Back to Basics of the "Sales-Sourcing Box" versus the "Production Box": A Note

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22/12/22

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1. Introduction

In a pioneering article Azhar et al. (1998) introduces the box methodology or geometrical representation of different types of trade, that is, *IIT* (intra-industry trade), *NT* (net-trade) and *TT* (total trade) of an industry at the industry-level. Baldwin and Okubo (2014) introduces the "sales-sourcing box" focussing on the international trade behavior of foreign affiliates in ascertaining whether they are vertical (networked) FDI or not. Foreign investors mainly sourcing inputs from abroad (imported intermediates) and mainly selling output abroad (exports) are referred to as networked FDI.

We propose an alternative measurement of networked FDI based on the "production box" of establishments (Khalifah and Azhar (2014)).[1] This note expands on the differences between the "sales-sourcing box" and "production box" alluded to in Khalifah (2022). Firstly, this note shows that a single point in the "sales-sourcing box" can be mapped into a myriad of points in the production box. Secondly, movement of points within the "sales-sourcing box" showing increasing networked or vertical FDI can show decreasing vertical FDI in the "production box" based on the vertical trade in output (*VTQ*) index or processing trade in output (*PTQ*) index resulting in an anomaly when making decisions as to whether networked FDI has increased or not.

2. The "Sales-Sourcing Box"

The "sales-sourcing" box has dimensions of one with the vertical axis showing the ratio of local sales to total sales (= local sales + exports) and the horizontal axis showing the ratio of local sourcing of inputs relative to total intermediate inputs (= local inputs + imported inputs)

[1] In this note we disregard aggregation issues from establishment-level to sectoral-level analysis.

used in production. The origin of the "sales-sourcing box" denotes zero local sales and local sourcing (entirely foreign sales and only foreign intermediate inputs used in production) resulting in completely networked or vertical or processing trade. As an illustration, we choose a point *R* (0.4, 0.2) in the "sales-sourcing box" of Figure 1. Since the dimensions of the box refer to ratios, we can map this point *R* into a myriad of scenarios (scenario *A* to *F*) as shown in Table 1 ("one-to-many" mapping) below that can arise from a particular point *R* (0.4, 0.2) in the "sales-sourcing box".

Figure 1: The trade ratios of point *R* and *S* in the "sales-sourcing box" corresponding to scenarios *A* to *F* and scenario *S* in Table 1 (Not to Scale)

