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Rybczynski's Theorem in the Heckscher–Ohlin World — Anything Goes ☆

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ABSTRACT

We demonstrate that Rybczynski's classic comparative statics can be reversed in a Heckscher–Ohlin world when preferences in each country favor the exported commodity. This taste bias has empirical support. An increase in the endowment of a factor of production can lead to an absolute curtailment in the production of the commodity using that factor intensively, and an absolute expansion of the commodity using relatively little of the same factor. This outcome – which we call "Reverse Rybczynski" – implies immiserizing factor growth. We present a simple analytical example that delivers this result with unique pre- and post-growth equilibria. In this example, production occurs within the cone of diversification, such that factor price equalization holds. We also provide general conditions that determine the sign of Rybczynski's comparative statics.

1. Introduction

Fifty-four years ago T. M. Rybczynski (1955) published a frequently referenced note in which he modeled the comparative statics associated with a change in the endowment of a factor of production. The questions that he considered are fundamental: How do the prices of final goods, and the production and consumption of these goods, depend on factor endowments? How do factor prices and the wealth of consumers vary with changes in factor endowments? What are the welfare implications of changes in factor endowments? Of similar importance to Rybczynski's contribution are the various derivatives of the Heckscher–Ohlin model in which factor endowments determine the pattern of trade. Both of these models have become cornerstones for teaching the pure theory of trade.

In this paper we reconsider Rybczynski's theoretical analysis within the framework of the Heckscher–Ohlin model. Thus, technology exhibits constant returns to scale, preferences are homothetic, and there are no factor intensity reversals. Similar to Jones (1956), and in accordance with empirical evidence (Linder, 1961; Weder, 2003), we consider a taste bias in favor of the exportable good.[3] In the context of this model we demonstrate the existence of economies in which Rybczynski's primary comparative statics' conclusions are reversed in sign. In these economies production prevails within the cone of diversification so that factor price equalization holds, and equilibrium is unique. From a theoretical perspective nothing is unusual. However, since the comparative statics of the Heckscher–Ohlin model must allow for endogenous changes in the distribution of income across

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[3] It is important to note that the original articulation of the Heckscher–Ohlin theorem by Ohlin (1933) did not rely on the assumption of identical preferences, but instead on an economic definition of factor abundance. Such a definition uses (autarky) factor prices rather than physical measures to determine relative factor abundance and renders the Heckscher–Ohlin theorem valid independently of the structure of demand. For the purpose of this article, the distinction between the economic and the physical definition of relative factor abundance does not turn out to play a role (both definitions apply). See Gandolfo (1998) for a discussion of this issue.

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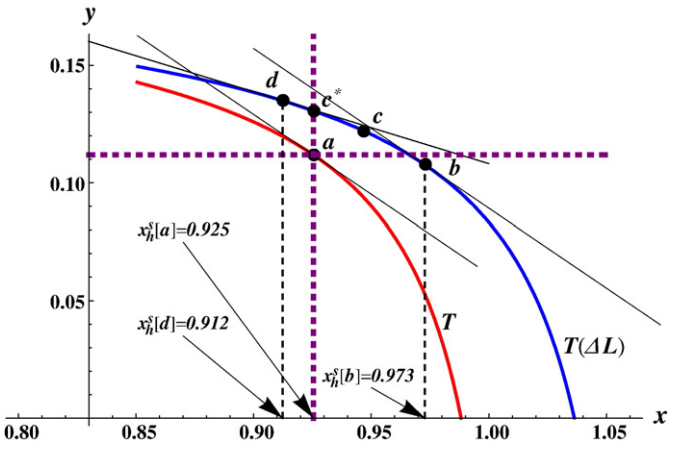

Fig. 1. Production possibilities in the home economy.

countries it is somewhat richer than the comparative statics in Rybczynski's closed economy model.

Before turning to the Heckscher–Ohlin world we ask the reader to recall that Rybczynski's analysis goes beyond the typical textbook treatment with fixed prices and includes a closed economy analysis in which prices were free to vary (see Rybczynski, 1955, p. 336). His presentation begins with the specification of an economy with two factors of production, say, capital (K) and labor (L), and two consumption goods, say, x and y, each produced according to constant returns to scale (CRS) and perfect competition. Let p denote the ratio of the price of x to the price of y. The Rybczynski theorem states that if x is labor intensive and y is capital intensive, *then for each p an increase in L leads to an increase in the equilibrium supply of x and a decrease in the equilibrium supply of y at price p*. Another way to state this conclusion is to say that if one holds the marginal rate of transformation in the production between x and y, MRT (x, y), constant then an increase in L, which allows for an increase in the production of both outputs, leads to an increase in x and a decrease in y. This is illustrated in Fig. 1 by the movement from a to b, where T is the original production possibilities frontier and $T(\Delta L)$ represents the new production possibilities when L is augmented by an increment ΔL.

