endowments and industry outputs are given by

$$\begin{aligned} a_{L1}y_1 + a_{L2}y_2 + a_{Lo}y_o &= L, \\ a_{K1}y_1 + a_{K2}y_2 + a_{Ko}y_o &= K, \\ a_{T1}y_1 + a_{T2}y_2 + a_{To}y_o &= T, \end{aligned} \tag{1}$$

where a_{ij} is the amount of input i used to produce one unit of good j. L, K, and T are the amounts of labor, capital, and land used annually to produce outputs in the three industries in the home country (United States).

The input-output relationship in (1) can be written as

$$AY = F, \tag{2}$$

where $A = \begin{bmatrix} a_{L1} & a_{L2} & a_{Lo} \\ a_{K1} & a_{K2} & a_{Ko} \\ a_{T1} & a_{T2} & a_{To} \end{bmatrix}$ is the input-output matrix, and $Y = \begin{bmatrix} y_1 \\ y_2 \\ y_0 \end{bmatrix}$, and $F = \begin{bmatrix} L \\ K \\ T \end{bmatrix}$ are 3×1 vectors of outputs and factor endowments.

Assume that the input-output matrix A is nonsingular and invertible. Then the output vector of the three industries can be written as: $Y = A^{-1}F$. From (1), we obtain the outputs of the three sectors in the home county:

[1] This possibility of nonequalization of factor prices may be discounted if the nontraded sector were unimportant. However, in 2014 the service share of GDP in the United States was 80.4 percent.

$$y_1=\frac{L(a_{K2}a_{To}-a_{Ko}a_{T2})-K(a_{L2}a_{To}-a_{Lo}a_{T2})+T(a_{Ko}a_{L2}-a_{K2}a_{Lo})}{\Delta},$$
$$y_2=\frac{-L(a_{K1}a_{To}-a_{Ko}a_{T1})+K(a_{L1}a_{To}-a_{Lo}a_{T1})-T(a_{Ko}a_{L1}-a_{K1}a_{Lo})}{\Delta}, \quad (3)$$
$$y_o=\frac{L(a_{K1}a_{T2}-a_{K2}a_{T1})-K(a_{L1}a_{T2}-a_{L2}a_{T1})+T(a_{K2}a_{L1}-a_{K1}a_{L2})}{\Delta},$$

where

$$\Delta\equiv\begin{vmatrix}a_{L1} & a_{L2} & a_{Lo}\\ a_{K1} & a_{K2} & a_{Ko}\\ a_{T1} & a_{T2} & a_{To}\end{vmatrix}=(a_{K2}a_{L1}-a_{K1}a_{L2})a_{To}+(a_{Ko}a_{L2}-a_{K2}a_{Lo})a_{T1}+(a_{K1}a_{Lo}-a_{Ko}a_{L1})a_{T2},$$

denotes the determinant of A. If the determinant is negative, it can be made positive by relabeling any two factors. For instance, if labor was the first input and capital the second initially, now labor can be treated as the second input and capital as the first. Thus, we assume that relabeling is done properly and Δ is positive.[2]

The outputs of the three sectors in the foreign country are:

$$y_1^*=\frac{L^*(a_{K2}a_{To}-a_{Ko}a_{T2})-K^*(a_{L2}a_{To}-a_{Lo}a_{T2})+T^*(a_{Ko}a_{L2}-a_{K2}a_{Lo})}{\Delta},$$
$$y_2^*=\frac{-L^*(a_{K1}a_{To}-a_{Ko}a_{T1})+K^*(a_{L1}a_{To}-a_{Lo}a_{T1})-T^*(a_{Ko}a_{L1}-a_{K1}a_{Lo})}{\Delta}, \quad (4)$$
$$y_o^*=\frac{L^*(a_{K1}a_{T2}-a_{K2}a_{T1})-K^*(a_{L1}a_{T2}-a_{L2}a_{T1})+T^*(a_{K2}a_{L1}-a_{K1}a_{L2})}{\Delta},$$

where L^*, K^* and T^* are labor, capital, and land endowments of the foreign country.

2.1. Growth of capital stock

The effects of an increase in capital stock on the outputs of the three sectors can be obtained by differentiating (3) with respect to K.

$$\frac{\partial y_1}{\partial K}=\frac{-(a_{L2}a_{To}-a_{Lo}a_{T2})}{\Delta}>0,$$
$$\frac{\partial y_2}{\partial K}=\frac{(a_{L1}a_{To}-a_{Lo}a_{T1})}{\Delta}<0, \quad (5)$$
$$\frac{\partial y_0}{\partial K}=\frac{-(a_{L1}a_{T2}-a_{L2}a_{T1})}{\Delta}<0,$$

which suggests that in determining the effect of capital on outputs, labor-land ratios are relevant. Note that growth of the capital stock raises only the output of industry 1, whose capital-labor ratio is the highest among the three industries, while reducing those of the other industries. These results are summarized below:

Proposition 1. Given the assumptions (i) – (vi) and $\Delta > 0$, an increase in capital endowment results in the expansion only of industry 1, and causes a contraction of industry 2 and the nontraded sector. If $\Delta < 0$, the opposite results hold for all industries.

