Nontradables Employment Patterns in a Balassa-Samuelson Model

Jorge Baldrich*

JEL Classification: O41, F41

Abstract

The aim of this paper is to analyze the rate of growth of labor allocated to the nontradables sector. The model shows that both total labor expansion and the interest rates affect positively the labor creation in nontradables. In contrast, tradables productivity growth and nontradables labor growth are negatively related. The paper includes an empirical analysis of 31 countries for the years 1970-1992. Productivity growth in tradables plays a minor role in explaining the creation of jobs in the nontradables sector. Conversely, the main force behind nontradables labor growth is the income effect of an increase in total labor.

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1. Introduction

More than four decades after the Balassa-Samuelson model (BSM) was introduced, the approach has regained relevance as the result of the European Union enlargement process and the controversy about the productivity convergence of new accessing countries under the Maastricht’s productivity-absent inflationary criteria1. In fact, the focus on relative prices has dominated the empirical agenda since the model was presented. Of the 58 published empirical papers surveyed by Tica and Druzic (2006), 54 have the relative price as a dependent variable, whereas the other 4 papers focus on the wage rate, the capital-labor ratios, and the sector productivities. However, as Obstfeld and Rogoff (1996) have shown, the model can also be used to analyze the relationship between productivity change and sector employment trends. The aim of this paper is to go a further step ahead from the Obstfeld and Rogoff’s version of the BSM, by expanding their model. In explaining the steady-state growth rate of nontradables labor not only sector productivity plays a role but, also, an exogenous rate of growth of total labor as well as the real interest rate are relevant explanatory variables. The model shows that total labor expansion and the interest rates affect positively the labor creation in the nontradables sector. Furthermore, the influence of tradables productivity growth on nontradables labor is negative. In addition, the productivity growth rate of nontradables has no effect on the nontradables employment growth rate. These aspects are consistent with the empirical evidence presented.

Our empirical findings suggest that productivity growth in tradables, in spite of being a highly significant variable, plays a minor role in explaining the creation of jobs in the nontradables sector. Conversely, the main force behind nontradables labor growth is the income effect of an increase in the growth of total labor. In this regard, our results point to some well known trends of the development process, such as the increase in participation rates and the differential dynamics of the birth and mortality rates, as elements associated with the nontradables and service sectors employment expansion. Finally, changing financial market

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1 See Tica and Druzic (2006)
conditions seem to be relevant in understanding employment trends. An increase in interest rates raises the rate of employment expansion through a relative price effect (provided tradables are more capital intensive than nontradables) as well as through a decline in the capital-labor ratio of nontradables growth rate. Both effects outweigh the effect of a decline in the growth of wages and labor income.

2. The model

We follow the Obstfeld and Rogoff’s version of the Balassa - Samuelson model (Obstfeld and Rogoff, 1996). Production at date $s$ of tradables and nontradables is characterized by a Cobb-Douglas technology. Labor is mobile among sectors and capital is mobile internationally.

$$Y_{T,s} = \theta_{T,s} K_{T,s}^{\alpha T} L_{T,s}^{1-\alpha T}$$

$$Y_{N,s} = \theta_{N,s} K_{N,s}^{\alpha N} L_{N,s}^{1-\alpha N}$$

Total factor productivity in each sector is given by:

$$\theta_{j,s} = \Pi_{j,s}^{1-\alpha j} \quad \text{for } j = T, N$$

where $\Pi_s$ is an index of Harrod-neutral technological innovation. Consequently, the differential in total factor productivity growth between sectors is:

$$\ln \left( \frac{\theta_{T,s+1}}{\theta_{T,s}} \right) - \ln \left( \frac{\theta_{N,s+1}}{\theta_{N,s}} \right) = (1 - \alpha T) \ln \left( \frac{\Pi_{T,s+1}}{\Pi_{T,s}} \right) - (1 - \alpha N) \ln \left( \frac{\Pi_{N,s+1}}{\Pi_{N,s}} \right)$$

