

Intermediate Goods with Leontief's Model and Joint Production with Activity Analysis in Ricardian Comparative Advantage

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Abstract

Jones (1961) essentially showed Jones' inequality as a solution of the production assignment problem in the multi-country, multi-good Ricardian model with Hawkins-Simon Theorem. Jones (1961) has assumed the existence of the solution, so the completeness, that is, the proof of the existence of the solution has been waited by Shiozawa (2014) using Herry's theorem. In the same Jones' (1961) paper, Jones questioned the Ricardian comparative advantage with intermediate goods, although his answer is very limited. After Jones (1961), the Ricardian comparative advantage with intermediate goods has become an open question, but since now, the complete solution hasn't been appeared.

The difficulty of the Ricardian comparative advantage with intermediate goods has multiple points. Firstly, the definition of the Ricardian comparative advantage with intermediate goods has not been shared the common definition. Deardorff (2005a) has been considered the definitions with several patterns, but no common definition obtains. Secondly, in the Ricardian comparative advantage with intermediate goods, the uniqueness of solution may be broken, at least with three-country, three-good model. This point is essentially showed by Higashida (2005) using Ikema's (1993) illustration showed by Amano (1966). Thirdly, the production assignment model needs several setting change. In the original Ricardo-Graham model, when Jones (1961) showed Jones' inequality with Hawkins-Simon theorem, he compared one production assignment to another production assignment. Including intermediate goods, the condition for Hawkins-Simon theorem is not satisfied. Moreover, there is a case which both assignments are solutions for the production assignment problem, limited within only one-to-one comparison. Higashida's (2005) illustration includes the case, but the meaning is appeared by Ogawa's (2014) example.

However, several hints has been showed the Ricardian comparative advantage. Firstly, Shiozawa (2007) essentially showed the existence of solution in the Ricardian comparative advantage with intermediate goods with both universal and regular cases. Shiozawa (2014b) considers that essentially with Shiozawa (2007), the model's analysis has been completed, but actual conditions which determines the pattern of specialization has not been showed. Secondly, Ogawa (2013b) showed the expanding way of the results of n -country, n -good model to n -country, m -good model, applying Ogawa's (2013a) way to the model including intermediate goods. Actually, Shiozawa's (2007) setting has a little limited in the meaning that $n \leq m$, but with Ogawa's (2013b) expansion way, Shiozawa's (2007) result holds robustness.

When intermediate goods are included in the Ricardian model, it is general to use the Leontief model. This model has the same formulation as the Koopmans' activity analysis model included joint production. The difference is that the technology parameters' sign. Thus, most of the results are kept between Ricardo-Leontief model and activity analysis model included joint production. Ogawa's (2013b) way is also used the fact, but actual conditions which determines the pattern of specialization is not appeared.

By the way, in most of economic theory, the area where Hawkins-Simon theorem exists are ignored, because Hawkins-Simon theorem has been applied widely in economics. To analyse this model, we need to recognize that Hawkins-Simon theorem is only one result of Linear Complementarty Problem. Hawkins-Simon theorem is summerized that within only Z -matrix, S -matrix and P -matrix are equivalent. In general, P -matrix is S -matrix, but the reverse does not held. In this paper, to use the word of Linear Complementarity Problem like S -matrix and applying Herry-Shiozawa's theorem, the actual conditions which determines the pattern of specialization can be appeared in the Ricardo-Leontief model with multi-country, multi-commodity goods. This result is kept with the activity ananalysis model including joint production.