[2] In a world of one industry and one input x_1, the total output y_1 must increase as the input increases. In this case, the determinant $A = a_{11}$ is positive, and the single output must move in the same direction as the single input x_1. In the Heckscher-Ohlin world of two factors and two industries.

$$\begin{bmatrix}a_{L1} & a_{L2}\\ a_{K1} & a_{K2}\end{bmatrix}\begin{bmatrix}y_1\\ y_2\end{bmatrix}=\begin{bmatrix}L\\ K\end{bmatrix}.$$

The determinant $\Delta = a_{L1}a_{K2} - a_{K1}a_{L2} > 0$ if the first industry is intensive in the first input, labor, in which case the second industry also is intensive in the second input. However, when the first industry is intensive in the second input, Δ is negative. In this case, it is possible to relabel inputs easily. For instance, if industry 1 is intensive in capital ($\Delta = a_{L1}a_{K2} - a_{K1}a_{L2} < 0$), then we can relabel the two factors and call capital the first input and labor the second. Then the above equation changes to

$$\begin{bmatrix}a_{K1} & a_{K2}\\ a_{L1} & a_{L2}\end{bmatrix}\begin{bmatrix}y_1\\ y_2\end{bmatrix}=\begin{bmatrix}K\\ L\end{bmatrix}.$$

Since the first industry is intensive in K, the new determinant becomes positive, i.e., $\Delta' = a_{K1}a_{L2} - a_{L1}a_{K2} = -\Delta = -(a_{L1}a_{K2} - a_{K1}a_{L2}) > 0$. Thus, if the determinant is negative in a three-factor world, then a pair of factors, say K and L, can be rearranged so that K becomes the first factor, and L the second, and the new determinant becomes positive. Such rearranging does not affect the fundamental input-output relationships. Thus, it is safe to assume $\Delta > 0$. For instance, Henry Thompson's determinant of matrix A is 0.30733.

3. Output and factor prices

Recall that output prices of traded goods are determined by the world market. In contrast, the price of the nontraded good is determined by the domestic demand and supply conditions. Recall that good 1 is the numéraire and its price p_1 is unity. The budget constraint is

$$I = p_1x_1 + p_2x_2 + p_ox_o = x_1 + p_2x_2 + p_ox_o. \tag{6}$$

The domestic market for the nontraded good clears if $x_o = y_o$. The relationship between output prices and factor prices is given by

$$\begin{aligned} 1 &= a_{L1}w + a_{K1}r + a_{T1}s, \\ p_2 &= a_{L2}w + a_{K2}r + a_{T2}s, \\ p_o &= a_{Lo}w + a_{Ko}r + a_{To}s, \end{aligned} \tag{7}$$

where w, r and s are wage, capital rent and land rent, respectively.

The relationship of the factor prices to output prices is written as

$$p = A'b, \tag{8}$$

where $A' = \begin{bmatrix} a_{L1} & a_{K1} & a_{T1} \\ a_{L2} & a_{K2} & a_{T2} \\ a_{Lo} & a_{Ko} & a_{To} \end{bmatrix}$ is the transpose of the input-output matrix A, and $p = \begin{bmatrix} 1 \\ p_2 \\ p_o \end{bmatrix}$ and $b = \begin{bmatrix} w \\ r \\ s \end{bmatrix}$ are 3×1 vectors of output and factor prices, respectively.

If A' is invertible, then $b = (A')^{-1}p$.[3] If all three goods were tradable and transportation costs are zero, then $p = p^*$ and, hence, $b = (A')^{-1}p = (A')^{-1}p^* = b^*$, where an asterisk (*) denotes a foreign variable. Thus, factor prices would be equalized. However, the output of the service sector is not traded.

Recall that the two countries have identical production technologies. Consider the relationship between output prices and factor prices in the presence of a nontraded good. Even though two tradable goods, 1 and 2, are freely traded, the price of the nontraded good will differ between countries. Assume that the price of the nontraded good is higher in the home country than in the rest of the world; that is, $p_2 = p_2^*$ and. $p_o > p_o^*$.