Rybczynski understood that in a closed economy the relative price p that prevails at equilibrium depends on the demand side of the economy, and varies with factor endowments (this is a general equilibrium effect), and his presentation continues with an analysis of how outputs (which are equal to consumptions in a closed economy) and prices will change following an increase in labor.[4] In particular, Rybczynski argued that in the absence of inferior goods, and with demand generated by the smooth indifference curves of a single consumer whose income is derived from her ownership of K and L, an increase in the amount of factor L leads to an increase in the equilibrium supply (=demand) of x, but that the effect on the equilibrium value of y is ambiguous and could take the economy of Fig. 1 to any point on $T(\Delta L)$ between b and c^*, such as c. Furthermore, it is apparent that he understood that with x inferior, an increase in L can lead to an absolute decrease in x and an increase in y, as in the movement from a to d in Fig. 1. We call this outcome "Reverse Rybczynski".

Although Rybczynski's own analysis took place in the context of a closed economy, it has prominently been recast in trade theory in the context of a home economy that is small (more properly, infinitesimal) relative to the rest of the world so that p is determined by the rest of the world. In Fig. 2 the equilibrium supply in the home country is initially a (on T) and is determined by profit maximization at p. When home labor increases by ΔL the equilibrium supply moves to b on $T(\Delta L)$. If the home country acts as a single consumer with homothetic preferences, the equilibrium demand moves from $\bar{a}$ to $\bar{b}$ of Fig. 2. The increment ΔL will increase the supply of x more than demand at p (in fact, the assumption that y is not inferior is enough for this conclusion). In the Heckscher–Ohlin world that we will consider the home country is not taken to be infinitesimal. Still, at each p the increment ΔL will increase the supply of x more than demand. This powerful implication of Rybczynski's theorem is evident from Fig. 1. It will play a major role in our analysis.

We now turn explicitly to the Heckscher–Ohlin world: there are two countries, neither of which is infinitesimal, and production functions are CRS and identical across countries. Relative factor endowments are different in the two countries and demand in each country is generated by a single consumer whose income is determined by her ownership of capital and labor and who has homothetic preferences; in particular, no goods are inferior in either country. Despite this rather standard form, we show that an increase in the amount of factor L in the home country may lead to a decrease in the relative price of x that is sufficiently large so that the equilibrium supply of x in that country decreases while the production of y increases, as in the movement from a to d in Fig. 1. World production of x also declines. In other words, in general equilibrium, and without the small country assumption, the output implications of an increase in a factor endowment can be the reverse of what is established in the Rybczynski analysis; that is, "Reverse Rybczynski", even with no inferior goods in either country. Furthermore, equilibrium is unique both before and after the increase in L and both equilibria are interior.[5]

The remainder of this paper is organized as follows. A brief overview of related literature is provided in the next section, and an example of "Reverse Rybczynski" in the case of a simple Heckscher–Ohlin model appears in Section 3. We emphasize that we do not assert that "Reverse Rybczynski" is normally the case. Despite the rather innocuous form of the example that demonstrates the above possibility, we are able to provide general conditions on preferences and endowments in the Heckscher–Ohlin model under which the comparative statics in the home and world economies are more or less as they are in Rybczynski's closed economy with no inferior goods. Namely, we are able to provide conditions under which an increase in the home endowment of the factor in which x is intensive leads necessarily to an increase in the supply of x in the home country and in the world. In this case the world production of y will also increase. Finally, we show that "Reverse Rybczynski" implies immiserizing factor growth. The preceding propositions are the work of Section 4. Concluding remarks are presented in Section 5.

2. Related literature

The possibility of "Reverse Rybczynski" was of great interest to Professor Xiaokai Yang, and his interest in that possibility led to this paper. Professor Yang conjectured that "Reverse Rybczynski" could be established using the Sonnenschein–Mantel–Debreu (SMD) theorem (Sonnenschein, 1972, 1973; Mantel, 1974; Debreu, 1974). On this premise some attempts were made to prove this possibility using the idea that derivatives in an equilibrium model could be given quite arbitrary signs (Cheng et al., 2004). However, the Cobb–Douglas utility specification used by the authors means that this approach cannot succeed.[6]

"Reverse Rybczynski" was first established by Hugo Sonnenschein using an elementary version of the Sonnenschein–Mantel–Debreu

[4] Rybczynski also understood than an increase in L leads to an improvement in welfare and, with y normal, to a fall in p.

[5] Uniqueness is key here, since with multiple equilibria both before and after the increase in L, there will generally be a selection from the equilibrium set that trivially yields "Reverse Rybczynski".

[6] This is a corollary to Proposition 1 of Section 4.