In the Asea and Mendoza’s (1994) model the source of greater productivity growth in tradables than in nontradables is higher tradables’ labor share $((1 - \alpha T) (1 - \alpha N))$. In our specification, different innovation indexes between sectors can also explain productivity differential growth. In fact, our empirical analysis assumes a lower labor share on tradables than in nontradables. Kongsamut, Rebelo and Xie (1997) analyze models of balanced growth paths consistent with the dynamics of labor reallocation from agriculture to
manufacturing and services. This paper, however, deals with nontradables employment creation under the traditional approach provided by the BS model.

The relative price of nontradables in terms of tradables is given by $p$:

$$p_s = \frac{P_{N,s}}{P_{T,s}}$$  \hspace{1cm} (3)

The representative firms of both sectors maximize the present discounted value of earnings less investment outlays. It is assumed that the world interest rate $r$ is constant and that there is no capital depreciation. The wage rate $w$ is measured in tradable goods units. The maximization problem for the tradables and nontradables representative firms are given by equations 4

$$\sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} \left[ \theta_T T_{t,s} K_T^{\alpha_T} L_T^{1-\alpha_T} - w_s L_T - \left( K_{T,s+1} - K_{T,s} \right) \right]$$

$$\sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} \left[ p_s \theta_N N_{s} K_N^{\alpha_N} L_N^{1-\alpha_N} - w_s L_N - \left( K_{N,s+1} - K_{N,s} \right) \right]$$

the firms' first-order conditions are\(^2\)

$$\theta_T \alpha_T K_T^{\alpha_T-1} = r$$  \hspace{1cm} (5)

$$\theta_T \left( 1 - \alpha_T \right) K_T^{\alpha_T} = w$$  \hspace{1cm} (6)

$$p \theta_N \alpha_N K_N^{(\alpha_N-1)} = r$$  \hspace{1cm} (7)

$$p \theta_N K_N^{\alpha_N} = w$$  \hspace{1cm} (8)

\(^2\) Time subscripts will be omitted in what follows.
where $k_T$ is the capital-labor ratio in the tradables sector, and $k_N$ is the capital-labor ratio in the nontradables sector. Equations 5 – 8 form a block of 4 equations in four unknowns: $k_T$, $k_N$, $w$, and $p$:

\[
\ln k_T = \left(\frac{1}{\alpha_T - 1}\right)\left(\ln r - \ln \theta_T - \ln \alpha T\right) 
\]

(9)

\[
\ln w = \left[\ln(1 - \alpha T) - \left(\frac{\alpha T}{1 - \alpha T}\right)\ln \alpha T\right] + \left(\frac{1}{1 - \alpha T}\right)\ln \theta_T - \left(\frac{\alpha T}{1 - \alpha T}\right)\ln r 
\]

(10)

\[
\ln k_N = \left[\ln(1 - \alpha T) - \left(\frac{\alpha T}{1 - \alpha T}\right)\ln \alpha T + \ln \alpha T\right] + \left(\frac{1}{1 - \alpha T}\right)\ln \theta_T - \left(\frac{1}{1 - \alpha T}\right)\ln r 
\]

(11)

\[
\ln p = \Theta + \left(\frac{1 - \alpha N}{1 - \alpha T}\right)\ln \theta_T - \ln \theta_N - \left[\frac{(1 - \alpha N) - (1 - \alpha T)}{1 - \alpha T}\right]\ln r 
\]

(12)

where:

\[
\Theta = \left[(1 - \alpha N)\left[\ln(1 - \alpha N) - \left(\frac{\alpha T}{1 - \alpha T}\right)\ln \alpha T + \ln \alpha N\right] - \ln \alpha N\right] 
\]

In order to assess long term employment trends the introduction of demand components is required. Following Obstfeld and Rogoff we will analyze steady-state results and assume homothetic preferences. In the steady-state consumption equals income and, therefore, the national financial wealth is constant at the level $\bar{Q}$. Given the zero flow of savings at the steady-state, any increase in the economy capital stock is financed by an equal increase in financial debt leaving total wealth unchanged.