If the outputs of all industries are freely traded, under certain conditions factor prices also will be equalized. However, factor prices may not be equalized if the prices of the nontraded good are unequal between countries. From (8), we obtain

$$\begin{aligned} w &= \frac{p_1(a_{K2}a_{To} - a_{Ko}a_{T2}) - p_2(a_{K1}a_{To} - a_{Ko}a_{T1}) + p_o(a_{K1}a_{T2} - a_{K2}a_{T1})}{\Delta}, \\ r &= \frac{-p_1(a_{L2}a_{To} - a_{Lo}a_{T2}) + p_2(a_{L1}a_{To} - a_{Lo}a_{T1}) - p_o(a_{L1}a_{T2} - a_{L2}a_{T1})}{\Delta}, \\ s &= \frac{p_1(a_{Ko}a_{L2} - a_{K2}a_{Lo}) - p_2(a_{Ko}a_{L1} - a_{K1}a_{Lo}) + p_o(a_{K2}a_{L1} - a_{K1}a_{L2})}{\Delta}. \end{aligned} \tag{9}$$

Recall that $\frac{K_1}{L_1} > \frac{K_o}{L_o} > \frac{K_2}{L_2}, \frac{L_0}{T_0} > \frac{L_1}{T_1} > \frac{L_2}{T_2}, \frac{K_0}{T_0} > \frac{K_1}{T_1} > \frac{K_2}{T_2}$, and $\Delta > 0$. Thus, we obtain

$$\begin{aligned} \frac{\partial w}{\partial p_o} &= \frac{(a_{K1}a_{T2} - a_{K2}a_{T1})}{\Delta} > 0, \\ \frac{\partial r}{\partial p_o} &= \frac{-(a_{L1}a_{T2} - a_{L2}a_{T1})}{\Delta} < 0, \\ \frac{\partial s}{\partial p_o} &= \frac{(a_{K2}a_{L1} - a_{K1}a_{L2})}{\Delta} < 0, \end{aligned} \tag{10}$$

$$\begin{aligned} \frac{\partial w}{\partial p_2} &= \frac{-(a_{K1}a_{To} - a_{Ko}a_{T1})}{\Delta} > 0, \\ \frac{\partial r}{\partial p_2} &= \frac{(a_{L1}a_{To} - a_{Lo}a_{T1})}{\Delta} < 0, \\ \frac{\partial s}{\partial p_2} &= \frac{-(a_{Ko}a_{L1} - a_{K1}a_{Lo})}{\Delta} < 0. \end{aligned} \tag{11}$$

Factor prices in the foreign country are given by

[3] The uniqueness of the factor price vector requires the invertibility of matrix A, i.e., A must be invertible. If A is singular, there may exist two or more factor price vectors consistent with the observed output price vector p and the system may not be stable. Thus, nonsingularity of A is a necessary condition for stability.

$$w^* = \frac{p_1{}^*(a_{K2}a_{To} - a_{Ko}a_{T2}) - p_2{}^*(a_{K1}a_{To} - a_{Ko}a_{T1}) + p_o{}^*(a_{K1}a_{T2} - a_{K2}a_{T1})}{\Delta},$$
$$r^* = \frac{-p_1{}^*(a_{L2}a_{To} - a_{Lo}a_{T2}) + p_2{}^*(a_{L1}a_{To} - a_{Lo}a_{T1}) - p_o{}^*(a_{L1}a_{T2} - a_{L2}a_{T1})}{\Delta},$$
$$s^* = \frac{p_1{}^*(a_{Ko}a_{L2} - a_{K2}a_{Lo}) - p_2{}^*(a_{Ko}a_{L1} - a_{K1}a_{Lo}) + p_o{}^*(a_{K2}a_{L1} - a_{K1}a_{L2})}{\Delta}.$$

Note that despite free trade in tradable goods, no factor price equalization occurs. Specifically,

$$\begin{aligned} w - w^* &= \frac{(p_o - p_o{}^*)(a_{K1}a_{T2} - a_{K2}a_{T1})}{\Delta} > 0, \\ r - r^* &= \frac{-(p_o - p_o{}^*)(a_{L1}a_{T2} - a_{L2}a_{T1})}{\Delta} < 0, \\ s - s^* &= \frac{(p_o - p_o{}^*)(a_{K2}a_{L1} - a_{K1}a_{L2})}{\Delta} < 0. \end{aligned} \tag{12}$$

Thus, when the prices of the nontraded good are unequal, factor prices also can differ between countries. Specifically, the wage rate is higher, and capital rent and land rent are lower in the country with a higher price of the nontraded good.

Proposition 2. Given the assumptions (i) – (vi) and $\Delta > 0$, free trade of tradable goods may not equalize factor prices when the prices of the nontraded goods differ between countries. Specifically, if $p_o > p_o^*$, then the wage rate is higher, but other factor prices are lower in the home country, i.e., $w > w^*$, $r < r^*$, and $s < s^*$.

This proposition is an extension of the Balassa-Samuelson effect to the three-factor world. The Balassa-Samuelson model attributes differing wages to different labor productivities or different production technologies. Proposition 2 suggests that wage rates can differ even when the two trading countries share identical production technologies, because income and, hence, the price of the nontraded good can differ.

