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# On technical progress and the boundary of non-traded goods

Reza Oladi [a,*], Hamid Beladi [b]

[a] Department of Applied Economics, Utah State University, 3530 Old Main Hill, Logan, UT 84322-3530, United States
[b] Department of Economics, University of Texas at San Antonio, United States

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ABSTRACT

We use a Ricardian model with continuum of goods to study the effect of technical progress on the endogenously determined ranges of non-traded, exported, and imported goods. We show that if technical progress is unbiased (biased toward the goods that a country has more comparative advantage), the range of non-traded goods increases (decreases).



## 1. Introduction

The consumption of non-traded goods accounts for a significant portion of any economy. In 2005, the GDP shares of non-traded goods were, respectively, 60%, 39.4%, and 41% for the European Union, Japan, and the United States. The GDP composition of traded and non-traded goods has important implications for an economy and therefore has attracted the attention of economists for the better part of the last century.

Although consideration of non-traded goods in dealing with a wide range of issues in international trade literature is abundant, most of the studies treat the number of non-traded goods exogenously (see Jones (2003, 1974), Batra (1973), Bond (1993), Thompson (1997), Leamer (1998), and more recently Beladi and Batra (2004), Long et al. (2005) and Oladi and Beladi (2008)). Nevertheless, the study of endogenously determined non-traded goods goes at least as far back to Haberler (1936) and Samuelson (1954). Dornbusch et al. (1977), showed how transportation costs give rise to a range of non-traded goods. This directly leads us to a proposition (or conventional wisdom): as transportation costs (and other impediments to trade) fall, the number of tradable goods increases while the number of non-traded goods decreases.

Over the past few decades we have witnessed a drastic decrease in trade costs, including reduction in transportation and communication costs as well as a general reduction in policy barriers to trade. Surprisingly, and somewhat puzzlingly, we observe that the share of non-traded goods has increased during these past few decades. Fig. 1 shows the trends of non-tradables as a percentage of GDP for the European Union, Japan, and the United States between 1970 and 2005.[1] Evidently, the share of non-traded goods has risen from about 20% to about 39% for the European Union. The trends are also similar for Japan and the United States. The share of non-traded goods as a percentage of GDP has risen from about 32% to about 42% for the US and from about 32% to 39.5% for Japan during this period. These trends (contrary to the above proposition) suggest that there must be other factors that influence the production (consumption) of non-traded goods. Thus, we ask: what other factors affect the range of non-traded goods produced in a country? This is the central issue that we will address in this paper. We propose that technical progress is another important factor that affects the range of produced non-traded goods.

For the purpose of this study we use a Ricardian continuum of goods model (Dornbusch et al., 1977) to study the effects of technical progress on ranges of traded and non-traded goods. The Ricardian framework pioneered by Dornbusch et al. (1977) is a powerful, yet reasonably tractable, set-up, often used in international trade literature; see, for example, Marjit (1987), which uses a Ricardian continuum of goods trade model to study the effect of technical progress on factoral terms of trade when economies trade in intermediary goods, and Marjit and Beladi

* Corresponding author. Tel.: +1 435 797 8196; fax: +1 435 797 2701.
*E-mail address:* reza.oladi@usu.edu (R. Oladi).

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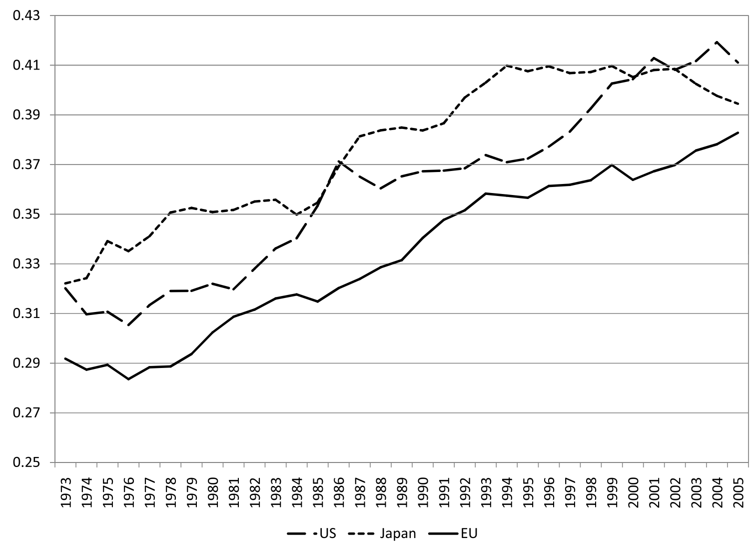