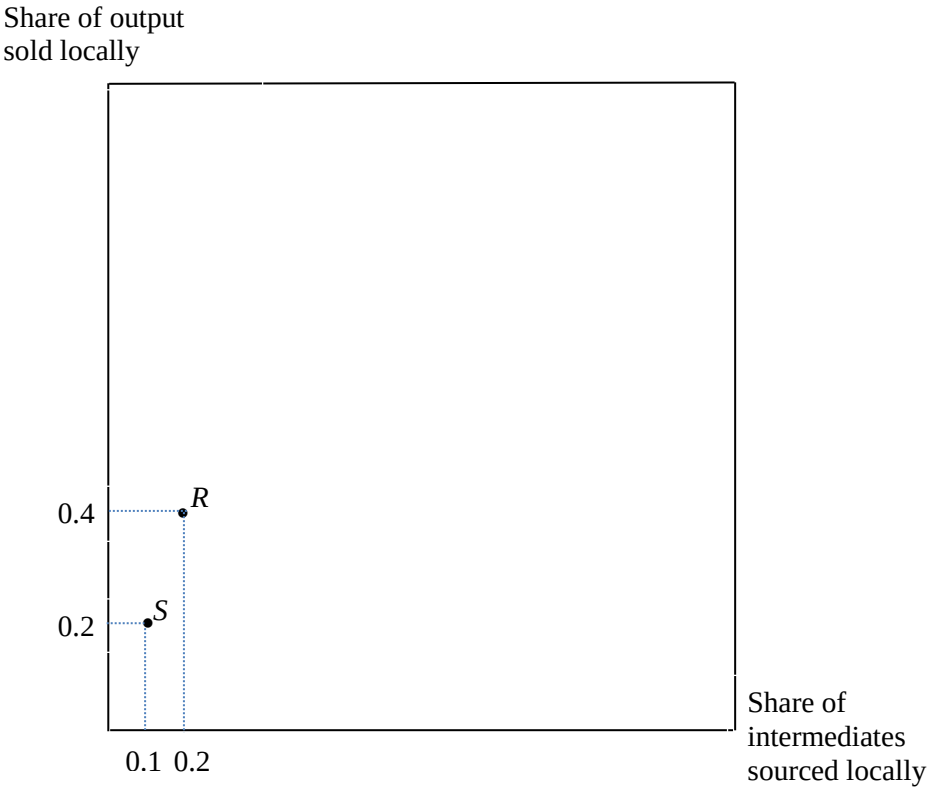


Table1: Mapping Local Sales Ratio and Local Sourcing Ratio to Real Values of Exports and Imported Inputs

Scenario	Local Sales Ratio	Local Inputs Ratio	Local Sales	Foreign Sales (Exports)	Local Inputs	Imported Inputs	Value Added*	*PTQ*= 2*min(*X,Minp)/ Q*
A	0.4	0.2	4	6	1	4	5	0.8
B	0.4	0.2	40	60	10	40	50	0.8
C	0.4	0.2	8	12	0.5	2.0	17.5	0.2
D	0.4	0.2	8	12	3	12	5	1.2
E	0.4	0.2	20	30	2	8	40	0.32
F	0.4	0.2	100	150	2	8	240	0.064
S	0.2	0.1	20	80	1	10	89	0.2

*Value added in production is not addressed in Baldwin and Okubo (2014) but incorporated in Khalifah and Azhar (2014).

Scenario *A* and scenario *B* of Table 1 depict an identical point *R* in "the sales-sourcing box" of Figure 1, with the latter affiliate being ten times larger than the former affiliate. However, the real values of trade for affiliate *B* are larger than that of affiliate *A* resulting in a greater trade impact than affiliate *A* not captured by the "sales-sourcing box" based on ratios of local sales to total sales and ratios of local sourcing of inputs to total intermediate inputs used in production. Hence, if an affiliate is 100 times larger or smaller than affiliate *A*; it is still shown by point *R* in Figure 1.

Scenario *C* and scenario *D* of Table 1 are identical on the output side with identical local sales and exports. However, on the sourcing of inputs; scenario *C* uses a smaller value of intermediate inputs (0.5 + 2.0 = 2.5) compared to scenario *D* with total intermediates of 15 and local sourcing of 3. Similar to scenario *A* and *B*, scenario *C* and *D* also yields point *R* in the "sales-sourcing box" of Figure 1 although the trade impact of scenario *D* is larger than that of scenario *C*.

Scenario *E* and scenario *F* of Table 1 are identical in terms of sourcing of inputs locally and abroad. However, the total sales of the foreign affiliate in scenario *F* is five times larger than that of the affiliate in scenario *E*. We show that an identical point *R* (0.4, 0.2) showing identical ratios of local sales to total sales and local sourcing to total sourcing in the

"sales-sourcing box" of Figure 1 can lead to different scenarios in terms of real values of exports and imported inputs. Hence, there is a "one-to-many" mapping from the trade-ratio of point *R* to the different scenarios in Table 1.

3. The Establishment "Production Box"

Khalifah and Azhar (2014) introduces a square establishment "production box" showing real output on the vertical axis and real inputs on the horizontal axis including value added resulting in an input-output framework for production at the establishment level. The dimensions of the "production box" shows output of an establishment. The vertical axis first shows exports followed by local sales whereas the horizontal axis shows imported inputs followed by intermediates sourced locally and value added. An establishment can refer to local establishments or affiliates of foreign parents as addressed in Baldwin and Okubo (2014). Points in the "production box" shows the quantum of trade involved not ratios of exports to total sales and ratios of imported inputs to total intermediate inputs. The exports and imports are embedded as a trade point in the "production box".