4. The effect of capital stock growth

The Balassa-Samuelson effect suggests that differences in marginal products of labor of traded goods are the cause of the disparity in the price of the nontraded good and wage rate. Specifically, they suggest that the price of the nontraded good is higher in countries with higher labor productivity. Thus, the Balassa-Samuelson model presupposes that high- and low-wage countries do not share identical production technologies. In the Heckscher-Ohlin model of two traded goods without a nontraded sector, a change in capital or labor endowment has no effect on output or factor prices. However, once the nontraded sector is introduced, the factor prices will be affected by a change in factor endowments. The Heckscher-Ohlin model suggests that factor prices will be equalized, despite the differences in capital-labor endowment ratios of the two trading countries.

4.1. *Prices of traded goods*

We now show that even when the two countries share the same production technologies in all industries, an increase in capital endowment will affect factor prices and, hence, the price of the nontraded good.

Demand for good i is written as $x_i = x_i(p_2, p_o, I)$, and the supply of good i is $y_i = y_i(p_2, p_o, L, K, T)$, $i = 0, 1, 2$. Assume all three goods are normal goods. The domestic demands for traded goods are given by

$$x_1 = x_1(p_2, p_o, I) = w(p_2, p_o)L + r(p_2, p_o)K + s(p_2, p_o)T,$$
$$x_2 = x_2(p_2, p_o, I) = \frac{w(p_2, p_o)L + r(p_2, p_o)K + s(p_2, p_o)T}{p_2}.$$

The foreign country's demands for traded goods are given by

$$x_1^* = x_1^*(p_2, p_o, I^*) = w(p_2^*, p_o^*)L^* + r(p_2^*, p_o^*)K^* + s(p_2^*, p_o^*)T^*,$$
$$x_2^* = x_2^*(p_2^*, p_o^*, I^*) = \frac{w(p_2^*, p_o^*)L^* + r(p_2^*, p_o^*)K^* + s(p_2^*, p_o^*)T^*}{p_2^*}.$$

By Walras' law, if one market is in equilibrium, the other market also is in equilibrium. The world market for good 2 is in equilibrium if

$$G = x_2 + x_2^* - (y_2 + y_2^*) = \frac{w(p_2,p_o)L + r(p_2,p_o)K + s(p_2,p_o)T}{p_2} + \frac{w(p_2^*,p_o^*)L^* + r(p_2^*,p_o^*)K^* + s(p_2^*,p_o^*)T^*}{p_2^*} - \frac{-L^*(a_{K1}a_{To} - a_{Ko}a_{T1}) + K^*(a_{L1}a_{To} - a_{Lo}a_{T1}) - T^*(a_{Ko}a_{L1} - a_{K1}a_{Lo})}{\Delta} - \frac{-L(a_{K1}a_{To} - a_{Ko}a_{T1}) + K(a_{L1}a_{To} - a_{Lo}a_{T1}) - T(a_{Ko}a_{L1} - a_{K1}a_{Lo})}{\Delta} = 0. \tag{13}$$

The price of the traded good 2 is affected by an increase in capital stock, which raises income. This induced increase in demand for the traded good 2 raises its price. Differentiating (13) with respect to K yields

$$\frac{\partial p_2}{\partial K} = -\frac{G_K}{G_2} > 0, \tag{14}$$

where $G_2 = \frac{\partial x_2}{\partial p_2} - \frac{\partial y_2}{\partial p_2} + \frac{\partial x_2^*}{\partial p_2} - \frac{y_2^*}{\partial p_2} < 0$, and. $G_K = \frac{\partial x_2}{\partial K} - \frac{\partial y_2}{\partial K} = \frac{r}{p_2} - \frac{(a_{L1}a_{To} - a_{Lo}a_{T1})}{\Delta} > 0$.

Thus, an increase in domestic capital increases the world's excess demand for good 2, and, hence, raises the equilibrium price of good 2.

4.2. Price of the nontraded good

Equilibrium condition of the market for the nontraded good is

$$x_o(p_2, p_o, wL + rK + sT) - y_o(p_2, p_o, K, L, T) = 0. \tag{15}$$

The price of the nontraded good is affected by an increase in domestic capital stock, which raises income, which in turn raises demand for all three goods. This induced increase in demand for the nontraded good raises its price. Differentiating (15) with respect to K yields

$$\frac{\partial p_o}{\partial K} = -\frac{g_K}{g_o} > 0, \tag{16}$$

where $g_o = \frac{\partial x_o}{\partial p_o} - \frac{\partial y_o}{\partial p_o} < 0$, and $g_K = \frac{\partial x_o}{\partial K} - \frac{\partial y_o}{\partial K} > 0$. Thus, an increase in capital stock raises the price of the nontraded good.