\[
\bar{Q} = B + K_T + K_N 
\]

In each period it is assumed that the representative agent maximizes a Cobb-Douglas utility function of the form:
Total consumption equals national income which, in turn, has two components: wage income and return on financial assets:

\[ C_T + p \cdot C_N = wL + rQ \]

Maximizing the utility function subject to the national income-consumption restriction gives:

\[
\frac{C_N}{C_T} = \left( \frac{1}{\lambda} \right) \frac{1}{p} \]  \hspace{1cm} (13)

where the ratio of the nontradables and tradable consumption levels depends on the relative price of nontradables. Using 10 and 12, total consumption must observe:

\[
C_T + p(r, \theta_T, \theta_N) \cdot C_N = w(r, \theta_T) L + rQ \]  \hspace{1cm} (14)

in addition, the equilibrium condition for nontradables implies

\[
C_N = Y_N \]  \hspace{1cm} (15)

Equations 13 and 14 determine \( C_T \) and \( C_N \). The nontradables equilibrium condition 15 determines \( Y_N \). Consumption of nontradables is given by:

\[
C_N = (1 - \lambda) \frac{Z}{p} \]  \hspace{1cm} (16)

where

\[
Z = w(r, \theta_T) L + rQ \]  \hspace{1cm} (17)

From equation 2 we can get the following expression, where the sign \( \wedge \) represents the growth rate of the variable:

\[
\hat{L}_N = \hat{Y}_N \hat{\theta}_N - \alpha \hat{N} k_N \]  \hspace{1cm} (18)
from 15 and 16:

\[ C_N = Y_N \]  

\[ \hat{C}_N = \hat{Z} - \hat{p} \]  

(19)  

(20)

taking differentials to equation 17 we get:

\[ \hat{Z} = \Omega_L \left( \hat{w} + \hat{L} \right) \]  

(21)

where

\[ \Omega_L = \frac{wL}{wL + rQ} \]

substituting 21 into 20 and using 18:

\[ \hat{L}_N = \Omega_L \hat{w} + \Omega_L \hat{L} - \hat{p} - \hat{\theta}_N - \alpha_N \hat{k}_N \]  

(22)

Finally, using 10, 11 and 12:

\[ \hat{L}_N = -\left( \frac{1 - \Omega_L}{1 - \alpha T} \right) \hat{\theta}_T + \Omega_L \hat{L} + \left[ \frac{1 - \Omega_L}{1 - \alpha T} \right] r \]  

(23)

Equation 23 is the basis of our empirical estimation. Several aspects of equation 23 are worth to mention. First, the rate of growth of total labor \( \hat{L} \) has a direct and positive effect on \( \hat{L}_N \). An increase in the growth rate of labor availability raises labor income and national income through equation 21 prompting a raise in \( \hat{C}_N, \hat{Y}_N \), and \( \hat{L}_N \) through equation 18.

Second, the nontradables productivity growth rate \( \hat{\theta}_N \) plays no role on \( \hat{L}_N \). The reason for that is because an increase in \( \hat{\theta}_N \) represents an increase in efficiency and triggers a reduction in \( \hat{L}_N \) through equation 18. However, this effect is fully compensated by the effect
of a declining rate of growth of the relative price of nontradables and its associated increase in the consumption of nontradables. Third, an increase in \( \hat{\theta}_T \) implies two negative and one positive on \( \hat{L}_N \). The negative links come from the increase in the efficiency of tradable production and from the increase in the relative price of nontradables. The increase in the efficiency of tradable production, given the perfect mobility of capital, increases the capital intensity in both sectors and reduces the growth rate of nontradables labor; the increase in the relative price of nontradables induces a shift in consumption into tradables. The positive association is due to the increase in consumption of nontradables stemming from a rise in wages and labor income. The net effect of an increase in \( \hat{\theta}_T \) is negative and its absolute value is greater the greater is the economy’s share of labor income \( \Omega_L \). Finally, an increase in \( \hat{r} \) has four components. First, it rises \( \hat{L}_N \) as a result of a decline in the (growth rate) of the capital intensity of nontradables. Second, it also raises \( \hat{L}_N \) through a decline in the relative price of nontradables, provided that \( \alpha_T > \alpha_N \). Third, it raises capital income for the given level of financial wealth. Finally, it reduces \( \hat{L}_N \) as wages and labor income growth decline with a higher \( \hat{r} \). The net effect of an increase in \( \hat{r} \) is unambiguously positive.