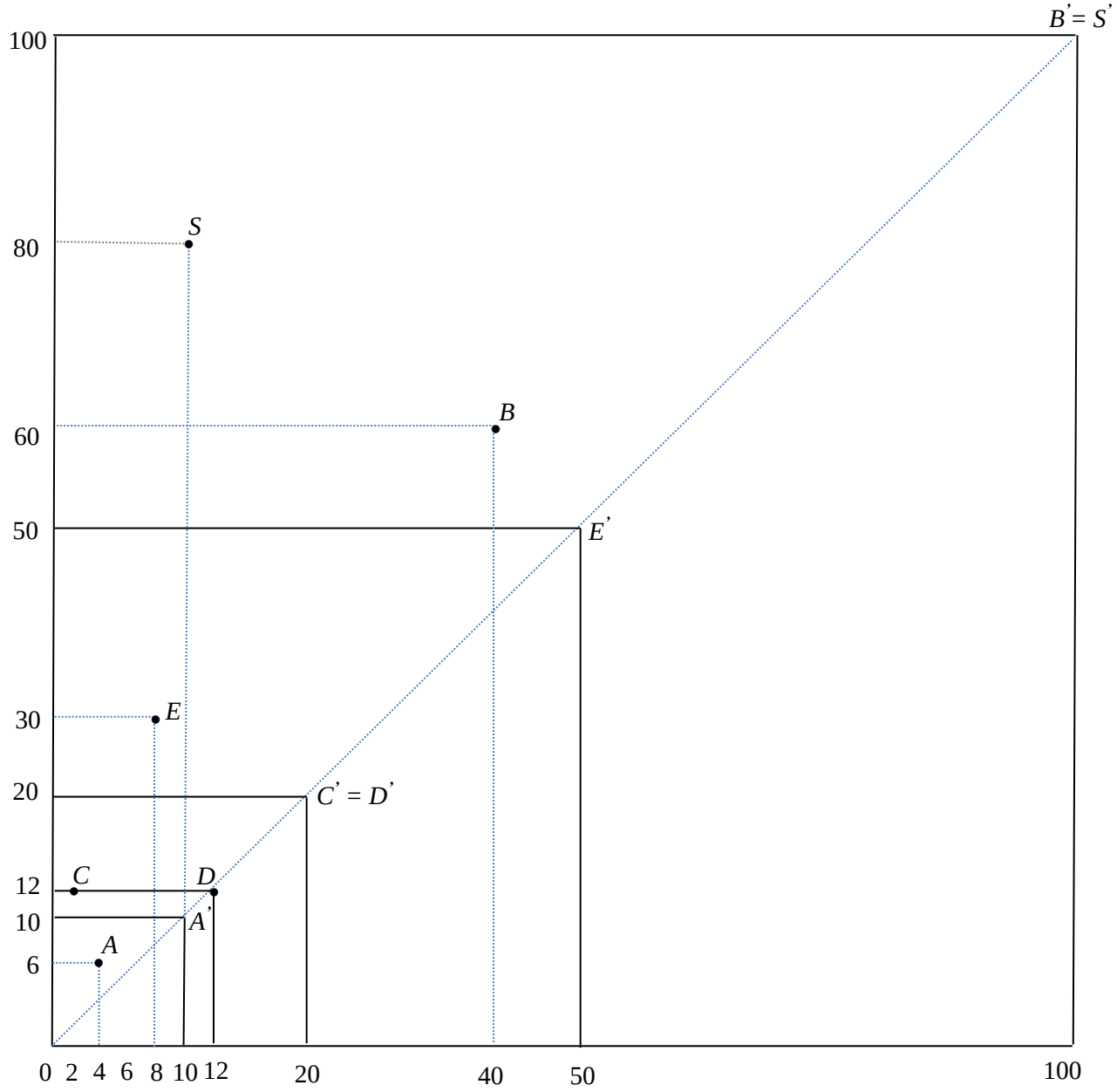
The different scenarios in Table 1 (with the exception of scenario *F*) are shown in Figure 2. The production boxes in Figure 2 with the north-east corner shown by points *A*', *B*', *C*', *D*' and *E*' correspond to the trade points *A*, *B*, *C*, *D* and *E* respectively in Table 1. For each trade point, the *PTQ* index (processing trade in output) or *VTQ* index (vertical trade in output) of Khalifah and Azhar (2014) denoted by 2*min(*X*, *Minp*)/*Q* provides an index of processing trade or vertical trade in output akin to the Grubel-Lloyd index in the numerator. *X*, *Minp* and *Q* respectively refer to exports, imported inputs and gross production. The *PTQ* index takes on values in the interval [0, 2) with higher values indicating higher processing trade. Corresponding to trade points *A*, *B*, *C*, *D*, *E* and *F* respectively are the *PTQ* indices 0.8, 0.8, 0.2, 1.2, 0.32 and 0.064. "*L*"-shaped lines with the vertex on the bisector of the

"production box" show equal processing trade with increasing processing trade as we move in the North-East direction.