Recall from (10) and (11) that both $\frac{\partial w}{\partial p_o}$ and $\frac{\partial w}{\partial p_2}$ are positive. Also, both $\frac{\partial p_o}{\partial K}$ in (16) and $\frac{\partial p_2}{\partial K}$ in (14) are positive. Differentiating (9) with respect to K, we obtain

$$\frac{\partial w}{\partial K} = \frac{\partial w}{\partial p_o}\frac{\partial p_o}{\partial K} + \frac{\partial w}{\partial p_2}\frac{\partial p_2}{\partial K} > 0.$$

Accordingly, an increase in capital stock raises domestic wage as well as p_o and p_2. Note that an increase in the price of good 2 increases demand for the nontradable good but reduces its production. These results are summarized below:

Proposition 3. Assume all three goods are normal goods. An increase in capital stock raises the price of the nontraded good and the wage rate.

This proposition is an extension of the Balassa-Samuelson effect that the real exchange rate or the ratio of the price of the traded good to that of the nontraded good is lower in countries with a higher per capita income, i.e., $\frac{p_2}{p_o} < \frac{p_2^*}{p_o^*}$ if $p_2 = p_2^*$ and $w > w^*$.[4] That is, $p_o > p_o^*$. Consider the case of the United States, which exports food (good 2) and imports the manufactured product (good 1). Assume the price of the nontraded good is higher in the United States. than in the rest of the world. Given the assumptions on factor intensities, as the price of the nontraded good increases above the world level, capital- and land-rent fall but the wage rate rises. Even with free trade of two goods, (i) capital and land rent are lower in the United States and (ii) the U.S. wage rate is higher than in the rest of the world. That is, $r < r^*$, $s < s^*$ and $w > w^*$. Alternatively, $\frac{\partial w}{\partial K} = \frac{\partial w}{\partial p_o}\frac{\partial p_o}{\partial K} > 0$, $\frac{\partial r}{\partial K} = \frac{\partial r}{\partial p_o}\frac{\partial p_o}{\partial K} < 0$, and $\frac{\partial s}{\partial K} = \frac{\partial s}{\partial p_o}\frac{\partial p_o}{\partial K} < 0$.

5. Numerical example: the case of a Cobb-Douglas utility function

5.1. U.S. economy

Preferences of the representative consumer are given by a Cobb-Douglas utility function:

[4] Some authors interpret the Balassa-Samuelson effect to mean that the price of the nontraded good is higher in richer countries, i.e., $p_o > p_o^*$ if $I/L > I^*/L^*$. However, this result cannot always be guaranteed.

$$U(x_1,x_2,x_o)=x_1^{1/3}x_2^{1/3}x_o^{1/3}. \tag{17}$$

Consumer income is $I=wL+rK+sT$. Domestic demand for the three goods can be written as:

$$x_1=\frac{wL+rK+sT}{3p_1},x_2=\frac{wL+rK+sT}{3p_2},x_o=\frac{wL+rK+sT}{3p_o}.$$

Consider Cobb-Douglas production functions of the three industries:

$$\begin{aligned} y_1&=L_1^{2/8}K_1^{4/8}T_1^{2/8},\\ y_2&=L_2^{2/8}K_2^{2/8}T_2^{4/8},\\ y_o&=L_o^{3/8}K_o^{4/8}T_o^{1/8}. \end{aligned} \tag{18}$$

Resource constraints are

$$\begin{aligned} L_1+L_2+L_o&=L,\\ K_1+K_2+K_o&=K,\\ T_1+T_2+T_o&=T. \end{aligned} \tag{19}$$

Each industry chooses its inputs to minimize its production costs. Then total profits of the three industries also are maximized. The Lagrangian function associated with this problem is

$$\begin{aligned} \mathrm{L}&=p_1y_1+p_1y_1+p_1y_1+w(L-L_1-L_2-L_o)+r(K-K_1-K_2-K_o)+s(T-T_1-T_2-T_o)\\ &=p_1L_1^{2/8}K_1^{4/8}T_1^{2/8}+p_2L_2^{2/8}K_2^{2/8}T_2^{4/8}+p_oL_o^{3/8}K_o^{4/8}T_o^{1/8}\\ &+w(L-L_1-L_2-L_o)+r(K-K_1-K_2-K_o)+s(T-T_1-T_2-T_o), \end{aligned}$$

where w, r, and s are shadow prices of labor, capital, and land, respectively. First order conditions for an interior solution are

$$\begin{aligned} w&=\frac{2}{8}p_1\left(\frac{K_1}{L_1}\right)^{4/8}\left(\frac{T_1}{L_1}\right)^{2/8}=\frac{2}{8}p_1y_1/L_1\\ &=\frac{2}{8}p_2\left(\frac{K_2}{L_2}\right)^{2/8}\left(\frac{T_2}{L_2}\right)^{4/8}=\frac{2}{8}p_2y_2/L_2\\ &=\frac{3}{8}p_o\left(\frac{K_o}{L_o}\right)^{4/8}\left(\frac{T_o}{L_o}\right)^{1/8}=\frac{3}{8}p_oy_o/L_o, \end{aligned} \tag{20}$$