**Fig. 1.** Non-traded goods share of GDP. Authors' calculations based on EU KLEMS Date Base (2008).

(2009). On the other hand, the Heckscher–Ohlin continuum of goods framework (Dornbusch et al., 1980) is hardly manageable, although it is clearly richer. For the sake of tractability we prefer the Ricardian model. As our main result we indicate that technical progress plays a vital role in determining the ranges of traded and non-traded goods. Conventional wisdom may seem to suggest that the technical progress increases (decreases) the number of traded (non-traded) goods. Our analysis illustrates that this is not generally true. More specifically, if technical progress is 'unbiased' (or if it is 'biased' but the transportation cost is large enough), then the range of non-traded goods will increase. On the other hand, we show that if 'biased' technical progress takes place in one country, given that the transportation cost is small enough, then the range of non-traded goods will shrink. Our results have implications with regard to patterns of trade. If 'unbiased' technical progress takes place in the home country, some non-traded goods will become exportable while some of the previously importable goods become non-traded. Thus, such a type of technical progress alters the pattern of trade. The set-up of our paper is somewhat similar to that in Melitz (2003), which studies intra-industry trade in the presence of firm level heterogeneity. This influential work uses a differentiated product set-up, in contrast to our model, and investigates firms' decisions to enter or exit export markets, among other things.

Our paper is also related to a strand of literature that focuses on the effects of technical progress on the real exchange rate within the paradigm of purchasing power parity, which is known as the Balassa–Samuelson effect (see Balassa (1964) and Samuelson (1964)). Accordingly, the productivity growth differential between the tradable and non-tradable sectors explains the price level differences between two countries (i.e., the real exchange rate). More recently, Ghironi and Melitz (2005) showed an endogenously determined Balassa–Samuelson effect by allowing firm heterogeneity. Bergin et al. (2006) also used a continuum goods model of trade, where goods are differentiated on the basis of productivities as in Melitz (2003), and showed that the Balassa–Samuelson effect emerges endogenously and evolves through time (see also De Gregorio et al. (1994), Stockman and Tesar (1995), Deardorff (2005), Lee and Chinn (2006), Ghironi and Melitz (2007), and Dotsey and Duarte (2008), among others).

The rest of the paper is organized as follows. We present a variant of Dornbusch et al. (1977) in Section 2. In Section 3 we derive our results. Section 4 provides some discussions of the relationship between our set-up and some other alternative formulations. We draw some concluding remarks in Section 5.

## 2. The model

Consider a Ricardian world with two countries, home and foreign. Both countries produce a continuum of goods indexed by $z \in [0, 1]$. Denote by $a(z; \beta)$ and $a^*(z; \beta^*)$ the units of labor required to produce one unit of good $z$ in the home and foreign countries, respectively, where $\beta$ and $\beta^*$ are the productivity parameters in these two countries. We assume that the initial values of these parameters are equal to unity. Also, throughout the paper we assume that the technical progress takes place only in the home country. Thus, to simplify our notation we drop $\beta^*$ from the unit labor cost for the foreign country. Define the relative labor productivity for the home country by $A(z; \beta) = a^*(z)/a(z; \beta)$. We assume that $\partial A/\partial z < 0$, $\partial A/\partial \beta > 0$. That is, the relative productivity is decreasing (increasing) in the index of goods for the home (foreign) country and technical progress at home increases (decreases) the relative productivity in the home (foreign) country.

As in Samuelson (1954), assume that transportation costs exist and take the iceberg type, denoted by $g$. We assume that such costs are identical for all goods in both directions. The home country produces any good for which the domestic unit cost is less than or equal to its foreign unit cost, adjusted for transportation costs. That is, the home country produces all goods $z \in [0, 1]$ such that

$$\omega \equiv \frac{w}{w^*} \leq \frac{A(z; \beta)}{g}, \tag{1}$$

where $w$ and $w^*$ are the wage rates in the home and foreign countries, respectively. Similarly, the foreign country produces any good if its unit cost is less than the cost of importing it. Thus, the foreign country produces any good $z \in [0, 1]$ such that

$$\omega \geq gA(z; \beta). \tag{2}$$

Note that for borderline goods the inequalities in Eqs. (1) and (2) turn into equalities. For any given relative wage $\omega$, these two equations determine the ranges of exportable, importable, and non-traded goods. For example, given that the relative wage is $\bar{\omega}$, the home country produces all goods $z \in [0, \bar{z}]$ and imports all goods $z \in (\bar{z}, 1]$, where $\bar{z}$ satisfies (1). Similarly, the foreign country produces all goods $z \in [\bar{z}^*, 1]$ and imports all goods $z \in [0, \bar{z}^*)$, where $\bar{z}^*$ satisfies (2). Therefore, all goods $z \in [\bar{z}^*, \bar{z}]$ are non-traded goods.

Turning now to the demand side of these economies, assume that all consumers in both countries have identical Cobb–Douglas preferences, with $b(z)$ being the expenditure share of good $z$ due