Therefore, it is shown that a particular point, *R*, in the "sales-sourcing box" of Figure 1 can be mapped into at least 6 different scenarios as shown in Table 1 and the "production

Figure 2: The different scenarios in Table 1 based on the establishment "production box".

(Not to Scale)



box" of Figure 2 (point *F* not shown due to its large size). Large and small affiliates with different trade behavior can arise from a single point in the "sales-sourcing box", making interpretations of share of output sold locally and share of intermediates sourced locally problematic.

4. Movement of trade ratios mapped into the "production box"

We now consider a trade ratio movement from point *R* (0.4, 0.2) to point *S* (0.2, 0.1) in the "sales-sourcing box" of Figure 1. For the trade ratio *R* (0.4, 0.2) we consider scenario *B* in Table 1. For the trade ratio *S* (0.2, 0.1) we consider scenario *S* in Table 1. Points *B* and *S* show identical production depicted by the "production box" with the North-East corner given by *B*'= *S*' in the "production box" of Figure 2. Movement of trade ratio in the South-West direction towards the origin from (0.4, 0.2) to (0.2, 0.1) corresponding to movement from point *R* to point *S* in Figure 1 shows increasing vertical FDI based on Baldwin and Okubo (2014). However, movement of trade point from *B* to *S* in Figure 2 shows decreasing vertical trade based on the *PTQ* index with the *PTQ* index decreasing from 0.8 to 0.2.[2] The "sales-sourcing box" provides a diagrammatic representation for a given trade-ratio movement which can include both expansion and contraction of total trade and its components whereas the "production box" methodology provides a "metric" that denote increases or decreases in networked or processing trade based on the scenarios chosen to depict the trade ratios.

Consider another example; movement of trade points in the "production box" of Figure 2 from scenario *E* to scenario *B* in the North-East direction show an increase of the *PTQ* index from 0.32 to 0.8 in the "production box". However, in the "sales-sourcing box" of

[2] The reader is reminded that the origin of the "sales-sourcing box" refer to local ratios of sales and sourcing with the residual depicting the foreign ratio. In the "production box", the origin refers to the foreign components of sales (exports) and sourcing (imported intermediate inputs) with ensuing local sales on the vertical axis and local sourcing and value added on the horizontal axis. Hence, movement of trade ratios towards the origin in the "sales-sourcing box" show increasing foreign sales and foreign content whereas movement of the trade point towards the origin in the production box show decreasing exports and decreasing foreign content in production.

Figure 1, both scenario *E* and scenario *B* refer to trade ratio *R* without any changes in networked trade. Many scenarios can be chosen to depict a single point in the "sales-sourcing box" supposedly showing unchanging networked trade. However, when these scenarios are mapped into the "production box", the resulting *PTQ* indices are different. The *PTQ* index assign an identical metric only for trade points on "*L*"-shaped lines with its vertex on the bisector for a given "production box".

5. Conclusion

We mapped a single point in the "sales-sourcing box" of Baldwin and Okubo (2014) into many trade points in the establishment/affiliate "production box" of Khalifah and Azhar (2014). We show that many scenarios with both small and large actual trade components can be derived from a single point in the "sales-sourcing box" ("one-to-many mapping"). Movement of trade ratios towards the origin of the "sales-sourcing box" (from *R* to *S*) in Figure 1 does not necessarily lead to increasing vertical FDI as shown by a movement from scenario *B* depicting point *R* to scenario *S* in the "production box" of Figure 2. Static or unchanging trade ratios can be mapped into un-identical trade points in the "production box" (*R* depicted by scenario *E* and *R* depicted by scenario *B*). For a given "production box", movement of trade points towards the origin of an affiliate shows increasing horizontal FDI and vice-versa towards the north-east corner of the box shows increasing vertical FDI. The more appropriate metric to measure "networked" FDI from trade behavior are real values of exports and imported intermediate inputs framed in a "production box" as shown by the *PTQ* index; not ratios showing share of output sold locally and share of intermediates sourced locally abstracting from the quantum of trade involved relative to production of establishments.

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