$$\begin{aligned} r&=\frac{4}{8}p_1\left(\frac{L_1}{K_1}\right)^{2/8}\left(\frac{T_1}{K_1}\right)^{2/8}=\frac{4}{8}p_1y_1/K_1\\ &=\frac{2}{8}p_2\left(\frac{L_2}{K_2}\right)^{2/8}\left(\frac{T_2}{K_2}\right)^{4/8}=\frac{2}{8}p_2y_2/K_2\\ &=\frac{4}{8}p_o\left(\frac{L_o}{K_o}\right)^{3/8}\left(\frac{T_o}{K_o}\right)^{1/8}=\frac{4}{8}p_oy_o/K_o, \end{aligned} \tag{21}$$

$$\begin{aligned} s&=\frac{2}{8}p_1\left(\frac{L_1}{T_1}\right)^{2/8}\left(\frac{K_1}{T_1}\right)^{4/8}=\frac{2}{8}p_1y_1/T_1\\ &=\frac{4}{8}p_2\left(\frac{L_2}{T_2}\right)^{2/8}\left(\frac{K_2}{T_2}\right)^{2/8}=\frac{4}{8}p_2y_2/T_2\\ &=\frac{1}{8}p_0\left(\frac{L_o}{T_o}\right)^{3/8}\left(\frac{K_o}{T_o}\right)^{4/8}=\frac{1}{8}p_oy_o/T_o. \end{aligned} \tag{22}$$

From equations (20)–(22), we have $8wL_1=2p_1y_1$, $8wL_2=2p_2y_2$, and $8wL_o=3p_oy_o$. Likewise, $8rK_1=4p_1y_1$, $8rK_2=2p_2y_2$, and $8rK_o=4p_oy_o$. For the land input, we have $8sT_1=2p_1y_1$, $8sT_2=4p_2y_2$, and $8sT_o=p_oy_o$. Combining these relations and the resource constraints, we have

$$y_o=\frac{6wL-2rK-2sT}{p_o}. \tag{23}$$

$$y_2 = \frac{2wL - 2rK + 2sT}{p_2}, \tag{24}$$

$$y_1 = \frac{-7wL + 5rK + sT}{p_1}. \tag{25}$$

From equations (20)–(22), we have

$$\begin{aligned} &\frac{K_1}{L_1} = \frac{2w}{r}, \quad \frac{L_1}{T_1} = \frac{s}{w}, \quad \frac{K_1}{T_1} = \frac{2s}{r}, \\ &\frac{K_2}{L_2} = \frac{w}{r}, \quad \frac{L_2}{T_2} = \frac{s}{2w}, \quad \frac{K_2}{T_2} = \frac{s}{2r}, \\ &\frac{K_o}{L_o} = \frac{4w}{3r}, \quad \frac{L_o}{T_o} = \frac{3s}{w}, \quad \frac{K_o}{T_o} = \frac{4s}{r}. \end{aligned} \tag{26}$$

Note that the factor intensities satisfy the assumptions: $\frac{K_1}{L_1} > \frac{K_o}{L_o} > \frac{K_2}{L_2}$, $\frac{L_0}{T_0} > \frac{L_1}{T_1} > \frac{L_2}{T_2}$, and. $\frac{K_0}{T_0} > \frac{K_1}{T_1} > \frac{K_2}{T_2}$.

From the first order conditions, we obtain the relationship between output prices and factor prices.

$$s = \frac{p_1 p_2^2}{3^{3/4} 2^{1/2} p_o^2}, \quad r = \frac{p_1^5}{3^{3/4} 2^{1/2} p_2^2 p_o^2}, \quad w = \frac{3^{9/4} p_2^2 p_o^6}{2^{9/2} p_1^7}. \tag{27}$$

These results confirm Proposition 3 or equation (10). As the price of the nontraded good rises, only the wage rate rises and both capital and land rent fall. Note that in (27) the prices of two traded goods, p_1 and p_2, are determined in the world market, and the price of the nontraded good rises if, and only if, the wage rate rises. This result is an extension of the Balassa-Samuelson result to the three-factor, three-industry world. These results are consistent with Proposition 3: $\frac{\partial w}{\partial p_o} > 0$, $\frac{\partial r}{\partial p_o} < 0$, $\frac{\partial s}{\partial p_o} < 0$, $\frac{\partial w}{\partial p_2} > 0$, $\frac{\partial r}{\partial p_2} < 0$, $\frac{\partial s}{\partial p_2} > 0$.