3. Data and results

Our data set includes output, labor and productivity for the tradables and nontradables sectors. The (unbalanced) panel contains 31 countries for the years 1970-1992. Appendix 1 presents the sources of data and Table 1 provides statistics for the variables of interest. The output data are from the Unite Nations’ National Accounts Database. Tradables output includes value added in agriculture and industry. Nontradables output is total value added minus tradable output. The tradable capital stock was defined as capital employed in agriculture and industry. The nontradable capital stock equals total capital less tradable capital. Capital data is from Crego et al (1998). Labor employed in the tradables sector and total labor data are from the International Labor Office’s Bureau of Statistics database. The labor allocated to the tradables sector includes labor of the ISIC’s divisions 1, 2 and 3 (Agriculture, Mining and Manufacturing). Sector productivity was calculated by a procedure

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3 This is the variable highlighted by Obstfeld and Rogoff (1996).
similar to the one used by Hall and Jones (1999). Country’s \( j \) productivity of sector \( i \) in year \( t \) is given by:

\[
\theta_{ji} = \frac{Y_{ji}}{K_{ji}^{\alpha} (1-\alpha)} \quad i = T, N
\]

In order to calculate the productivity a 0.49 value for \( \alpha T \) was used. Initially, we tried to calculate the productivity levels by applying the wages by sector of economic activity to the sector employment data\(^4\). However, the different coverage of the wages and employment data sets prevented us to get a direct capital share for each country. Therefore, we followed Hall and Jones’s approach of using a common \( \alpha \) value. Also in line with the literature, we tried to be consistent with the national accounts dataset used and, therefore, we selected a 0.49 value for \( \alpha T \), and a 0.44 value for \( \alpha N \), both numbers corresponding to the sector shares of the US economy computed from our data set\(^5\).

Once the level of sector productivity is calculated, a measure of the annual rate of productivity growth is required. In this regard, two definitions of the productivity growth rate are employed. The first comes from regressing the log of sector productivity on a constant and a time trend. The second is calculated as the year equivalent rate of productivity growth experienced under the whole data period for each country. These estimations are presented in our tables as definitions \( a \) and \( b \) respectively.

The interest rate is measured as the real interest rate on the 10 years maturity US Treasury note. The US GDP deflator was used as the inflation variable.

Nontradables employment annual average rate of growth was 1 percentage point higher than total employment growth. The difference of total factor productivity growth between tradables and nontradables sectors was 0.86 and 0.75 percentage points under definitions \( a \) and \( b \), respectively. Our productivity numbers are consistent with the slow productivity change of the service sector in relation with agriculture emphasized by Kongsamut, et al (1996). In 1970-1992 the interest rate increased importantly as the average country experienced a 245 basis point raise in real rates.

Figure 1 shows nontradables labor rates of growth plotted against our three explanatory variables.