5.2. Effect of capital stock growth

Recall that in the nontraded sector, $y_o = \frac{6wL - 2rK - 2sT}{p_o}$, and $x_o = \frac{wL + rK + sT}{3p_o}$. Also, $w = \frac{3^{9/4} p_2^2 p_o^6}{2^{9/2} p_1^7}$, $r = \frac{p_1^5}{3^{3/4} 2^{1/2} p_2^2 p_o^2}$, and $s = \frac{p_1 p_2^2}{3^{3/4} 2^{1/2} p_o^2}$. The excess demand for the nontraded good is written as

$$g = x_o(p_1, p_2, p_o, wL + rK + sT) - y_o(p_1, p_2, p_o, K, L, T),$$

where $x_o = \frac{wL + rK + sT}{3p_o} = \frac{3^{5/4} p_2^2 p_o^5}{2^{9/2} p_1^7} L + \frac{p_1^5}{3^{7/4} 2^{1/2} p_2^2 p_o^3} K + \frac{p_1 p_2^2}{3^{7/4} 2^{1/2} p_o^3} T$, and $y_o = \frac{6wL - 2rK - 2sT}{p_o} = \frac{3^{13/4} p_2^2 p_o^5}{2^{7/2} p_1^7} L - \frac{2^{1/2} p_1^5}{3^{3/4} p_2^2 p_o^3} K - \frac{2^{1/2} p_1 p_2^2}{3^{3/4} p_o^3} T$. Thus, excess demand for the nontraded good is

$$g = x_o - y_o = -17 \frac{3^{5/4} p_2^2 p_o^5}{2^{9/2} p_1^7} L + 7 \frac{p_1^5}{3^{7/4} 2^{1/2} p_2^2 p_o^3} K + 7 \frac{p_1 p_2^2}{3^{7/4} 2^{1/2} p_o^3} T. \tag{28}$$

Partially differentiating (28) with respect to K and p_o, we obtain

$$\frac{\partial g}{\partial K} = \frac{7 p_1^5}{3^{7/4} 2^{1/2} p_2^2 p_o^3} > 0, \frac{\partial g}{\partial p_o} = -85 \frac{3^{5/4} p_2^2 p_o^4}{2^{9/2} p_1^7} L - 21 \frac{p_1^5}{3^{7/4} 2^{1/2} p_2^2 p_o^2} K - 21 \frac{p_1 p_2^2}{3^{7/4} 2^{1/2} p_o^2} T < 0,$$

and hence $\frac{\partial p_o}{\partial K} = \frac{-g_K}{g_o} > 0$, as expected.

The supply and demand for good 2 in the foreign country are.

$y_2^* = \frac{2w^* L^* - 2r^* K^* + 2s^* T^*}{p_2^*}$, and. $x_2^* = \frac{w^* L^* + r^* K^* + s^* T^*}{3p_2^*}$.

By Walras' law, if one market is in equilibrium, the other market also is in equilibrium. The world market for good 2 is in equilibrium if

$$\begin{aligned} G = x_2 + x_2^* - \left(y_2 + y_2^*\right) = \frac{wL + rK + sT}{p_2} + \frac{wL^* + rK^* + sT^*}{p_2^*} \\ - \frac{2wL - 2rK + 2sT}{p_2} - \frac{2w^* L^* - 2r^* K^* + 2s^* T^*}{p_2^*} = 0. \end{aligned} \tag{29}$$

Differentiating (29) with respect to K and p_2 yields

$$\frac{\partial p_2}{\partial K} = -\frac{G_K}{G_2} > 0, \tag{30}$$

where $G_K = \frac{\partial x_2}{\partial K} - \frac{\partial y_2}{\partial K} = \frac{r}{p_2} - \frac{-2r}{p_2} = \frac{3r}{p_2} > 0$, and the slope of the world's excess demand for good 2 is assumed to be negative, i.e., $G_2 = \frac{\partial x_2}{\partial p_2} - \frac{\partial y_2}{\partial p_2} + \frac{\partial x_2^*}{\partial p_2} - \frac{y_2^*}{\partial p_2} < 0$. Thus, an increase in domestic capital increases the world's excess demand for good 2, and hence raises the equilibrium price of good 2. Differentiating (27) with respect to K yields

$$\frac{\partial w}{\partial K} = \frac{\partial w}{\partial p_o}\frac{\partial p_o}{\partial K} + \frac{\partial w}{\partial p_2}\frac{\partial p_2}{\partial K} > 0.$$

It follows that an increase in capital endowment raises the price of the nontraded good as well as the wage rate, as indicated in Proposition 3.

6. Income and housing prices in 23 OECD countries

Housing price data are available for 23 countries of the Organization for Economic Cooperation and Development (OECD) during the period 2000–2016. In this section we investigate the effect of per capita real GDP on housing prices. These countries are divided into two groups: European Union (EU) members and non-EU countries. The following 14 EU countries are included in our analysis: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, and United Kingdom. Non-EU members of the OECD include the following nine countries: Australia, Canada, Israel, Japan, New Zealand, Norway, South Korea, Switzerland, and United States.