\(^4\)Wages by economic activity are also published by the ILO’s Bureau.
\(^5\) The 0.51 value for the tradables labor share is get by multiplying the average yearly earning in manufacturing times the total tradables labor divided by the tradables output. Similarly, the 0.56 value for the nontradables labor share results from multiplying the average yearly earning in construction times the total nontradables labor over the nontradables output. All numbers correspond to 1990.
Empirical estimations of the BS model are usually carried out using the relative price of nontradables as the dependent variable (equation 12). Of the 58 empirical estimations of the model surveyed by Tica and Druzic (2006), 54 have the relative price as a dependent variable, whereas the other 4 papers focus on the wage rate (two of them), the capital-labor ratio, and the sector productivities. One common obstacle for the empirical analysis is to confront the long term view of the BS model with the relative high frequency data usually employed. In this regard, three empirical approaches have been used. The first one is to use the average rate of growth of the variables during the period to be analyzed (De Gregorio et al., 1994\(^6\)). The second approach is to filter the short term data in order to extract the long term trends (Asea et al., 1994). The last approach is the use of the relative high frequency data in order to take advantage of a greater number of observations under the assumption that the variables are around their steady-state values.

Table 2 presents our empirical findings. Columns 1(a) – 4(a), and 1(b) - 4(b) show the OLS estimation of equation 23 for the 31 countries of our data set. The annual average rate of growth was employed for the variables of interest and, therefore, 31 observations were included. Columns (a) correspond to productivity defined by regressing the log of productivity on a time trend. In columns (b) the productivity variable was calculated as the year equivalent rate of productivity growth. The rate of growth of total labor is a highly significant variable in all the equations. The rate of tradables productivity growth coefficient has the sign suggested by equation 23, but it is only significant once \(\hat{L}\) is removed as a right hand side variable (columns 3a and 3b). The reason for this seems to be the high correlation between \(\hat{L}\) and \(\hat{\theta}_T\) (Columns 5a and 5b). This multicollinearity problem between explanatory variables can be addressed by expanding the number of observations and making full use of the panel data set. Column 6 is our preferred equation. A SUR estimation procedure was used and allowance was made for different constants terms among the 30 countries\(^7\). The three explanatory variables of equation 23 are significant at the 1 % confidence level and have the sign implied by the model. Finally, column 7 presents the results for the Hodrick-Prescott filtered series. Unfortunately, an autocorrelation problem turns the coefficients of this equation unreliable.

Our empirical findings suggest that productivity growth in tradables, in spite of being a highly significant variable, plays a minor role in explaining the creation of jobs in the nontradables sector. An annual increase of 2 percent of tradables productivity only implies a reduction in nontradables employment growth of 0.03 percent. In term of our model, the increase in

\(^6\) Equation 14 of the mentioned paper.
\(^7\) The observations corresponding to Sri Lanka were not included.
nontradables consumption caused by the rise in wages and labor income temper the relative prices and efficiency effects of tradables productivity growth and perhaps this can explain the low $\hat{\theta}_r$ elasticity. The main force behind nontradables labor growth is the income effect of an increase in the growth of total labor. In this regard, our results point to some common trends of the development process, such as the increase in participation rates and the differential dynamics of the birth and mortality rates, as elements associated with the nontradables and service sectors employment expansion. Finally, financial market conditions are also relevant in understanding employment trends. The low elasticity of real interest rates has to be viewed in relation with the important raise in real rates under the period of analysis. The increase in real interest rates during 1970-1992 helps to explain a third of a percentage point increase in nontradables labor.
REFERENCES