Among the EU members, resources are generally more mobile are lower than non-EU countries. These countries are located in the same region, sharing common culture and linguistic heritage. Because of proximity, transportation costs among EU countries are much lower than among non-EU members. Accordingly, increased demands for nontraded goods can be met without raising prices by moving real resources such as capital and labor inputs. Thus, we expect housing prices to be insensitive to changes in per capita income.

Non-EU members are geographically separate and transportation costs among them are much higher than those between EU members. Also, immigration to these countries is tightly regulated and labor is less mobile among these countries. An increase in GDP will necessarily increase the demand for the nontraded good, which will be met by an increase in the price, rather than by an increase in the supply of the nontraded good. In these countries, we expect nontraded goods price to be more sensitive to income changes than in EU countries.

We use the house price indices (HPIs) which measure the real prices of residential properties over time from the *OECD Statistics*. Per capita real GDP data are from the World Bank (World Development Indicators database).

6.1. Econometric model

To analyze the impact of real GDP per capita on house prices, we consider the dynamic relationships between housing price index and per capita real GDP in the following equation:

$$HP_{it} = \beta_0 HP_{i,t-1} + \beta_1 RGDP_{it} + v_i + \varepsilon_{it}, \mathrm{t} = 1,\&\mathrm{T}, \quad (31)$$

where HP_{it} is housing price index of country i at time t, $RGDP_{it}$ is per capita real GDP, β's are parameters to estimate, v_i is country-specific effect, and ε_{it} is the error term.

Inclusion of a lagged dependent variable ($HP_{i,t-1}$) is aimed at capturing autocorrelation among the error terms. When the model in (31) is estimated using ordinary least squares (OLS), the lagged variable is correlated with the error term. In order to resolve this problem, we employ a generalized method of moments (GMM) estimator that eliminates country specific effects or any time-invariant country specific effect. Using the panel data approach, one can control for the biases generated by potential heterogeneity and omitted variable problems. Since the dataset used in this model is available for 17 years, and the number of countries is relatively large, Arellano and Bond, 1991 estimator is appropriate. By considering the GMM estimation of the dynamic panel, we include the lagged housing price index.

6.2. Estimation results

It is necessary to test whether the housing price index is non-stationary. We apply the panel unit root test proposed by Levin, Lin, and Chu (2002), which test shows that the housing price index is non-stationary at level but stationary at the first difference. Thus, the housing price variable in the model is integrated of order 1, i.e., I(1). The econometric analysis is based on panel data estimation, using the Stata software.

Table 1 summarizes the dynamic Generalized Method Moment (GMM) panel regression results for non-EU and EU members of

Table 1
Dynamic GMM –Panel regression results.

	Non-EU Countries	EU Countries
ln $HP_{i,t-1}$	0.738	0.814
	(0.034)*	(0.019)*
ln $RGDP_{i,t}$	0.199	−0.024
	(0.030)*	(0.0164)
Observation	135	209
Number of Countries	9	14

Note: time period is 17 years. *indicates significance at 1%.

OECD.

It can be seen that the effects of per capita real GDP on house prices are strong and significant among non-EU members of OECD, whereas there is no evidence of a positive relationship between per capita real GDP and house prices among EU countries. Since capital and labor inputs are more mobile among EU countries, an increase in real income does not affect the real house price. However, among the non-EU OECD countries resources have been generally immobile, and an increase in income raises house prices. These results demonstrate the Balassa Samuelson effect for the non-EU countries. Specifically, a 10% increase in real GDP per capita leads to a 2% increase in real house price in non-EU members of the OECD.

7. Concluding remarks

Balassa (1964) and Samuelson (1964) assumed that the high-income countries have a comparative advantage in the traded sectors. They observed the stylized fact that the price of the nontraded good is higher in countries with higher labor productivity. This model follows Bhagwati's (1984) suggestion that poor and rich countries share identical production technologies and explores a general Balassa-Samuelson effect. It is shown that unlike the traditional Heckscher-Ohlin model, changes in capital-labor endowment ratio affect factor prices.

This paper suggests that higher wages and higher prices of the nontraded good may reflect higher endowments of capital stock in developed economies. The Balassa-Samuelson effect only refers to the rising price of the nontraded good in high-wage economies, but the resulting inflation is likely to be more pronounced as the income share of the nontraded good increases. Available empirical studies suggest that the nontraded sector has the largest share of GDP in the United States, European Union and China and, hence, the inflationary effect of the rising wage is likely to be present even if the production technologies are the same throughout the world.

The empirical result shows that among the non-EU countries, increases in per capita real GDP had positive and statistically significant effect on the house prices, which corroborates the Balassa-Samuelson effect.

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