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Figure 1

**TOTAL LABOR AND NONTRADABLES LABOR GROWTH RATES**
Coeff: 0.966     Std Err: 0.100    R2: 0.76

**TRADABLES PRODUCTIVITY (a) AND NONTRADABLES LABOR GROWTH RATES**
Coeff: -0.367     Std Err: 0.110    R2: 0.25

**TRADABLES PRODUCTIVITY (b) AND NONTRADABLES LABOR GROWTH RATES**
Coeff: -0.407     Std Err: 0.119    R2: 0.26

**REAL INTEREST RATES AND NONTRADABLES LABOR GROWTH RATES**
Coeff: 0.0046    Std Err: 0.0016    R2: 0.22
<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Nontradable employment</th>
<th>Nontradable employment</th>
<th>Nontradable employment</th>
<th>Nontradable employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1a) (2a) (3a) (4a) (5a)</td>
<td>(1b) (2b) (3b) (4b) (5b)</td>
<td>(6) (7) HP Filtered</td>
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<tr>
<td>Observations</td>
<td>31 31 31 31 31</td>
<td>31 31 31 31 31</td>
<td>443 418</td>
<td></td>
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<tr>
<td>Constant</td>
<td>0.013 0.013 0.032 0.011 0.021</td>
<td>0.143 0.014 0.342 0.011 0.023</td>
<td>Fixed effects Fixed effects</td>
<td></td>
</tr>
<tr>
<td>Fixed effects</td>
<td>(4.66)* (4.08)* (11.41)* (5.02)* (7.38)*</td>
<td>(4.66)* (4.23)* (-10.5)* (2.02)* (7.38)*</td>
<td></td>
<td></td>
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<tr>
<td>Traded productivity rate $\dot{\theta}_T$</td>
<td>-0.101 -0.098 -0.367 -0.299</td>
<td>-0.124 -0.122 -0.408 -0.321</td>
<td>-0.013 0.038</td>
<td></td>
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<tr>
<td>Fixed effects</td>
<td>(-1.43) (-1.32) (-3.47)* (-2.90)*</td>
<td>(-1.64) (-1.57) (-3.401)* (-2.831)*</td>
<td>(-3.597)* (46.33)*</td>
<td></td>
</tr>
<tr>
<td>Total labor growth rate $\dot{L}$</td>
<td>0.89 0.882 0.966</td>
<td>0.882 0.862 0.966</td>
<td>0.869 1.019</td>
<td></td>
</tr>
<tr>
<td>Fixed effects</td>
<td>(7.98)* (7.21)* (9.66)*</td>
<td>(8.03)* (7.94)* (9.68)*</td>
<td>(69.43)* (573.46)*</td>
<td></td>
</tr>
<tr>
<td>Interest rate growth $\dot{r}$</td>
<td>0.0002</td>
<td>0.0004</td>
<td>0.0019 0.0056</td>
<td></td>
</tr>
<tr>
<td>Fixed effects</td>
<td>(-0.19)</td>
<td>(-0.4)</td>
<td>(3.29)* (120.1)*</td>
<td></td>
</tr>
<tr>
<td>Adj$R^2$</td>
<td>0.76 0.76 0.25 0.76 0.2</td>
<td>0.77 0.76 0.26 0.75 0.19</td>
<td>0.265 0.945</td>
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</tr>
<tr>
<td>Fixed effects</td>
<td>1.853 1.841 2.96 1.621 2.22</td>
<td>1.84 1.84 2.78 1.62 2.05</td>
<td>2.45 0.1026</td>
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<tr>
<td>DW</td>
<td>0.0000 0.0000 0.0023 0.0000 0.007</td>
<td>0.0000 0.0000 0.0020 0.0000 0.0083</td>
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<tr>
<td>Prob (F)</td>
<td>OLS OLS OLS OLS OLS</td>
<td>OLS OLS OLS OLS OLS</td>
<td>SUR SUR</td>
<td></td>
</tr>
</tbody>
</table>

Note: T-statistics are reported in parentheses. Significance at the 1 % level is denoted by *.
Appendix 1: Data Source Appendix

- The output data are from the United Nations' National Accounts Database. Tradable output includes value added in agriculture and industry. Non tradable output is total value added minus tradable output. [http://unstats.un.org/unsd/snaama/dnllist.asp](http://unstats.un.org/unsd/snaama/dnllist.asp)


- Labor employed in the tradables sector and total labor data is from the International Labor Office’s Bureau of Statistics database. The labor allocated to the tradable sector includes labor of the ISIC’s divisions 1, 2 and 3 (Agriculture, Mining and Manufacturing). [http://laborsta.ilo.org](http://laborsta.ilo.org).